ARCO
MASTER THE ACT
ASSESSMENT

2005
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Introduction

WHY DO I NEED THIS BOOK?

Every year, almost 2 million students take a college entrance exam called the ACT Assessment. This 3-hour standardized test plays a crucial part in whether or not students like you are accepted to the college or university of their choice.

You are holding one of the best proven ways to maximize your score—the 2005 edition of *ARCO Master the ACT Assessment*. The main idea behind this guide is simple: The best way to prepare for an exam of this type is to practice on the exam itself. You need to know the format, the kind of questions asked, the time limits, what the exam measures, and how the test-makers think.

*ARCO Master the ACT Assessment* brings you all this help and more.

HOW CAN I PREPARE EFFECTIVELY?

This guide has been written to help you succeed on the ACT Assessment no matter how long you have to prepare, how much time each day you have to devote to that preparation, or what your skill level might be. You might have bought *ARCO Master the ACT Assessment* six months before your test date or two weeks before. Your personal schedule might enable you to devote long hours to ACT Assessment preparation, or you might have only a few hours a day. You might be a math wizard, but maybe you’re a bit weaker in verbal skills.

Wherever you are right now, *ARCO Master the ACT Assessment* can help you. You’ll see how to set up a course of preparation that’s tailored to your own schedule and to how much time you have before your test date. And you’ll see how to focus on those areas where you need the most improvement.

HOW CAN I MAXIMIZE MY SCORE?

Backed by ARCO’s years of test-guide experience, *ARCO Master the ACT Assessment* gives you proven strategies that can add significant points to your score. These strategies go way beyond general test-taking advice like “get a good night’s sleep the night before” or “pace yourself so that you don’t get delayed early on and therefore don’t have time to finish.” Although both tips are true, they are true of just about every test.
We offer the best of these general tips, as well as proven strategies that are specific to the ACT Assessment exam, such as, “Which answer can you always skip reading in the sentence-correction part of the ACT Assessment English Test?” and “What’s the best answer to try first when solving a problem in the ACT Assessment Math Test?” This is the kind of expert help that allows you to master the ACT Assessment.

HOW DO I EVALUATE MY READINESS?

We have developed an initial test to give you a quick overall estimate of your test-taking skills. The estimate reveals your strengths and weaknesses, and with this knowledge, you can save time and effort in preparing for the ACT Assessment while greatly increasing the effectiveness of your study.

You also see how to continue to measure your ACT Assessment readiness as you progress through the material in the book. When you compare the results against your initial score, you’ll see which subject areas still need improvement. And when you see your scores increasing over time, you have concrete proof that you’re ready to take the ACT Assessment—the best confidence-booster, anxiety-reducer there is.

HOW CAN I DO MY BEST ON EVERY SUBJECT AREA?

There are four subject areas tested on the ACT Assessment exam: Standard English skills, math skills, reading comprehension skills, and science reasoning skills. Within each of these subjects, there’s an enormous range of material; without guidance, you could wander in many directions. For example, should you try to prepare for the ACT Assessment English Test by reading all of Shakespeare? By skimming a writing guide, such as the Chicago Manual of Style? By memorizing every grammar rule taught to you from third grade till now? Where would your preparation begin, and would it ever end?

Here is the material that appears on ACT Assessment exams, in the actual form in which it appears. Plus there’s added help. After you work through each subject and complete the exercises, you get the opportunity to evaluate your understanding. If the diagnostic test and the topic-area exercises show that you still need further help, don’t worry. *ARCO Master the ACT Assessment* also includes a basic review of each subject covered on the exam.

IF ALL I CARE ABOUT IS PRACTICE, HOW WILL THIS BOOK HELP ME?

We realize that practice is one of the most critical components for success on a standardized examination: *ARCO Master the ACT Assessment* brings you a full-length diagnostic exam and three additional full-length sample tests. That’s more than any other guide. This is the heart of the *ARCO Master the ACT Assessment* guide, and we’ll
repeat why: The best way to prepare for an exam of this type is to practice on the exam itself. Instead of the result of subject-area guesswork or teacher surveys, you get passages, problems, and questions written by experts to closely represent those used on ACT Assessment exams, followed by the answer keys and full walk-through answer explanations. Of course you expect an answer key to score your self-evaluation test, exercises, and full-length sample tests. But an answer key doesn’t help you understand why your answer is wrong. That’s why *ARCO Master the ACT Assessment* fully explains *why* the right answer is the right one and what errors in thinking might have led you to choose the wrong one.

**HOW DO I REGISTER FOR THE ACT ASSESSMENT?**

If you haven’t yet registered for the ACT Assessment, this guide brings you concrete help for making the registration process simpler. You see how to decide *when* it’s the best time for you to take the ACT Assessment, *where* is the best site for you to take it, and *what to do* when unusual test-taking situations come up.

**WHAT DO MY SCORES MEAN?**

There will be a score for each of the four ACT Assessment sections, subscores for each area tested within a subject, a composite score, and a score range that accounts for statistical error. You’ll also get a percentile score that measures you against a group of other test-takers.

What do these figures really mean? How do colleges use these figures? How should you use them—say, in deciding whether or not you need to retake the ACT Assessment? *ARCO Master the ACT Assessment* explains the test results clearly and helps you decide what to do next.

The guide also shows how to cancel your scores, what to do if you think your test was scored improperly, what to do when your score is delayed, even how to challenge the validity of a question.

**WHAT ABOUT LIFE AFTER THE ACT ASSESSMENT?**

Sometimes the nerves and preparation leading up to the ACT Assessment make it seem as if the exam itself is the goal. But it’s only one step on the path to your goal—attending the college or university of your choice. So much more is involved: choosing the college, getting teacher recommendations, and making it through the admissions procedure. And after you’re accepted, there’s the huge question of how to pay for tuition.

*ARCO Master the ACT Assessment* brings you a wealth of bonus material to help make the admissions process easier. Here are proven ways to stand out from the crowd on your application and in your admissions interview, key points to look for during a campus visit, and alternate methods of financing your education.
HOW DO I USE THIS BOOK?

How can you get the most out of this book?

• Step 1: Read Chapter 1, which tells you all about the ACT Assessment. This chapter answers your most important questions: What's on the four ACT Assessment subject tests? What does each test look like? How are they scored? How do colleges use these scores? How do I register for the ACT Assessment? And what can I do if I have a special situation when it comes to testing?

• Step 2: Take the Diagnostic Test in Chapter 2. This is the first of the four full-length practice tests in the guide. The Diagnostic Test is your first real taste of the ACT Assessment—great practice in itself. It also pinpoints those areas in which you're ready for testing, as well as those areas in which you need improvement. The Diagnostic Test provides you with a baseline from which you'll measure all your progress. Write these scores on the Score Card at the front of the book and watch them steadily improve as your study continues!

• Step 3: After you've taken the Diagnostic Test, read Chapter 3. This explains what each of the four subject tests measures and what you can expect from each. It then shows how to set up a personalized study plan, working with the amount of time you have right now. The chapter also explains how to handle test anxiety from now to the day of the test. Finally, to help you do the best you can the day of the test, it reveals ten proven strategies for scoring higher on the ACT Assessment.

What you do next depends on your personalized schedule. If you have the maximum time (three months or more), we suggest you work through the discussion chapters in Part 2: Strengthening Your ACT Assessment Subject Skills. There's a chapter for each subject. Here you get a more detailed explanation of what topics within the subject are covered and are walked through every type of question that will be asked. When an ACT Assessment test uses tables, charts, diagrams, or figures, you get true-to-life samples so there'll be no surprises the day of the test. Plus you get score-boosting strategies specifically designed for ACT Assessment English, Math, Reading, and Science Reasoning. At the end of each of these chapters are two exercises to see if you've understood the explanations and know how to use the strategies. A scoring guide helps you decide whether you need further review in a subject or can move on to another. Cross-referenced notes alert you to other sections in the book that might help you with a particular problem. Summaries at the end of each chapter recap the most important points.

After finishing the subject chapter, you might decide to go to the in-depth subject review; this provides an extensive explanation of the material most likely to be tested on the ACT Assessment, as well as three exercises to give you more practice in that area. Or you might want to go directly to one of the remaining full-length practice tests. It's up to you. Whenever you do take one of the tests, note the results on your personal score card. Your improving scores are the proof of your hard work. Scores that are slower to
improve show where to focus your next efforts. Work back and forth as you need—from review and exercises, to a full-length test, back to the review. If you’re doing well, toward the end you can just skim those few areas that remain a bit of a problem.

Review and practice, review and practice—this is the overall strategy for scoring higher on the ACT Assessment. If you have a shorter timetable, remember: Chapter 3 tells you how to use the subject and review chapters to zero in on just those areas that give you the most trouble, so that you’ll get maximum results for the most intensive study period.

Besides the subject discussions, exercises, and reviews, *ARCO Master the ACT Assessment* also brings you dozens of tips and alerts all throughout the book. These are tucked away in the margins. Read them as you come to them or save them for later. Either technique works. Margin notes also include general advice, relevant facts, and little extras to help make studying more interesting.

After you’ve taken the ACT Assessment, you’ll have questions—from how long scores take to arrive, to how to make the best impression during a college interview, to how to finance your education when the school of your dreams finally says yes. *ARCO Master the ACT Assessment* answers those questions and dozens more, continuing even after the test to help you get into your first-choice school.

All in all, *ARCO Master the ACT Assessment* has all the answers you need—answers about the exam, answers to sample exams, answers to test-taking problems and situations. That’s why it’s the one book you need to get into your first-choice school.
PART I
MEETING AND MASTERING THE ACT ASSESSMENT

CHAPTER 1  Get to Know the ACT Assessment

CHAPTER 2  Diagnostic Test

CHAPTER 3  Mastering the ACT Assessment: Your Plan for Success
Get to Know the ACT Assessment

OVERVIEW

- Understand the ACT Assessment
- Understand ACT Assessment contents and format
- A close look at the ACT Assessment test components
- Understand how the ACT Assessment is scored
- Understand how admissions offices use the score
- Registering for the ACT Assessment
- Deciding where to take the ACT Assessment
- Know what you need to take on test day
- Special registration arrangements

UNDERSTAND THE ACT ASSESSMENT

The ACT Assessment is a battery of multiple-choice tests used by colleges and universities to help decide which applicants to choose. Even though there are other types of standardized tests available, almost all colleges accept the ACT Assessment, and many colleges require it. The ACT Assessment is given five times each year at locations throughout the United States, Canada, and overseas, as well. This schedule enables students to apply for early admissions or to have sufficient time to retake the test if desired or if necessary.

There are several parts to the ACT Assessment. One part is a personal interest inventory. The results of this section are useful in career planning by suggesting several occupations related to those subjects or areas that appeal to you or that are suited to your personality. It’s good to know these possible career choices early because many of them have special educational requirements. Thus, the ACT Assessment not only is part of the admissions process, it can become a tool that guides your selection of courses and/or major.

In addition, the ACT Assessment includes a course and grade information questionnaire and a student profile. These help create a picture of you for the college admissions board. Each board knows from years of experience what type of student fits in well with its programs and other students. There are always exceptions, and many other elements go into the acceptance process, but the questionnaire and profile provide the board a quick “snapshot” of you.

Of course, the ACT Assessment also includes the part that concerns you most right now—the test itself. This is actually a series of tests based on a standard high school curriculum. In other words, the ACT Assessment tests what most high school students learn every day.
**ACT ASSESSMENT CONTENTS AND FORMAT**

The ACT Assessment is a 3-hour exam broken into four sections, each of which is separately timed. With breaks and with time spent listening to instructions and passing out and returning forms, the actual time spent taking the exam is 4 or more hours.

The four sections test Standard English skills, math skills, reading comprehension skills, and science reasoning skills. No one is expected to know every answer to every section. Because the ACT Assessment assesses the full range of students, from the less-than-average to the brilliant, there will be questions that most students will not be able to answer. That is taken into account in the scoring.

The ACT Assessment contains a total of 215 multiple-choice questions, divided among the four subject areas or sections. The following table gives you an at-a-glance look at the content breakdown.

**SUMMARY OF THE ACT ASSESSMENT**

<table>
<thead>
<tr>
<th>Section</th>
<th>Questions</th>
<th>Time</th>
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<tbody>
<tr>
<td>Standard English Test</td>
<td>75</td>
<td>45 minutes</td>
</tr>
<tr>
<td>Reading Comprehension Test</td>
<td>40</td>
<td>35 minutes</td>
</tr>
<tr>
<td>Math Test</td>
<td>60</td>
<td>60 minutes</td>
</tr>
<tr>
<td>Science Reasoning Test</td>
<td>40</td>
<td>35 minutes</td>
</tr>
<tr>
<td><strong>Total Questions</strong></td>
<td>215</td>
<td>2 hours, 55 minutes</td>
</tr>
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Although most colleges accept the ACT Assessment, it’s always good to ensure that the colleges in which you’re interested accept it. When you check that information, also find out what the college’s deadline is for applications. This date is the cut-off for receiving all the necessary information, including ACT Assessment scores. Each college will have its own date, so check each college or university to which you’re planning to apply before deciding when to schedule your ACT Assessment date.

In the next part of this chapter, you learn what each section of the ACT Assessment contains and how it’s organized.
CHAPTER 1: Get to Know the ACT Assessment

THE ACT ASSESSMENT ENGLISH TEST

The ACT Assessment English Test lasts 45 minutes and contains 75 questions. Of those questions, 40 test your knowledge of grammar, usage, punctuation, and sentence structure. The other 35 questions address the more subtle points of writing, such as the organization of the ideas presented, the logic of the ideas, and whether the ideas are expressed in the best way possible.

The ACT Assessment English Test is broken down into two areas—usage/mechanics and rhetorical skills. Usage and mechanics cover those aspects of writing where there are strict rules—grammar, usage, punctuation, sentence structure. Rhetorical skills cover writing style, or how to express an idea.

Usage and Mechanics

The first area might be easier for some people to grasp because “mechanically” a sentence is either right or wrong.

Example: Because he needs to swap the VW Beetle for the mini-van to take the Cub Scout troop home he will go to lunch at the same time as his wife had gone.

There are two mechanical errors in the sentence. There should be a comma after “home” to separate the subordinate clause from the main clause. And there is an error in the tense of the final verb; instead of “had gone,” it should be “goes.” Without making these corrections, the sentence is wrong.

Rhetorical Skills

Rhetorical skills involve something subtler. There might be no mechanical error, but often you can “hear” the mistake.

Example: As I previously mentioned to you when explaining at last week’s meeting the incredible and undisputed advantages of combining our two clubs, The Poetry Society and Poets Out of the Closet, I have written up here for your further study my thoughts on the matter, detailing the many benefits that will accrue to both organizations.

There’s nothing “mechanically” wrong with this sentence. It’s a complete sentence and not a fragment; the subjects and verbs within the clauses agree with each other; the punctuation is correct. However, it would be much clearer to write the following:

At last week’s meeting, I said there were benefits to combining our two clubs. Here’s a note repeating why.

Wordiness and repetition are just two of the rhetorical errors that will appear on the test. Other areas include clarity, logic, organization, and expression. Is the passage

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ambiguous? Can you understand the writer’s purpose? Does the writer present an argument that moves from point A, to B, to C, to D, to the conclusion? Or does the passage move from point A to B, jump to the conclusion, then double back to D, and back again to C? Is the passage well written and original, or is it filled with cliches? Look for overall problems like these.

THE OPTIONAL WRITING TEST

Increasingly, many major standardized tests are including an actual writing component. Responding to this trend, the ACT Assessment is adding an optional 30-minute Writing Test beginning in 2004–2005.

Each college and university will decide on its own whether or not to require the ACT Assessment Writing Test. Some colleges may require it, others may recommend it, and still others may not wish to use it at all. Always check with your prospective schools to find out their policy on the ACT Assessment Writing Test.

Although taking the ACT Assessment Writing Test will be optional, it is strongly recommended that you take it. Adding your score from the essay to your score on the multiple-choice questions gives a more complete assessment of your abilities. Taking the ACT Assessment Writing Test shows that you recognize the importance of writing to your success in college and a career.

The Writing Prompt

The ACT Assessment Writing Test is made up of one essay. You will be given a topic that has two sides. You will have to argue one side of the topic and support your viewpoint with specific details, examples, and facts. Here is a sample ACT Assessment–style writing prompt:

Fast-food franchises are installing outlets in some high schools, selling hamburgers, fried chicken, tacos, fries, and sodas. Many soda companies already pay a great deal of money to be allowed to install soda machines in high schools. The money from these commercial ventures helps fund “extras” such as athletic equipment, field trips, and audio-visual equipment. On the other hand, fast food is greatly contributing to the epidemic of obesity among America’s youth. Placing fast-food outlets in schools encourages students to eat food that is high in salt, fat, and empty calories. In your opinion, should fast-food franchises be allowed in high schools?

In your essay, take a position on this issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.

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The ACT Assessment Essay Scoring System

The ACT Assessment Writing Test is scored holistically. This means that readers form an overall impression of your writing ability rather than picking out specific errors and deducting points. The ACT Assessment scorers use a 6-point holistic scoring scale. These scales are called “rubrics.” The ACT Assessment rubric looks like this:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>lowest score</td>
<td>middle score</td>
<td>highest score</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An equivalent in conventional grading would look like this:

<table>
<thead>
<tr>
<th>F</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>B+</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

Scorers will be assessing your writing on the following criteria:

- Your skill in choosing a side and sticking to it
- The quality of your details, examples, and facts
- How well you organize your information
- Your ability to carry through a logical and persuasive argument
- Your skill at using language

Here is what ACT Assessment scorers will be looking for as they assess your essay:

**ESSAYS THAT RECEIVE A SCORE OF 1**

These essays barely touch on the topic because the writer has not included any specific details. Or, the writer may write about a topic that has nothing to do with the essay question at all. The papers may be very brief and the ideas not divided into logical paragraphs. These papers are usually seriously deficient in the conventions of standard written English, so they are riddled with errors in grammar, usage, and mechanics.

**ESSAYS THAT RECEIVE A SCORE OF 2**

Here, the writer did not focus on the topic directly or did not answer the question. The writer may have tried to prove both sides of the topic and in so doing, proved neither side. In addition, the writer may have made strange or unrelated conclusions. Further, these essays show major problems with writing skills. The papers are too brief to develop the argument with any detail. Ideas may not be divided into logical paragraphs.

**ESSAYS THAT RECEIVE A SCORE OF 3**

In these essays, the scorers can see that the writer chose a side and tried to organize the essay, but the structure is flawed and the supporting detail is weak. The writer may ramble and include unnecessary details and information. In addition, the paper has
some serious problems with grammar, usage, and mechanics. These problems get in the way of readers understanding the writer’s points.

**ESSAYS THAT RECEIVE A SCORE OF 4**

In these essays, the writer chose one side of the issue and supported it. However, it is evident that the writer has not completely considered the issue. Key points may be missing. The style is plodding and dull, with little variation in sentence structure, word choice, or punctuation. There are often a lot of short, choppy sentences. In addition, there are some writing errors that may distract the reader from the argument and the writer’s point.

**ESSAYS THAT RECEIVE A SCORE OF 5**

These essays demonstrate solid, logical, and persuasive discussion. Generalizations are supported by specific examples. The essays stay on target, too, not straying from the topic. The writer includes appropriate word choice and sentence variety. There may be a few writing errors, but these do not distract the reader from the writer’s main points. However, these essays lack the originality or insight of the “6” papers. In addition, the writer did not use words with exceptional style or grace, as shown in the “6” papers.

**ESSAYS THAT RECEIVE A SCORE OF 6**

These essays are clearly focused discussions made up of coherent arguments of exceptional clarity. The writers show originality and imagination. These essays leave the reader convinced of the soundness of the discussion, impressed with the quality of the writing style, and stimulated by the writer’s intelligence and insight. There are few, if any, errors in grammar, usage, and mechanics.

**THE ACT ASSESSMENT MATH TEST**

The ACT Assessment Math Test lasts 60 minutes and contains 60 questions. There are 14 questions on pre-algebra, which encompasses basic arithmetic and such things as linear equations and simple probability. Then there are 10 questions on elementary algebra, and then 9 questions on intermediate algebra. Coordinate geometry (9 questions) includes graphing equations, slope, distance, and midpoints. Plane geometry (14 questions) includes questions on plane figures—such as circles, squares, triangles—as well as proofs. Finally, there are 4 questions on trigonometry.

The ACT Assessment Math Test, then, is broken down into six areas: pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry. These six areas are scored as three, with a subscore for pre-algebra/elementary algebra, a subscore for intermediate algebra/coordinate geometry, and a subscore for plane geometry/trigonometry. Let’s look closer at the questions within this section of the ACT Assessment.
Pre-Algebra/Elementary Algebra

Pre-algebra covers those basic elements we tend of think of as “arithmetic”—basic whole-number operations; work with fractions, decimals, and integers; square roots, ratios, percents, and proportion. It also includes scientific notation, factors, simple linear equations, and the interpretation of data from graphs. With algebra, linear equations are replaced by quadratic equations, there are more variables, equations are solved by factoring, and problems concern properties of exponents and square roots.

Intermediate Algebra/Coordinate Geometry

Intermediate algebra involves more detailed work with quadratic equations, radical expressions, absolute values, functions, complex numbers, and roots of polynomials. Coordinate geometry takes algebraic principles and plots them out physically on a graph—a coordinate plane. Problems using graphs include plotting equalities and inequalities, and finding slopes, distances, and midpoints.

Plane Geometry/Trigonometry

Plane geometry is what we first think of when we hear the word “geometry”—plane figures such as circles, squares, triangles, trapezoids, rhombi, and others. Problems involve working with the properties of these figures—angles, arcs, parallel lines, etc.—and include the solving of geometric proofs. Trigonometry covers trigonometric functions, identities, and relations—working with sines, cosines, tangents, cotangents, secants, and cosecants.

THE ACT ASSESSMENT READING TEST

The ACT Assessment Reading Test lasts 35 minutes and contains 40 questions. The questions test your level of comprehension: Do you understand a passage well enough to answer questions about it? Because reading is essential to every subject, there are 10 questions using social studies passages, 10 using natural science, 10 using prose fiction, and 10 using passages about the humanities—music, art, theater, and so on. Here’s a closer look at each of these question types:

Most of the questions on the ACT Assessment Reading Test have to do with comprehension: Do you understand what the author is saying?

Example: After that night, Jack forbade his cousin Sarah from ever contacting him or any member of his family again, under threat of legal action.

A question of comprehension would in some way repeat the facts: Jack did not want to see his cousin Sarah ever again, he did not want his family to see Sarah ever again, and if she attempted to contact him or his family, he would see that she suffered a legal penalty.

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Other questions on the test have to do with implications: What else is implied but not necessarily stated? To pick up the full implications, the sentence might need to be read within the context of the whole passage. In the previous example, possible implications are that Sarah did something “that night” that prompted Jack’s reaction, that Sarah might be dangerous, or that Jack is afraid of Sarah.

Some questions have to do with style and structure, the presentation of the ideas. Does a passage present several approaches to one idea, or does it present several ideas? Does it give evidence supporting one theory or a pro-and-con debate about the theory? Does it compare and contrast two people, things, or ideas? Or, does it show step-by-step how something happened?

The score breakdowns come in the subject matter of the reading material. Reading is tested in four subjects—social studies, natural sciences, prose fiction, and the humanities. These four areas are scored as two, with a subscore for social studies/natural sciences reading skills and a subscore for prose fiction/humanities reading skills.

**Social Studies/Natural Sciences**

More scholarly material is likely to fall within these areas and includes excerpts from books, magazines, newspapers, and journals. Topics within social studies range from the history, political science, and economics you might naturally expect, to the fields of anthropology, sociology, and psychology. The natural sciences cover the physical sciences, biology, chemistry, and physics. You don’t necessarily need to have taken courses in psychology or physics just to understand what a well-written passage about the topic means.

**Prose Fiction/Humanities**

The passages of prose fiction might be a short story in itself, or selections from short stories, novellas, and novels. The ACT Assessment does not use material from poetry or drama. The humanities questions will have passages about music, visual arts, theater, philosophy, architecture, and dance.

**THE ACT ASSESSMENT SCIENCE REASONING TEST**

The ACT Assessment Science Reasoning Test lasts 35 minutes and contains 40 questions. Encompassing biology, physics, chemistry, and earth and space science, the test measures not so much your “book knowledge” of a particular subject but your ability to interpret and analyze problems, given certain information. The test is broken into 15 questions on data representation (using graphs and tables), 18 questions on research summaries (understanding the design and results of experiments), and 7 questions on conflicting viewpoints (understanding and comparing different hypotheses).
Though it encompasses biology, physics, chemistry, and earth and space science, the Science Reasoning Test does not measure your knowledge of content in those areas. Instead, the emphasis is on the “reasoning”—if presented with adequate information, can you interpret it and draw conclusions? In other words, do you have the ability to think like a scientist?

Three areas are tested: data representation, research summaries, and conflicting hypotheses. However, in this one instance alone the ACT Assessment has no breakdown of topics for subscores. There’s only one score for the Science Reasoning Test. The following sections take a closer look at the ACT Assessment Science Reasoning question types.

**Data Representation**

In this section, information is presented in the form of graphs, tables, charts, and diagrams. Questions determine not only if you can “read” the graph (that is, understand what it means), but if you can spot trends (that is, if you can make logical predictions about what will happen next).

**Research Summaries**

These passages briefly describe experiments and their results. Questions in this area might ask about the design of the experiment or the interpretation of the results. For example, can you take the results and apply them to a new situation not described in the original passage?

**Conflicting Hypotheses**

Conflicting hypotheses present individual points of view about a scientific issue, the “pro” and “con” of a debate. Questions will analyze and compare the different theories for such things as logic, adequate proof, and so on. Other questions might have to do with hidden assumptions: What is the author assuming to be true about his or her position, or about the opposition’s, without necessarily having the proof to back it up?

**NUTS AND BOLTS: THE ACT ASSESSMENT TEST BOOKLET AND ANSWER SHEET**

The format of the ACT Assessment exam should be familiar to you from standardized tests in school. All of the previously discussed questions are printed in a booklet you will receive the day of the test. Although you may mark up this booklet, for scoring purposes the answers must be put on the answer sheet, which is a separate piece of paper.

Questions for all four subject tests go on a separate answer sheet. You should be familiar with this type of answer sheet from other standardized tests—a fill-in-the-circle grid. All questions are multiple choice. The English, Reading, and Science Reasoning Tests have four choices for each answer; the Math Test has five choices for each answer.
Part I: Meeting and Mastering the ACT Assessment

Completely fill in the circle of your choice with your pencil. The sheets are “read” and graded by computer, so it’s important that your mark is clear and complete. A check in the circle or an X through it might not be readable by the machine and possibly won’t be counted even if your answer is correct. See the figure below for an example of the answer sheet and the correct way to fill in your answers (you’ll see some incorrect examples there, too). Be sure to mark only one circle per question, and do not skip lines by mistake because one misplaced mark can make every answer following it wrong.

How to mark the answer sheet.

To help prevent test-takers from skipping answers, the ACT Assessment answer sheet is formatted a bit differently than what you might be used to seeing. Instead of each set of choices being A, B, C, and D—or A, B, C, D, and E for Math—the ACT Assessment answer sheet alternates between sets of answers. As you can see in the figure on the previous page, the odd-numbered questions starting with Question 1 use A, B, C, and D—or A, B, C, D, and E for Math—then the even-numbered questions starting with Question 2 use F, G, H and J—or F, G, H, J, and K for Math. This format is to help catch your attention if you miss a line and begin to fill in an answer for the wrong question.

How the ACT Assessment is scored

For each of the four tests, the number of correct answers is determined, giving you a raw score. The raw score for each subject is then “scaled” or calculated in such a way as to make the varying ACT Assessment exams given on that day equal to each other. So if you receive a slightly harder test than your neighbor, the increased level of difficulty will be taken into account. The scaled scores range from 1 to the highest of 36. In recent years, the average score for each subject has been 21.

No single test is a completely accurate measure of a person’s true ability. Everything from the weather, to the testing environment, to a person’s physical and emotional wellbeing can affect an individual’s results. To account for this, the ACT Assessment test makers have determined that there’s a 4-point “margin of error” for each subject score—that if there could be a completely accurate measure of your ability in that subject, it would fall within those four points.

In addition, within each subject you get subscores for different areas of that subject. For example, in English, you’ll get a subscore for usage and mechanics and a subscore for rhetorical skills. Subscores range from 1 to the highest of 18. You’ll also receive a composite score that’s the average of all four subject scores.

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Because everyone taking the ACT Assessment is a potential competitor for the same college seat that you want, the ACT Assessment results also include a percentile score. The percentile score—based on the more familiar 1–100 percent—measures your composite score against the composite score of other test-takers. The number indicates the percentage of students that are below you. So if you received an ACT Assessment percentile of 87 percent, that means you scored better than 87 percent of other test-takers.

HOW COLLEGE ADMISSIONS OFFICES USE THE ACT ASSESSMENT SCORE

Every college that you list on your ACT Assessment form will receive a copy of your scores, as well as your personal profile and information about your high school performance. What does a college do with the scores? Obviously, it looks for high scores, but it also takes into consideration your school record. Some people are not good test-takers: They may be better at writing reports or participating in class. Most colleges recognize these differences, although admittedly there are some that use an arbitrary ACT Assessment score to eliminate most applicants.

High ACT Assessment scores can help offset average or less-than-average high school grades. If the ACT Assessment score is higher, colleges will look to your personal information to help explain the difference. Perhaps you received only a B in chemistry, but that was while you were also president of the debate team, sports editor for the school paper, a member of the soccer team, and a representative on the student senate. Or perhaps financial need forced you to hold a part-time job throughout the school year. Or perhaps you had personal circumstances, such as a lengthy illness, that made you fall behind.

Colleges also look at the ACT Assessment scores to see if there’s a balance between the different subject areas. A student’s major might be math, but he or she will also have to take classes in a variety of other subjects, depending on the particular college’s requirements. So although a 36 on the ACT Assessment Math Test would be wonderful (and roughly a 1 in 14,000 possibility), its combination with a 12 on the Reading exam would make an admissions officer doubt that the applicant could pass the many courses other than math required for a college career.

In addition, colleges use the ACT Assessment scores to measure you against this year’s applicants. Admissions officers face a changing pool of applicants every year. For example, if the college received a terrific write-up in a popular national magazine or, on the other hand, a critical write-up, applications could double—or be cut in half. So what is an average score one year might be high or low another year, depending on who your actual competition is.

After a student is accepted, a college might use the ACT Assessment score together with his or her high school performance to decide placement in freshmen classes. For example, if a particular course has three levels of study—basic, intermediate, and...
advanced—the ACT Assessment score might be used to place the student in the appropriate level. The score might also be used to approve a student’s choice of major. For example, if a student wishes to major in physics, but his or her high school grades and ACT Assessment Science Reasoning Test indicate a lack of ability for this difficult course of study, the college might advise the student against choosing that major and might even base acceptance on the student’s willingness to change majors.

Finally, the ACT Assessment score together with high school performance is often considered when financial aid is awarded, both as scholarships or loans.

REGISTERING FOR THE ACT ASSESSMENT

Because the ACT Assessment is a standard part of the college admissions process, most high school guidance offices have descriptive brochures on the ACT Assessment that include a registration form. The ACT Assessment is given on Saturday mornings five times during each year in February, April, June, October, and December. There are more than 5,000 testing locations throughout the United States and Canada, possibly even your own high school. It is also offered overseas. You can request which testing center you prefer.

If your guidance office does not have a brochure, you can call the ACT Assessment National Office directly (see, “How to Contact the ACT, Inc. Office” later in this chapter) to request a registration form.

Online registration is also possible via the ACT, Inc. Web site (www.act.org/aap/). Use of a credit card is needed to pay the fee on line. Whether you apply by mail or on line, the fee is the same.

CALCULATING THE TESTING FEE

The basic fee is low, $25 as we go to press, except in Florida, where it’s $28. The basic fee includes reporting your score to up to four colleges. However, additional fees can really boost that low basic cost. Initial registration for the ACT Assessment by telephone requires an additional $10. Late registration requires an additional $15.

Including a fifth and sixth college on your initial registration form requires an additional $6 each. If you decide to wait for your scores first, then ask that they be reported, you’ll pay an additional $7 per report per test date for normal processing. Rush processing is available; the fees are determined by what level of priority is requested. If you would like to view your scores on the web, there is a fee of $8 each time you view a set of scores.

Each test date has a cut-off date for registering, so check your brochure or the Web site to make sure you apply in time without incurring the penalty. If you miss even the late cut-off, you may apply for standby testing for an additional $30. The $30 is not a
guarantee that you will take the test. It only gives you the right to go to a test center and wait until all the test-takers have arrived and material has been distributed. If there is a seat left and materials left, then you may take the test.

WHEN SHOULD YOU TAKE THE ACT ASSESSMENT?

Because test results take an average of four weeks after the test date to be reported, you want to schedule the ACT Assessment accordingly, plus allow time for delays. ACT Assessment scores are always mailed and are never released by phone. That means, at the bare minimum, you should take the ACT Assessment eight weeks before the earliest college application deadline you have.

However, you’ll put yourself under considerably less pressure if you take the ACT Assessment even earlier than that. An early ACT Assessment score enables you to take the option of early admission, as well as the option of taking the test again. Even with preparation, many students take the ACT Assessment at least twice, then choose the higher of the scores. The choice of which scores to report is up to the test-taker, but scores cannot be divided. You can not, for example, take an English score from an April test date and a Math score from a June test date. Only a single date’s scores will be reported.

What does all this timeline advice come down to? It means it’s best to take the ACT Assessment sometime in the second semester of your junior year.

WHERE SHOULD YOU TAKE THE ACT ASSESSMENT?

It’s up to you. Look at the centers listed in the brochure or on the Web site. Is your own school one of them? Would a familiar surrounding soothe you, or would nervous friends just pass their anxiety on to you? What do you know of the other test centers? Your cousin goes to one. Doesn’t she always complain that her school freezes its students in the winter and roasts them in the summer? On the day of the test, when you’re trying to concentrate, such things become important considerations.

If you are taking the ACT Assessment in an unfamiliar site, be sure you know how to get there and how long it takes to get there. A dry run to the site beforehand can be very helpful.

A LOOK AHEAD: WHAT YOU NEED TO DO THE DAY OF THE ACT ASSESSMENT

You must bring to the test center the following items:

- Your official admissions ticket, which you’ll receive in the mail after you’ve registered
- Photo identification, such as your picture in the yearbook or a driver’s license with picture, a physical description of you written on school letterhead by the guidance office, or a picture of you with a notarized statement stating that the picture is you
- Two or three sharpened #2 pencils with erasers

Although they’re not necessary, it’s also advisable to bring:

- A battery-operated four-function, scientific, or graphing calculator (all other kinds are forbidden, including calculators with paper tape, calculators with a power cord, pen input devices, laptops, electronic writing pads, and so on)
- A snack for break, such as a granola bar or a bottle of juice
- A sweater in case there’s too little heat or too much air-conditioning

Of course, you will also bring a well-rested, well-fed student who is calm and confident with the knowledge that his or her ACT Assessment preparation has been the most thorough and effective possible with the help of ARCO Master the ACT Assessment.

**SPECIAL REGISTRATION SITUATIONS**

Although most of the almost 2 million students this year will register and take the ACT Assessment under the circumstances described above, some applicants require special consideration. In the decades that the ACT Assessment has been administered, just about every possible situation has come up and there are procedures for most.

**Financial Hardship**

The $25 basic fee might not seem expensive to many people, but to some families it might mean the difference between buying—or not buying—a bag of much-needed groceries. After additional fees are added in for extra services, the cost can easily triple.

If you feel that the registration fee would be a financial hardship, it might be possible for you to get the fee waived. Do not contact ACT, Inc. directly; see your guidance office, which should have an ACT Assessment fee-waiver form. If you qualify for consideration, fill out the form and submit it with your registration form.

The terms for qualifying are one of the following: if the student’s family receives public assistance, if the student is a ward of the state or is in a foster home, or if total family income is at or below the figure cited in the Bureau of Labor Statistics Low Standard Budget.

**Non-Saturday Testing**

If your religious beliefs prevent you from taking the ACT Assessment on the usually scheduled Saturday dates, you can apply for a non-Saturday date. The ACT Assessment brochure has a list of non-Saturday dates and the test centers that offer them. If there is no non-Saturday test center within 50 miles of your residence, you can arrange for individualized testing from the ACT Assessment Universal Testing Office (see page 18).
Physical Accommodations

Students with disabilities might need special physical accommodations to take the test, such as a different seating arrangement for a wheelchair, a large-print test booklet and answer sheet, or a sign-language interpreter to repeat the proctor’s verbal instructions.

If you fall into this category, contact your guidance office. The guidance office will then give you a letter describing the accommodation needed and why it’s needed, which confirms you receive a similar accommodation to take tests at school, and that also verifies you do not need extra test time. Send this letter with your registration form.

Extended Test Time

Certain learning disabilities, physical conditions, and psychological conditions might require that a student take an untimed test in order for the results to be judged fairly. This option is available at regularly scheduled ACT Assessment test centers but only during the October, December, and April dates. Up to 5 hours of total testing time is allowed.

Again, see your guidance office or contact the ACT, Inc. office. Either will provide you with a copy of a form called the ACT Assessment Application for Extended Time National Testing. You need to complete the form and file it with your registration.

Homebound or Confined Students

Certain applicants might not be able to get to a test center at all for many reasons. They might be homebound by disability or long-term illness or might be incarcerated at the time of testing. Such students should write to the ACT Universal Testing Office (see the following section, “How to Contact the ACT, Inc. Office”) and describe their situation. The ACT, Inc. office will contact these students directly to arrange for individualized testing.

If you have questions about any of the above special registration situations—or any general questions—contact the ACT, Inc. office directly.

HOW TO CONTACT THE ACT, INC. OFFICE

Because of the volume of questions it handles, ACT Assessment has different phone numbers, office hours, and addresses for the various issues that come up.

- **For registration material, questions, and problems** (including lost or delayed admission tickets, test center changes, test date changes, incorrect information on an admission ticket, or cancellation of scores), call (319) 337-1270 central time from 8 a.m. to 8 p.m., Monday through Friday. Or write to ACT Assessment Registration, P.O. Box 414, Iowa City, IA 52243-0414.
To re-register when taking the test again, first complete a copy of the phone worksheet in the registration booklet, make sure you have use of a touch-tone phone and a credit card, then call (800) 525-6926, 24 hours a day.

For questions about I.D. requirements (including which forms of I.D. are acceptable and to report being denied admittance to a test center), call (319) 337-1510 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Test Administration, P.O. Box 168, Iowa City, IA 52243-0168.

For questions about score reports (including additional score reports, delayed or missing score reports, and score report corrections), call (319) 337-1313 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Records, P.O. Box 451, Iowa City, IA 52243-0451.

For questions about special physical accommodations for students who can take the test during regular time limits on national test dates, call (319) 337-1510 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Test Administration, P.O. Box 168, Iowa City, IA 52243-0168.

For questions about extended-time testing during the regular national test dates in October, December, or April, call (319) 337-1270 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Registration, P.O. Box 414, Iowa City, IA 52243-0414.

For questions about extended time and alternate formats at specially arranged times that are not during the national dates, call (319) 337-1332 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Special Testing, P.O. Box 4028, Iowa City, IA 52243-4028.

For questions about homebound or confined students, call (319) 337-1332 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Universal Testing, P.O. Box 4028, Iowa City, IA 52243-4028.

For questions about testing outside of the United States, call (319) 337-1448 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Universal Testing, P.O. Box 4028, Iowa City, IA 52243-4028.

For questions about no non-Saturday test sites within 50 miles, call (319) 337-1332 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday. Or write to ACT Assessment Universal Testing, P.O. Box 4028, Iowa City, IA 52243-4028.

For challenges about test questions, request a Test Question Inquiry Form from ACT Assessment Test Administration, P.O. Box 168, Iowa City, IA 52243-0168. The form is also available on line at the ACT Assessment Web site (www.act.org/aap/) so your challenge may be submitted electronically.

For callers using a TDD (text telephone), call (319) 337-1524 central time from 8:30 a.m. to 4:30 p.m., Monday through Friday.
CHAPTER 1: Get to Know the ACT Assessment

SUMMARY

What You Need to Know about the ACT Assessment

• The ACT Assessment, a battery of multiple-choice tests used by colleges and universities to assess applicants, is given five times each year, across the United States and Canada, and overseas.

• The ACT Assessment is a 3-hour exam of 215 questions, divided into four sections that test skills in Standard English, math, reading comprehension, and science reasoning. The questions are designed to cover these areas at the standard level taught in most high schools across the country.

• The ACT Assessment English Test covers two broad skill sets: usage/mechanics and rhetorical skills.

• The ACT Assessment Math Test covers six areas: pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry.

• The ACT Assessment Reading exam tests your ability to read and interpret information from written passages drawn from four basic subject areas: social studies, natural science, prose fiction, and humanities.

• The ACT Assessment Science Reasoning Test encompasses biology, physics, chemistry, and earth and space science. This part of the ACT Assessment tests your ability to interpret and analyze problems based on information supplied to you in the exam.

• For each of the four ACT Assessment tests, your score is based on a “scaled score”; because the specific content of each ACT Assessment might be different, scaling is necessary to standardize your results with those of everyone else who takes the exam. Your raw score is determined by the number of correct answers on your exam; the raw score is then scaled.

• Your ACT Assessment score is only one of the factors considered by college admissions offices; they also assess your high school performance, your personal profile and circumstances, and other information you submit with your application.

• Take the ACT Assessment as early as you can, so you have time to retake it if necessary. For your scores to be available for your college applications, you should take the ACT Assessment no less than eight weeks before the earliest college application deadline that you have.

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Diagnostic Test

OVERVIEW

- Taking the ACT Assessment Diagnostic Test
- Score your test
- Review answer explanations
- Interpret your score in each ACT Assessment subject area

TAKING THE ACT ASSESSMENT DIAGNOSTIC TEST

As much as you might dread jumping into the ACT Assessment waters, the ACT Assessment diagnostic test gives you the best opportunity to evaluate where your skills are now—and where they need to be. DO NOT SKIP THIS ESSENTIAL STEP. Doing this exercise first shows your current level of readiness. Only by having this first score will you be able to measure your progress—to know which areas need to be improved and which ones need less attention, even to know that you have improved at all. Then if test nerves start to eat away at you midway through your preparation and you ask yourself “What’s the use?”—you can look at your increasing scores and regain your confidence.

This diagnostic test is the first of four full-length practice tests of the ACT Assessment included in this book. Since the results of this diagnostic test will help you form your study plan and track your progress as you prepare for the real ACT Assessment, try to simulate a genuine testing environment for yourself. Plan to do the exercise in one sitting; if you take no breaks between sections, you will need about 90 minutes. Work on a clear desk or table. Don’t use notes, textbooks, or other reference material. A simple calculator may be used only where indicated. You may also use blank scrap paper to work out your answers.

Time each section, just as it would be timed under normal testing conditions. Use a stopwatch or kitchen timer, or have someone else time you. Don’t try to time yourself with a clock or watch; it’s too easy to lose track while you’re involved in a problem. After your time is up on one section of the test, stop at once and go on to the next section. When you are done, score yourself using only those questions you answered during the time limit. Be honest. No one else will see this first score or any other score in the book. Later, for practice purposes, complete the questions you were unable to finish at the time.
Enter your answers on the answer sheet on the next page. For the sake of convenience, you may copy the answer sheet only.

The answer key, a full explanation of every answer, and information on how to interpret your score follow the test.
**DIAGNOSTIC TEST**

**Answer Sheet**

**SECTION 1: ENGLISH**


**SECTION 2: MATHEMATICS**

Diagnostic Test

SECTION 1: ENGLISH

75 Questions • Time—45 Minutes

**Directions:** This test consists of five passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box. After you select the correct answer for each question, mark the oval representing the correct answer on your answer sheet.

**Passage I**

An Oboist’s Quest

I started playing the oboe because I’ve heard it was a challenging instrument. That was four years ago and, I’ve enjoyed learning to play the oboe as much as I expected. However, it was not until recently that I realized what an oboist’s real challenge is: finding good oboe reeds.

Though the reed is a small part of the instrument, they largely determine the quality of the oboe’s sound.

1. **(A)** NO CHANGE  
   (B) I’d have heard  
   (C) I’ve been hearing  
   (D) I’d heard

2. **(F)** NO CHANGE  
   (G) four years ago, and I’ve  
   (H) four years ago; and I’ve  
   (J) four years ago. And, I’ve

3. **(A)** NO CHANGE  
   (B) they determine, in large part,  
   (C) it largely determines  
   (D) it determines largely
Professional oboists make their own reeds, so students like me must buy reeds either from their teachers or from mail-order companies.

My troubles began when my teacher stopped making reeds. Sending all of her students on a wild goose chase for the perfect reed. The problem is that there is no such thing as a perfect reed, though oboists like to daydream about it. There is also no such thing as a perfect reed supplier. Reed makers are much in demand, and the reeds are often very expensive—$15 to $20 each for something which, in my opinion, is only worth $7.

Also, the reed makers tend to take their time in sending reeds to you; I usually have to wait three to six weeks after they’ve received my check in the mail. This wouldn’t be a problem if I always ordered my reeds in advance of the time when I need them, but oboe reeds are temperamental and often crack or break without warning. Thus, I need to have several back-up reeds available at all times.

I first tried buying reeds from a reed maker in Massachusetts. They were pretty good at first, but they became progressively worse and lower and lower in quality the longer I bought them from him. It got to the point where none of the reeds he supplied worked, so I had to move on.

At this point, the writer wants to provide readers with a specific detail to substantiate her claim about the expense of oboe reeds. Which alternative does that best?

Although professional oboe players could probably afford to pay a relatively high price for their reeds.

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At this point, the writer wants to provide readers with a specific detail to substantiate her claim about the expense of oboe reeds. Which alternative does that best?

Although professional oboe players could probably afford to pay a relatively high price for their reeds.
CHAPTER 2: Diagnostic Test

10. (F) NO CHANGE
   (G) their reeds
   (H) the reeds of this company
   (J) this company

11. (A) NO CHANGE
   (B) Desperate, my parents called an oboist friend of theirs.
   (C) Desperate, I called an oboist friend of my parents.
   (D) An oboist friend of my parents was the next person I called, desperate.

12. (F) NO CHANGE
   (G) However, within two weeks; those
   (H) Within two weeks however; those
   (J) However, within two weeks those

13. (A) NO CHANGE
   (B) (Place before I)
   (C) (Place after I)
   (D) (Leave where it is now) immediately

Items 14 and 15 pose questions about the essay as a whole.

14. The writer wishes to include the following sentence in the essay:
    Oboe reeds are made from two pieces of cane tied together with string and supported by a cylindrical piece of metal with some cork wrapped around at the base.
    That sentence will fit most smoothly and logically into Paragraph
    (F) 2, before the first sentence.
    (G) 2, after the last sentence.
    (H) 3, after the last sentence.
    (J) 4, before the first sentence.

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15. Suppose the writer were to eliminate Paragraph 4. This omission would cause the essay as a whole to lose primarily

(A) a relevant anecdote about the unreliability of many makers of oboe reeds.
(B) irrelevant details about the technicalities of ordering oboe reeds through the mail.
(C) relevant details about some of the difficulties oboists encounter in maintaining an adequate supply of reeds.
(D) an irrelevant anecdote about the slowness of mail-order oboe reed suppliers.

Passage II

The Viking Mission—In Search of Life

A major goal of the Viking spacecraft missions of the late 1980s were to determine whether the soil of Mars is dead, like the soil of the moon, or teeming with microscopic life, like the soils of Earth. Soil samples brought into the Viking lander were sent to three separate biological laboratories to be tested in different ways for the presence of living things indicating the existence of life.

16. (F) NO CHANGE
(G) was to determine
(H) were determining
(J) was the determination of

17. (A) NO CHANGE
(B) beings that indicated the existence of life.
(C) creatures that contained life.
(D) life.

18. Which of the following sentences, if added here, would most clearly and accurately indicate the topic of Paragraph 2?

(F) This was a challenging scientific assignment.
(G) The tests were based on two assumptions.
(H) The Viking scientists were uncertain how to proceed.
(J) There were several main objectives being pursued in these experiments.
CHAPTER 2: Diagnostic Test

19. (A) NO CHANGE
   (B) Earth that is
   (C) Earth, which is
   (D) Earth—

20. (F) NO CHANGE
   (G) with thousands or millions of them
   (H) containing thousands or millions
   (J) numbering in thousands or millions

21. Which of the following sentences, if added here, would best provide a smooth transition between the previous paragraph and this one?
   (A) The Viking instruments were designed, therefore, to detect carbon-based Martian microbes or similar creatures living in the soil.
   (B) Thus, the Viking scientists had first to determine what kind of life they would seek before designing experiments to uncover it.
   (C) The Viking mission, then, was as much a matter of biological experimentation as of interplanetary exploration.
   (D) The possibility of life on other planets has fascinated humankind for as long as people have stared in wonder at the beauty and mystery of the nighttime sky.

22. (F) NO CHANGE
   (G) of the organism’s.
   (H) of the organisms’.
   (J) the organisms engaged in.

23. (A) NO CHANGE
   (B) the transformation of
   (C) to transform
   (D) that they transform

One characteristic of earthly plants is transforming carbon dioxide in the air into the com-

with sensitive instruments the chemical activity of the organisms.
Viking experiment, called the carbon assimilation test, added radioactive carbon dioxide to the atmosphere above the soil sample.

The sample was then flooded with simulated Martian sunlight. If any Martian life-forms converted the carbon dioxide into other compounds, the compounds could be detected by their radioactivity.

At this point, the writer would like to provide specific details about the plant structures created out of carbon dioxide. Which alternative does that best?

(F) NO CHANGE

(G) constitute the plants’ physical substance.

(H) make up their roots, branches, and leaves.

(J) make up the various parts of the plants themselves.

At this point, the writer is considering the addition of the following sentence:

The Martian day is 24.6 hours long, almost the same length as the day here on Earth.

Would this be a logical and relevant addition to the essay?

(A) Yes, because it provides an interesting fact about Mars, which is the planet being discussed in the essay.

(B) Yes, because the length of the Martian day affects the amount of sunlight to which possible Martian life-forms are exposed.

(C) No, because the length of the Martian day is basically irrelevant to the topic of the Viking experiments.

(D) No, because the sunlight mentioned in the previous sentence is simulated rather than real Martian sunlight.

Living organisms on Earth give off gases. A second experiment on each lander, the gas exchange test, was designed to detect this kind of activity. Plants give off oxygen, animals give off carbon dioxide, and water is exhaled by both. Nutrients and water were added to the soil, and the chemical composition of the gas above the soil was continuously analyzed for changes that might indicate life.

Which of the following sequences of sentences makes this paragraph most logical?

(A) NO CHANGE

(B) 1, 3, 2, 4

(C) 1, 4, 3, 2

(D) 2, 4, 1, 3
Finally, a third experiment on each lander was based on the fact that earthly animals consume organic compounds and give off carbon dioxide. The labeled release test added a variety of radioactive nutrients to the soil and then waited to see whether any radioactive carbon dioxide would be given off.

Much to the disappointment of scientists, the Viking experiments uncovered no clear indications of Martian life-forms. However, the experience itself of designing and implementing the Viking experiments was useful. It has helped scientists to clarify their understanding of terrestrial life and formulate new ideas about life beyond Earth, which may be useful as further planetary explorations are conducted in the future.

28. (F) NO CHANGE
   (G) (Do NOT begin new paragraph) Finally, a
   (H) (Do NOT begin new paragraph) A
   (J) (Begin new paragraph) Nevertheless, a

29. (A) NO CHANGE
   (B) (Place after implementing)
   (C) (Place after was)
   (D) (Place after useful)

Item 30 poses a question about the essay as a whole.

30. Suppose the writer had been assigned to write a brief essay about the results of any single scientific research project of the last twenty years. Would this essay successfully fulfill the assignment?

   (F) Yes, because the essay explains that the Viking experiments failed to detect any life in the Martian soil.
   (G) Yes, because the essay describes in detail the nature of the experiments conducted by the Viking researchers.
   (H) No, because the Viking experiments could be considered a series of projects rather than a single project.
   (J) No, because almost the entire essay is devoted to the plans for the Viking missions rather than their results.
Passage III

The Not-So-Good Old Days

Many of us look back at the end of the nineteenth century through a haze of nostalgia. Perhaps it’s because we’ve begun to feel overwhelmed by modern technology—computers, jets, fax machines—and long for an era we like to think of as having been a simpler time.

Perhaps its images of glowing coal stoves, the gentle aura of gaslight, the sound of a horse and buggy on the pavement, the simple pleasures of the “good old summer time” that make that era seem so appealing.

Although in our imaginations we see the “Gilded Age” as a more genteel time, the reality was less pleasant. In many respects, things were really not as good as we imagine they were in “the good old days.”

Although in our imaginations we see the “Gilded Age” as a more genteel time, the reality was less pleasant. In many respects, things were really not as good as we imagine they were in “the good old days.”

Which of the alternatives best introduces the central theme of the essay and provides an appropriate transition between the first and second paragraphs?

31. (A) NO CHANGE
   (B) we began
   (C) we’ve began
   (D) we begun

32. (F) NO CHANGE
   (G) what we think of as
   (H) a return to a period that we want to consider
   (J) a part of history that we regard as being

33. (A) NO CHANGE
   (B) it’s
   (C) it may be
   (D) there are

34. Which of the alternatives best introduces the central theme of the essay and provides an appropriate transition between the first and second paragraphs?

   (F) Yet modern technology has been more of a boon than a bane.
   (G) None of us, however, have actually experienced life as it was at the end of the nineteenth century.
   (H) Admittedly, life in today’s world has both positive and negative aspects.
   (J) But was that world really as idyllic as we think?

35. (A) NO CHANGE
   (B) —a huge chunk of change for those days—
   (C) —which would have been a lot of money then—
   (D) OMIT the underlined portion.
While it provided relatively little heat, coal-burning stoves were all too powerful at using up the oxygen in a room and replacing it with enough soot and dust to make a house almost uninhabitable.

Then there were those horses in the street. We think nostalgically of the days before automobiles befouled our air, but horses and buggies produced a different kind of pollution. The stench was overwhelming, and there was so much manure in the streets that some observers voiced fears that America’s cities would disappear like ancient Pompeii—but buried under something other than volcanic ash.

36. (F) NO CHANGE  
(G) Little heat though they gave,  
(H) Although they provided relatively little heat,  
(J) While relatively little heat was provided,

37. Which of the following provides the most logical ordering of the sentences in Paragraph 3?  
(A) NO CHANGE  
(B) 1, 3, 4, 2  
(C) 1, 4, 2, 3  
(D) 2, 3, 1, 4

38. (F) NO CHANGE  
(G) one’s  
(H) their  
(J) this

39. At this point, the writer is considering the addition of the following sentence:  
At the end of the nineteenth century in New York City, for example, there were 150,000 horses, each of which dropped between 20 and 25 pounds of manure every day, which was then spread around by the buggies’ wheels.  
Would this be a logical and relevant addition to the essay?  
(A) Yes, because it provides details concerning the pollution created by horses at the end of the nineteenth century.  
(B) Yes, because horses remain popular as pets and companions to this day.  
(C) No, because it refers only to New York City, whereas the main theme of the essay is more widely applicable.  
(D) No, because it fails to draw a detailed comparison to the pollution created today by automobiles.
Even worse, perhaps, were those “good old summer times.” There was, of course, no air conditioning, and in the cities, at least, summers were hotter than they are today, because of the shorter buildings then. Contemporary 40

clothing, too, added to the problem—the garments worn by the average person during the 1890s were considerably more bulky than those worn today.

Which of the alternatives most effectively supports the assertion made earlier in the sentence about the discomforts of summer clothing at the end of the nineteenth century?

(A) NO CHANGE

(B) most people at the time wore heavy clothes, even during the summer, despite the fact that it only made them feel hotter.

(C) heavy suits, long underwear, vests for men, and voluminous dresses with multiple undergarments and girdles for women.

(D) unlike today, when many people wear shorts, open-toed shoes, and thin, airy shirts or blouses on the hottest summer days.

Much worse could be cited—the condition of the poor, the status of women and children, medical science was undeveloped; the list is almost endless. It’s probably true that the

42. (F) NO CHANGE

(G) the underdevelopment of the science of medicine,

(H) the undeveloped state of medical science;

(J) the fact that medical science had not been developed—
pace of life was slower and, at least in that respect, perhaps more congenial to human sensibilities a hundred years ago, the truth is that the “good old days” really weren’t so good after all.

Item 45 poses a question about the essay as a whole.

45. The writer wishes to include the following sentence in the essay:

The heat waves were not just unpleasant, they could be deadly: During the summer of 1896, 3,000 people and 2,000 horses died of the heat in New York City alone.

That sentence will fit most smoothly and logically into Paragraph

(A) 3, after the last sentence.
(B) 5, after the first sentence.
(C) 5, after the last sentence.
(D) 6, before the first sentence.

Passage IV

Gloria Steinem, Feminist Heroine

Gloria Steinem is a political writer and activist, mostly famous for her work as a leading figure in the women’s rights movement. Growing up with the lasting effects of the Great Depression of the 1930s on her once-wealthy family, Steinem became an independent young woman, working her way through elite Smith College with minimal aid from the school or her family. While in college, she became engaged, but her fiancé called off the wedding because his parents felt that Steinem was not wealthy enough to marry into their family. It was one of Steinem’s first encounters with the social and economic aspects of relations between the sexes.

After this upsetting breakup, Steinem decided to take refuge in India, making plans to attend the universities of Delhi and Calcutta. However, while on her way to India, she learned of same upsetting news.

46. (F) NO CHANGE
(G) most famous
(H) more famous
(J) famousest

47. (A) NO CHANGE

—dding, because, his
48. (F) NO CHANGE
   (G) (Her fiance had already left her.)
   (H) He had left Steinem, as previously mentioned.
   (J) OMIT the underlined portion.

49. (A) NO CHANGE
   (B) England, there
   (C) England. In England,
   (D) England, where

50. (F) NO CHANGE
   (G) than
   (H) as in
   (J) by comparison to

51. (A) NO CHANGE
   (B) (Do NOT begin new paragraph) Now that
   (C) (Begin new paragraph) Once
   (D) (Begin new paragraph) Being that

52. (F) NO CHANGE
   (G) club; and
   (H) club, and
   (J) club. And she

53. Which of the alternatives best emphasizes how unusual Steinem’s article was?
   (A) NO CHANGE
   (B) fascinating
   (C) colorful
   (D) vivid
54. Which of the following sentences provides the best transition from the previous paragraph to this one?

(F) Steinem was now 30 years old.
(G) This famous story helped to boost Steinem’s career.
(H) Undercover reporting was not Steinem’s major interest, however.
(J) The article has been widely reprinted and is still well known to this day.

55. (A) NO CHANGE
(B) magazines, that included
(C) such magazines including
(D) magazines like

56. (F) NO CHANGE
(G) hairstyles and weight loss, for example
(H) including topics like hair styles and weight loss
(J) OMIT the underlined portion.

57. (A) NO CHANGE
(B) rights, and this issue, she says, helped
(C) rights; and this issue she says helped
(D) rights—and this issue, she says—helped

58. Which of the alternatives would most effectively support the assertion made in the previous sentence?

(F) NO CHANGE
(G) Abortion rights was only one of the many causes feminists espoused during the 1960s.
(H) Many people, especially those who oppose abortion, have been critical of her stand on this issue.
(J) She wanted women to have the option of a safe and legal abortion.
Vietnam. Steinem soon stepped to the forefront of the women’s rights movement, a tireless worker and advocate. In 1972, she 59 co-founded the most successful feminist publication, Ms. Although the magazine was popular and influential, it lost money due to lack of advertising, and within fifteen years, the magazine was sold.

Steinem was now able to concentrate on her true love—writing. She wrote many famous articles, the list of which included “Marilyn,” about the actress Marilyn Monroe, and published several books, including a psychological memoir called Revolution from Within, a collection of essays titled Beyond Words, and, her autobiography.

60. (F) NO CHANGE
61. (A) NO CHANGE
62. (F) NO CHANGE

Movies: Economics and Artistry

The strength of film as an art form has always derived from cinema’s role of entertaining a large and avid public. As early as the 1920s, during the silent movie era, a generation of filmmakers grew up whose essential vision belonged to no other medium, than that of the cinema and whose public was a universal audience spread across

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Their movies were watched by people around the world. Like the first dra-
63
mas of Shakespeare, their art was not a product of the salon, but of the common play-
64
house. This is what gave such great moviemakers as Charles Chaplin, D. W. Griffith, and Sergei Eisenstein their strength and freshness.

However, there has always been a price to be paid for the popular appeal of movies. The salon artist has only a known patron, or group of patrons, to satisfy, if he is strong enough he
66
can, like the painters of the Renaissance, mold their taste to match his own. This may also be true of the greatest artists of the
67

63. (A) NO CHANGE
   (B) People everywhere watched their movies.
   (C) They made movies that people from all over the world watched.
   (D) OMIT the underlined portion.

64. (F) NO CHANGE
   (G) a product not
   (H) in no way a product
   (J) not produced

65. The writer is considering adding the following phrase at this point in the essay:

   (three of the movie geniuses of the 1920s, two from America, one from Europe)

Would this phrase be a relevant and appropriate addition to the essay, and why?
(A) Yes, because it helps to clarify the role played by the three moviemakers named in the development of the art of film.
(B) Yes, because it provides interesting details about the background of the three moviemakers mentioned.
(C) No, because the only information it adds, that of the moviemakers' geographic origins, is irrelevant to the theme of the essay.
(D) No, because it singles out these three moviemakers as though they were the only significant film artists of their era.

66. (F) NO CHANGE
   (G) satisfy—if
   (H) satisfy, and if
   (J) satisfy. For if

67. (A) NO CHANGE
   (B) as
   (C) similarly to
   (D) as with
movies; from Chaplin in the 1920s to, say, 68

Bergman or Antonioni in the 1960s. Furthermore, the larger and more numerous the public audience and the more costly the movies to produce, equally great are the pressures brought to bear on the less conventional creator to make your work conform to the pattern of the more conventional artist. Today, the most expensive and popular movies—think of any film by Steven Spielberg as an example—are also the most thoroughly conventional, however skillfully crafted they may be.

[3] As the twentieth century nears its end, it is clear that the greatest artistic innovation of the century has been the emergence of the movies. The worldwide popularity of film and its power to transmit culture and values are unprecedented in the history of art. But what makes the movies truly unique are the special relationship between the moviemaker and his audience.

68. (F) NO CHANGE
(G) movies. From
(H) movies. Consider
(J) movies, from

69. (A) NO CHANGE
(B) But
(C) So
(D) Therefore,

70. (F) NO CHANGE
(G) and greater in number
(H) in quantity
(J) OMIT the underlined portion.

71. (A) NO CHANGE
(B) the greater
(C) so much greater
(D) similarly great

72. (F) NO CHANGE
(G) one’s
(H) his
(J) their

73. (A) NO CHANGE
(B) is nearing its end
(C) draws near to its end
(D) nears its end

74. (F) NO CHANGE
(G) is
(H) will be
(J) must be
Item 75 poses a question about the essay as a whole.

75. For the sake of the unity and coherence of this essay, which of the following provides the most effective ordering of the paragraphs?
   (A) NO CHANGE
   (B) 1, 3, 2
   (C) 2, 3, 1
   (D) 3, 1, 2

STOP

END OF SECTION 1. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
SECTION 2: MATHEMATICS

60 Questions • Time—60 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. Of 42 horses in a stable, \( \frac{1}{3} \) are black and \( \frac{1}{6} \) are white. The rest are brown. What is the number of brown horses?
   (A) 7
   (B) 14
   (C) 21
   (D) 28
   (E) 35

2. A faucet is dripping at a constant rate. If at noon on Sunday 3 ounces of water have dripped from the faucet into a holding tank and if at 5 p.m. a total of 7 ounces have dripped into the tank, how many total ounces will have dripped into the tank by 2 a.m. on Monday?
   (F) 10
   (G) \( \frac{51}{5} \)
   (H) 12
   (J) \( \frac{71}{5} \)
   (K) \( \frac{81}{5} \)

3. \( P = (-1,2) ; Q = (3,5) \). What is the slope of \( PQ \)?
   (A) \( \frac{3}{4} \)
   (B) \( \frac{7}{4} \)
   (C) \( \frac{3}{2} \)
   (D) \( \frac{4}{3} \)
   (E) \( \frac{7}{2} \)

4. (2,6) is the midpoint of the line segment connecting \((-1,3)\) to \(P(x,y)\). What is the value of \(2x + y\)?
   (F) 01
   (G) 09
   (H) 10
   (J) 12
   (K) 19
5. What is the value of $y^0 + y^{-1}$ when $y = \frac{1}{2}$?
(A) 0.5  
(B) 1.50  
(C) 3  
(D) 4  
(E) 5

6. Two rectangles have the same area. One is twice as long as the other. If the longer rectangle has a length of $L$ and a width of $W$, what is the perimeter of the shorter rectangle?
(F) $2L + 2W$  
(G) $2L + 4W$  
(H) $2L + W$  
(J) $L + 4W$  
(K) $4L + 2W$

7. If the average of $x$ and $y$ is $m$, and $z = 2m$, what is the average of $x$, $y$, and $z$?
(A) $m$  
(B) $\frac{2m}{3}$  
(C) $\frac{4m}{3}$  
(D) $\frac{3m}{4}$  
(E) $\frac{3}{4m}$

8. In the figure below, $\overline{AC}$ and $\overline{AD}$ trisect $\angle A$. What is the value of $x^\circ$?
(F) 21°  
(G) 27°  
(H) 42°  
(J) 48°  
(K) 6°

9. A box contains five blocks numbered 1, 2, 3, 4, and 5. John picks a block and replaces it. Lisa then picks a block. What is the probability that the sum of the numbers they picked is even?
(A) $\frac{9}{25}$  
(B) $\frac{2}{5}$  
(C) $\frac{1}{2}$  
(D) $\frac{13}{25}$  
(E) $\frac{3}{5}$
10. If a fleet of $m$ buses uses $g$ gallons of gasoline every 2 days, how many gallons will be needed by four buses every 5 days?

(F) $\frac{10g}{m}$

(G) $10gm$

(H) $\frac{10m}{g}$

(J) $\frac{20g}{m}$

(K) $\frac{5g}{4m}$

11. The cost of producing a certain machine is directly proportional to the number of assembly line workers required and inversely proportional to the square of the number of hours of assembly line downtime during production. If the cost was $1,500 when there were 12 workers and only 2 hours of downtime, how many hours of downtime was there when 9 workers were producing machines at the cost of $2,000 per machine?

(A) 1 hour

(B) 1.5 hours

(C) 2 hours

(D) 2.5 hours

(E) 3 hours

12. Which of the following is one root of the equation $x^2 - 4x + 13 = 0$?

(F) $-1$

(G) 5

(H) $4 + 3i$

(J) $2 - 6i$

(K) $2 + 3i$

13. In the figure below, what is the length of the perimeter of triangle $OPQ$?

(A) $\sqrt{7}$

(B) 3

(C) $\sqrt{5} + \sqrt{2}$

(D) $\sqrt{5} + 2\sqrt{2}$

(E) $2\sqrt{5} + \sqrt{2}$

14. If $N = 3p$ and $M = p - 1$, then, in terms of $M$, $\frac{3}{N} = \frac{1}{3^M}$?

(F) $3^M$

(G) $\frac{3^M}{9}$

(H) $\frac{3^M}{3^M}$

(J) $3^{1-M}$

(K) $3^{1-M}$

15. If $A$ and $B$ are positive integers, and $A^2 - B^2 = 36$, then $A = ?$

(A) 6

(B) 7

(C) 8

(D) 9

(E) 10
16. The price of a hat and scarf is $38. The hat cost $3 more than the scarf. What is the price of the scarf?
   (F) $17.50
   (G) $18
   (H) $18.50
   (J) $19
   (K) $20.50

17. If $\sqrt{6}(\sqrt[3]{x}) = \sqrt{30}$, then $x =$?
   (A) $\frac{2}{5}$
   (B) $\frac{3}{5}$
   (C) $\frac{5}{3}$
   (D) $\sqrt[3]{3}$
   (E) $\sqrt{5}$

18. If $2x - y + 4z = 7$ and $-4x + 2y - 3z = 1$, what is the value of $z$?
   (F) $-3$
   (G) $0$
   (H) $3$
   (J) $5$
   (K) It cannot be determined.

19. If $x$ and $y$ are unequal positive integers and $xy = 36$, what is the least possible value of $x + y$?
   (A) 12
   (B) 13
   (C) 15
   (D) 20
   (E) 37

20. If it costs $c$ cents per minute plus $5$ per month for long distance calls, what is the average price per minute (in cents) in a month in which $n$ calls with an average length of 15 minutes are made?
   (F) $\frac{c + 100}{3n}$
   (G) $c + 15n$
   (H) $15c + \frac{500}{n}$
   (J) $15c + \frac{500}{3n}$
   (K) $500 + \frac{nc}{15n}$

21. What is the area of a circle that has a diameter of $\pi$?
   (A) $\frac{1}{4}\pi^2$
   (B) $\frac{1}{2}\pi^2$
   (C) $\frac{1}{4}\pi^3$
   (D) $\frac{1}{2}\pi^3$
   (E) $\pi^3$

22. A quadrilateral has angles in the ratio 1:2:3 and a fourth angle that is $31^\circ$ larger than the smallest angle. What is the difference in degree measure between the two middle-sized angles in the quadrilateral?
   (F) $16^\circ$
   (G) $31^\circ$
   (H) $47^\circ$
   (J) $51^\circ$
   (K) $63^\circ$
23. A jar contains 6 numbered blocks. Four of the blocks are numbered 0 and the other two are not. If two blocks are drawn at random from the jar, what is the probability that the product of the two numbers is not 0?

(A) \( \frac{1}{15} \)
(B) \( \frac{1}{12} \)
(C) \( \frac{2}{15} \)
(D) \( \frac{1}{6} \)
(E) \( \frac{1}{3} \)

24. What is the value of \( \frac{x^2 - 3x}{3x - 9} \) if \( x = 3.03 \)?

(F) 1.01
(G) 1
(H) 3
(J) 101
(K) 303

25. When the tires of a taxicab are underinflated, the cab odometer will read 10% over the true mileage driven. If the odometer of a cab with underinflated tires shows \( m \) miles, what is the actual distance driven?

(A) \( \frac{10m}{11} \)
(B) \( 1.1m \)
(C) \( \frac{10}{11}m \)
(D) \( 0.9m \)
(E) \( \frac{11}{10m} \)

26. The ratio of Elaine’s weekly salary to Carl’s weekly salary is 3:2. If Elaine gets a 20% raise and Carl gets a $200 raise, the ratio of their salaries will drop to 6:5. What is Elaine’s salary?

(F) $200
(G) $400
(H) $600
(J) $720

27. \( P \) percent of \( 20\sqrt{3} \) is 3. \( P = ? \)

(A) \( \sqrt{3} \)
(B) 3
(C) \( 5\sqrt{3} \)
(D) 10\( \sqrt{3} \)
(E) 20

28. In triangle \( ABC \), the measure of \( \angle B \) is 50° more than the measure of \( \angle A \), and the measure of \( \angle C \) is three times the measure of \( \angle A \). The measure of \( \angle B \) – the measure of \( \angle C \) in degrees = ?

(F) –6°
(G) –4°
(H) –2°
(J) 0°
(K) 2°

29. If \( 2n - m = 6 \), and \( 2n + m = 10 \), \( m = ? \)

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5
30. In a group of 18 students taking Spanish or German, 12 are taking Spanish and 4 are taking both languages. What is the number of students taking Spanish but not German?

(F) 4  
(G) 6  
(H) 8  
(J) 10  
(K) 12

31. When \( x = 2 \), \( 3x^2 + x^4 = \) ?

(A) \(-8\)  
(B) \(1.0625\)  
(C) \(3.0625\)  
(D) 16  
(E) 19

32. If \( x = \frac{1}{2} \) and \( x^2 + 2y^2 = 1 \), then which of the following values is closest to the value of \( |y| \)?

(F) 0.1  
(G) 0.2  
(H) 0.4  
(J) 0.5  
(K) 0.6

33. If \( \log_{x} (0.001) = 3 \), then \( x = \) ?

(A) \(0.001)^3\)  
(B) 0.01  
(C) 0.1  
(D) 10  
(E) 1,000

34. In the figure below, if \( m\angle ABC = 130^\circ \), what is the area of triangle \( ABC \)?

\[ A = \frac{1}{2} \times 6 \times 9 \sin 50^\circ \]

(F) \(27 \sin 50^\circ\)  
(G) \(27 \cos 50^\circ\)  
(H) 27  
(J) \(\frac{27}{\sin 50^\circ}\)  
(K) \(54 \sin 50^\circ\)

35. The cost of 4 cookies, 6 doughnuts, and 3 boxes of doughnut holes is \(8.15\). The cost of 2 cookies, 3 doughnuts, and 4 boxes of doughnut holes is \(7.20\). What is the cost of a box of doughnut holes?

(A) \$0.85\)  
(B) \$0.95\)  
(C) \$1.05\)  
(D) \$1.15\)  
(E) \$1.25\)

36. Which of the following is closest to the length of the hypotenuse of a triangle with legs 3 and 5?

(F) 4  
(G) 5  
(H) 6  
(J) 7  
(K) 8
37. If \( x + 2y - 3z = 5 \) and \( 2x + 2y + 3z = 8 \), then \( 9x + 12y = ? \)
   (A) 15
   (B) 23
   (C) 31
   (D) 39
   (E) It cannot be determined.

38. What is the number of different 3-digit license plate numbers that can be formed if the first digit cannot be 0?
   (F) 90
   (G) 100
   (H) 800
   (J) 900
   (K) 1,000

39. Three consecutive odd integers are written in increasing order. The sum of the first and second and twice the third is 46. What is the second number?
   (A) 7
   (B) 9
   (C) 11
   (D) 13
   (E) 15

40. In the figure below, the area of the shaded section of the circle is \( 33\pi \). What is the diameter of the circle?

41. Jerome is 4 years older than Rodney. Two years ago, Rodney was \( \frac{2}{3} \) of Jerome’s age. How many years ago was Jerome twice as old as Rodney?
   (A) 2
   (B) 3
   (C) 4
   (D) 5
   (E) 6

42. Point \( Q(1, u) \) lies on a circle with a radius of 13 whose center is located at (6,9). Which of the following is a possible value of \( u ? \)
   (F) –21
   (G) –3
   (H) 3
   (J) 6
   (K) 12
43. John can vacuum a hotel room in 20 minutes. Armando needs 15 minutes to do the same job. How many hours does it take them working together to vacuum 30 rooms?
   (A) $\frac{20}{7}$
   (B) 3
   (C) 4
   (D) $\frac{30}{7}$
   (E) $\frac{50}{7}$

44. If $x = \log 2$ and $y = \log 5$, then $2^y - 3^x = \ ?$
   (F) $\log \frac{8}{25}$
   (G) $\log \frac{25}{8}$
   (H) $\log \frac{25}{4}$
   (J) $\log 200$
   (K) $\frac{25}{8}$

45. A plane is flying from City A to City B at $m$ miles per hour. Another plane flying from City B to City A travels 50 miles per hour faster than the first plane. The cities are $R$ miles apart. If both planes depart at the same time, in terms of $R$ and $m$, how far are they from City A when they pass?
   (A) $\frac{R}{m} + 50$
   (B) $\frac{Rm}{2m} - 50$
   (C) $\frac{Rm}{2m + 50}$
   (D) $\frac{R + 50}{m + 50}$
   (E) $\frac{m + 50}{R}$

46. One $x$-intercept for the parabola $y = x^2 - 2x - 6$ is in which of the following intervals?
   (F) $[-3,-2]$
   (G) $[-2,-1]$
   (H) $[-1,0]$
   (J) $[0,1]$
   (K) $[1,2]$

47. If $f(x) = x^2$ and $f(g(x)) = \frac{1}{(x^2 + 1)}$, then $g(x)$ could be which of the following?
   (A) $\frac{1}{x + 1}$
   (B) $\sqrt{x} + 1$
   (C) $\frac{1}{\sqrt{x^2 + 1}}$
   (D) $\frac{1}{x}$
   (E) $\frac{1}{x}$

48. The numbers $-2, x, -32$ are the first three terms in a geometric progression. Which of the following could be the sixth term in the progression?
   (F) $-4,096$
   (G) $-2,048$
   (H) $-1,024$
   (J) $512$
   (K) $1,024$
49. Simplified to simplest form,
\[ \frac{4x^2 - 9}{2x^2 + x - 3} = ? \]
(A) \( \frac{2x + 3}{x - 1} \)
(B) \( \frac{2x - 3}{x + 1} \)
(C) \( \frac{2x + 3}{x + 1} \)
(D) \( \frac{2x - 3}{x - 1} \)
(E) \( \frac{2x^2 - 9}{x^2 + x - 3} \)

50. If points \( P \) and \( Q \) have coordinates \((-1,2)\) and \((1,6)\), respectively, which of the following is the equation of a line that is a perpendicular bisector of \( PQ \)?

(F) \( y = -\frac{1}{2}x + 4 \)
(G) \( y = \frac{1}{2}x + 4 \)
(H) \( y = 2x + 4 \)
(J) \( y = -2x + 4 \)
(K) \( y = -2x - 4 \)

51. A random survey of 50 computer users was taken to determine how many used a disc drive and how many used a tape drive. The number who used both was 5 less than the number who used only a disc drive. In addition, there were 7 who used a tape drive but not a disc drive and 2 who used neither. How many used a tape drive?

(A) 18
(B) 20
(C) 23
(D) 25
(E) 28

52. A surveyor standing at a point 50 meters from the base of a vertical cliff measures the angle of elevation to the top as 40°. She then walks another \( M \) meters directly away from the cliff until the angle of elevation to the top is 20°. \( M \) is equal to ?

(F) \( 50 \tan 40° - 50 \tan 20° \)
(G) \( \frac{50 \tan 40° - 50 \tan 20°}{\tan 40°} \)
(H) \( \frac{50 \tan 20°}{\tan 40° - \tan 20°} \)
(J) \( \frac{50 \tan 40° - 50 \tan 20°}{\tan 20°} \)
(K) \( \frac{50 \tan 40°}{\tan 40° - \tan 20°} \)
53. \(3\sqrt{2} + 2\sqrt{8} = ?\)
   (A) \(5\sqrt{2}\)
   (B) \(7\sqrt{2}\)
   (C) \(5\sqrt{8}\)
   (D) \(5\sqrt{10}\)
   (E) 20

54. When Caroline travels on business, she is reimbursed $16 more per day for meals than for lodging. If she were given 50% more for lodging and \(\frac{2}{3}\) as much for meals, the difference would be reversed. What is the total daily amount that Caroline is reimbursed for food and lodging?
   (F) $32
   (G) $48
   (H) $64
   (J) $72
   (K) $80

55. If the numbers \(-3 < M < N < 5\) are in arithmetic progression, then \(M = ?\)
   (A) \(-\frac{1}{3}\)
   (B) 0
   (C) \(\frac{1}{3}\)
   (D) \(\frac{7}{3}\)
   (E) 3

56. Combined into a single monomial,
   \(10y^2 - \frac{4y^4}{2y^2} = ?\)
   (F) \(\frac{5y}{2}\)
   (G) \(\frac{6}{y}\)
   (H) \(6y^2\)
   (J) \(8y^2\)
   (K) \(-6y^2\)

57. Given \(A = \begin{bmatrix} -2 & 1 \\ 1 & 3 \end{bmatrix}\) and \(B = \begin{bmatrix} x & 2 \\ 3 & y \end{bmatrix}\) and \(2A + B = \begin{bmatrix} -5 & 4 \\ 5 & 4 \end{bmatrix}\), find \(xy\).
   (A) \(-2\)
   (B) \(-1\)
   (C) 0
   (D) 1
   (E) 2

58. If \(f(x) = x + 1\), then \(\frac{1}{f(x)} \cdot f\left(\frac{1}{x}\right) = ?\)
   (F) 1
   (G) \(\frac{x + 1}{x}\)
   (H) \(\frac{1}{x}\)
   (J) \(\frac{x}{x + 1}\)
   (K) \(x\)
59. If the slope of the line from \((-1, 0)\) to \(P(x, y)\) is 1 and the slope of the line from \((-4, 0)\) to \(P(x, y)\) is \(\frac{1}{2}\), what is the value of \(x\)?

(A) \(-1\)
(B) 0
(C) 1
(D) 2
(E) 3

60. In the diagram below, \(O_1\) and \(O_2\) are concentric circles, and \(AB\) is tangent to \(O_1\) at \(C\). If the radius of \(O_1\) is \(r\) and the radius of \(O_2\) is twice as long, what is the area of the shaded region?

\[
\begin{align*}
\text{(F)} & \quad \frac{1}{2} \pi r^2 \\
\text{(G)} & \quad \pi r^2 \\
\text{(H)} & \quad 1.5 \pi r^2 \\
\text{(J)} & \quad 2 \pi r^2 \\
\text{(K)} & \quad 3 \pi r^2
\end{align*}
\]

STOP

END OF SECTION 2. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
CHAPTER 2: Diagnostic Test

SECTION 3: READING

40 Questions • Time—35 Minutes

Directions: This test consists of four passages, each followed by several questions. Read each passage, select the correct answer for each question, and mark the oval representing the correct answer on your answer sheet.

Passage I—PROSE FICTION

Newland Archer was speaking with his fiancée, May Welland. He had failed to stop at his club on the way up from the office where he exercised the profession of the law in the leisurely manner common to well-to-do New Yorkers of his class in the middle of the nineteenth century. He was out of spirits and slightly out of temper, and a haunting horror of doing the same thing every day at the same hour besieged his brain.

"Sameness—sameness!" he muttered, the word running through his head like a persecuting tune as he saw the familiar tall-hatted figures lounging behind the plate glass; and because he usually dropped in at the club at that hour, he had passed by instead. And now he began to talk to May of their own plans, their future, and Mrs. Welland's insistence on a long engagement.

"If you call it long!" May cried. "Isabel Chivers and Reggie were engaged for two years, Grace and Thorley for nearly a year and a half. Why aren't we very well off as we are?"

It was the traditional maidenly interrogation, and Archer felt ashamed of himself for finding it childish. No doubt she simply echoed what was said for her, but she was nearing her twenty-second birthday, and he wondered at what age "nice" women like May began to speak for themselves.

"Never, if we won't let them, I suppose," he mused, and recalled his mad outburst to his friend Jackson: "Women ought to be as free as we are!"

It would soon be his task to take the bandage from this young woman's eyes, and bid her look forth on the world. But how many generations of women before her had descended bandaged to the family vault? He shivered a little, remembering some of the new ideas in his scientific books, and the much-cited instance of the Kentucky cave-fish, which had ceased to develop eyes because they had no use for them. What if, when he had bidden May Welland to open hers, they could only look out blankly at blankness?

"We might be much better off. We might be truly together—we might travel." Her face lit up. "That would be lovely," she admitted; she would love to travel. But her mother would not understand their wanting to do things so differently.

"As if the fact that it is different doesn't account for it!" Archer insisted. "Newland! You're so original!" she exulted.

His heart sank. He saw that he was saying all the things that young men in the same situation were expected to say, and that she was making the answers that instinct and tradition taught her to make—even to the point of calling him original.

"Original! We're all as like each other as those dolls cut out of the same folded paper. We're like patterns stenciled on a wall. Can't you and I strike out for ourselves, May?"

He had stopped and faced her in the excitement of their discussion, and her eyes rested on him with a bright unclouded admiration.
Goodness—shall we elope?” she laughed.
“If you would—”
“You do love me, Newland! I’m so happy.”
“But then—why not be happier?”
“We can’t behave like people in novels, though, can we?”
“Why not—why not—why not?”
She looked a little bored by his insistence. She knew very well why they couldn’t, but it was troublesome to have to produce a reason. “I’m not clever enough to argue with you. But that kind of thing is rather—vulgar, isn’t it?” she suggested, relieved to have hit on a word that would certainly extinguish the whole subject.
“Are you so much afraid, then, of being vulgar?”
She was evidently staggered by this. “Of course I should hate it—and so would you,” she rejoined, a trifle irritably.
He stood silent, beating his walking-stick nervously against his shoe-top. Feeling that she had indeed found the right way of closing the discussion, she went on lightheartedly, “Oh, did I tell you that I showed cousin Ellen my engagement ring? She thinks it the most beautiful setting she ever saw. There’s nothing like it in Paris, she said. I do love you, Newland, for being so artistic!”

1. What was Archer’s reason for failing to stop at his club after leaving the office?
   (A) He wanted to avoid talking with his friends there.
   (B) He was afraid that his life was becoming overly routine.
   (C) He disliked most of the other members of the club.
   (D) He was eager to discuss the future with his fiance.

2. The reference to the “Kentucky cave-fish” (line 47) underscores Archer’s concern about May Welland’s
   (F) greed.
   (G) timidity.
   (H) immaturity.
   (J) bossiness.

3. It can be inferred from the passage that Archer’s engagement is expected to last
   (A) two or three months.
   (B) somewhat less than a year and a half.
   (C) about two years.
   (D) more than two years.

4. The first paragraph suggests that Archer’s work as a lawyer
   (F) is not very demanding.
   (G) has become tedious to him.
   (H) is very lucrative.
   (J) is a traditional family occupation.

5. May Welland apparently considers the idea that she and Archer might elope
   (A) frightening.
   (B) romantic.
   (C) fascinating.
   (D) absurd.

6. The fifth paragraph (lines 35–38) suggests that Archer considers most women in the society of his time
   (F) unduly powerful.
   (G) indecisive and irresponsible.
   (H) unfairly dominated by men.
   (J) excessively demanding.

7. Archer’s reaction to being called “original” by his fiance is a feeling of
   (A) dismay.
   (B) pride.
   (C) bewilderment.
   (D) glee.
8. Which of the following conclusions about the relationship between Archer and May Welland is best supported by the details in the passage?

(F) Archer’s eagerness to accelerate their wedding is motivated by his passion for his fiance.

(G) Archer and May Welland both feel trapped in an unhappy relationship by social restrictions.

(H) Archer feels stultified by his fiance’s conventionality but feels unable to alter the situation.

(J) May Welland is eager to do whatever she can to satisfy the emotional needs of her fiance.

---

9. May Welland considers the discussion begun by Archer finished when she

(A) dismisses his ideas as “vulgar.”

(B) appeals to the authority of her mother.

(C) accedes to his request that their engagement be shortened.

(D) realizes that Archer truly loves her.

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10. Archer regards May Welland’s attitudes as having been excessively influenced by which of the following?

   I. The traditions of her sex and class
   II. Her mother
   III. The novels she has read
   IV. Her friends Isabel and Grace

   (F) I and II
   (G) II and III
   (H) I and IV
   (J) II and IV

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Passage II—SOCIAL STUDIES

From the opening days of the Civil War, one of the Union’s strategies in its efforts to defeat the rebelling southern states was to blockade their ports. Compared to the Union, relatively little was manufactured in the Confederacy—either consumer goods or, more important, war materiel—and it was believed that a blockade could strangle the South into submission. But the Confederacy had 3,500 miles of coastline and, at the start of the war, the Union had only 36 ships to patrol them.

Even so, the Confederate government knew that the Union could and would construct additional warships and that in time all its ports could be sealed. To counter this, the Confederacy decided to take a radical step—to construct an ironclad vessel that would be impervious to Union gunfire. In doing so, the South was taking a gamble because, though the British and French navies had already launched experimental ironclad vessels, none had yet been tested in battle.

Lacking time as well as true shipbuilding capabilities, rather than construct an entirely new ship, in July, 1861, the Confederacy began placing armor-plating on the hull of an abandoned U.S. Navy frigate, the steam-powered U.S.S. Merrimack. Rechristened the C.S.S. Virginia, the ship carried ten guns and an iron ram designed to stave in the wooden hulls of Union warships.

Until then, Union Secretary of the Navy Gideon Welles had considered ironclads too radical an idea, and preferred to concentrate on building standard wooden warships. But when news of the Virginia reached Washington, the fear it engendered forced him to rethink his decision. In October, 1861, the Union began construction of its own ironclad—the U.S.S. Monitor—which would revolutionize naval warfare.

Designed by John Ericson, a Swede who had already made substantial contributions to marine engineering, the Monitor looked like no other ship afloat.
With a wooden hull covered with iron plating, the ship had a flat deck with perpendicular sides that went below the waterline and protected the propeller and other important machinery. Even more innovative, the ship had a round, revolving turret which carried two large guns. Begun three months after work started on the conversion of the Virginia, the Monitor was nevertheless launched in January, 1862, two weeks before the Confederacy launched its ironclad.

On March 8th, now completely fitted, the Virginia left the port of Norfolk, Virginia, on what was expected to be a test run. However, steaming into Hampton Roads, Virginia, the Confederateship found no fewer than five Union ships at the mouth of the James River—the St. Lawrence, Congress, Cumberland, Minnesota, and Roanoke. The first three of these were already-obsolete sailing ships, but the others were new steam frigates, the pride of the Union navy.

Attacking the Cumberland first, the Virginia sent several shells into her side before ramming her hull and sinking her. Turning next to the Congress, the southern ironclad sent broadsides into her until fires started by the shots reached her powder magazine and she blew up. At last, after driving the Minnesota aground, the Virginia steamed off, planning to finish off the other ships the next day. In just a few hours, she had sunk two ships, disabled a third, and killed 240 Union sailors, including the captain of the Congress—more naval casualties than on any other day of the war. Although she had lost two of her crew, her ram, and two of her guns, and sustained other damage, none of the nearly 100 shots that hit her had pierced her armor.

The Monitor, however, was already en route from the Brooklyn Navy Yard, and the next morning, March 9th, the two ironclads met each other for the first—and only—time. For nearly four hours the ships pounded at each other, but despite some damage done on both sides, neither ship could penetrate the armor-plating of its enemy. When a shot from the Virginia hit the Monitor’s pilot house, wounding her captain and forcing her to withdraw temporarily, the Confederate ship steamed back to Norfolk.

Although both sides claimed victory, the battle was actually a draw. Its immediate significance was that, by forcing the withdrawal of the Virginia, it strengthened the Union blockade, enabling the North to continue its ultimately successful stranglehold on the South. Even more important, it was a turning point in the history of naval warfare. Although neither ship ever fought again, the brief engagement of the Monitor and Virginia made every navy in the world obsolete, and, in time, spelled the end of wooden fighting ships forever.

11. According to the passage, the Confederacy wanted an ironclad vessel for all the following reasons EXCEPT

(A) an ironclad vessel might be able to withstand Union attacks.
(B) it needed open ports in order to receive supplies from overseas.
(C) the British and French navies already had ironclads.
(D) it knew that the Union would be building more warships.

12. The passage implies that the South was vulnerable to a naval blockade because of its

(F) limited manufacturing capabilities.
(G) relatively short coastline.
(H) lack of access to natural resources.
(J) paucity of skilled naval officers.
13. According to the passage, the Confederate government chose to refit the Merrimack rather than build an ironclad from scratch because
   (A) it lacked sufficient funds to construct a new vessel.
   (B) it had neither the time nor facilities to build a new ship.
   (C) the design of the Merrimack was especially suitable for armor plating.
   (D) it believed that converting a Union warship would damage Northern morale.

14. All of the following were unusual design features of the Monitor EXCEPT its
   (F) perpendicular sides.
   (G) revolving gun turret.
   (H) flat deck.
   (J) wooden hull.

15. As it is used in line 57, the word innovative most nearly means
   (A) dangerous.
   (B) unusual.
   (C) revolutionary.
   (D) clever.

16. It can be inferred from the passage that, by comparison with the design of the Monitor, that of the Virginia was more
   (F) offensively oriented.
   (G) costly.
   (H) versatile.
   (J) traditional.

17. It can be inferred from the passage that, although construction on the Monitor began three months after that of the Virginia, the Monitor was completed first because the
   (A) Union had more money to spend on building its ship.
   (B) Monitor was less complicated to construct.
   (C) Union had greater manufacturing abilities and resources.
   (D) Confederacy did not feel compelled to hurry in completing its ship.

18. It can be inferred from the passage that the Virginia was able to sink or disable the St. Lawrence, Congress, and Cumberland for which of the following reasons?
   (F) Its armor plating was virtually impervious to gunfire.
   (G) Its steam-powered engines made it highly maneuverable.
   (H) Its armor plating made it fire proof.
   (J) It was capable of greater speed than the Union war ships.

19. As it is used in line 93, sustained most nearly means
   (A) survived.
   (B) inflicted.
   (C) suffered.
   (D) risked.

20. The author suggests that the most important long-term result of the battle between the Virginia and the Monitor was that it
   (F) enabled the Union to maintain its blockade of southern ports.
   (G) demonstrated that ironclad ships represented the future of naval warfare.
   (H) saved the Union navy from destruction by the Virginia.
   (J) demonstrated the superior technological prowess of the North.
Passage III—HUMANITIES

On July 1, 1882, a brief notice appeared in the Portsmouth (England) Evening News. It read simply, “Dr. Doyle begs to notify that he has removed to 1, Bush Villas, Elm Grove, next to the Bush Hotel.” So was announced the newly-formed medical practice of a 23-year-old graduate of Edinburgh University—Arthur Conan Doyle. But the town of Southsea, the Portsmouth suburb in which Doyle had opened his office, already had several well-established physicians, and while he waited for patients the young Dr. Doyle found himself with a great deal of time on his hands.

To fill it, he began writing—short stories, historical novels, whatever would keep him busy and, hopefully, bring additional funds into his sparsely-filled coffers. By the beginning of 1886, his practice had grown to the point of providing him with a respectable if not munificent income, and he had managed to have a few pieces published. Although literary success still eluded him, he had developed an idea for a new book, a detective story, and in March he began writing the tale that would give birth to one of literature’s most enduring figures.

Although he was familiar with and impressed by the fictional detectives created by Edgar Allan Poe, Emile Gaboriau, and Wilkie Collins, Doyle believed he could create a different kind of detective, one for whom detection was a science rather than an art. As a model, he used one of his medical school professors, Dr. Joseph Bell. As Bell’s assistant, Doyle had seen how, by exercising his powers of observation and deduction and asking a few questions, Bell had been able not only to diagnose his patients’ complaints but also to accurately determine their professions and backgrounds. A detective who applied similar intellectual powers to the solving of criminal mysteries could be a compelling figure, Doyle felt.

At first titled A Tangled Skein, the story was to be told by his detective’s companion, a Dr. Ormand Sacker, and the detective himself was to be named Sherrinford Holmes. But by April, 1886, when Doyle finished the manuscript, the title had become A Study in Scarlet, the narrator Dr. John H. Watson, and the detective Mr. Sherlock Holmes.

A tale of revenge, in which Holmes is able to determine that two Mormons visiting England from Utah have been killed by Jefferson Hope, an American working as a London hansom cab driver, A Study in Scarlet was rejected by several publishers before being accepted that fall for publication by Ward, Lock & Company as part of Beeton’s Christmas Annual in 1887. Although the author asked to be paid a royalty based on sale of the book, his publisher offered instead only a flat fee of £25 for the copyright (the equivalent of approximately $50.00 today). Doyle reluctantly accepted.

A handful of reviewers commented kindly on the story, but the reading public as a whole was unimpressed. Ward, Lock published A Study in Scarlet in book form the following year, while the disappointed author returned to his historical novels, with which he had finally achieved some modest success. Fictional detection, Doyle thought, was behind him. In August, 1889, however, he was approached by the editor of the American Lippincott’s Monthly Magazine, published in Philadelphia and London, to write another Sherlock Holmes story. Although he had little interest in continuing Holmes’s adventures, Doyle was still in need of money and accepted the offer.

Published in Lippincott’s in February, 1890, and in book form later that year, The Sign of the Four chronicled Holmes’s investigation of the murder of Bartholomew Sholto and his search for Jonathan Small and a treasure stolen by British soldiers in India. It too, however, met with little enthusiasm from the public. In the meantime, however, Doyle’s other small literary successes had enabled him to move to London, where he became a consulting...
CHAPTER 2: Diagnostic Test

physician. Fortunately, even this new (105) London practice did not keep him very busy, leaving him time to concentrate on his writing.

In April, 1891, he submitted a short Sherlock Holmes story, “A Scandal in Bohemia,” to a new magazine called The Strand. It was with the publication of this story, and the series of Holmes tales which followed, that the public finally took an interest in Dr. Doyle’s detective, (110) enabling him to give up his practice and turn to writing full-time. Despite his own continuing lack of enthusiasm for his protagonist—he considered the Holmes stories insignificant compared to his “serious” historical novels—spurred by the public clamor for more Sherlock Holmes, Doyle eventually wrote 56 short stories and four novels in the series, and in the process created what (115) may be the best-known character in all of English literature.

21. According to the passage, Arthur Conan Doyle began writing for all the following reasons EXCEPT
(A) his medical practice did not keep him very busy.
(B) he needed additional income.
(C) he was not interested in practicing medicine.
(D) he was fond of literary fiction.

22. As it is used in line 41, the word deduction most nearly means
(F) decreasing.
(G) discounting.
(H) reducing.
(J) reasoning.

23. It can be inferred from the passage that Sherlock Holmes differed from previous fictional detectives in that
(A) he conducted his investigations on a scientific basis.
(B) he used his own background in medicine as a source of detective methods.
(C) his cases were chronicled by a companion rather than by the detective himself.
(D) his exploits were based on the experiences of a real individual.

24. As it is used in line 48, compelling most nearly means
(F) inescapable.
(G) believable.
(H) fascinating.
(J) insistent.

25. In can be inferred from the passage that the first two Sherlock Holmes tales were similar in all the following respects EXCEPT
(A) both were based on historical events.
(B) both were originally published in periodicals rather than as books.
(C) neither received a strong initial reception from the public.
(D) both were written more for financial than literary reasons.

26. The author implies that Doyle’s move to London was primarily triggered by
(F) Doyle’s desire to move in literary circles.
(G) the failure of his medical practice in Southsea.
(H) an increase in Doyle’s income from writing.
(J) a growing demand for Doyle’s medical services.
27. The author uses the word *Fortunately* in line 104 primarily to imply that
   (A) a medical practice in London can be especially demanding.
   (B) the popular demand for Doyle’s writing had begun to grow at this time.
   (C) Doyle’s literary career was more significant than his medical practice.
   (D) Doyle was strongly tempted at this time to abandon writing as a career.

28. It can be inferred from the passage that the public finally became interested in Doyle’s Sherlock Holmes stories as a result of
   (F) their continued appearance in *The Strand* magazine.
   (G) the public’s growing interest in detective stories.
   (H) the success of Doyle’s other works.
   (J) the first publication of a Holmes story in the United States.

29. According to the passage, Doyle’s reluctance to write further Holmes stories after 1891 was due primarily to
   (A) his belief that he was not fairly compensated for them.
   (B) his lack of interest in Holmes as a character.
   (C) his desire to be considered a serious author.
   (D) the significant income provided by his other literary efforts.

30. Which of the following titles best summarizes the content of the passage?
   (F) “Arthur Conan Doyle and The Creation of the Modern Detective Story”
   (G) “A Detective’s Reluctant Chronicler: The Birth of Sherlock Holmes”
   (H) “Physician and Author: How Arthur Conan Doyle Balanced Two Callings”
   (J) “The Many Strands in the Character of Sherlock Holmes”

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**Passage IV—NATURAL SCIENCE**

If you’ve ever cupped your hand around a blinking firefly or noticed an eerie glow in the ocean at night, you are familiar with the phenomenon of bioluminescence. The ability of certain plants and animals to emit light has long been a source of fascination to humans. Why do certain species of mushrooms glow? Why are midwater squids designed with ornate light-emitting organs underneath their eyes and ink glands? Why do certain particles and biological detritus floating in the depths of the ocean sparkle after a physical disturbance? Are these light displays simply an example of nature in its most flamboyant mode—a case of “if you’ve got it, flaunt it”—or do they serve any practical purposes?

As it turns out, the manifestations of bioluminescence are as diverse as they are elegant. Yet virtually all of the known or proposed ways in which bioluminescence functions may be classed under three major rubrics: assisting predation, helping escape from predators, and communicating.

Many examples of the first two uses can be observed in the ocean’s midwaters, a zone that extends from about 100 meters deep to a few kilometers below the surface. Almost all of the animals that inhabit the murky depths where sunlight barely penetrates are capable of producing light in one way or another. Certain animals, when feeding, are attracted to a spot of light as a possible food source. Hence, other animals use their own luminescence to attract them. Just in front of the angler fish’s mouth is a dangling luminous ball suspended from a structure attached to its head. What unwitting marine creatures see as food is really a bait to lure them into the angler fish’s gaping maw.

The uses of luminescence to elude prey are just as sophisticated and various. Some creatures take advantage of the scant sunlight in their realm by using bioluminescence as a form of camouflage. The glow generated by photophores, light producing organs, on the
under sides of some fishes and squids acts to hide them through a phenomenon known as countershading: the weak downward lighting created by the photophores effectively erases the animals' shadows when viewed from below against the (relatively) lighted waters above.

Some marine animals use bioluminescence more actively in their own defense, turning their predators into prey. For instance, there is the so-called "burglar alarm effect," in which an animal coats an advancing predator with sticky glowing tissue that makes the would-be attacker vulnerable to visually-cued hunters—like bank robbers marked by exploding dye packets hidden in stolen currency.

Bioluminescence is used not only in such interspecific feeding frays between predators and prey, but also as an intraspecific communication facilitator. The fireflies that seem to blink on and off randomly in the summer woods are actually male and female members signaling each other during courtship. Certain fish use their luminescence as a kind of Morse code in which the female responds to the flashing of a male fish with its own flash exactly two seconds later, which the male recognizes by its timing.

Bioluminescence clearly functions to help certain species ensure their survival, whether it helps them to trick predators or to mate and produce offspring. Yet, when we look at the larger evolutionary picture, bioluminescence as such is generally considered a "nonessential" characteristic. After all, closely related species and even strains of the same species may have both luminous and nonluminous members, and the nonluminous ones appear just as viable and vigorous as their glowing counterparts. For instance, while many of the small marine organisms known as dinoflagellates are luminous, many are not. Yet, on closer inspection, we find that the nonluminous dinoflagellates may benefit from the diversionary flashing tactics of the luminous ones. When the sea is disturbed and light flashes create phosphorescence, the species that flash may provide enough light to serve the entire population. Thus, selection pressure for the development or maintenance of luminescence in additional species is not great if light generated by a part of the population serves the entire community.

There are instances in which bioluminescence seems truly purposeless. What does one make of a creature, such as a newly discovered species of a tomopterid worm, that emits light for no apparent purpose? This agile swimmer with a multitude of paired legs spews a bright yellow bioluminescent fluid from each of its leg pores. While other types of spewers use this strategy to create a visual distraction, this worm’s display remains enigmatic, particularly since the light produced is yellow, while most midwater animals have eyes that are sensitive only to blue-green. Perhaps some animal species are simply exploiting their capacity for flamboyance, in the same way that some humans bring a distinctively colorful flair to whatever they do.

31. The passage focuses on all of the following aspects of bioluminescence EXCEPT (A) its role in interactions between predators and prey. (B) its role in the evolution of various animal species. (C) whether bioluminescence is a purely functional feature. (D) how bioluminescent species may serve nonluminous ones.
32. From the author’s description of the angler fish in lines 39–44, we can infer that this fish
(F) is attracted to light as a possible food source.
(G) uses its light-producing organ to deter predators.
(H) dwells primarily in the ocean’s midwaters.
(J) uses countershading to elude predators below.

33. The angler fish’s use of bioluminescence in predation is most nearly analogous to a(n)
(A) exterminator’s use of insecticide to poison the insects that have infested a home.
(B) duck hunter’s use of a reed shielded blind as a hiding place from which to shoot at ducks.
(C) trout fisherman’s use of a lure designed to resemble an insect that trout love to eat.
(D) police detective’s use of a bright lamp to blind and so intimidate a suspect during questioning.

34. Each of the following statements about the use of bioluminescence in countershading is true EXCEPT
(F) the light given off by photophores underneath certain fish and squid makes the animals appear to blend in with the sunlit waters above them.
(G) bioluminescence allows the parts of an animal normally in shadow to appear lighter.
(H) countershading is used most effectively in regions of relatively weak sunlight.
(J) bioluminescent animals use countershading as a way to elude predators that lurk in the sunlit waters above them.

35. The reference to bank robbers in lines 68–70 serves mainly to
(A) distinguish between two phenomena that appear similar but are fundamentally different.
(B) suggest a practical application for recent discoveries from natural science.
(C) point out the weaknesses in one proposed solution to a scientific conundrum.
(D) clarify a phenomenon of the animal world by comparing it to human behavior.

36. The author mentions the behavior of bioluminescent and nonluminous dinoflagellates (lines 88–100) primarily in order to illustrate
(F) why bioluminescence is generally considered an unnecessary function in dinoflagellates.
(G) one of the functions of bioluminescence in the ocean’s midwaters.
(H) why more species have not evolved with bioluminescence.
(J) how nonluminous animals may benefit from proximity to luminous ones.

37. The passage implies that, if bioluminescence were NOT a nonessential characteristic, which of the following would be true?
(A) Luminous species would be seen to thrive more successfully than closely related nonluminous ones.
(B) Nonluminous species would enjoy a reproductive advantage by comparison to luminous ones.
(C) Luminous species would gradually die out and be replaced by closely related nonluminous ones.
(D) Luminous and nonluminous species would not be observed living in close proximity to one another.
38. The phrase “selection pressure” in lines 107–108 refers to
(F) the potential extinction of an animal species due to the depletion of essential resources.
(G) environmental factors that favor development of a particular biological characteristic.
(H) competition among predators for a finite population of prey.
(J) selective winnowing of an animal population based on the attractiveness of specific individuals.

39. By comparison with the other species mentioned in the passage, the phenomenon of bioluminescence in the tomopterid worm discussed in lines 115–127 might best be described as
(A) extreme.
(B) archetypal.
(C) exceptional.
(D) prototypical.

40. The author’s comments about the tomopterid worm would be most seriously called into question by the discovery of which of the following?
(F) A predator of the tomopterid worm that is sensitive to yellow light
(G) Another species of tomopterid worm that produces bioluminescent blue-green fluid
(H) A prey of the tomopterid worm that does not exhibit bioluminescence
(J) Other species of midwater animals that produce bioluminescent yellow fluids
SECTION 4: SCIENCE REASONING

40 Questions • Time—35 Minutes

Directions: This test consists of seven passages, each followed by several questions. Read each passage, select the correct answer for each question, and mark the oval representing the correct answer on your answer sheet. You may NOT use a calculator on this test.

Passage I

Tree age is important to researchers for understanding typical life-cycles in the forest and developing sustainable forestry practices. Counting tree rings is the method that is usually used to determine the age of trees, but in tropical rain forests, such as the Amazon, tree rings may be irregular (not annual) or nonexistent.

Carbon-14 dating is another method of determining tree age. Trees take carbon dioxide, which contains some of the radioactive element carbon-14, into their tissues at a known rate. By measuring the levels of carbon-14 in a plant, scientists can determine its age. Table 2.1 lists the age and other data for trees that have emerged from the canopy in a small Amazon forest plot. The age of the trees was determined by carbon-14 dating.

Table 2.1

<table>
<thead>
<tr>
<th>Tree #</th>
<th>Tree Species</th>
<th>Tree Diameter (cm)</th>
<th>Tree Age (Years)</th>
<th>Calculated Average Growth Rate (cm/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cariniana micrantha</td>
<td>140</td>
<td>200</td>
<td>0.7</td>
</tr>
<tr>
<td>2</td>
<td>Cariniana micrantha</td>
<td>100</td>
<td>400</td>
<td>0.25</td>
</tr>
<tr>
<td>3</td>
<td>Cariniana micrantha</td>
<td>140</td>
<td>1,400</td>
<td>0.1</td>
</tr>
<tr>
<td>4</td>
<td>Hymenolobium species</td>
<td>180</td>
<td>300</td>
<td>0.6</td>
</tr>
<tr>
<td>5</td>
<td>Hymenolobium species</td>
<td>90</td>
<td>900</td>
<td>0.1</td>
</tr>
<tr>
<td>6</td>
<td>Bagassa guianensis</td>
<td>120</td>
<td>400</td>
<td>0.3</td>
</tr>
<tr>
<td>7</td>
<td>Bagassa guianensis</td>
<td>150</td>
<td>300</td>
<td>0.5</td>
</tr>
<tr>
<td>8</td>
<td>Caryocar glabrum</td>
<td>130</td>
<td>200</td>
<td>0.65</td>
</tr>
<tr>
<td>9</td>
<td>Caryocar vilosum</td>
<td>120</td>
<td>200</td>
<td>0.6</td>
</tr>
<tr>
<td>10</td>
<td>Iryanthera grandis</td>
<td>160</td>
<td>800</td>
<td>0.2</td>
</tr>
<tr>
<td>11</td>
<td>Dipteryx odorata</td>
<td>120</td>
<td>1,200</td>
<td>0.1</td>
</tr>
<tr>
<td>12</td>
<td>Sclerolobium species</td>
<td>80</td>
<td>200</td>
<td>0.4</td>
</tr>
</tbody>
</table>
CHAPTER 2: Diagnostic Test

Historical patterns of forest disturbance are also important to biologists for determining the extent to which the forest is affected and the forest's pattern of recovery. The following diagram shows the catastrophic events that are known to have occurred in the area where the trees in Table 2.1 were growing.

![Legend: ★ = catastrophic event]

1. Looking at trees in just the *Hymenolobium* species (trees 4 and 5) in Table 2.1, researchers might conclude that
   (A) tree age is positively correlated with both tree diameter and growth rate.
   (B) tree age is inversely correlated with tree diameter and positively correlated with growth rate.
   (C) tree age is inversely correlated with tree diameter and growth rate.
   (D) tree diameter is inversely correlated with growth rate.

2. Based on the data presented, which of the following statements is true?
   (F) Trees 5 and 12 demonstrate that tree diameter is a relatively poor predictor of tree age.
   (G) Trees 5 and 12 demonstrate that trees that survived a natural catastrophe will begin to grow at a faster rate because there is little competition for resources.
   (H) Trees 5 and 12 demonstrate inconsistencies in the carbon-14 dating process.
   (J) Trees 5 and 12 demonstrate that it is not always possible to calculate a tree's average growth rate even when the tree's diameter and age are known.

3. Looking at the catastrophe timeline and the data in Table 2.1, it is clear that
   (A) more than half of the canopy trees in the forest plot survived the most recent catastrophe.
   (B) about one half of the canopy trees in the forest plot survived at least two catastrophes.
   (C) about one third of the canopy trees in the forest plot survived at least two catastrophes.
   (D) some trees will always survive a natural catastrophe.

4. If a tree has an age of 1,100 years and a long-term average growth rate of 0.1 cm/year, what is the diameter of the tree?
   (F) 100 cm
   (G) 110 cm
   (H) 120 cm
   (J) It cannot be determined.

5. Which of the following conclusions do the growth rates of trees 1, 2, and 3 demonstrate?
   (A) Canopy trees of a single species tend to be close in age.
   (B) Canopy trees of different species may have widely divergent ages.
   (C) Average growth rates generally remain constant for each species.
   (D) Trees of the same species may have different average growth rates at different ages.
6. Reaching the canopy, with its important resource of sunlight, is a critical goal for rain forest trees. The traditional view is that trees have a fast growth spurt to reach the canopy. The researchers in this study hypothesized that trees might reach the canopy using strategies of fast or slow growth and that both strategies might be used by trees in the same species. Which of the following findings would support their theory?

(F) It is discovered that tree 3 reached the canopy 1,200 years ago.

(G) Research on trees that have not reached the canopy show that they are all under 200 years of age.

(H) The growth rates of trees that have not reached the canopy are investigated and are found to be highly variable.

(J) The growth rates of trees that have not reached the canopy are investigated and are found to be relatively fast.

Passage II

Recently, flywheels with magnetic bearings have been designed (see figure below). These flywheels produce none of the friction associated with mechanical bearings, making them efficient energy storage devices. One application they may have is in alternative energy cars. In experimental designs, a flywheel is “spun-up” while the car is at rest with the electrical power supplied from a standard electrical outlet. After the flywheel has reached a high rate of rotation, the car can be disconnected from the socket, and the energy can be extracted from the high-speed rotating flywheel.

Experiment 1

Researchers looked at flywheels with different radii to gauge the effect of size on the total energy they could store. The wheels were all started at an initial frequency of 50 revolutions per second (rev/sec). All of the flywheels were disk-type (they had a uniform thickness along their entire radius), all were made of the same material, and all had the same thickness. After reaching the initial speed, a uniform resisting force was applied to determine how much energy it took to stop the wheel. The results of this experiment appear in Table 2.2.

<table>
<thead>
<tr>
<th>Radius (cm)</th>
<th>Energy Stored (joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>1,600</td>
</tr>
<tr>
<td>30</td>
<td>8,100</td>
</tr>
<tr>
<td>40</td>
<td>25,600</td>
</tr>
</tbody>
</table>

Experiment 2

Next, a disk-type flywheel with a radius of 30 cm was brought up to various initial speeds by an electric motor. The energy stored at each speed was measured. Results appear in Table 2.3.

<table>
<thead>
<tr>
<th>Frequency (rev/sec)</th>
<th>Energy Stored</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>5,184</td>
</tr>
<tr>
<td>60</td>
<td>11,664</td>
</tr>
<tr>
<td>80</td>
<td>20,736</td>
</tr>
<tr>
<td>100</td>
<td>32,400</td>
</tr>
</tbody>
</table>

Experiment 3

One of the limiting factors in the use of flywheels is the centrifugal force (the force pulling outward from the rim) that is generated as the wheel is turning. When this force becomes too great, it causes the wheel to fly apart or explode. The centrifugal force is determined by
CHAPTER 2: Diagnostic Test

8. Assuming that the researchers considered energy storage and wheel strength to be of equal importance, which of the wheel designs in Experiment 3 would they conclude was optimal?

(F) Flat Disk
(G) Rim Disk
(H) Concave Disk
(J) The best design would depend on the wheel radius.

9. The experimental data indicate that for optimal energy storage, the flywheel should be a

(A) concave wheel with a large radius.
(B) rimmed wheel with a small radius.
(C) flat disk wheel with a large radius.
(D) concave wheel with a small radius.

10. Which of the following statements about the centrifugal force on a flywheel is best supported by the data presented?

(F) A graph of the force versus wheel radius would look similar to a graph of frequency versus energy stored.
(G) A graph of the force versus wheel radius would look similar to a graph of energy stored versus wheel strength.
(H) A graph of the force versus frequency would look similar to a graph of frequency versus energy stored.
(J) A graph of the force versus frequency would look similar to a graph of energy stored versus wheel strength.

7. The difference between Experiment 1 and Experiment 2 is in Experiment

(A) 1, the fly wheel radius is varied, while in Experiment 2, the initial speed of the flywheel is varied.
(B) 1 the flywheel type is varied, while in Experiment 2, the initial flywheel speed is varied.
(C) 2 the resisting force is varied, while in Experiment 1, it is uniform.
(D) 1 the centrifugal force was varied, while in Experiment 2, it remains constant.

8. The difference between Experiment 1 and Experiment 2 is in Experiment

(A) 1, the fly wheel radius is varied, while in Experiment 2, the initial speed of the flywheel is varied.
(B) 1 the flywheel type is varied, while in Experiment 2, the initial flywheel speed is varied.
(C) 2 the resisting force is varied, while in Experiment 1, it is uniform.
(D) 1 the centrifugal force was varied, while in Experiment 2, it remains constant.

the frequency and the radius of the wheel.

A doubling of the radius results in a doubling of the centrifugal force; a doubling of the frequency results in a quadrupling of the centrifugal force.

Researchers tested three wheel designs (see figure below). All of the wheels had a radius of 30 cm and the same mass; wheel thicknesses were changed to keep the mass constant. The frequency of each wheel was increased slowly until it exploded. The frequency at which this occurred as well as the energy stored in the wheel at the time was recorded. Results appear in Table 2.4.

Results appear in Table 2.4.

Flat Disk: Rim: Concave:

TABLE 2.4

<table>
<thead>
<tr>
<th>Flywheel Type</th>
<th>Energy Stored (joules)</th>
<th>Strength (Maximum frequency)(rev/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Disk</td>
<td>17,266</td>
<td>73</td>
</tr>
<tr>
<td>Rim Disk</td>
<td>16,231</td>
<td>42</td>
</tr>
<tr>
<td>Concave Disk</td>
<td>19,627</td>
<td>72</td>
</tr>
</tbody>
</table>

7. The difference between Experiment 1 and Experiment 2 is in Experiment

(A) 1, the fly wheel radius is varied, while in Experiment 2, the initial speed of the flywheel is varied.
(B) 1 the flywheel type is varied, while in Experiment 2, the initial flywheel speed is varied.
(C) 2 the resisting force is varied, while in Experiment 1, it is uniform.
(D) 1 the centrifugal force was varied, while in Experiment 2, it remains constant.
11. A car has a disk-type flywheel with a radius of 30 cm. The disk is initially storing 120,000 joules while rotating at 64 rev/sec. When the wheel is turning at half the original speed, how much energy will remain?

(A) 10,000 joules  
(B) 30,000 joules  
(C) 50,000 joules  
(D) 70,000 joules

12. Flywheels have been considered for the storage of energy that is collected using solar panels during the day. This stored energy could be used as a city power source at night. Such a flywheel would need to handle vast amounts of energy, perhaps 5 million megajoules. In consideration of these energy storage needs and safety, which of the following would be the best design for such a system?

I. One very large flywheel that would turn at a relatively slow frequency  
II. Collections of small flywheels, each turning at high frequencies  
III. One large flywheel that would transfer its energy to many smaller flywheels as it slowed down

(F) I only  
(G) II only  
(H) III only  
(J) I and III

Passage III

Lake ecosystems are highly sensitive to changes in the acid-base balance. In the last few decades there has been concern about increases in lake sulphate concentrations and pH. This has led to an environmental campaign to reduce the amount of sulphates released into the atmosphere from industrial sources.

Experiment 1

Ecologists measured the terrestrial deposition (land deposits) of sulphate at five alpine stations located adjacent to lakes annually between 1990–1998. Sulphate was measured in soil and rock samples. The averages for two-year sampling periods appear in Table 2.5.

<table>
<thead>
<tr>
<th>Lake</th>
<th>Sulphate Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.65</td>
</tr>
<tr>
<td>2</td>
<td>0.60</td>
</tr>
<tr>
<td>3</td>
<td>0.82</td>
</tr>
<tr>
<td>4</td>
<td>0.89</td>
</tr>
<tr>
<td>5</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Experiment 2

In 1998, the researchers looked at the sulphate concentrations (in µ equivalents/L) and pH in the lakes adjacent to the alpine stations and compared them to concentrations recorded in the same lakes in 1990. Results appear in the following figure.
CHAPTER 2: Diagnostic Test

Experiment 3
In order to take into account changing climatic parameters in the study area, the researchers looked at rainfall and temperature since 1900. The results appear in the following figure.

![Temperature and Precipitation Graph](image)

<table>
<thead>
<tr>
<th>Mean Annual Precipitation (mm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>-2.0</td>
</tr>
<tr>
<td>600</td>
<td>-1.0</td>
</tr>
<tr>
<td>800</td>
<td>0</td>
</tr>
<tr>
<td>1000</td>
<td>1.0</td>
</tr>
</tbody>
</table>

13. The researchers discovered that during the study period,

(A) the trend in sulphate lake concentration was neither up nor down but tended to mirror terrestrial deposition trends.

(B) terrestrial deposition and lake concentrations of sulphate increased.

(C) terrestrial deposition and lake concentrations of sulphate decreased.

(D) terrestrial deposition of sulphate decreased, while lake concentrations increased.

14. One difference between Experiments 1 and 2 was

(F) Experiment 1 was conducted over a longer period of time.

(G) Experiment 2 looked at glacial and nonglacial lakes, while Experiment 1 looked at only glacial lakes.

(H) Experiment 2 measured pH and sulphate concentrations, while Experiment 1 measured only sulphate concentrations.

(J) in Experiment 1, data was collected by analyzing rocks and soil, while in Experiment 2, air samples were taken.

15. Experiment 2 demonstrated that

(A) lake pH did not increase in the study period.

(B) the increase in pH in the study period was more dramatic than the increase in sulphate.

(C) the increase in sulphate was more dramatic in glacial lakes than in nonglacial lakes.

(D) the increase in pH was more dramatic in glacial lakes than in alpine lakes.

16. Which of the following statements about the sulphate concentrations measured in Experiment 1 is best supported by the data presented?

(F) Concentrations dropped in all the study areas.

(G) Concentration drops were most profound for lake 4.

(H) Concentrations dropped by about 75 percent for most areas.

(J) Concentrations dropped by about 50 percent for most areas.
17. Which of the following hypotheses might explain the findings of Experiment 2 in a way that is consistent with the findings in the other two studies?

I. Warmer air temperatures in the lake areas may have resulted in less annual ice cover. This provided more time for the weathering, by light and wind, of sulphate-containing rocks, leading to sulphate runoff into the lakes.

II. Drought conditions in the lake areas may have led to lower water levels, which concentrated the sulphate present.

III. The environmental campaign failed to reduce sulphate emissions.

(A) I only  
(B) III only  
(C) I or II  
(D) II or III  

Passage IV

In the 1970s, a spacecraft called the Mariner 10 flew by Mercury at close range three times. These flybys provided clues about an intriguing planet that we know less about than any other barring Pluto. Table 2.6 shows data on Mercury, compared with the other planets in our Solar System. Some of the numbers are approximations only. A planet’s rotational period is the time it takes to turn once on its axis, completing one planetary day. A planet’s orbital period is the time it takes to move once around the sun, completing one planetary year.

The following figure is a plot of the density versus the diameter for the terrestrial (nongaseous) planets.
18. Looking at the rotation periods and orbital periods in Table 2.6, it is clear that a Mercury
(F) day is about two thirds the length of a Mercury year.
(G) year is about two thirds the length of a Mercury day.
(H) year is about one half the length of a Mercury day.
(J) year is about the same length as a Mercury day.

19. If the moon (a terrestrial body) has a diameter of about 4,000 miles and a density of about 3.3 g/cm³, which of the following statements is most probably correct?
(A) The density versus diameter of terrestrial bodies appears to have a linear relationship.
(B) The density versus diameter of terrestrial bodies appears to have a linear relationship for Mars, Venus, and Earth only.
(C) The density versus diameter for the moon follows the linear relationship seen with the other terrestrial bodies, with the exception of Mercury.
(D) The linear relationship of density versus diameter does not appear to apply to terrestrial bodies other than the planets.

20. Which of the following is the terrestrial planet with the most eccentric orbit?
(F) Mercury
(G) Earth
(H) Jupiter
(J) Pluto
21. Which planet has a density that is most similar to that of water?
   (A) Jupiter
   (B) Saturn
   (C) Uranus
   (D) Pluto

22. Mercury has the hottest peak daytime temperature of any planet (around 973°C). Based on this information, which of the following statements is most probably correct?
   (F) Mean surface temperature is a good predictor of daytime temperature.
   (G) Mercury’s temperature remains stable throughout its rotational period.
   (H) Temperatures plunge on Mercury at night.
   (J) Nighttime temperatures are warmer on Mercury than daytime temperatures.

23. It is thought that Mercury has the largest core (dense planet center) in relation to the planet’s overall size of any of the terrestrial planets. If the earth’s core is approximately 3,000 miles in diameter, which of the following is a probable diameter for Mercury’s core?
   (A) Greater than 3,000 miles
   (B) Around 2,000 miles
   (C) Around 1,000 miles
   (D) Around 500 miles

Passage V
Schizophrenia is a mental illness that involves the dissociation of reason and emotion, resulting in symptoms including hallucinations, hearing voices, intense withdrawal, delusions, and paranoia. The average age at which schizophrenia is diagnosed is 18 years for men and 23 years for women. It has been observed to run in families.

The cause remains a mystery, but there are several competing theories. These theories are based in part on findings from twin studies, which look at identical twins in which one or both have the disease. (Identical twins share 100 percent of their genetic material, while nonidentical twins share about 50 percent.) In 50 percent of the cases, when one identical twin is affected, the other will also suffer from schizophrenia. Identical twin pairs in which one individual is ill and the other is well are referred to as discordant twins.

Genetic Theory
One school of thought is that schizophrenia is a genetic disorder (one passed through the genes from parents to children). This theory gained support from the fact that schizophrenia runs in families. While it was originally believed that it was the family environment that caused this, a study has shown that children of schizophrenics adopted by families without the disease have the same risk of developing the illness as those raised by their birth parents. A final piece of evidence is the fact that the children of discordant identical twins all have the same chance of developing the illness: 17 percent. This indicates that even the healthy twin is somehow carrying the agent of the disease, presumably in the genes.

Infection Theory
Another school of thought is that schizophrenia arises because of a viral infection of the brain. Studies have shown that a class of viruses called “slow viruses” can linger in the brain for twenty years or longer before the infected person shows symptoms. Brain infections with viruses such as the common cold-sore virus and herpes simplex type 1 can cause symptoms that resemble schizophrenia. Schizophrenia is also more common in children born in the winter, the season when viral infections are more common. Also, one study looking at families with a history of schizophrenia
showed a 70 percent increase in the rate of schizophrenia among children whose mothers had the flu during the second trimester of pregnancy.

24. The schizophrenia theories are similar in that both
(F) postulate that the foundation of the illness may be laid before birth.
(G) postulate that the family environment plays some role.
(H) predict that the children of schizophrenics are not at greater risk than other individuals.
(J) show that identical twins are at greater risk for schizophrenia than other individuals.

25. Which of the following findings best supports the gene theory?
(A) Parents of discordant twins report that the behavior of the twins begins to diverge at about 5 years of age, on average.
(B) In discordant identical twin pairs, a brain structure called the basal ganglia is activated more often in the ill twin than in the healthy twin.
(C) An identical twin of a schizophrenia sufferer is four times as likely to have the illness as a nonidentical twin of a schizophrenia sufferer.
(D) Studies have shown that viral infections sometimes infect one identical twin in the uterus and not the other.

26. The infection theory is most effective at explaining the fact that
I. schizophrenic patients do poorly on some memory tests.
II. among identical twins discordant for schizophrenia, the healthy twin may have some borderline schizophrenic traits.
III. ill twins in discordant pairs have higher rates of finger abnormalities, which can be an indication of a viral infection that occurred in the womb.
(F) I only
(G) II only
(H) III only
(J) II and III

27. Which of the following hypotheses might supporters of both theories agree with?
I. Individuals with schizophrenia have certain genes that predispose them to the disease but require some kind of trigger to turn the disease on.
II. Individuals with schizophrenia have certain genes that predispose them to viral infections of the brain.
III. Schizophrenia is not one disease but a collection of diseases.
(A) I and II
(B) I and III
(C) II and III
(D) I, II, and III
28. An identical pair of twins is found in which one was adopted at birth. Both received a diagnosis of schizophrenia as teenagers. An explanation that might be offered by supporters of the viral theory is that children are most prone to viral infections when they are school age, long after the infant in this case was adopted. The stress of being an adopted child may have triggered schizophrenia in the predisposed twin. Since 50 percent of identical twin pairs with schizophrenia are discordant for the disease, this case does not shed light on its origin. The brains of both twins may have been infected with a slow-acting virus when they were still in the womb.

29. Which of the following studies would be logical for supporters of the genetic theory to conduct next?

(A) One that looks for finger abnormalities in the parents and grandparents of schizophrenic children
(B) One that looks for differences in the chromosomes (which hold the genes) of schizophrenic individuals and healthy individuals
(C) One that looks for scarring in the brains of schizophrenic individuals, which might be a sign of an early injury or infection
(D) One that looks at the home environments of identical twins versus non-identical twins

Passage VI

Researchers are experimenting with chemical sensors that could act as artificial noses. These artificial noses are capable of detecting odors indicating that meats or produce are spoiling, making them useful in the food industry. The sensors detect volatile organic compounds (VOCs), which are indicators of food quality. In an experimental system, researchers created thick films of certain semiconductors (materials that are neither good electrical conductors nor insulators). Each film is sensitive to a small range of VOCs. When they come into contact with these VOCs, they are oxidized. In this process, oxygen molecules combine with the semiconductors to form new molecules and free electrons are released. The addition of the free electrons alters the electrical properties of the semiconductor films, and this electrical change is detected.

**Experiment 1**

Researchers developed artificial noses by coupling a number of different VOC detectors, similar to those described above. They then tested the ability of the different artificial noses to detect these VOCs. Results appear in the following figure.

**Experiment 2**

The researchers sampled the air on a daily basis above a variety of stored fruits, vegetables, and meats. These air samples were injected into the column of a chromatograph. A chromatograph is a tool that separates mixtures into their component parts allowing researchers to identify the vapors. The results of the chromatograph experiment appear
in the following figure. (Low-molecular weight alcohols, esters, and aldehydes appear grouped in the results.)

30. Which of the following statements is best supported by the experimental data presented?
   (F) Alcohols are the most important VOCs for the detection of fruit spoilage.
   (G) Limonene is the most important VOC for the detection of fruit spoilage.
   (H) Diacetyl is the most important VOC for the detection of vegetable spoilage.
   (J) Esters are the most important VOCs for the detection of fruit spoilage.

31. Which of the following is the most likely interpretation of the data on vegetable spoilage?
   (A) Vegetables start to spoil slightly earlier than fruits.
   (B) Vegetables start to spoil on about day 5 but show improvement by day 9.
   (C) The concentrations of some VOCs continue to rise as vegetables decay, while others begin to wane, making them less useful as indicators.
   (D) The concentrations of all VOCs begin to wane after some time, showing that they are not reliable indicators of food spoilage.

32. Which of the following statements about the artificial noses tested is best supported by the data?
   (F) Nose 1 is the best indicator of meat spoilage.
   (G) Nose 2 is the best indicator of vegetable spoilage.
   (H) Nose 2 is the best indicator of fruit spoilage.
   (J) Nose 3 is the best indicator of fruit spoilage.

33. If cost constraints limited a food processing company to one VOC detector for use in testing fruits, vegetables, and meats, which would be the best choice?
   (A) A limonene detector
   (B) An alcohol detector
   (C) An ester detector
   (D) A diacetyl detector

34. Diacetyl concentration accumulates slowly. Its first appearance signals the tenderization of the meat. If researchers were to create a patch that would appear on packaged meats indicating diacetyl presence, which of the following would be the best use of such a patch?
   (F) A patch sensitive to the presence of .05 mg/L of diacetyl, alerting a grocer that the meat should be destroyed
   (G) A patch indicating the presence of ≥ 2 mg/L of diacetyl, alerting a consumer that the meat should be eaten soon
   (H) A patch indicating the presence of ≥ 2 mg/L of diacetyl, alerting a processing plant that the meat must be sold soon
   (J) A patch indicating the appearance of 0.5 mg/L of diacetyl, alerting a consumer that the meat should be eaten soon
Passage VII

Interstellar objects (objects among the stars) in outer galaxies are often investigated using a method known as spectroscopy. Spectroscopy is a method of determining the atomic or molecular makeup of something by observing the object’s spectral lines. Atoms and molecules have fixed energy levels. When an electron in an atom moves from one of its possible energy states to another, the atom releases light. This light has an energy equal to the difference in the two energy levels through which the electron moved. These energy transitions are observed as a sequence of spectral lines. Spectral lines that are close together indicate transitions in which the change in energy levels is similar.

The following figure depicts three hypothetical atoms. Energy levels are represented as horizontal segments. The distance between the segments is representative of the energy difference between the various levels. All possible transitions between energy levels are indicated by arrows.

Scientists can observe the spectral lines of atoms that are dominant in far-away galaxies. Due to the speed at which these galaxies are traveling, these lines are shifted, but their pattern remains the same. This allows researchers to use the spectral pattern to determine which atoms they are seeing. Table 2.7 shows spectroscopic measurements made by researchers trying to determine the atomic makeup of a particular far-away galaxy. Light energy is not measured directly, but rather is determined from measuring the frequency of light, which is proportional to the energy.

<table>
<thead>
<tr>
<th>Frequencies measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,096,400</td>
</tr>
<tr>
<td>2,092,790</td>
</tr>
<tr>
<td>2,021,140</td>
</tr>
<tr>
<td>1,940,200</td>
</tr>
<tr>
<td>1,946,260</td>
</tr>
</tbody>
</table>

35. Which of the following statements is correct, based on the information in the figure above?
(A) Atom 1 has five energy levels.
(B) Atom 1 has seven energy levels.
(C) Atom 3 has more energy levels than Atom 2.
(D) The greatest energy transition in Atom 2 is larger than the greatest transition in Atom 3.

36. Which of the following statements is most likely to be incorrect, based on the information in the figure?
(F) Atom 1 would emit six spectral lines.
(G) Atom 2 would emit four spectral lines.
(H) Atom 3 would emit five spectral lines.
(J) The number of spectral lines emitted by an atom does not necessarily match the number of energy levels.
CHAPTER 2: Diagnostic Test

37. Physicists using spectroscopy to investigate the atoms depicted in the figure would observe which of the following?
   (A) Atom 2 would have three spectral lines that are very close together.
   (B) Atom 3 would have two spectral lines that are very close together and three more spectral lines that are relatively far from each other.
   (C) Atom 3 would have three spectral lines that are very close together.
   (D) Atom 1 would have three spectral lines that were close together as well as another pair of spectral lines that are very close together.

38. The researchers making the measurements for Table 2.7 might reach which of the following conclusions?
   I. The atoms appear to have five energy levels, indicating that they could be the same as Atom 1.
   II. The atoms appear to be emitting two sets of two closely spaced frequencies, indicating that they could be the same as Atom 3.
   III. The observed atoms do not appear to be going through any transitions in energy levels.
   (F) I only
   (G) II only
   (H) III only
   (J) II and III

39. Atoms have “forbidden” transitions. These are transitions between energy levels that are not allowed by the laws of conservation in atomic physics. Which of the following statements concerning the atoms in the figure are true?
   (A) Atom 1 has no forbidden transitions.
   (B) Atom 2 has one forbidden transition.
   (C) Atom 3 has no forbidden transitions.
   (D) Atom 3 has more than one forbidden transition.

40. The difference in the information represented in the figure and Table 2.7 is the figure
   (F) was arrived at with spectroscopic measurements, while the information in Table 2.7 was arrived at using only a mathematical formula.
   (G) indicates the pattern of frequencies emitted by an atom, while Table 2.7 indicates the exact frequencies emitted by an atom.
   (H) indicates the number of energy levels that an atom has, while in Table 2.7, this number can be determined only by identifying the atom being observed.
   (J) gives an idea of the proximity of spectral lines associated with the atoms, while Table 2.7 indicates only the energy levels associated with the atoms observed.
ANSWER KEY

Section 1: ENGLISH


Section 2: MATHEMATICS

Section 3: READING

1. B  
2. H  
3. B  
4. F  
5. D  
6. H  
7. A  
8. H  
9. A  
10. F  
11. C  
12. F  
13. B  
14. J  
15. C  
16. J  
17. C  
18. F  
19. C  
20. G  
21. C  
22. J  
23. A  
24. H  
25. A  
26. H  
27. C  
28. F  
29. C  
30. G  
31. B  
32. H  
33. C  
34. J  
35. D  
36. J  
37. A  
38. G  
39. C  
40. F

Section 4: SCIENCE REASONING

1. C  
2. F  
3. C  
4. G  
5. D  
6. H  
7. A  
8. H  
9. A  
10. H  
11. B  
12. F  
13. D  
14. H  
15. C  
16. G  
17. A  
18. F  
19. C  
20. F  
21. D  
22. H  
23. B  
24. F  
25. C  
26. H  
27. D  
28. J  
29. B  
30. G  
31. B  
32. H  
33. B  
34. J  
35. A  
36. F  
37. D  
38. G  
39. B  
40. F
EXPLANATORY ANSWERS

Section 1: ENGLISH

1. The correct answer is (D). Since the event being described is a past event prior to another past event, the verb tense that’s needed is the past perfect, not the present perfect: “I’d heard” rather than “I’ve heard.”

2. The correct answer is (G). When two independent clauses are joined by the conjunction “and,” a comma is normally inserted before the “and” (unless the clauses are very short). It’s not necessary or particularly effective to use either a semicolon—as in choice (H)—or a period—as in choice (J)—to separate these two clauses; they naturally seem to belong together.

3. The correct answer is (C). Since the antecedent of the pronoun is “the reed” (singular), the pronoun should be the singular “it” rather than the plural “they.”

4. The correct answer is (J). The logical connector here is “but” rather than “so,” since a contrast rather than a cause-and-effect relationship is being described. The semicolon in choice (H) is wrong; with the conjunction “although,” the second clause becomes a subordinate or dependent clause, which can’t stand alone as a sentence and therefore can’t properly follow a semicolon.

5. The correct answer is (D). In both the original wording and choice (B), what follows the period is a fragment rather than a complete sentence. In choice (C), the combined sentences form a run-on. Choice (D) avoids both errors.

6. The correct answer is (F). The original phrase substantiates the writer’s complaint about the high price of oboe reeds. Choices (G), (H), and (J) introduce ideas that are either completely irrelevant or slightly off the point.

7. The correct answer is (C). Both the original wording and choice (B) create run-on sentences. The shift of pronoun to “one” in choice (D) sounds a little stilted, and the colon seems less appropriate than the semicolon. (In general, the colon is best when it could be replaced with the phrase “that is,” which isn’t the case here.)

8. The correct answer is (J). All of the answer choices are grammatically correct, but choice (J) is the most concise.

9. The correct answer is (D). The underlined words can be omitted, because they merely repeat the idea already stated in the words “progressively worse.”

10. The correct answer is (G). The pronoun reference here is unclear: Who or what is “they”? Choices (G) and (H) both clarify what is being referred to (the reeds, of course), but choice (G) does so more concisely.

11. The correct answer is (C). The modifier “desperate” must be next to “I,” since that is the person whom the modifier describes.

12. The correct answer is (F). As in the original wording, the parenthetical phrase “within two weeks” should be set off from the rest of the sentence by a pair of commas.

13. The correct answer is (D). The placement of the modifying word is fine, but it should be changed from an adjective to an adverb (“immediately”), since it modifies the verb “called.”

14. The correct answer is (F). This basic introductory information about what oboe reeds are needs to appear early in the essay.
15. The correct answer is (C). The information in paragraph 4 is relevant to the overall content and theme of the essay, since it contributes to the explanation of why oboists have so much difficulty in getting enough good reeds for their instruments.

16. The correct answer is (G). The subject of the verb is "goal," so the verb should be singular, "was" rather than "were." "To determine" is the idiomatic construction to use in this context.

17. The correct answer is (D). The original wording is verbose and repetitive; so, to a lesser extent, are choices (B) and (C). Choice (D) says the same thing concisely.

18. The correct answer is (G). The paragraph is devoted to explaining the two underlying ideas that guided the scientists who designed the Viking experiments. Choice (G) sets this up accurately and clearly.

19. The correct answer is (C). The semicolon in the original wording is wrong, since what follows the semicolon can’t stand alone as a sentence. Changing the punctuation mark to a comma solves the problem.

20. The correct answer is (G). This is the most idiomatic (normal-sounding) and clear of the alternatives. Note that choice (H) is definitely wrong because it’s unclear who or what “contains” the thousands or millions of life-forms mentioned.

21. The correct answer is (A). Having explained, in paragraph 2, that the Viking scientists wanted to look for the most abundant forms of life, and that these were expected to take the form of soil-dwelling microbes, this sentence makes a logical transition to paragraph 3 by beginning the explanation of how the Viking experiments were designed to search for creatures of these kinds.

22. The correct answer is (F). The original wording is correct. The possessive form (using an apostrophe) isn’t appropriate here, since organisms isn’t followed by anything that is “possessed” by the organisms, nor is any such possession implied.

23. The correct answer is (D). The idiomatic way to phrase this is the one in choice (D): “one characteristic . . . is that they transform” etc.

24. The correct answer is (H). This phrasing provides the most specific information about the plant structures that the writer is thinking about.

25. The correct answer is (C). The essay is about how the Viking experiments were designed to test for life on Mars. In that context, information about how long the Martian day lasts is basically irrelevant.

26. The correct answer is (G). The three clauses being strung together here should be in grammatically parallel form. Choice (G) carries out the parallelism.

27. The correct answer is (B). Sentences 1 and 3 belong together; both describe how living organisms on Earth give off gases. Sentence 2 follows naturally after these; it connects this phenomenon to one of the Viking tests. Sentence 4 provides detail about the test and makes a natural conclusion.

28. The correct answer is (F). It makes sense to start a new paragraph here; each of the three Viking experiments gets a paragraph of its own. And since this is the last of the experiments to be described, it’s appropriate to start the paragraph with the adverb Finally.

29. The correct answer is (C). This adverb sounds most natural immediately after the verb it modifies, “was.”
30. **The correct answer is (J).** Only the last paragraph of the essay deals with the *results* of the Viking mission. The rest focuses on the theoretical concepts behind the Viking experiments and the design of the experiments themselves. Thus, the essay really doesn’t fulfill the assignment given.

31. **The correct answer is (A).** The original wording is correct. The present perfect tense makes sense here, and the proper form of the verb, *begun*, is used. (*Began* is the past tense and would never be used with a helping verb.)

32. **The correct answer is (G).** All of the answer choices say more or less the same thing. Choice (G) does so most succinctly and clearly.

33. **The correct answer is (B).** In this context, the contraction “its” is being used to mean “it is.” Therefore, the word should contain an apostrophe: “it’s.”

34. **The correct answer is (J).** The main theme of the essay is that “the good old days” weren’t really very good. The rhetorical question posed in choice (J) introduces this theme well and makes a good start to the second paragraph. Choice (F) is the best wrong answer, but it suggests that the essay will focus mainly on the advantages of modern technology, which is not true.

35. **The correct answer is (A).** This information is relevant to the theme of the essay because it underscores the fact that the average person at the turn of the century did not have access to many advantages that would make life more pleasant in later years. The original wording is best; choices (B) and (C) are both too informal (slangy) to fit comfortably into the overall tone of the essay.

36. **The correct answer is (H).** “It” is the wrong pronoun, of course, since what’s being referred to is “coal-burning stoves,” which is plural. Choice (H) corrects this error less awkwardly and more clearly than the alternatives.

37. **The correct answer is (C).** The second and third sentences describe the disadvantages of central heating, which came *after* coal stoves. Therefore, they should follow the sentences about coal stoves and appear last in the paragraph.

38. **The correct answer is (F).** The sentence begins with the first-person pronoun “We,” and “our” continues this construction in a logical and consistent way.

39. **The correct answer is (A).** The proposed addition is very appropriate: It contributes in a vivid way to our understanding of the problems created by the “romantic” horse and buggy in end-of-the-nineteenth-century cities.

40. **The correct answer is (G).** The original wording is vague and fails to explain why the shorter buildings made the summers seem hotter. Choice (G) is the only alternative that provides the information needed to clarify the point.

41. **The correct answer is (C).** This choice provides specific details to support the writer’s point. Choices (A) and (B) merely state the idea without providing evidence to support it, and choice (D) digresses into a discussion of today’s summer fashions, which is basically irrelevant.

42. **The correct answer is (H).** This choice maintains the grammatical parallelism required to make the three items listed sound consistent.

43. **The correct answer is (D).** The original wording creates a run-on sentence, with two independent clauses merely jammed together. Choice (D) fixes this by
adding the appropriate subordinating conjunction “While,” which clarifies the logical relationship between the two ideas and also corrects the grammatical error.

44. The correct answer is (F). The phrase “at least in that respect” is a logical unit that should be kept together and set off from the rest of the sentence with a comma on either side.

45. The correct answer is (C). This fact clearly belongs in paragraph 5, where the “bad old summers” are described; and since it offers a fact that is even worse than the facts already given in that paragraph, it seems appropriate to put it at the end of the paragraph, where it can serve as the climax of that portion of the essay.

46. The correct answer is (G). The correct superlative form of the adjective “famous” is “most famous”—the same kind of construction used with most adjectives that are two syllables long or longer.

47. The correct answer is (B). The semicolon is wrong because what follows the punctuation mark is not an independent clause. Choices (C) and (D) are wrong because they insert an intrusive comma after the word “because,” which instead should flow directly into what follows.

48. The correct answer is (J). Omit this sentence, since it merely repeats information stated a few sentences earlier. It’s obvious that the fiance being referred to is the same one mentioned previously.

49. The correct answer is (D). The two sentences should be joined into one, since the second is a mere fragment. Choice (C) is grammatically correct (it fixes the fragment), but it’s repetitive and awkward to mention “England” twice within three words.

50. The correct answer is (F). The original wording is correct, since what’s being compared is “comfort in England” with comfort “in the United States.”

51. The correct answer is (C). “Once” makes a better introductory word for two reasons: It clarifies the logical relationship between the two clauses, and it makes the first clause into a subordinate clause, thus avoiding the grammatical problem of a run-on sentence.

52. The correct answer is (H). The best punctuation to use when two independent clauses are joined by and is a comma preceding the and.

53. The correct answer is (A). Since the writer wants to stress the unusual nature of the article, “ground-breaking” seems to be the appropriate adjective.

54. The correct answer is (G). In paragraph 3, Steinem was struggling to find work; in paragraph 4, she is a successful writer. The sentence given in choice (G) explains the transition logically and gracefully.

55. The correct answer is (D). This choice is the most idiomatic, graceful, and concise.

56. The correct answer is (F). The details here are appropriate and help clarify the kind of writing Steinem was relegated to, so omitting them would be a poor choice. The original wording is the most graceful of the three alternatives.

57. The correct answer is (B). The semicolon isn’t needed here; the independent clauses are joined by “and,” which calls for a comma instead. Choice (B) appropriately sets off the parenthetical phrase “she says” with a pair of commas.

58. The correct answer is (J). This sentence is the only one that explains and demonstrates how concern over abortion rights motivated Steinem to become a committed feminist.

59. The correct answer is (C). The modifying phrase “a tireless worker and advocate” must be placed next to “Steinem,” since that
is what the phrase modifies. Choices (B) and (D) are grammatically correct, but they sound awkward and a little unclear.

60. The correct answer is (J). The simple "including" is the clearest and most concise choice for this context.

61. The correct answer is (B). The comparison being drawn here calls for the phrase to be uninterrupted by commas.

62. The correct answer is (F). The pronoun "whose" is perfectly correct; its antecedent is "filmmakers."

63. The correct answer is (D). This sentence should be omitted; it’s redundant, since it merely repeats the idea stated in the clause immediately preceding it.

64. The correct answer is (G). It’s better to put the word “not” after “product,” to create the appropriate parallelism: “not of the salon but of the common playhouse.” Now the words that follow the linked prepositions “not . . . but” are strictly parallel in form.

65. The correct answer is (C). We already know, from the rest of the paragraph, that the three people named were geniuses of the early movies. Information about where they came from seems irrelevant, since the essay doesn’t discuss national differences in cinema. This phrase can be left out without losing a thing.

66. The correct answer is (H). The original wording creates a run-on sentence. Choice (H) fixes the problem. So does choice (J), but “For” doesn’t connect the two ideas logically; and the dash in choice (G) leaves the relationship between the two ideas vague and confusing.

67. The correct answer is (A). The preposition “like” is correct here, since what follows is a phrase rather than a clause.

68. The correct answer is (J). Since what follows the semicolon is not an independent clause, the mark should be changed to a comma.

69. The correct answer is (B). The idea in this sentence is in contrast to the idea of the previous sentence; therefore, “But” is a more logical word with which to start the sentence.

70. The correct answer is (J). The underlined phrase should be omitted; it merely repeats the idea contained in the word “larger” without adding any information.

71. The correct answer is (B). The idiomatic construction in English runs, “the larger . . . the greater.” Once you’ve used the first half of a pair of phrases like these, you’re committed to using the second half as well.

72. The correct answer is (H). The antecedent of the pronoun is “creator,” so the third-person pronoun “his” (or “his or her”) must be used here.

73. The correct answer is (D). Since this is the possessive “its” rather than the contraction meaning “it is,” no apostrophe should be used.

74. The correct answer is (G). The subject of the verb is “what makes the movies truly unique,” which is singular in form; therefore, the singular verb “is” must be used.

75. The correct answer is (D). The third paragraph should come first; it introduces the topic and places the movies in their context as the leading twentieth-century artistic innovation. The other two paragraphs, which discuss some specifics about the development of movies as an art form, follow logically after this.

Section 2: MATHEMATICS

1. The correct answer is (C). ⅓ of 42 is 14, and ⅙ of 42 is 7. Thus, 21 horses are black or white, leaving 21 horses that are brown.

www.petersons.com/arco
2. The correct answer is (J). In 5 hours, 4 ounces \((7 - 3)\) of water have dripped. Therefore, the “drip rate” is \(\frac{4}{5}\) of an ounce per hour. From 5 p.m. on Sunday until 2 a.m. on Monday is 9 hours, so the total that will have dripped is 
\[
7 + \left(\frac{4}{5} \times 9\right) = 7 + \frac{36}{5} = \frac{71}{5} \text{ ounces.}
\]

3. The correct answer is (A).

\[
m_{PQ} = \frac{(5 - 2)}{3 - (-1)} = \frac{3}{4}
\]

4. The correct answer is (K). We know that the average of \(x\) and \(-1\) must be 2. That is:
\[
2 = \frac{x + (-1)}{2}
\]

Thus, \(4 = x - 1\), \(x = 5\).

Similarly, we know that the average of \(y\) and 3 must be 6.

Thus, \(6 = \frac{y + 3}{2}\); \(12 = y + 3\); \(y = 9\).

So, \(2x + y = 19\).

5. The correct answer is (C).

Substituting \(y = \frac{1}{2}\), we have
\[
\left(\frac{1}{2}\right)^0 + \left(\frac{1}{2}\right)^{-1} = 1 + 2 = 3.
\]

6. The correct answer is (J). The perimeter of the longer rectangle is \(2L + 2W\).

The other rectangle must have a length of \(\frac{1}{2}L\) and a width of \(2W\), since the area is the same. Thus, the second rectangle has a perimeter of \(2\left(\frac{1}{2}L\right) + 2(2W) = L + 4W\).

7. The correct answer is (C). The arithmetic mean of \(x\) and \(y\) is \(\frac{(x+y)}{2} = m\). This means that \(x + y = 2m\), and \(x + y + z = 4m\). Dividing by 3 to get the arithmetic mean of \(x, y,\) and \(z\), we have \(\frac{(x+y+z)}{3} = \frac{4m}{3}\).

8. The correct answer is (J). Looking first at triangle \(ABE\), we have a right triangle with one angle of \(90^\circ\) and one angle of \(27^\circ\). Thus, \(m\angle A\) must be \(63^\circ\). Hence, \(m\angle BAC\) is one third of that, or \(21^\circ\). So, looking at triangle \(ABC\), \(m\angle BCA\) must be \(180^\circ - 21^\circ - 27^\circ = 132^\circ\). Since \(x\) is the supplement to that angle, \(x = 48^\circ\).

9. The correct answer is (D). Because each person had five choices, there are 25 possible pairs of numbers. The only way the sum could be odd is if one person picked an odd number and the other picked an even number. Suppose that John chose the odd number and Lisa the even one. John had three possible even numbers to select from, and for each of these, Lisa had two possible choices, for a total of \((3 \times 2) = 6\) possibilities. However, you could have had John pick an even number and Lisa pick an odd one, and there are also six ways to do that. Hence, out of 25 possibilities, 12 have an odd total and 13 have an even total. The probability is \(\frac{13}{25}\).

10. The correct answer is (F). Running \(m\) buses for two days is the same as running one bus for \(2m\) days. If we use \(g\) gallons of gasoline, each bus uses \(\frac{g}{2m}\) gallons each day. So if you multiply the number of gallons per day used by each bus by the number of buses and the number of days, you should get total usage. Thus:
\[
\frac{g}{2m} \times 4 \times 5 = \frac{10g}{m}.
\]

11. The correct answer is (B). Letting \(C = \frac{\text{cost}}{t}\), \(w = \text{number of workers, and } t = \text{time in hours, we have the relationship } C = k \frac{w}{t^2}\). Therefore, when \(w = 12\) at \(t = 2\), we have \(1,500 = k \frac{12}{4} = 3k\); therefore, \(k = 500\). Using \(k = 500\) and substituting \(w = 9\) and \(C = 2,000\), we have:
\[
2,000 = 500 \times \frac{9}{t^2} = \frac{4500}{t^2}.
\]

Multiplying by \(t^2\) and dividing by 2,000, we have:
\[
t^2 = \frac{9}{4}; t = \frac{3}{2} = 1.5.
\]
12. The correct answer is (K). Using the quadratic formula with \( a = 1, b = -4, \) and \( c = 13 \):
\[
x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(13)}}{2(1)} = \frac{4 \pm \sqrt{16 - 52}}{2} = \frac{4 \pm \sqrt{-36}}{2}
\]
x = \frac{4 \pm 6i}{2} = 2 \pm 3i
Hence, one root is 2 + 3i.

13. The correct answer is (E).

The length of \( \overline{OQ} \) and \( \overline{OP} \) are the same:
\[
\sqrt{2^2 + 1^2} = \sqrt{5}
\]
The length of \( \overline{PQ} \) is \( \sqrt{1^2 + 1^2} = \sqrt{2} \). So the perimeter is 2\(\sqrt{5} + \sqrt{2} \).

14. The correct answer is (F). Since \( P = M + 1, N = 3 \), \( 3^{m+1} = 3(3^3) \), and \( \frac{3}{N} = \frac{1}{3^m} \).

15. The correct answer is (E).

Since \( A^2 - B^2 = (A - B)(A + B) \), \( A - B \) and \( A + B \) must be factors of 36. The possibilities are as follows:
\[
A - B = 1 \quad A + B = 36
A - B = 2 \quad A + B = 18
A - B = 3 \quad A + B = 12
A - B = 4 \quad A + B = 9
A - B = 6 \quad A + B = 6
\]
Only the second and fifth possibilities yield integer solutions, and in the fifth case, \( A = 6 \) and \( B = 0 \), which is not positive. The only choice that works is \( A = 10, B = 8 \), for which \( A + B = 18 \) and \( A - B = 2 \).

16. The correct answer is (F). Letting \( h \) be the price of the hat and \( s \) be the price of the scarf, \( h + s = 38 \), and \( h = s + 3 \). Substituting:
\[
s + s + 3 = 38
2s = 35
s = $17.50
\]

17. The correct answer is (C). Multiplying radicals gives \( \sqrt{18x} = \sqrt{30} \). Hence, \( 18x = 30 \), and \( x = \frac{5}{3} \).

18. The correct answer is (H). Doubling the first equation and adding it to the second gives us:
\[
4x - 2y + 8z = 14
-4x + 2y - 3z = 1
5z = 15; z = 3
\]

19. The correct answer is (B). The possible factors of 36 are (1,36), (2,18), (3,12), (4,9), and (6,6). The least possible sum is 12, but that is when \( x \) and \( y \) are equal. So we must take choice (B), 13, which we get with the factors (4,9).

20. The correct answer is (F). The total cost for the month is \( 500 + 15n \) for \( 15n \) minutes of calling. Thus, the average is \( \frac{500 + 15n}{15n} = \frac{c + 100}{3n} \).

21. The correct answer is (C). If the diameter is \( \pi \), the radius is \( \frac{1}{2} \pi \) and the area is \( \pi r^2 = \pi \left( \frac{1}{2} \pi \right)^2 = \frac{1}{4} \pi^3 \).

22. The correct answer is (F). Calling the smallest angle \( x \), the others are \( 2x, 3x, \) and \( (x+31) \). Because the measures of the angles in the quadrilateral must sum to 360°, we get:
\[
x + 2x + 3x + (x + 31) = 360°
7x + 31 = 360°
7x = 329°; x = 47°
\]
That makes the degree measures of the four angles 47°, 94°, 141°, and 78°. The difference between the two in the middle is 94° - 78° = 16°.

23. The correct answer is (A). Four out of 6 times, the first block drawn will be a zero. The remaining one third of the time, a non-zero number will be drawn, leaving one non-zero and four zero blocks. The chance of drawing a second non-zero block is \( \frac{1}{4} \). Hence, the product will not be zero only \( \frac{1}{4} \) of \( \frac{1}{4} \times \frac{1}{4} = \frac{1}{16} \) of the time.
24. The correct answer is (F). Factoring the numerator and denominator of the fraction, we see that we can divide out the common factor \((x - 3)\), thus:

\[
\frac{x^2 - 3}{x - 3} = \frac{(x+3)(x-3)}{x-3} = \frac{x+3}{1} = 4
\]

Substituting \(x = 3.03\) yields \(\frac{101}{1} = 1.01\).

25. The correct answer is (A). If the true distance is \(T\), then the odometer will show \(m = T + 0.10T = 1.17T = \left(\frac{11}{10}\right)T\). That is, \(m = \frac{11}{10}T\), so \(\frac{10m}{11} = T\).

26. The correct answer is (J). Let Elaine’s salary be \(3k\), and Carl’s will be \(2k\). A 20% raise for Elaine will bring her salary to \((1.2)(3k) = 3.6k\), while a $200 raise for Carl will bring his salary to \(2k + 200\). Thus, \(3.6k:(2k + 200) = 6:5\), or, in fractional form:

\[
\frac{\frac{3.6k}{2k+200}}{\frac{6}{5}} = \frac{\frac{3.6k}{2k+200}}{\frac{6}{5}} = \frac{\frac{3.6k}{2k+200}}{\frac{6}{5}}
\]

Cross-multiplying: \(18k = 12k + 1200; 6k = 1200; k = 200\). So Elaine’s salary is \(3k = 600\).

27. The correct answer is (C). \(P\) percent means \(\frac{P}{100}\). Hence, \(\frac{P}{100} \times 20\sqrt{3} = 3\) must be solved for \(P\). Thus, \(\frac{P\sqrt{3}}{100} = 3\). Multiplying by \(\frac{100}{\sqrt{3}}\), and noticing that \(\frac{1}{3\sqrt{3}} = \sqrt{3}\), gives us \(P = 5\sqrt{3}\).

28. The correct answer is (H). The sum of the measures of the angles in the triangle must be \(180^\circ\). Letting the degree measure of \(\angle A\) be \(x\), we have \(x + 50\) for \(B\) and \(3x\) for \(C\). Now:

\[
x + (x + 50) + 3x = 180^\circ
\]
\[
5x + 50 = 180^\circ
\]
\[
x = 26^\circ
\]

Hence, \(m\angle B = 76^\circ\) and \(m\angle C = 78^\circ\). Therefore, \(m\angle B - m\angle C = -2^\circ\).

29. The correct answer is (B). Adding the two equations gives us \(4n = 16\), so \(n = 4\). Knowing that \(n = 4\), the second equation tells us that \(8 + m = 10\), and \(m = 2\).

30. The correct answer is (H). Of the 12 students taking Spanish, 4 are taking both languages, leaving 8 taking only Spanish.

31. The correct answer is (C). If \(x = 2\), \(x^2 = 2^2 = 4\) and \(x^4 = 2^4 = \frac{1}{2} = \frac{1}{2} = 0.0625\). Hence, \(3x^2 + x^4 = 3.0625\)

32. The correct answer is (K). If \(x = \frac{1}{3}\), \(x^2 = \frac{1}{3} + 2y^2 = \frac{1}{3} + 2y^2 = 1\) implies that \(2y^2 = \frac{1}{3}\) and \(y^2 = \frac{1}{3}\). Now, \(1 + \frac{1}{3} = \sqrt{0.375} = \approx 0.6\).

33. The correct answer is (C). The logarithmic equation is equivalent to \(x^3 = \frac{1}{1000}\), for which \(x = 3\left(\frac{1}{\sqrt[3]{1000}}\right)\), or \(x = \frac{1}{10} = 0.1\).

34. The correct answer is (F). Dropping the perpendicular from \(C\) down to the extension of \(AB\) (see the diagram below), we see that \(m\angle CBD = 50^\circ\) and that the altitude of the triangle, \(h\), given by \(\frac{h}{2} = \sin 50^\circ\). Thus, \(h = 9\sin 50^\circ\), and the area of triangle \(ABC\) is thus \(\frac{1}{2}(6)(9)\sin 50^\circ = 27\sin 50^\circ\).

35. The correct answer is (E). Using the obvious notation, we have:

\[
4c + 6d + 3h = 815
\]
\[
2c + 3d + 4h = 720
\]

Multiplying the second equation by \(-2\) and adding the equations together yields \(-5h = -625; h = 125\).

36. The correct answer is (H). By the Pythagorean theorem,

\[
c^2 = \sqrt{3^2 + 5^2} = \sqrt{34} = 5.83,
\]

which is closest to 6.
37. The correct answer is (D). Adding the two equations, we have $3x + 4y = 13$. Multiplying by 3 gives us $9x + 12y = 39$.

38. The correct answer is (J). We see that we have 9 choices for the first digit, 10 choices for the second digit, and 10 choices for the third digit. Thus, the total is $9 \times 10 \times 10 = 900$.

39. The correct answer is (C). Calling the least number $x$, the second is $(x + 2)$, and the third is $(x + 4)$. Therefore, $x + (x + 2) + 2(x + 4) = 46$.

40. The correct answer is (J). The unshaded region is a sector with a $30^\circ$ angle, which is $\frac{1}{12}$ of the area of the circle. Hence, the shaded portion must be $\frac{11}{12}$ of $\pi r^2$. Dividing by $11\pi$ and multiplying by 12, we have $r^2 = 36$. Hence, $r = 6$, and the diameter is 12.

41. The correct answer is (E). Using J and R to stand for their present ages, we have:

$$J = R + 4$$
$$R - 2 = \frac{1}{4}(J - 2)$$

Multiplying the second equation by 3:

$$3R - 6 = 2(J - 2)$$

Substituting from equation one:

$$3R - 6 = 2(R + 4 - 2) = 2(R + 2)$$
$$3R - 6 = 2R + 4$$
$$R = 10$$

Hence, Rodney is 10 and Jerome is 14. $x$ years ago, Rodney was $10 - x$ and Jerome was $14 - x$, giving us:

$$14 - x = 2(10 - x)$$
$$14 - x = 20 - 2x$$
$$x = 6$$

42. The correct answer is (G). The equation of the circle is $(x - 6)^2 + (y - 9)^2 = 13^2$. Substituting $x = 1$ and $y = u$, we have:

$$25 + (u - 9)^2 = 169$$

$(u - 9)^2 = 144$; $u - 9 = \pm 12$

This gives us two possibilities: $u = -3$ or $u = 21$.

43. The correct answer is (D). Since John takes 20 minutes per room, he can do 3 rooms in 1 hour. Armando can do 4 rooms in an hour. Thus, together they do 7 rooms in 1 hour. To do 30 rooms will take them $\frac{30}{7}$ hours.

44. The correct answer is (G). Using the laws of logarithms, $2y - 3x = 2\log 5 - 3\log 2 = \log 5^2 - \log 2^3 = \log 25 - \log 8 = \log (\frac{25}{8})$.

45. The correct answer is (C). The planes pass at the moment when the total distance traveled by both equals $R$. Call this time $t$. The first plane, going $m$ mph, has traveled $mt$ miles. The second plane, going $(m + 50)$ mph, has traveled $(m + 50)t$. The two sum to $R$. Thus,

$$R = mt + mt + 50t$$
$$R = (2m + 50)t$$

Therefore,

$$t = \frac{R}{2m + 50}$$

Hence, the planes’ distance from City A is $m$ times this time:

$$mt = \frac{Rm}{2m + 50}$$

46. The correct answer is (G). Setting $y = 0$ and solving the quadratic formula with $a = 1$, $b = -2$ and $c = -6$:

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(-6)}}{2(1)} = \frac{2 \pm \sqrt{28}}{2} = \frac{2 \pm 2\sqrt{7}}{2} = 1 \pm \sqrt{7}$$

Since $\sqrt{7}$ is between 2 and 3, choosing the minus sign, $1 - \sqrt{7}$ is less than $-1$ and greater than $-2$.

47. The correct answer is (C). $f(g(x)) = (g(x))^2$. That is, $(g(x))^3 = \frac{1}{(x^2 + 1)}$, and $g(x) = \pm \frac{1}{\sqrt{x^2 + 1}}$. Choose the plus sign.
48. **The correct answer is (G).** Since the terms must have a common ratio,
\[
\frac{2}{x} = \frac{x}{3y}.
\]
Cross multiplying, \(x^2 = 64\), and \(x = \pm 8\). Hence the common ratio is either \(\pm 4\). For \(\pm 4\), the sixth term would be \((-2)(4)^5 = -2,048\), while for \(-4\) it would be \(2,048\).

49. **The correct answer is (D).** Factoring numerator and denominator:
\[
\frac{4x^2-9}{2x^2+x-3} = \frac{(2x-3)(2x+3)}{(x-1)(2x+3)}.
\]
Dividing out the common factor \((2x + 3)\) yields \(\frac{2x-3}{(x-1)}\).

50. **The correct answer is (F).** The slope of \(PQ\) is \(m = \frac{6-2}{(11-5)} = 2\).
Hence, any line perpendicular to it has slope \(-\frac{1}{2}\). Averaging the coordinates of \(P\) and \(Q\), we see that the midpoint of \(PQ\) is \((0, 4)\), which must be the y-intercept of the line we seek. Thus, \(y = -\frac{1}{2}x + 4\).

51. **The correct answer is (D).** We display the data in the Venn Diagram shown below, letting \(x\) be the number of users who have both a tape and disc drive.

```
2
\left\{\begin{array}{c}
T = \text{Tape Drive} \\
7 \\
x \\
x + 5 \\
\end{array}\right.
\Rightarrow D = \text{Disc Drive}
```

Totaling the numbers, we see that \(2 + 7 + x + (x + 5) = 50\); \(2x + 14 = 50\); \(2x = 36\); \(x = 18\). Knowing that \(x = 18\), we can see from the diagram that the total number in \(T\) is 25.

52. **The correct answer is (J).** Calling the height of the cliff \(H\), and illustrating the situation with the diagram below, we see in triangle \(BCD\) that \(\frac{H}{50} = \tan 40^\circ\), that is, \(H = 50 \tan 40^\circ\).
Then, in triangle \(ACD\), we see that \(\frac{H}{(H+M)} = \tan 20^\circ\), that is, \(H = 50 \tan 20^\circ + M \tan 20^\circ\).

![Diagram](08fig16.png)

Equating the two expressions, since both are equal to \(H\), we have:
\[50 \tan 40^\circ = 50 \tan 20^\circ + M \tan 20^\circ\]
We can solve for \(M\) by subtracting \(50 \tan 20^\circ\) from both sides and then dividing by \(\tan 20^\circ\) to give us:
\[M = \frac{50 \tan 40^\circ - 50 \tan 20^\circ}{\tan 20^\circ}\]

53. **The correct answer is (B).** Since \(\sqrt{8} = \sqrt{(4)(2)} = 2\sqrt{2}\), \(2\sqrt{8} = 4\sqrt{2}\), and \(3\sqrt{2} + 4\sqrt{2} = 7\sqrt{2}\).

54. **The correct answer is (K).** Letting \(L\) be the amount reimbursed on lodging and \(M\) be the amount reimbursed on food, the first piece of information we have says: \(M = L + 16\).
\[
M = L + 16
\]
(from first statement)
\[
\frac{1}{3} M = \frac{1}{3} L - 16
\]
(from second statement)
\[
-\frac{1}{3} M = -\frac{1}{3} L - 24
\]
(multiply first equation by \(-\frac{1}{3}\))
\[
-\frac{1}{6} M = -40
\]
(add the second and third equations)
\[
-5M = -240
\]
(cross multiply)
\[
M = $48 = \text{cost of meals}
\]
\[
M = L + 16, \text{ so } L = M - 16 = $32 \text{ for lodging.} \quad $48 + $32 = $80
\]

55. **The correct answer is (A).** The numbers in an arithmetic progression have a common difference. Hence, \(5 - (-3) = 3d\).
That is, $8 = 3d$ and $d = \frac{8}{3}$. Thus, $M = -3 + \frac{8}{3} = -\frac{1}{3}$.

56. The correct answer is (J). The fraction simplifies to $2y^2$, and $10y^2 - 2y^2 = 8y^2$.

57. The correct answer is (E). When adding the matrices, you add entries in corresponding locations. Remember to multiply each entry in A by 2 first. Thus, in the upper-left-hand corner, you have $-4 + x = -5$, so $x = -1$. Similarly, in the lower-right-hand corner, you have: $6 + y = 4$, so $y = -2$. Hence, $xy = 2$.

58. The correct answer is (H). To calculate $f\left(\frac{1}{x}\right)$, you substitute $\frac{x+1}{x}$ for $x$ wherever it appears, giving $f\left(\frac{1}{x}\right) = \frac{1}{x} + 1$. Combining this into a single fraction, you have $\frac{1}{x} = \frac{x+1}{x^2}$. The $(x + 1)$ divides out the numerator and denominator, leaving $\frac{1}{x}$.

59. The correct answer is (D). Since the slope is the change in $y$ divided by the change in $x$, the line through $(1,0)$ having slope 1 gives us the equation:

$$1 = \frac{y-0}{(x-1)} = \frac{y}{x+1}$$

That is, $y = x + 1$.

The line through $(-4,0)$ having slope $\frac{1}{2}$ gives us the equation:

$$\frac{1}{2} = \frac{y-0}{(x+1)} = \frac{y}{x+1}$$

That is, $2y = x + 4$.

We need to know $x$, so substitute $x + 1$ for $y$ in the second equation:

$$2(x + 1) = x + 4$$

Then $2x + 2 = x + 4$; $x = 2$.

60. The correct answer is (J). The entire area between the two circles is the area of the greater minus the area of the lesser. Call this value $A$. Now,

$$A = \pi r^2 - \pi r^2 = 3\pi r^2.$$  

Drawing the line segment from $C$ to $O$ forms two right triangles, each with a hypotenuse of length $2r$ and $OC = r$. Thus, the measures of angle $A$ and angle $B$ are each $30^\circ$, making the measure of angle $AOC = 120^\circ$, or one third of the circle. Hence, the area of the shaded region is two thirds of the area $A$ and must equal $2\pi r^2$.

Section 3: READING

1. The correct answer is (B). The first two paragraphs make this point, especially these words from the second paragraph: “because he usually dropped in at the club at that hour, he had passed by instead.”

2. The correct answer is (H). Archer fears that Welland is becoming figuratively “blind,” that is, unable to perceive reality because of the conventionality of her upbringing and her social surroundings. The cave-fish symbolizes his fear that Welland will never be grown-up enough to see and think for herself.

3. The correct answer is (B). Paragraph 3 makes it clear that the Archer-Welland engagement will be somewhat shorter than that of Welland’s friends “Grace and Thorley,” which was “nearly a year and a half.” However, it can’t be much shorter than theirs; otherwise, Archer would hardly be complaining about its length—hence choice (B).

4. The correct answer is (F). The first paragraphs refer to the “leisurely manner” in which men of Archer’s class practiced the law.

5. The correct answer is (D). She laughs when she mentions the idea and considers it “boring” to have to explain to him why it would never do. Clearly, for Welland, the idea of eloping is almost too silly to discuss.
6. The correct answer is (H). Archer recalls saying to his friend Jackson, “Women ought to be as free as we are—!” And earlier in the paragraph, he muses that “nice” women may begin “to speak for themselves” “Never, if we won’t let them.” The two statements in combination show that Archer feels that men (“we”) are largely responsible for constraining women and taking away their freedom.

7. The correct answer is (A). As soon as Welland says this to Archer, the author comments, “His heart sank.”

8. The correct answer is (H). Throughout the passage, Archer feels trapped by the “sameness” and conventionality of his relationship with Welland. Yet when she rejects his ideas about breaking out of this conventionality, he apparently is helpless to respond, and is reduced to standing silently, “beating his walking-stick nervously against his shoe-top.”

9. The correct answer is (A). The last three paragraphs state, twice, that Welland feels that calling the idea “vulgar” effectively dismisses the topic.

10. The correct answer is (F). The third, fifth, and tenth paragraphs refer to family, class, and gender traditions as the constraining forces that control Welland’s attitudes. The second and eighth paragraphs refer to Welland’s mother as the source of the idea that a long engagement is necessary. Welland mentions “novels” only as the kind of guide to behavior she would never follow, and her friends are mentioned merely for comparison’s sake, not as sources of her beliefs.

11. The correct answer is (C). The fact that the British and French already had (experimental) ironclads is merely mentioned in the second paragraph, not cited as a reason for the South’s eagerness to build one.

12. The correct answer is (F). This point is made in the second sentence of the passage.

13. The correct answer is (B). See the first sentence of the third paragraph.

14. The correct answer is (J). The last sentence of the third paragraph makes it obvious that wooden hulls were the rule, not the exception, among ships of the period.

15. The correct answer is (C). As used in the passage, “innovative” refers to the design choices made by John Ericson, which made the Monitor a remarkably new type of vessel.

16. The correct answer is (J). The Virginia was created simply by armor-plating a traditional wooden boat, whereas the Monitor had an entirely new design that “looked like no other ship afloat.”

17. The correct answer is (C). As the third paragraph suggests, the South, by comparison with the North, had fewer facilities for ship-building.

18. The correct answer is (F). See the last sentence of the seventh paragraph: “none of the nearly 100 shots that hit her had pierced her armor.”

19. The correct answer is (C). To “sustain” damage, as the word is used in this sentence, means to receive or suffer it.

20. The correct answer is (G). Choice (B) restates the idea found in the last sentence of the passage.

21. The correct answer is (C). The first two paragraphs show that Doyle pursued both writing and medicine simultaneously, apparently eager to succeed in both fields; he abandoned medicine only
22. The correct answer is (J). In this context, the word “deduction” is used to refer to the practice of drawing logical conclusions from evidence—reasoning, in other words.

23. The correct answer is (A). See the first sentence of the third paragraph, which explains what made Holmes “a different kind of detective” from his fictional predecessors.

24. The correct answer is (H). The word “compelling” is being used here to describe the effect of a character like Sherlock Holmes on readers; he compels the reader’s interest because of his remarkable personal qualities.

25. The correct answer is (A). Although Doyle was writing historical novels at the same time as his mystery stories, neither of the Holmes tales mentioned here is described as “based on historical events.”

26. The correct answer is (H). See the seventh paragraph: “Doyle’s other small literary successes had enabled him to move to London.”

27. The correct answer is (C). If the author considers it “fortunate” that Doyle was able to concentrate on his writing rather than on practicing medicine, clearly Doyle’s literary career must have been more important or worthwhile in the author’s eyes than his medical work.

28. The correct answer is (F). The second sentence of the last paragraph makes this point.

29. The correct answer is (C). According to the last paragraph, Doyle “considered the Holmes stories insignificant compared to his ‘serious’ historical novels.”

30. The correct answer is (G). Choice (H) is too narrow, while choices (F) and (J) are too broad. The passage concentrates quite specifically on the origin and early history of the Holmes character, which makes choice (G) the best answer.

31. The correct answer is (B). Each of the other answer choices is discussed in one or more paragraphs of the passage.

32. The correct answer is (H). The first sentence of the third paragraph of the passage, which is where the angler fish is discussed, makes it clear that the paragraph is entirely devoted to examples of bioluminescence found in the mid-waters of the ocean.

33. The correct answer is (C). Just as the angler fish uses a fake piece of food as bait to capture a hungry prey, so does the trout fisherman when he lures a trout with a tasty-looking fake insect.

34. The correct answer is (J). Countershading is described in the fourth paragraph, where it is stated that this effect protects fish from predators below them, not above.

35. The correct answer is (D). The author mentions the “exploding dye packets” that help mark a bank robber in order to clarify how some animals coat predators with glowing tissue to mark them and make them vulnerable.

36. The correct answer is (J). This point is made in the first sentence of the eighth paragraph.

37. The correct answer is (A). The seventh paragraph says that bioluminescence is considered nonessential because nonluminous species seem to thrive as well as luminous ones. For this, we can conclude that if bioluminescence were essential, the opposite would be true—
luminous species would do better than nonluminous ones.

38. The correct answer is (G). In the eighth paragraph, “selection pressure” is discussed specifically as an environmental force that helps promote “the development or maintenance of luminescence” among animal species. Choice (G) paraphrases this concept.

39. The correct answer is (C). The tomopterid worm is the only example in the passage of a kind of bioluminescence that seems to have no purpose at all; thus, it is “exceptional.”

40. The correct answer is (F). This discovery would suggest that the tomopterid worm’s bioluminescence is, in fact, useful, since it would mean that the yellow fluid it spews could help to distract dangerous predators.

Section 4: SCIENCE REASONING

1. The correct answer is (C). Considering only the two trees mentioned in the question, this would be a reasonable conclusion, since the younger of the trees (tree 4) has a much larger diameter and a much faster growth rate.

2. The correct answer is (F). The data in the table shows that these two trees, though they have almost the same diameter (90 cm versus 80 cm), are of vastly different ages (900 years versus 200 years). Thus, it seems clear that one cannot tell a tree’s age by extrapolation from its diameter.

3. The correct answer is (C). Four of the twelve trees in the table—one third of the group—are 800 years old or older, which means that they survived at least the last two catastrophes charted on the timeline.

4. The correct answer is (G). This is a simple exercise in multiplication: 1,100 × 0.1 cm = 110 cm.

5. The correct answer is (D). The three trees listed, all of the same species, are widely different in age and have widely varying growth rates as well. This is consistent with the conclusion stated in choice (D)—that trees of the same species may have different growth rates at different ages.

6. The correct answer is (H). A hypothesis that trees might use more than one strategy for reaching the canopy, and that varying growth rates might consequently be found, would certainly be supported by the finding that trees growing toward the canopy do in fact exhibit widely varying growth rates.

7. The correct answer is (A). The descriptions of the two experimental set-ups make it clear that the variable in Experiment 1 was the radius of the flywheel, while in Experiment 2 it was the initial speed of the flywheel.

8. The correct answer is (H). The concave disk design provides the best overall results in Experiment 3. As Table 2.4 shows, that design stores considerably more energy than either of the two alternatives, while its strength is almost equal to that of the flat disk, which is the strongest. If both criteria are equally important, then the concave disk design is the best.

9. The correct answer is (A). As the answer to question 8 indicates, the concave design is preferable to either the rimmed or flat disk. Experiment 1 shows that a flywheel with a larger radius is capable of storing more energy than a flywheel with a smaller radius. Thus, for optimal energy storage, a concave, large-radius wheel is best.
10. The correct answer is (H). As frequency increases, centrifugal force increases even more quickly; the same relationship exists between frequency and energy stored.

11. The correct answer is (B). Look at Table 2.3. By comparing the first and third lines of that table, we can see that when the speed of the flywheel is halved (from 80 to 40 revolutions per second), the amount of energy stored is quartered (from about 20,000 to about 5,000 joules). Applying this same relationship to the example in the question, we can estimate that the energy in the car flywheel will be quartered from 120,000 joules to about 30,000 joules.

12. The correct answer is (F). Since safety is mentioned in the question as a primary consideration, it seems logical to choose a system that uses size rather than frequency as the primary factor for storing a large amount of energy. As Experiment 3 shows, the flywheel’s frequency has a far more powerful effect on centrifugal force than does the flywheel’s radius.

13. The correct answer is (D). You can see in Table 2.5 that the average sulphate concentration in land deposits decreased between 1990 and 1998, while the figure shows that the amounts of sulphate in the five lakes increased during the same period. (To read the graph in the figure, compare the vertical axis—the 1990 reading—for each dot with the horizontal axis—the 1998 reading. In each case, the horizontal axis is greater.)

14. The correct answer is (H). The figure includes graphs for both sulphate and pH levels, while Table 2.5 shows only sulphate readings without pH numbers.

15. The correct answer is (C). You can see in the sulphate graph from the figure that the two dots furthest into the lower right-hand corner are “open” dots, representing glacial lakes. This indicates that these lakes experienced the greatest increase in sulphate levels between 1990 and 1998.

16. The correct answer is (G). The concentration for lake 4 was from 0.89 milligrams per liter to 0.66, a drop of almost 26 percent. This is a greater decline than experienced at any of the other lakes studied.

17. The correct answer is (A). The figure shows that precipitation varied within a steady range throughout the period, which isn’t consistent with the idea of a serious drought, as suggested by hypothesis II. The notion that the overall level of sulphate emissions did not decrease during the period is weakened by the results of Experiment 1, which show a steady decline in terrestrial deposition of sulphates; this weakens hypothesis III. Hypothesis I, however, is not contradicted by any of the experimental findings and in fact may help to explain why the lakes might show increased sulphates while the adjacent land areas show lower levels.

18. The correct answer is (F). As you can see in the Mercury line on Table 2.6, a Mercury day is about 59 Earth days, while a Mercury year is about 88 Earth days. The former is about \( \frac{2}{3} \) of the latter.

19. The correct answer is (C). Visualize where the moon would appear on the graph shown in the figure. It would be in very much the same line as Mars, Venus, and Earth. Only Mercury seems to have a different density/diameter relationship than the other terrestrial bodies.

20. The correct answer is (F). This figure can be read from Table 2.6. The only planet with a more eccentric orbit, Pluto, is not a terrestrial planet.
21. The correct answer is (D). The second column of Table 2.6 provides the answer. We’re told at the top of the column that the density of water has been set to equal 1. Then we see that Pluto’s density happens to be exactly 1; in other words, it is virtually the same as that of water.

22. The correct answer is (H). Since Mercury’s mean (average) surface temperature is “only” 179°, the nighttime temperature must be very low, in order to offset and reduce the very high daytime peak.

23. The correct answer is (B). If the earth’s core has a diameter of about 3,000 miles, this represents about \( \frac{3}{8} \) of the overall diameter of the planet. Then, if Mercury’s core represents a larger fraction of the planet’s overall diameter, and if Mercury’s overall diameter is about 3,000 miles, then Mercury’s core probably has a diameter that is around half the planet’s overall diameter, or perhaps a little more. Any value in the 1,500- to 2,000-miles range would be appropriate, and only choice (B) fits.

24. The correct answer is (F). Both the genetic theory and the infection theory attribute schizophrenia to prenatal events: in one theory, to a genetic disorder; in the other, to a prenatal infection that affects the brain of a developing infant.

25. The correct answer is (C). The fact that the shared incidence of schizophrenia is four times as great between identical twins as between nonidentical twins supports the idea that shared genetic material is a major factor in the development of the disorder.

26. The correct answer is (H). The phenomenon described in option III would be consistent with the idea that an infection occurred during prenatal development, thus supporting the infection theory.

27. The correct answer is (D). All three hypotheses could be consistent with both theories, and, in fact, all three could help to explain how both genetic and disease factors could be involved in producing schizophrenia.

28. The correct answer is (J). Those who favor the viral theory would be apt to explain the shared incidence of schizophrenia in this case as having resulted from the shared experience of a viral infection when both infants were in the womb together.

29. The correct answer is (B). It would be natural from supporters of the genetic theory to want to study the genes themselves in the hope of substantiating their theory by pinpointing the actual genetic differences that cause (or help to cause) the illness.

30. The correct answer is (G). As the figure shows, limonene increases steadily and dramatically as fruit ages, making this the most relevant and useful VOC for the detection of fruit spoilage.

31. The correct answer is (C). You can see in the figure that the concentration of alcohols continues to rise steadily over time as vegetables decay, while some other VOCs, such as esters, rise for a time and then diminish. This state of affairs is succinctly described in choice (C).

32. The correct answer is (G). Since Nose 2 is highly sensitive to alcohols, which are the best indicator of vegetable spoilage, that nose would be the best choice for detecting vegetable decay.

33. The correct answer is (B). An alcohol detector would be the best single choice, since that VOC is a fairly reliable indicator of spoilage for all three food groups.
34. The correct answer is (J). The figure shows that a concentration level of about half a milligram of diacetyl is reached some three days after the meat is fresh. Thus, it makes sense that this would be the level at which the consumer should be alerted that the meat should soon be consumed.

35. The correct answer is (A). Just count the number of horizontal lines shown in the illustration to determine the number of energy levels found in a given element. Atom 1 has five such lines; therefore, it has five energy levels.

36. The correct answer is (F). As explained in the passage, the spectral lines are emitted when an atom moves from one energy level to another. Thus, the number of spectral lines observed would correspond to the number of arrows seen in the figure (since each arrow represents an energy-level transition). Understanding this lets us pick choice (F) as incorrect; there are seven energy transitions possible for Atom 1, so seven spectral lines would be observed, not six.

37. The correct answer is (D). The passage says that the amount of space between spectral lines indicates the relative size of the change in energy levels. If two energy transitions are quite similar in size, then the spectral lines will be close; if the transitions are very different in size, the spectral lines will be far apart. Based on this, we can see that choice (D) is correct: The three transitions shown on the upper-left-hand side of the diagram would be represented by three spectral lines that are close together, while the two transitions shown on the lower-left-hand side would produce two more spectral lines that are close together.

38. The correct answer is (G). In Table 2.7, the first two frequencies measured are very close; so are the last two. These would correspond to spectral lines that are close to one another, and these would reflect two pairs of similar energy transitions—the situation found in Atom 3.

39. The correct answer is (B). A “forbidden” transition, as defined in the question, would be represented visually by a pair of horizontal lines that is not connected by an arrow. As you can see, Atoms 1 and 3 both have one or more pairs of horizontal lines that are not connected by arrows, making choices (A) and (C) wrong; Atom 3 has just one forbidden transition (between the two horizontal lines at the top), making choice (D) wrong. Choice (B) is correct because Atom 2 has one forbidden transition, between the highest and lowest energy levels, represented by the horizontal lines at the top and bottom of the diagram.

40. The correct answer is (F). As the explanation for Table 2.7 says, the information in that table does not reflect direct measurement of energy but rather “the frequency of light, which is proportional to the energy.” Thus, whereas the figure is generated directly by spectroscopy, the information in Table 2.7 contains information that is analogous to that derived from spectroscopy but not the same.
WHAT THIS FIRST SCORE MEANS

The results from this self-evaluation test will give you a general idea of what you might score if you had to take the ACT Assessment today. To convert the number of right answers on your self-evaluation test into an ACT Assessment scaled score, do the following:

Refer to Table 2.8 below. For each subject area, count the number of right answers and find that number in the left-hand column marked “Raw Score.” Move to the right until you have the column for the appropriate subject. That is your ACT Assessment scaled score for the subject area. For example, if you had 39 right answers on your Math test, you would find the number 39 in the left-hand column, then move right to the Math column and see that you have an ACT Assessment scaled score of 23.

After you have found your scaled score for each subject, add all four scaled numbers together and divide by four. Round fractions to the nearest whole number; round \( \frac{1}{2} \) upward. This number is your ACT Assessment composite score.

### TABLE 2.8: SCORE CONVERSION TABLE FOR THE DIAGNOSTIC TEST

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## CHAPTER 2: Diagnostic Test

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Because each subject is divided into different topics, it’s also important to know how you performed within each subject. Using the eight breakdowns listed below, circle the number if you had that answer right, then see where your subscore falls in the range of answers.

**Section 1: English**

**Usage/Mechanics:** Questions 1, 2, 3, 4, 5, 7, 10, 11, 12, 13, 16, 19, 20, 22, 23, 26, 29, 31, 33, 36, 38, 42, 43, 44, 46, 47, 49, 50, 52, 55, 57, 59, 60, 61, 62, 64, 66, 67, 68, 71, 72, 73, 74

- If you had 0–20 answers right, your subscore in this area is poor.
- If you had 21–32 answers right, your subscore in this area is average.
- If you had 33–43 answers right, your subscore in this area is good.

**Rhetorical Skills:** Questions 6, 8, 9, 14, 15, 17, 18, 21, 24, 25, 27, 28, 30, 32, 34, 35, 37, 39, 40, 41, 45, 48, 51, 53, 54, 56, 58, 63, 65, 69, 70, 75

- If you had 0–15 answers right, your subscore in this area is poor.
- If you had 16–23 answers right, your subscore in this area is average.
- If you had 24–32 answers right, your subscore in this area is good.

**Section 2: Mathematics**

**Pre-Algebra/Elementary Algebra:** Questions 1, 2, 6, 7, 9, 10, 12, 16, 19, 20, 23, 25, 26, 29, 30, 35, 37, 38, 39, 41, 43, 51, 54, 55

- If you had 0–11 answers right, your subscore in this area is poor.
- If you had 12–17 answers right, your subscore in this area is average.
- If you had 18–24 answers right, your subscore in this area is good.

**Intermediate Algebra/Coordinate Geometry:** Questions 3, 4, 5, 14, 15, 17, 18, 24, 27, 31, 32, 33, 42, 45, 48, 50, 53, 56, 59

- If you had 0–8 answers right, your subscore in this area is poor.
- If you had 9–13 answers right, your subscore in this area is average.
- If you had 14–19 answers right, your subscore in this area is good.
CHAPTER 2: Diagnostic Test

Plane Geometry/Trigonometry: Questions 8, 11, 13, 21, 22, 28, 34, 36, 40, 44, 46, 47, 49, 52, 57, 58, 60

If you had 0–7 answers right, your subscore in this area is poor.
If you had 8–12 answers right, your subscore in this area is average.
If you had 13–17 answers right, your subscore in this area is good.

Section 3: Reading

Prose Fiction: Questions 1–10

If you had 0–4 answers right, your subscore in this area is poor.
If you had 5–7 answers right, your subscore in this area is average.
If you had 8–10 answers right, your subscore in this area is good.

Social Studies: Questions 11–20

If you had 0–4 answers right, your subscore in this area is poor.
If you had 5–7 answers right, your subscore in this area is average.
If you had 8–10 answers right, your subscore in this area is good.

Humanities: Questions 21–30

If you had 0–4 answers right, your subscore in this area is poor.
If you had 5–7 answers right, your subscore in this area is average.
If you had 8–10 answers right, your subscore in this area is good.

Natural Sciences: Questions 31–40

If you had 0–4 answers right, your subscore in this area is poor.
If you had 5–7 answers right, your subscore in this area is average.
If you had 8–10 answers right, your subscore in this area is good.
Section 4: Science Reasoning

There is no breakdown of subjects within the Science Reasoning Test.

Overall Performance

Questions 1–40

If you had 0–18 answers right, your subscore in this area is poor.

If you had 19–29 answers right, your subscore in this area is average.

If you had 30–40 answers right, your subscore in this area is good.

TRACKING YOUR PROGRESS

No matter what your scores are, don’t worry. ARCO Master the ACT Assessment will help you improve that score, whatever it is.

The following pages look at the separate subject tests of the ACT Assessment exam. There are exercises for each, as well as test-taking strategies specific to that subject. After you’ve worked through the subject-area discussions, you’ll find a series of in-depth subject reviews. The above diagnostic has given you some ideas about which of these reviews are most important to you right now. As you complete the exercises in the subject-discussion chapters, you’ll form a more complete idea of where you need to focus your pre-test practice. Finally, after the last review chapter come three full-length practice ACT Assessment exams.

With each full-length exam, you have the opportunity to analyze the results of your score, just as you did now with the diagnostic test. The score of your next full-length exam will show the results of your diligent working through of the exercises and review. And the results of the other two exams will help you track your progress—and your growing mastery of the ACT Assessment.
Mastering the ACT Assessment: Your Plan for Success

OVERVIEW

- Create your ACT Assessment study plan
- Your three-month plan
- Your two-month plan
- Your two-week plan
- Minimize test anxiety
- Learn the top ten strategies for higher ACT Assessment scores

CREATING YOUR ACT ASSESSMENT STUDY PLAN

Perhaps you’ve already registered for the ACT Assessment and have only two weeks left before the test date; perhaps you haven’t yet registered. Whichever is true, you can work out a timetable of preparation that can help boost your score.

Following are three different schedules of preparation you can either use as is or adapt. These range from having three or more months to prepare, to having just two weeks to prepare. A “middle point” of four to six weeks of preparation time is also given.

One of the most important steps for creating a study plan is not concerned with the contents of this book, and that is the issue of time. Only you can adjust your personal schedule to create the time you need to prepare. Because the results of the ACT Assessment play such a crucial role in the college or university you’ll eventually attend, it’s worth the sacrifice. Remember, the schedule changes are only temporary. Of course, the closer you are to your test date right now, the more adjustment is necessary.

For example, the test-taker with three or more months might have to give up a few hours of watching television or socializing with friends each week to make the time to prepare. A test-taker with only two weeks needs to find every available minute. That means a bare-bones life of school, homework, meals, showers, sleep—and ACT Assessment preparation. No phones, no friends, no television, no music; and most likely, no clubs, no sports, no part-time job. It’s tough, but it’s possible—and it’s just for two weeks.
For every timetable, begin with the following three steps:

1. **Take the Diagnostic Test.** If you haven’t already taken the Diagnostic Test, do that as your first step. Arrange as-close-to-normal testing conditions as possible (a quiet place, no interruptions, use of a timer). Grade your test and find your subject scores and subscores.

2. **Identify weaknesses.** Identify in each subject the type of questions on which you need the most improvement. If you ever grow short of time, you’ll know this is where to concentrate your efforts.

3. **Familiarize yourself with the test contents and format.** If you know what the material looks like, how the test will be presented, and how you will be asked to respond, you won’t need to “reinvent the wheel” the day of the test. Besides being more comfortable with it, you’ll save valuable time.

What will be the specific details of your ACT Assessment study plan? Out of the next three sections (“If You Have Three Months or More to Prepare,” “If You Have Four to Six Weeks to Prepare,” or “If You Have Two Weeks to Prepare”), turn to the one that applies to you.

**IF YOU HAVE THREE MONTHS OR MORE TO PREPARE**

If you have three months or more to prepare, set aside a regular time to begin your ACT Assessment preparation. Basically, you’ll be reading and working through this entire book. It’s long, but you’ve given yourself plenty of time in which to do it. Spend at least 3 or 4 hours each week on preparation and accustom yourself to working for extended periods of times, as you’ll be doing during the test.

After you’ve completed the preliminary steps listed in the preceding section, here’s how the rest of your plan breaks down:

1. Assuming you’ve finished Chapters 1 and 2, finish reading this chapter. Then move on to Part 2. Read the initial sections of each subject, which tell you “What to Expect” and “Do’s and Don’ts” for success.

2. Work through the two sets of practice exercises for each subject. Score yourself. If you score above average or excellent, you can move on to the next subject.

3. If your remaining scores on the exercises still show areas of weakness, work through the entire subject review in Part 3. Pay special attention to those areas where your subscores were lowest. Work through the exercises that follow the subject review—if there’s time, do all three sets of the exercises.

4. One month before the ACT Assessment, if there is any review chapter you have not yet read because your scores in that subject were above average, look over the material now. Put a check mark by those individual topics that seem unfamiliar, difficult, or confusing. If you’re not sure, look at your initial subscores to pinpoint the weakest areas in your strongest subjects. Between now and the test date, review those areas.
CHAPTER 3: Mastering the ACT Assessment: Your Plan for Success

5 Two weeks before the ACT Assessment, take at least one more full-length practice test, arranging normal test conditions for yourself. Score your test. Compare this score with the Diagnostic Test. Look for those areas where you might still need help. Study those parts of the review chapters.

6 The week before the ACT Assessment, finish taking the full-length practice tests. There are three altogether. You should see better overall scores. With each test, you'll become more comfortable with the real ACT Assessment.

7 Two days before the ACT Assessment, reread the last two sections of this chapter—“Minimizing Test Anxiety” and “Ten Strategies for Scoring Higher on the ACT Assessment.” Also reread the “Do’s and Don’ts” and “What You Need to Know” sections of the four subject chapters.

8 After taking the ACT Assessment, read Part 4, which talks about your scores, college admission, and financing your education.

IF YOU HAVE FOUR TO SIX WEEKS TO PREPARE

If you have four to six weeks to prepare, you will spend your time concentrating on your specific weaknesses. Try to schedule three long blocks of time per week to prepare.

When you’ve completed the preliminary steps, here’s how the remainder of your plan breaks down:

1 Finish reading this chapter. Then move to Part 2. Out of all your subscores, rank the types of questions by priority, from the one in which you need the most improvement to the one in which you need the least improvement. Pick no more than three subjects containing these low subscores. In other words, if your four lowest subscores each occurred within a different subject, pick only the lowest three. These three subjects are where you’ll spend the most time.

2 Read the initial sections of each subject, which tell you “What to Expect” and “Do’s and Don’ts” for success.

3 For each of your focus subjects, work through the two sets of practice exercises. Score yourself. If you score above average or excellent, you can move on to the next subject. If you score average or below, work through the appropriate subject review (or reviews) in Part 3. Try to work through at least one set of the exercises following the review.

4 If you have time, look over any review chapter you have not yet read. Put a check mark by those individual topics that seem unfamiliar, difficult, or confusing. Between now and the test date, review those topics.

5 The week before the ACT Assessment, take at least one more full-length practice test, arranging normal test conditions for yourself. Score your test. Compare this score with the Diagnostic Test. Look for the two areas where you still need the most improvement. If you have time, study those parts of the review chapters.
If you have time, take another full-length practice test (in addition to the diagnostic exam, there are three practice exams). With each test, you’ll become more comfortable with the real ACT Assessment.

Two days before the ACT Assessment, reread the last sections of this chapter—“Minimizing Test Anxiety” and “Ten Strategies for Scoring Higher on the ACT Assessment.” Also reread the “Do’s and Don’ts” and “What You Need to Know” sections of the four subject chapters.

After taking the ACT Assessment, read Part 4, which talks about your scores, college admission, and financing your education.

IF YOU HAVE TWO WEEKS TO PREPARE

If you have two weeks to prepare, consider yourself to be working under “battle conditions.” Eliminate every single distraction and time-consuming activity that can be suspended for two weeks. You will concentrate your time on the two lowest subscores from your Diagnostic Test and on short-term test-taking strategies.

After you’ve completed the preliminary steps recommended earlier in this chapter, here’s how the rest of your plan breaks down:

1. Finish reading this chapter. Then move to Part 2. Out of all your subscores, rank the types of questions in priority, from the one in which you need the most improvement to the one in which you need the least improvement. Pick no more than two subjects containing these low subscores. In other words, if your four lowest subscores each occurred within a different subject, pick only the lowest two. These two subjects are where you’ll spend the most time.

2. Read the initial sections of all four subjects, which tell you “What to Expect” and “Do’s and Don’ts” for success.

3. For each of your focus subjects, work through the two sets of practice exercises. Score yourself. If you score above average or excellent, you can move on to the next subject. If you score average or below, work through the subject review in Part 3. If you have time, work through one set of the exercises following the review.

4. If you have time, skim any review chapter you have not yet read. Put a check mark by those individual topics that seem unfamiliar, difficult, or confusing. Between now and the test date, review those topics.

5. Three days before the ACT Assessment, take one more full-length practice test (the diagnostic test was your first), arranging normal test conditions for yourself. Score your test. Compare this score with the Diagnostic Test. Look for the one area in which you need the most improvement. If you have time, study that part of the review chapters.

6. Two days before the ACT Assessment, take another full-length practice test, under timed conditions. This additional test will give you important practice in your test-taking skills and can help relieve your anxiety on test day.
The day before the ACT Assessment, reread the last two sections of this chapter—“Minimizing Test Anxiety” and “Ten Strategies for Scoring Higher on the ACT Assessment.” Also reread the “Do’s and Don’ts” and “What You Need to Know” sections of the four subject chapters.

After taking the ACT Assessment, read Part 4, which talks about your scores, college admission, and financing your education.

**MINIMIZING TEST ANXIETY**

After looking over your course of action, your immediate reaction might be, “I can’t do it!” And you might feel that way whether you have two weeks to prepare or three months. You can do it! The only way you can’t is if you convince yourself that you can’t, so if you’re going to spend time talking yourself into something, talk yourself into success. Mental pep talks might sound foolish, but they work. All the great athletes use them, as well as dancers, musicians, actors—anyone who needs to “perform on demand.”

How do you give yourself a mental pep talk? Do it through visualization: Mentally rehearse how well the test will go.

**A Visualization Exercise**

Close your eyes and visualize yourself sitting at the test. You’re calm, you’re confident, and you’re prepared. Breathe deeply right now and let yourself feel the calm. You’re actually looking forward to the work. The test is handed out. See yourself opening it and recognizing how familiar it looks. Think, “I know this! I can do this! Sure!” See yourself calmly and confidently marking your answers.

Also visualize yourself weeks later opening the ACT Assessment envelope and reading your score. Pick a number you’d be thrilled to see and visualize it on a piece of paper right below your name. Breathe deeply right now and feel how satisfied you are with your test performance.

Try this visualization exercise often, at least once a day. It takes only minutes and can be done while you’re showering, riding (not driving) to school, or going to sleep. Like most things, visualization becomes better with practice. Athletes visualize playing the “perfect game.” You’ll visualize taking the “perfect test.”

**A Relaxation Exercise**

It might be hard to visualize being calm and confident when your body feels like one raw nerve. A deliberate relaxation exercise can help eliminate that raw-nerve feeling.

Sit or lie quietly with closed eyes. After a few minutes, begin to flex each group of muscles, hold the position for about 10 seconds, then relax. Begin with your toes,
squeezing them down as if you’re trying to pick up a marble with each bare foot, then relax. Progress up your body, squeezing then relaxing the muscles in your ankles, calves, thighs, and so on. If you’re not sure how to contract your muscles in a particular part of your body, push downward against the chair, bed, or floor with that part. Slowly tense and relax each group, working your way up to your hands, arms, shoulders, and neck. When you get to your face, do each part of your face separately. Never mind the “faces” you’re making. Open your mouth wide, then pucker it up to tense the muscles, wrinkle your nose, frown fiercely—then relax after each movement. After you’re finished with your whole body, remain in this state of relaxation for several minutes.

**An Exercise in Silliness**

Sometimes you might not have the time or the place to do the previous exercise. Some people have found relaxing a method that might seem to be the opposite of the previous relaxation exercise. But this is another instance of “Try it, it works!”

Find a private place (an empty rest room is good if you’re “in public”) and engage in some very physical, very ridiculous activity. Make faces at yourself in the mirror. Practice a few operatic arias, even if—or perhaps especially if—you can’t sing. Hop around and wiggle parts of your body while chanting, “Shake out the willies and shake in the sillies.”

Sound stupid? It sure does, but it works. In fact, the internationally famous Dale Carnegie School helps students in its public speaking courses the same way. Even as you read this, the company president of a billion-dollar corporation could be in a bathroom preparing for a major speech to stockholders by doing a Dale Carnegie exercise: shouting out the nursery rhyme, “There was a Duke of York./ He had 10,000 men./ He marched them up the hill/ and marched them down again./ And when you’re up, you’re up./ And when you’re down, you’re down./ And when you’re only halfway up,/ you’re neither up nor down.” And all this to the accompaniment of hand-clapping, foot-stomping, and smacking the body.

Effective as these exercises are, they’re just a supplement to the more important academic preparation. But not every bit of academic preparation involves studying harder and longer. There are tips and tricks even to the ACT Assessment exam.

**TEN STRATEGIES FOR SCORING HIGHER ON THE ACT ASSESSMENT**

In the following chapters, you’ll get strategies that are specific for each subject. Here now are ten strategies that help you score higher on the ACT Assessment, no matter the subject area on which you’re working.

1. **Skip the directions.** Reading the directions takes valuable time. The directions for each type of question are the same as the directions in this book. Read the
directions for each type of question in the Diagnostic Test, the practice exercises, and the four full-length practice tests. The day of the test, just make sure the section has the same type of questions—then get to work.

2 **Skim the whole section.** Because you’ve just deliberately saved time by skipping the directions, you might feel a sense of urgency tugging at you to begin. Take a minute to look at the section first. Find out the kinds of questions that are being asked, how many sections there are, and how many questions.

3 **Pace yourself.** Use the knowledge you picked up from skimming to pace your work. For example, the ACT Assessment Reading Test allows you 35 minutes. In that time, you have to read and answer 40 questions about four passages. This breaks down to about 8 minutes to read each passage and to answer its 10 questions before you need to move on to the next. Put your watch on the desk and glance at it from time to time to keep yourself on track.

4 **Answer the easy questions first.** Each section contains a mixed level of difficulty, but every answer is “weighted” the same—that is, you don’t get more points for answering a more difficult question. So, skip the hard questions and come back to them later. Answer the easy questions first. This will give you confidence and allow more time for working on the remainders.

5 **When in doubt, guess.** In some tests, you’re penalized for having the wrong answer. Not in the ACT Assessment. *Only correct answers are counted.* So even if you don’t have the vaguest idea of what the answer should be, you have a 1 in 4 chance (1 in 5 in Math) of being right simply by picking a random answer. If you have a hunch about one or two of the answers, or can eliminate one or two, your chances of being right are greatly improved.

6 **Don’t let tough questions make your confidence slip.** Remember that almost no one gets everything right. The ACT Assessment is intended to measure the widest possible range of ability, including the 6-year-old genius in senior physics who could be teaching the class. If you missed 40 percent of the questions on a high school test, you’d fail. If you missed 40 percent of the questions on an ACT Assessment Science Reasoning Test, you’d have an average score of 21.

7 **Frequently check your place on the answer sheet.** Yes, the use of choices (F), (G), (H), (J), and (K) for even-numbered answers helps prevent this, but losing your place can still happen, especially if you’re skipping questions. Every five answers or so, double check that the number of the question corresponds with the number of the answer. When you do skip harder questions, don’t just leave them blank. Lightly circle their number on both the test booklet and on the answer sheet, so you can return to each one more quickly and to make sure you leave that line blank on the answer sheet.

Don’t panic even if you lose your place, and don’t start wildly erasing. Mark where the wrong answers begin and where you noticed the error and answer correctly from that point on. If you have time, go back and correct the section you marked. If you run out of time, raise your hand. Explain to the proctor what happened and...
ask that you be allowed 5 minutes after the test with just the answer sheet to move those answers up or down a line each to the correct space. The proctor will probably say yes.

5 **Don’t get sidetracked by the unimportant.** Often a question will contain an enormous amount of useless details for the sole purpose of distracting you. This is like the riddle, “As I was going to St. Ives, I met a man with seven wives.” You don’t need to understand every detail to be able to answer the question.

6 **Understand what you’re being asked.** Some of the choices might be “correct”—but not for the question that’s really being asked. Be sure you understand the question before attempting to find the answer.

7 **Stop a minute or two before your time is up.** When the time is almost up, finish the question on which you’re working, then look at the questions you have left. If an answer is immediately apparent, fill it in. If certain answers can be immediately disqualified, pick one of the others. For all the rest, just fill in the circles. A blank circle gets you nothing; guess and you could get lucky.

**Bonus strategy:** There’s one more essential strategy for scoring higher on the ACT Assessment, and you don’t have to wait until the test date to use it.

_That’s making a study plan and following it._
CHAPTER 3: Mastering the ACT Assessment: Your Plan for Success

SUMMARY

What You Need to Know about Making Your Study Plan

- Whether you have only a few weeks or three months to prepare for the ACT Assessment, you can construct a workable study plan.

- When your time is limited, focus on the areas where you need the most improvement. The results of the Diagnostic Test help you identify those areas.

- Anxiety won’t help you prepare for or take the ACT Assessment—in fact, it can really harm your performance. Use visualization and relaxation techniques to help overcome test anxiety. You should consider visualization and relaxation exercises to be part of your total ACT Assessment study plan.

- Read, reread, and remember the ten strategies for higher ACT Assessment scores. These strategies can boost your confidence and your scores.
PART II

STRENGTHENING YOUR ACT ASSESSMENT SUBJECT SKILLS

CHAPTER 4  The ACT Assessment English Test

CHAPTER 5  The ACT Assessment Math Test

CHAPTER 6  The ACT Assessment Reading Test

CHAPTER 7  The ACT Assessment Science Reasoning Test
The ACT Assessment English Test

OVERVIEW

• Learn what to expect on the ACT Assessment English Test
• Learn strategies for success on the ACT Assessment English Test
• Practice your skills with ACT Assessment English exercises
• Evaluate your understanding of the ACT Assessment English Test

The ACT Assessment English Test determines how well you understand and can use “standard written English.” What exactly is “standard written English”? That’s the style of writing used in this book. It’s the style of writing used for television news reports. It’s the style of writing your teacher wants to see in English class. Standard written English does not allow the use of slang, colloquial or informal expressions, technical jargon, geographic or ethnic dialects, archaic language (which means language that is no longer in use, such as Shakespearean English), and creative or experimental language (which means invented words or invented uses for words, such as in James Joyce’s *Ulysses*). In this chapter, you will learn the types of questions you can expect on the ACT Assessment English sections, and you will get an opportunity to practice your skills in answering those questions. You also will learn some valuable tips that will help you succeed on ACT Assessment English questions—and you will learn how to avoid some common pitfalls of the test.

WHAT TO EXPECT ON THE ACT ASSESSMENT ENGLISH TEST

The ACT Assessment tests your understanding and use of standard English by providing passages of writing, then drawing your attention to particular sentences that might or might not have mistakes in them. These might be mistakes in grammar, weaknesses in style, errors in punctuation, lapses in logic, and other writing flaws. The test questions ask you to identify the mistake, then to correct it by choosing an alternative that doesn’t introduce a new mistake.

The English Test items fall into two broad categories: Usage/Mechanics and Rhetorical Skills. Usage/Mechanics refers to whether the sentence is technically correct. Check that it obeys the rules of English grammar and usage, including subject-verb agreement, correct verb tenses, parallel sentence structure, and proper use of punctuation. Rhetorical Skills refers to the overall organization of the passage, including the order of topics, clear transitions from topic to topic, clarity of expression, and the avoidance of stylistic problems like wordiness, redundancy, and vagueness.
The questions are based on five passages of 300–400 words each. The passages will be from nonfiction prose such as you read in magazines, books, journals, even student essays. For each passage, there will be 15 questions testing your understanding of how the passage was written—for a total of 75 questions.

Questions on Usage and Mechanics

These questions will underline part or all of a sentence and put the corresponding question number beneath the underlined portion. You will then be presented with four choices. The first choice repeats the underlined portion with no change, and three choices rephrase or eliminate the underlined portion. You must decide which of the four alternatives is best. Look for grammatical correctness, proper usage, and clarity.

Example

On the day of the test, his over-protective mother packed him an ACT Assessment survival kit. Ten sharpened pencils, a pencil sharpener, a calculator, a pack of batteries, three different-weight sweaters, four pieces of fruit, a liter of spring water, and a box of tissues.

(A) NO CHANGE
(B) kit, ten
(C) kit; ten
(D) kit: ten

The correct answer is (D).

Questions on Rhetorical Skills

Questions on rhetorical skills will either underline the portion as above or have a boxed number before, after, or in the middle of a passage, which will refer to a corresponding question number. If the question is about a section of the paragraph, the boxed number will be placed at the appropriate point. If the question refers to the paragraph or passage as a whole, the boxed number will be at the end of the paragraph or passage. Questions with boxed numbers are about the passage’s overall organization and will suggest changes, additions, or deletions to the passage. For these items, you must decide which alternative adds to the overall effectiveness of the passage as a piece of writing.
CHAPTER 4: The ACT Assessment English Test

Example

School Paper Editorial
The first reason why the Denville school district should not be combined with the Jackson school district is the fact that the schools have been sports rivals for too long. Trying to unite the schools after so many years of competition would inevitably lead to friction. [2]

1. (A) NO CHANGE
   (B) because of the fact that
   (C) about
   (D) that

A The correct answer is (D).

2. Is the author's introductory sentence effective?
   (A) Yes, because it gets immediately to the problem.
   (B) No, because an introduction should outline the whole subject.
   (C) No, because it doesn’t say how many other reasons there will be.
   (D) Yes, because sports is the number one interest of most students.

A The correct answer is (B).

The Directions

The directions for the ACT Assessment English Test are similar to the following:

Directions: This test consists of five passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box.

After you select the correct answer for each question, mark the oval representing the correct answer on your answer sheet.

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STRATEGIES FOR SUCCESS ON THE ACT ASSESSMENT ENGLISH TEST

Yes, you’ll try to get a good night’s sleep before the test, you’ll try to eat a healthy breakfast, and you’ll try to stay calm and focused. Although these are good pieces of advice, these tips will also help your younger sister on next week’s French quiz. Here are some success strategies specifically designed to help you score higher on the ACT Assessment English Test.

Skim the Passage Before Reading

Skimming a passage before reading is like checking a strange body of water before you dive in. What’s the water temperature? Is the water deep enough? Are there rocks just below the surface? Checking first for general conditions alerts you to both possible dangers or a carefree experience.

Skimming alerts you to the “general conditions” of a strange passage. What’s the overall structure of the piece? What’s its theme or purpose? Is the style quick and breezy or slow and scholarly? Just a few seconds of skimming will help you better focus your reading.

Read the Whole Sentence

You’ve skimmed then read the entire passage. You next turn your attention to the first question, which refers you to an underlined section (granted, not every question in the English section uses underlined phrases, but you learn strategies for the other English question types later in this chapter). Be sure to read the whole sentence for that question, not just the few words that are underlined, before you attempt to answer. While the mistake itself (if there is one) will be in the underlined section, the reason why it’s a mistake often lies elsewhere in the sentence. If a pronoun is wrong, you need to know the word to which it refers. If a verb’s number is wrong, you need to know the number of the subject. If a verb’s tense is wrong, you need to know the tense of the rest of the sentence. Read the whole sentence first.

Listen for the Mistake

Most of us make fewer grammar mistakes when we speak standard English than when we stop and make conscious decisions about each word to use. Why? We talk before we write—speech is our primary form of communication. Throughout the day—in class, on radio, and on TV—we hear standard English. In a way, we know most of the rules of grammar even if we cannot explain them.

On the ACT Assessment English Test, you don’t have to explain a mistake. You merely have to “hear” when a mistake is being made, which in itself is relatively easy because it will be in the underlined part. Then, from the available choices, you have to “hear” the best alternative. That’s another reason why reading the whole sentence is important.
You need to be able to put the mistake within the context of the entire sentence in order both to hear if the underlined section sounds “funny” or “weird” and to find the right replacement.

Listening can reveal a wide range of problems, from subject-verb agreement to incorrect usage of idioms—expressions that are always said a certain way “just because” they are.

**Correct the Mistake on Your Own First**

After you’ve identified the mistake, even if you can’t explain what it is, try to correct it before looking at the choices. When you have “your” correction in mind, look over the answers.

*Why correct the mistake first when the correction is there to be found?* For two reasons: If your exact correction is among the choices, your answer is probably right; on the other hand, if two of the remaining choices are very close to the wording of your correction, you can at least eliminate those choices that did not correct the mistake. So either way, you save time.

**Look for Common Mistakes**

Although there are many possible grammatical mistakes, the ones most commonly made fall into just a few categories. So if you can’t “hear” the mistake in the underlined section, look instead to see if it contains one of these common types of errors: sentence fragments, mistakes in subject-verb agreement, problems with verb tense or verb form, incorrect referents, dangling and misplaced modifiers, parallel construction, and incorrect usage of idioms. (If you are not sure of the rules for any of these, look up the subject in the English Review in Part 3.)

Even better than having just a few mistakes to check, some of these errors frequently show up the same way on the ACT Assessment Test. Here are some tips on “when to look for what.”

- **Sentence fragments are** often present when an underlined section includes a period.

  *Example:* In the park Saturday, I threw a Frisbee to the dog in the red collar. Because I wanted to meet its owner.

  (Correct: collar, because.)

- **Mistakes in subject-verb agreement** are often present when an underlined verb is not relatively close to the subject.

  *Example:* The woman, persuaded by dozens of encouraging phone calls from her children, grandchildren, and great-grandchildren and even by multiple letters from strangers who had seen the newspaper articles, are traveling round the world.
If you need to brush up on your English grammar and usage rules, you’ll find a complete review in Chapter 8, “English Review: Grammar.”

Remember That Shorter Is Usually Better

On occasion, you’ll find that eliminating all the answers that contain errors does not narrow your options to a single choice. You might find that two (or rarely three) answer choices all appear correct and equally clear, graceful, and unambiguous.

When this happens, choose whichever answer is shortest. Generally speaking, a concise, tightly worded sentence is more stylistically effective than a wordy, loosely structured one. Therefore, when all other factors appear equal, the shortest sentence is the one that the test-makers are most likely to consider correct.

Don’t Add a New Mistake

When there are two closely worded choices or two possible ways to correct the error, be careful. Often one of the choices creates a new error. Read each choice as part of the whole sentence and “listen” for any new mistakes.
Example

Although my brother was a talented painter, he gave up his dream of a life as an artist. Making instead a living as an electrical engineer and painting on weekends.

(A) NO CHANGE
(B) artist, instead making
(C) artist. Instead he makes
(D) artist. Rather, making

A The correct answer is (B).

Choice (C) corrects the error of a sentence fragment. (Your tip-off: The underlined portion includes a period.) However, if you now read the new version of the sentence using “Instead he makes” as its opening words, you see that a new problem crops up. The phrase at the end, “and painting on weekends,” doesn’t grammatically match “he makes.” (If it read “and paints on weekends,” it would be all right.) Choice (B) solves the problem without creating a new one.

Find the Right Sequence by Finding the First Item

Questions on mechanics and usage test grammar and punctuation. Questions on rhetorical skills deal with larger issues of organization, choice of contents, and style.

One such item you’ll certainly encounter is an overall structure question, which is often a question about the sequence of ideas. You might be asked to select the best sequence of sentences within a paragraph or the best sequence of paragraphs for the passage as a whole. Following is an example:

[1] The immigration laws led, ultimately, to a quota system based on the number of individuals of each national origin reported in the 1890 census. [2] The United States, which was founded mainly by people who had emigrated from northern Europe, had an essentially open-door immigration policy for the first 100 years of its existence. [3] But starting in the 1880s and continuing through the 1920s, Congress passed a series of restrictive immigration laws. [4] The door to freedom hadn’t been slammed shut, exactly, but it was now open only to the “right” sort of people.

Which of the following sequences of sentences will make this paragraph most logical?

(A) 4, 3, 1, 2
(B) 2, 3, 1, 4
(C) 1, 3, 2, 4
(D) 2, 3, 4, 1

A The correct answer is (B).
The easiest way to find the right sequence is to find the first item—the first sentence or the first paragraph. The first item will often introduce the overall topic about which the rest of the material covers. After you’ve found the opening element, the others should quickly fall into place. You’ll usually note some clear time sequence or progression of action that will make the correct order apparent.

**Expect a Single Idea per Paragraph**

Another type of rhetorical skills question focuses on the clear and logical development of the ideas in the passage. You may be asked to choose a sentence that would make a logical addition to the passage; you may be asked whether it would be a good idea to delete a particular sentence from the passage; or you may be asked where in the passage a certain idea would fit best.

Here’s a sample of what this kind of question might look like:

Many owners of professional baseball teams are concerned about sagging attendance figures. Various gimmicks have been tried to boost attendance, from ballpark giveaways to special “nights” honoring various ethnic groups. Teams have changed the colors of their uniforms, played rock music between innings, and set off fireworks after the game.

Q The writer wishes to add another relevant example to this paragraph without straying from the purpose of illustrating the gimmicks used by baseball in an effort to improve attendance. Which of the following sentences does that best?

(F) It’s hard to see what playing Goo Goo Dolls over the centerfield loudspeakers adds to the experience of a ballgame.

(G) For many sports fans, baseball is just too slow-paced; they prefer the quick, constant action of basketball.

(H) They’ve even tinkered with the rules of the game, introducing the so-called designated hitter.

(J) Some teams claim they are losing millions of dollars each year due to poor attendance.

A The correct answer is (H).

The most important principle to apply to a question like this is that every paragraph should be unified around a single idea. No sentence should appear in a paragraph that doesn’t clearly relate to that idea, either by explaining it, illustrating it, defending it, elaborating on it, or otherwise supporting it. In this case, only choice (H) extends the paragraph’s idea.
Don’t Worry about Tiny Details

There are some points of grammar that your teachers over the years might have emphasized again and again, such as “don’t split infinitives,” “don’t use dangling prepositions,” and so on. Because English is a living language, its rules change over time. Although in some instances a dangling preposition is incorrect, common usage dictates that some sentences can end in a preposition. The same is true for the use of split infinitives. Because such small details of proper usage are subject to change, they don’t appear on the ACT Assessment. If you find yourself considering the small details of a sentence’s structure, you’re unlikely to spot the more obvious mistake the sentence might contain. Don’t invest time—or attention—to these small details while taking the ACT Assessment.

Also, because the test deals with larger issues of grammar, you won’t be questioned on vocabulary, spelling, capitalization, and hyphenation. If you think you’ve spotted an error of this sort on the ACT Assessment, you haven’t. Ignore it and keep looking.

Avoid the Repetition of Ideas

Another rhetorical skills question focuses on wordiness or verbosity. One way to test for this type of mistake is to look for redundancy—the needless repetition of ideas—within the sentence containing the underlined phrase. When the same concept is stated twice or more in a given sentence, the test-makers are sending you a broad hint that this is an ineffective sentence that needs to be simplified. Here’s an example:

The remarkable growth in increased attendance currently being enjoyed by such formerly moribund sports franchises as baseball’s Cleveland Indians shows that building a new stadium can have a powerful effect on the popularity of a team.

(A) NO CHANGE
(B) The growth in attendance remarkably being enjoyed currently enjoyed
(C) The remarkable growth in increased attendance currently enjoyed
(D) The remarkable attendance boom currently enjoyed

The correct answer is (D).

The original phrasing here contains not one but two examples of redundancy. The words “growth” and “increased” both convey the same idea. The word “being” tells you that this phenomenon is happening now—the same idea that the word “currently” expresses. Only choice (D) eliminates both redundancies without changing the meaning of the sentence, as choice (B) does by changing “remarkable” to “remarkably.”
SUCCESS STRATEGY ROUNDUP: A LIST OF DO’S AND DON’TS

Here’s the “short version” of the above advice, along with a few other miscellaneous tips, arranged in a handy list of Do’s and Don’ts. After you understand each point and the reasoning behind it, you need only know the boldface sentence to jog your memory—whether you’re working on the exercises at the end of this chapter, your full-length practice tests, or the ACT Assessment itself.

A list of Do’s:

✔ Skim the passage before reading it. This will give you an idea of the overall structure, meaning, and purpose of the passage, which is especially important for questions dealing with rhetorical skills. Look for the general theme, style, and tone and the basic sequence of ideas.

✔ Find the grammatical error before looking at the choices. Reread any sentence that contains an underlined segment. Try to find the error before considering the choices. Mentally correct the error, then look for the answer that matches yours. If you aren’t able to correct the error, scan only that part of the choice in which the original error appeared. Then eliminate any answer that does not correct the error. You can quickly eliminate one or two choices this way.

✔ Skip reading choice (A). Choice (A) is always the same: NO CHANGE, meaning the underlined part of the sentence should remain as it is. Because choice (A) is always what you’ve just read in the passage itself, save time by skipping it.

✔ Check the underlined part for the most common types of errors. If the error isn’t apparent, ask yourself these questions: Is the sentence a complete sentence? Do the subject and the verb agree? Is the tense right? Is the verb form right? Does the pronoun refer to the correct word and agree with it in person and number? Are similar ideas expressed in parallel construction? Are modifiers attached to what they’re meant to modify?

✔ Trust your ear. If you can’t identify the error, silently listen for what “sounds wrong.” Even when you can’t identify an error by its grammatical name, you can often hear when something sounds wrong—and also when it sounds right. Remember that, silently listen, and increase the odds of your guessing the correct answer.

✔ When adding a sentence, stay with the central idea. If you’re asked to choose the next sentence in the paragraph, choose one that in some way further explains the main idea. Don’t bring in unrelated topics.

✔ For a sequence question, begin by finding the first sentence or the first paragraph. Look for the sentence or the paragraph that introduces the overall topic. After you have it, the order of the other sentences or other paragraphs will be more apparent.

✔ For style, choose the shortest. When all the choices on a rhetorical-skills question say the same thing and all are grammatically correct, choose the shortest one. It’s usually the best, most concise expression of the idea.
A list of Don’ts:

Don’t try to “correct” every sentence. NO CHANGE is the correct answer to about 25 percent of the questions.

Don’t be distracted by wordiness. The structural complexity of a sentence might have nothing to do with the question. Ignore anything that is not related to the question and focus only on what’s being asked.

Don’t choose an answer that contains a new error. Some choices correct the original error but add a different one. Be careful when new words are added to the underlined part.

Don’t worry about what’s not there. Don’t look for mistakes in spelling, capitalization, and hyphenation. They’re not on the test. Also, don’t look for mistakes such as split infinitives and dangling prepositions. As these forms are increasingly used in daily language, the rules “against” them are weakening.

Don’t try to change what isn’t underlined. If a choice includes any part of the passage that isn’t underlined, eliminate it. That’s not what’s being questioned.

Don’t separate basic sentence parts. Subjects and verbs, verbs and objects, verbs and complements—in natural speech and in clear writing, these elements occur close to each other. So if a sentence separates, for example, the subject from the verb with a long complicated clause, look for a choice that positions subject and verb more closely together.

Don’t be fooled by fragment length. A sentence must have a subject and a verb in the main clause to be complete. No matter how long a fragment is, if there’s no subject and verb, it’s not a sentence.

Don’t confuse it’s with its. This is a very common mistake. Its is the possessive of it. Because nouns form their possessive with an apostrophe, the contraction it’s (the shortening of it is) is often mistakenly used in place of its. Reminder: its is a possessive pronoun. No possessive pronoun uses an apostrophe: his, hers, yours, theirs, mine, ours, and its.

PRACTICE EXERCISES

You’ve just learned some new skills for taking the ACT Assessment English Test. The following exercises will help you to practice these new skills as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are two English Test exercises in this chapter. Each exercise contains 30 questions and should be answered in 18 minutes. Do each exercise in one sitting in a quiet place, with no notes or reference material. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

Score yourself only on those items you finished. When you’re done, work through the rest of the exercise.
EXERCISES: THE ACT ASSESSMENT ENGLISH TEST

Exercise 1

30 Questions • Time—18 Minutes

Directions: This test consists of two passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box.

Passage I

The Magic of Special Effects

The movies are one place where magic can come true. You can see sights you might never under any circumstances hope to see in real life—ocean liners sinking, earthquakes swallowing cities, planets exploding. You can also see sights that might never exist at all: such as rampaging monsters, battles in outer space, sky-high cities of the future.

All these are examples of the movie magic known as special effects. It's the work of amazingly clever and skilled effects artists. And the real magic lies in how they're able to make a man in a gorilla suit into King Kong . . . tiny plastic models into huge space ships . . . and instructions in a computer into images of a world that no one have ever imagined before.

Effects artists have developed many tricks and techniques over the years. Working closely

1. (A) NO CHANGE
(B) normally
(C) in daily life
(D) OMIT the underlined portion.

2. (F) NO CHANGE
(G) all, such as
(H) all. Such as
(J) all—such as

3. (A) NO CHANGE
(B) It's the work of
(C) They're by
(D) They are the work of

4. (F) NO CHANGE
(G) Nonetheless,
(H) Although
(J) Because

5. (A) NO CHANGE
(B) could ever imagine
(C) has ever imagined
(D) ever had been imagining
6. (F) NO CHANGE
   (G) moviemaking today requires them to play a growing role.
   (H) they play a growing role in moviemaking today.
   (J) their role in moviemaking today is a growing one.

7. (A) NO CHANGE
   (B) to save money. Some movie scenes
   (C) for saving money, some movie scenes
   (D) to save money; since some movie scenes

8. Which of the following sequences of sentences will make the paragraph most logical?
   (F) 2, 1, 4, 3
   (G) 3, 1, 4, 2
   (H) 2, 4, 3, 1
   (J) 1, 4, 3, 2

9. Which of the following sentences would provide the best transition here from the topic of the previous paragraph to the new topic of this paragraph?
   (A) Today's moviemakers are highly budget conscious.
   (B) Some of the most exciting special effects involve computer-simulated imagery.
   (C) There is a long history to the use of special effects in movies.
   (D) Special effects can also make moviemaking safer.

10. (F) NO CHANGE
    (G) these events
    (H) those
    (J) it
out the exposing of actors to real hazards.  

Most important, special effects allow moviemakers to film scenes that would otherwise be impossible. They let movies show nonexistent, even impossible worlds.

Most important, special effects allow moviemakers to film scenes that would otherwise be impossible. They let movies show nonexistent, even impossible worlds.

Visions of unknown, unseen worlds have long stimulated the imaginations of human beings the world over.

Would this be a logical and relevant addition to the essay?

(A) Yes, because it emphasizes the important role that special effects play in the movies.

(B) No, because it does not directly relate to the topic of movie special effects.

(C) Yes, because it underscores the universal appeal of works of the imagination.

(D) No, because most of the world's most popular movies are produced in the United States, not "the world over."

And after all— that's one of the reasons we all go to the movies.

And— after all, that's one of the reasons we all go to the movies.

And—after all, that's one of the reasons we all go to the movies.

And—after all, that's one of the reasons we all go to the movies.

Most important, special effects allow moviemakers to communicate a unique imaginative experience. And—after all, that's one of the reasons we all go to the movies.

And—after all, that's one of the reasons we all go to the movies.

And—after all, that's one of the reasons we all go to the movies.

And that after all, is
Passage II

Cities on the Sea

Hunger has long plagued millions of the world’s people, especially in the vast cities of the underdeveloped nations of Africa, Asia, and India. The food to feed the world’s growing population may come largely from ocean resources. [B]

Three quarter’s of the earth’s surface is covered with water. Many scientists are now looking at these vast watery regions for solutions to some pressing human dilemmas. [B]

Minerals such as iron, nickel, copper, aluminum, and tin are in limited supply on the earth. Undersea mines are expected to yield fresh supplies of many of these resources. Oil and gas deposits have been discovered under the ocean floor. [B]

16. Which of the following sentences, if added here, would most effectively support the assertion made in the previous sentence?

(F) Fish, sea-grown plants, and even food-stuffs synthesized from algae are all examples.

(G) If population growth can be brought under control, the problem of hunger may well be alleviated.

(H) Pollution of the seas has not yet reached a level where it endangers the use of salt-water fish by humans.

(J) For thousands of years, humans have drawn nourishment from the seas around us.

17. (A) NO CHANGE
   (B) Three quarters
   (C) Three fourth’s
   (D) Three-quarter’s

18. (F) NO CHANGE
   (G) deposits has
   (H) deposits have
   (J) deposits, has

19. The writer wishes to add another relevant example to Paragraph 3. Which of the following sentences does that best?

(A) Exploration of the deepest reaches of the ocean floors has only recently begun.

(B) And the tides and thermal currents—water movements caused by temperature variations—may be future energy sources.

(C) Solar energy, too, is expected to become a major supplier of the world’s future energy needs.

(D) The sea, after all, is the ultimate source of all life on Earth.
To take advantage of these ocean-based resources, some scientists foresee entire cities on the ocean. At first, they will be built close to the shore. Later, floating cities might be located hundreds of miles at sea. These cities could serve many functions, playing a variety of roles. Some of the people living there could harvest fish and sea plants, like farmers of the ocean. Others could operate oil and gas wells or work in undersea enclosures mining the ocean floors. Also, the floating cities could serve as terminals or stations for international travel, where ships could stop for refueling or repairs.

Much of the technology needed to build such cities have already been developed. Oil drilling on a large scale is already conducted at sea. Rigs as large as small towns built on floating platforms or on platforms anchored into the seabed serving as homes to scores of workers for months at a time. The same principles, on a larger scale, could be used to create ocean-going cities.

The cities would have to be virtually self-sufficient, although shipping supplies from the mainland would be costly. Each city would
be a multi-story structure with room for many kinds of facilities needed by the inhabitants. 

The ocean itself could provide much of the needed food and other raw materials; while solar panels and generators running on water power could provide energy.

Many thousands of men, women, and children might inhabit such a city. They would probably visit the mainland from time to time, but otherwise they would spend their lives at sea as ocean-dwelling pioneers.

27. **(A) NO CHANGE**
   (B) apartments, small factories, offices, schools, and stores.
   (C) various living and other quarters to be used by the town’s citizens.
   (D) people to live and engage in other activities as in a land-based city.

28. **(F) NO CHANGE**
   (G) materials. While
   (H) materials, while
   (J) materials,

**Items 29 and 30 pose questions about the essay as a whole.**

29. The writer wishes to include the following sentence in the essay:
    
    Tourists might find the floating cities attractive vacation spots for boating, swimming, and fishing.
    
    That sentence will fit most smoothly and logically into Paragraph
    (A) 3, after the last sentence.
    (B) 4, before the first sentence.
    (C) 4, after the last sentence.
    (D) 6, after the last sentence.

30. For the sake of the unity and coherence of this essay, Paragraph 1 should be placed
    (F) where it is now.
    (G) after Paragraph 2.
    (H) after Paragraph 3.
    (J) after Paragraph 4.
Exercise 2

30 Questions • Time—18 Minutes

Directions: This test consists of two passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box.

Passage I

The Devastation of El Niño

[1]
Throughout 1998, it seemed, whenever anything went wrong, someone could be heard exclaiming, “Blame it on El Niño!” This unusually powerful weather system received so much attention in the news media around the world that El Niño came to seem like a good scapegoat for almost any mishap.

1. (A) NO CHANGE
   (B) as a good
   (C) as if it was a good
   (D) as a

[2]
Every year, in late December—around Christmas time—oceanic winds from the West tend to shift, causing warm water from the western Pacific to move toward South America, heating the waters along its coast. These hot currents and the weather disturbances they cause have been dubbed El Niño—Spanish for “the child”—because of their annual association with the Christmas holiday.

2. Which of the choices best introduces a central theme of the essay and provides the most appropriate transition between the first and second paragraphs?
   (F) Yet the underlying meteorological causes of El Niño remain obscure.
   (G) Unfortunately, the problems it really caused for creatures living on the Pacific coast of Peru were all too real.
   (H) All over the United States, people found their lives disrupted by the violent effects of El Niño.
   (J) But the real effects of El Niño proved to be surprisingly mild.

3. (A) NO CHANGE
   (B) have been dubbed
   (C) was dubbed
   (D) is known as
CHAPTER 4: The ACT Assessment English Test

In 1998 however, the wind shifts occurred around April and didn’t peak until January, lasting substantially longer than usual. The resulting storms and other climatic changes produced widespread flooding and erosion. And, among other problems, devastated Peru’s population of seals and birds.

When El Niño hit, vast schools of small fish, such as anchovies and sardines, sought cooler temperatures farthest down in the depths of the Pacific than the levels where they are usually found. While this protected the fish from the unseasonable weather conditions, their predators were unable to reach them at these new, greater depths, thus the predators had no food readily available.

Aquatic mammals were hit especially hard. Along one Peruvian beach, the Punta San Juan, a whole season’s pup production of fur seals and sea lions died, as well as thousands of juveniles and and breeding adults. By May 13, 1998, only 15 fur seals were counted, when there are usually hundreds. On the other hand, only 1,500 sea lions were found in an area that usually houses 8,000.

The Humboldt penguins also faced population losses due to El Niño. These penguins normally breed twice a year; but in 1998, their second breeding ground was flooded by 52 consecutive hours of rain. Only 50 of the 3,500

4. (F) NO CHANGE
   (G) However in 1998,
   (H) In 1998, however,
   (J) In 1998—however,

5. (A) NO CHANGE
   (B) erosion; and,
   (C) erosion, and,
   (D) erosion and

6. (F) NO CHANGE
   (G) more far
   (H) farther
   (J) farthest

7. (A) NO CHANGE
   (B) depths: thus
   (C) depths—thus
   (D) depths. Thus,

8. (F) NO CHANGE
   (G) hard, especially.
   (H) especially hard.
   (J) specially hardly.

9. (A) NO CHANGE
   (B) as also
   (C) at the same time as
   (D) so did

10. (F) NO CHANGE
     (G) Yet
     (H) Similarly,
     (J) Likewise,

11. (A) NO CHANGE
    (B) year, but
    (C) year. And
    (D) year, however
to 5,000 penguins that usually lay eggs were able to do so.

12. (F) NO CHANGE
   (G) capable of this.
   (H) able to lay them.
   (J) possible.

13. (A) NO CHANGE
   (B) very close in distance
   (C) not distant
   (D) so close

Items 14 and 15 pose questions about the passage as a whole.

14. Which of the following sentences, if added here, would best conclude the passage and effectively summarize its main idea?
   (F) Two or three more such years may spell an end to many species of wildlife that once thrived on Peruvian shores.
   (G) Fortunately, other countries in South America do not suffer the ill effects of El Niño to the same extent as does Peru.
   (H) Government officials in Peru are currently at work to develop plans for dealing with the problems caused by El Niño the next time it strikes.
   (J) However, aid from foreign countries has helped Peru to save certain of the endangered species whom El Niño has decimated.

15. Suppose the writer were to eliminate Paragraph 4. This omission would cause the essay as a whole to lose primarily
   (A) relevant details about how Pacific fish are destroyed by the effects of El Niño.
   (B) irrelevant facts about feeding patterns among creatures in the southern Pacific ocean.
   (C) relevant information about how El Niño affects aquatic animals on the shores of Peru.
   (D) irrelevant details about the kinds of fish that live off the shores of Peru.

Because Peru is so close in distance to the Pacific regions where the wind shifts and water warming of El Niño originate, it experiences the harshest effects of this unpredictable weather phenomenon.
Passage II

The First Thanksgiving: Turkey Day and a Whole Lot More

Every autumn, when Thanksgiving rolls around, anxiety and stress levels in millions of American families rise. Hosting friends and relatives from all over the country and then to prepare one of the largest meals of the year is not an easy job. But when the typical Thanksgiving dinner of today is compared with the celebration of the first Thanksgiving, it doesn’t seem like quite a feat.

First, consider the menu. At a typical modern-day Thanksgiving, there is a roast turkey, baked yams, stuffing, cranberry sauce, gravy, and some sort of dessert—maybe ice cream and some pie or cake. Of course, you can fix everything yourself, from scratch, if you like; but if you prefer, all of the food can be purchased at a local supermarket: just one trip, and you have all you need for your dinner.

Today’s menu seems stingy by comparison to the Pilgrims’ meal enjoyed on the first Thanksgiving in 1621. According to contemporary records, the list of foods included five deer; wild turkeys, geese, and duck; eels, lobsters, clams, and mussels fished from the ocean; pumpkin; an assortment of biscuits; hoe and ash cakes (whatever those were); popcorn balls, made with corn and maple syrup; pudding; berries of several kinds—gooseberries, cranberries, strawberries—plums, cherries, and

16. (F) NO CHANGE
   (G) preparing
   (H) working on preparation of
   (J) doing preparation for

17. (A) NO CHANGE
   (B) is compared against
   (C) is viewed in reference to
   (D) compares with

18. (F) NO CHANGE
   (G) as great a feat.
   (H) all that much of a feat.
   (J) such a feat.

19. (A) NO CHANGE
   (B) Start by thinking about the food that was served.
   (C) The menu is the first thing we shall discuss.
   (D) The food at the first Thanksgiving was incredible.

20. (F) NO CHANGE
   (G) supermarket, just one trip
   (H) supermarket. One trip;
   (J) supermarket; one trip is all,

21. (A) NO CHANGE
   (B) what the Pilgrims’
   (C) the meal that the Pilgrim’s
   (D) the dinner the Pilgrims

22. (F) NO CHANGE
   (G) what they are is unknown to me)
   (H) unheard-of today)
   (J) OMIT the underlined portion.
bogbeans; beer made from barley; and wine spiked with brandy. Just in case this wasn’t enough, you could fill in the corners with “flint corn,” a rock-hard corn ground into a mush. And once the dinner was served, the meal didn’t last a few hours, but a few days—and with no football on TV to distract the Pilgrims and their friends from the serious business of eating.

The other major difference was the guest list. Nowadays, in many households, the whole family comes for Thanksgiving, this provokes many groans from besieged hosts. Statistics show that the average Thanksgiving dinner boasts 23 total guests—no tiny gath-
At the first Thanksgiving, when Squanto, the Indian-in-residence, decided to invite Massasoit, the leader of the Wampanoags, for a little pot-luck supper, the Pilgrims weren’t expecting him to bring along the other 90 person guest list. I guess they weren’t overdoing it, after all.

So, when the next Thanksgiving rolls around, and you’re tempted to complain about “all this cooking—all this food—all these people!”—just be thankful it isn’t 1621 and you aren’t hosting the first Thanksgiving!

27. Which of the following sentences, if inserted here, would provide the best transition between the first half and the second half of the paragraph?
   (A) We rarely have that many guests in my house.
   (B) It could be a lot worse, however.
   (C) Both family and friends are included in this number.
   (D) And all of them show up hungry.

28. (F) NO CHANGE
   (G) the Wampanoag’s leader,
   (H) who was leading the Wampanoag’s
   (J) Wampanoag leader,

29. (A) NO CHANGE
   (B) the repast served was not, in fact, excessive,
   (C) that dinner menu wasn’t overdoing it,
   (D) it wasn’t too much,

30. (F) NO CHANGE
   (G) your feeling a temptation
   (H) you’re tempted
   (J) there’s a temptation
ANSWER KEY AND EXPLANATIONS

Exercise 1

1. The correct answer is (D). The underlined phrase is redundant, since the words “under no circumstances” add nothing to the meaning conveyed by the word “never.” It can be omitted with no loss of meaning, making the sentence more concise.

2. The correct answer is (G). The semicolon in the underlined portion is wrong, since what follows it cannot stand alone as a sentence. Instead, a comma should be used.

3. The correct answer is (B). When the word “its” is used in place of the words “it is,” it should be spelled “it’s”; the apostrophe stands for the omitted letter “i” in the contraction.

4. The correct answer is (F). “And” is the most logical conjunction among the answer choices for connecting this sentence with the previous one. The other answer choices all imply a contraction or some other shift in meaning, which in fact doesn’t exist.

5. The correct answer is (C). The subject of the verb “have . . . imagined” is the pronoun “no one,” which is singular. Therefore, the singular verb “has . . . imagined” is necessary to make the subject and verb agree in number.

6. The correct answer is (H). The modifying phrase with which the sentence begins, “Working closely” etc., describes effects artists. In order to keep the modifier from “dangling,” what follows the phrase should be a word naming the people being described. Thus, it’s correct for the word “they” (meaning, of course, the effects artists) to immediately follow the comma. Choice (H) is also more concise and graceful than the other answer choices.

7. The correct answer is (B). As originally written, the sentence is a run-on—two complete sentences jammed together with a comma between them. Choice (B) corrects the error by breaking the two sentences apart at the logical place.

8. The correct answer is (F). It makes sense to start with sentence 2, which makes the general point (about the usefulness of special effects) that the rest of the paragraph then explains in more detail. And it makes sense for sentence 3 to follow sentence 4, since it refers to “those costs” described in that sentence.

9. The correct answer is (D). This sentence introduces the topic around which the other sentences in the paragraph are organized.
10. The correct answer is (G). The pronoun “such” is vague, leaving the reader slightly uncertain what is being referred to. (It also is awkward and non-idiomatic; i.e., “weird sounding.”) “These events” refers to the previous sentence clearly and understandably.

11. The correct answer is (B). This wording is the simplest and most concise of the answer choices.

12. The correct answer is (F). The words “Most important” introduce the point made in the final paragraph in a logical fashion: The idea that special effects free movie makers to depict impossible worlds is, arguably, the “most important” or at least most remarkable idea in the passage. The other alternative connecting words or phrases don’t make as much sense in the context.

13. The correct answer is (B). Since this sentence adds nothing to our understanding of movie special effects or how they are used, it can be omitted without losing anything.

14. The correct answer is (G). The word “maker’s” is a possessive; the sentence refers to something (the “tool” of special effects) that belongs to the movie makers. Therefore, it should be spelled with an apostrophe s, as possessives generally are.

15. The correct answer is (C). The parenthetical phrase “after all” should be surrounded by commas to set it off from the rest of the sentence.

16. The correct answer is (F). We’re looking for a sentence that will support the idea that the hungry people of the world may be fed from resources in the sea. The sentence in choice (F) does this by giving several concrete examples of foods derived from the oceans.

17. The correct answer is (B). The phrase “three quarters” is neither a possessive nor a contraction; it’s a simple plural and therefore should be spelled without an apostrophe.

18. The correct answer is (H). There’s no reason to separate the subject (“deposits”) from the verb (“have been discovered”) with a comma.

19. The correct answer is (B). Only the sentence given in choice (B) offers an additional example of important resources that may be provided by the oceans.

20. The correct answer is (G). Since the sentence is talking about the “cities on the ocean” mentioned in the previous sentence, the logical pronoun to use is “they” (a plural pronoun to match the plural antecedent). Choice (H) is wrong because it seems to refer to a “they” we can’t identify—some unnamed group of people who will build the futuristic cities on the sea.

21. The correct answer is (D). The words “playing a variety of roles” mean exactly the same as the words “could serve many functions” that precede them. Since the underlined phrase adds no new information to the sentence, it can and should be eliminated.

22. The correct answer is (G). It’s generally best for the adverb to be as close as possible to the word it modifies—in this case, the verb “could serve.” It should be graceful and natural to insert it in the middle of the verb phrase: “could also serve.”

23. The correct answer is (B). The subject of the verb “have . . . been developed” is the singular pronoun “much.” Therefore, the verb should also be singular: “has been developed.”
24. The correct answer is (J). As originally written, the sentence is a fragment; it has no independent verb. Choice (J) fixes the problem by turning the gerund “serving” into the verb “serve,” whose subject is the word “rigs” way back at the start of the sentence.

25. The correct answer is (A). It makes sense to start a new paragraph here. The previous paragraph talks about the existing oil-rig technology that could be used to build cities on the sea; this paragraph talks about what these new cities would be like. The ideas are distinct and deserve separate paragraphs.

26. The correct answer is (G). The logical relationship between the two clauses in this sense is best expressed by the word “since”; the fact that shipping supplies from the mainland would be costly is the reason why the cities would have to be self-sufficient. “Since” states this relationship.

27. The correct answer is (B). The original phrase is vague, as are choices (C) and (D). Choice (B) names the kinds of facilities to be included in the new cities rather than merely alluding to them.

28. The correct answer is (H). Since what follows the semicolon can’t stand alone as a sentence, that punctuation mark is incorrect. It must be changed to a comma.

29. The correct answer is (C). Paragraph 4 is devoted to describing the various purposes that cities on the sea might serve. The new sentence, which adds an extra example of these purposes, would make sense at the end of that paragraph.

30. The correct answer is (G). Paragraph 1 describes an example of the “human dilemmas” introduced in paragraph 2. Therefore, it makes sense to have paragraph 1 follow paragraph 2.

Exercise 2

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1. The correct answer is (A). The conjunction “like” is correct: It’s idiomatic to say that something “seems like” something else, rather than “seems as” something else.

2. The correct answer is (G). Since the first paragraph talks in a somewhat light-hearted way about how people blamed all kinds of problems on El Niño, while the rest of the passage describes the very serious problems El Niño really caused, a transitional sentence is needed that says to the reader, “All kidding aside—El Niño produced some real headaches.” The sentence in choice (G) does that.

3. The correct answer is (B). The subject of the verb “has been dubbed” is plural—it’s the two things, “hot currents” and “weather disturbances” (a compound subject). Therefore, the plural verb “have been dubbed” is needed.
4. The correct answer is (H). The parenthetical word “however” needs to be set off from the rest of the sentence by a pair of commas, one before it and one after it.

5. The correct answer is (C). The last sentence of the paragraph, as originally written, is a fragment, lacking any real subject. By changing the period before it into a comma, the sentence is merged with the previous one, and “storms and . . . climatic changes” becomes the subject of the verb “devastated.”

6. The correct answer is (H). Two things are being compared: the greater depths the fish sought during El Niño and the lesser depths at which they normally swim. Since only two things are being compared, the comparative adjective “farther” is wanted rather than the superlative “farthest.”

7. The correct answer is (D). Break this sentence into two, since it’s a run-on as it stands.

8. The correct answer is (H). The adverb form of the adjective “hard” looks the same as the adjective “hard.” The -ly suffix isn’t used in this case.

9. The correct answer is (A). The conjunction “as well as” is the most graceful and idiomatic of the answer choices. Note that choice (D) would turn the sentence into a run-on: “So did thousands of juveniles and breeding adults” could and should stand on its own as a complete sentence.

10. The correct answer is (H). Logically, the word “similarly” makes the most sense here, since what’s being described in the sentence is a phenomenon that resembles the one described in the previous sentence. “Likewise” sounds awkward in this context.

11. The correct answer is (B). When two potentially complete sentences are linked in one with a coordinating conjunction (in this case, “but”), it’s normally correct to use a comma before the conjunction rather than some other punctuation mark.

12. The correct answer is (F). The original wording is the clearest and most concise choice. Choices (G) and (J) are vague and confusing, and choice (H) sounds clumsy.

13. The correct answer is (D). The words “in distance” are redundant, since “close” obviously refers to distance; they should be eliminated.

14. The correct answer is (F). This sentence neatly ties together the various destructive effects of El Niño on wildlife living on the shores of Peru.

15. The correct answer is (C). Paragraph 4 explains the indirect way El Niño affects the Peruvian mammals (by reducing the availability of their food, the schools of anchovies and sardines). It’s necessary if we are to understand how El Niño affected the seals and sea lions in Peru.

16. The correct answer is (G). Because it is grammatically parallel with “hosting,” the present participle “preparing” is better than the infinitive “to prepare.”

17. The correct answer is (A). The idiomatic phrase is “compared with,” not “compared against” or any of the other answer choices.

18. The correct answer is (J). In this rather casual, mildly humorous essay, the phrase “such a feat” sounds both idiomatic and appropriate. The other answer choices either sound a bit awkward or are verbose by comparison.
19. **The correct answer is (A).** The original sentence is clear and concise. The alternatives add words without adding anything to the meaning or tone of the essay.

20. **The correct answer is (F).** Note that what follows the colon restates or summarizes what precedes it. This is a good example of the proper use of a colon.

21. **The correct answer is (D).** Choice (D) states the idea most clearly of all the answer choices. The original wording is wrong, among other reasons, because the phrase “Pilgrims meal” would have to be written as the possessive “Pilgrims’ meal.”

22. **The correct answer is (F).** The parenthetical phrase is appropriate in this light-hearted look back at a long-ago, slightly amazing, and mysterious holiday celebration. Choices (G) and (H) say almost the same thing but less gracefully and idiomatically.

23. **The correct answer is (A).** The original wording is more concise and clear than the alternatives.

24. **The correct answer is (F).** The proposed addition fits logically into the overall theme of the essay. Note, too, that it picks up on the idea that the original Thanksgiving dinner was much harder to prepare than today’s Thanksgiving dinners, which can be purchased ready-made at the supermarket (as mentioned in the second paragraph).

25. **The correct answer is (A).** The original wording is correctly parallel to the phrase it’s paired with: not “a few hours, but a few days.”

26. **The correct answer is (J).** As written, the sentence is a run-on. By changing the subject-verb pair “this provokes” into the present participle “provoking,” the second half of the sentence is tightly and correctly linked with the first half, and the run-on problem is eliminated.

27. **The correct answer is (B).** The first half of the paragraph talks about the many guests who show up at today’s Thanksgiving dinners, while the second half talks about how many more guests there were at the first Thanksgiving. The sentence in choice (B) deftly links the two ideas.

28. **The correct answer is (F).** The original word is both perfectly correct and idiomatic.

29. **The correct answer is (C).** As originally worded, the underlined phrase is pretty vague; it’s hard to tell what the writer is getting at. Choice (C) clarifies the point: The huge menu described in the previous paragraph makes sense when you consider how many people attended the dinner.

30. **The correct answer is (H).** The contraction “you’re” is necessary in this sentence, since what’s intended is the same meaning as the two words “you are.”
ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment English Test? How well have you incorporated your new skills into your test-taking behavior?

After you’ve corrected each exercise, find the number below. This will give you an idea of whether you need to go to the English Review in Part 3 or whether you can move on to another subject area.

**SCORE KEY FOR EACH PRACTICE EXERCISE**

<table>
<thead>
<tr>
<th>NUMBER CORRECT</th>
<th>SCORE</th>
<th>SUGGESTED ACTION</th>
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<tbody>
<tr>
<td>0–7</td>
<td>Poor</td>
<td>Study the review chapter and complete the exercises there. Study this chapter again.</td>
</tr>
<tr>
<td>8–13</td>
<td>Below average</td>
<td>Study problem areas in the review chapter; do at least one exercise there. Study this chapter again.</td>
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<tr>
<td>14–18</td>
<td>Average</td>
<td>Study this chapter again if you wish to and have time. Skim problem areas in the review chapter if you have time.</td>
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<tr>
<td>19–24</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
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<td>25–30</td>
<td>Excellent</td>
<td>You’re ready for the ACT Assessment English Test.</td>
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SUMMARY

What You Need to Know about the ACT Assessment English Test

- The ACT Assessment English Test will include 40 questions on usage and mechanics and 35 questions on rhetorical skills. The 75 different questions will refer to five passages. You'll complete the test in one sitting that is 45 minutes long.

- Skim each passage first for overall theme, style, and organization.

- Underlined sections may be questions on either usage and mechanics or rhetorical skills. Boxed numbers always refer to questions on rhetorical skills.

- Approach each usage/mechanics item by reading the entire sentence in which the item appears and trying to identify the error before you look at the test choices.

- Approach each rhetorical-skills item by focusing on the central idea of the passage. Eliminate the unrelated answers.

- The easiest way to arrange a sequence is to begin by finding the first sentence or paragraph.

- The best way to say something is usually the shortest way.
The ACT Assessment Math Test

OVERVIEW

• Learn what to expect on the ACT Assessment Math Test
• Learn proven strategies for success on the ACT Assessment Math Test
• Practice your skills with ACT Assessment Math exercises
• Score your results and evaluate your performance
• Review a summary of ACT Assessment Math facts and tips

WHAT TO EXPECT ON THE ACT ASSESSMENT MATH TEST

The ACT Assessment Math sections test your knowledge of a range of mathematical subjects. Specific topics covered include pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry. Within these topics, you will need to understand the basic arithmetic operations of addition, subtraction, multiplication, and division, as well as such procedures as working with fractions and decimals, figuring out averages, and so on. You’ll also need to be skilled at basic algebraic operations, including solving equations, using negative numbers and square roots, and factoring. You will need to understand the principles of geometry: concepts such as the properties of triangles, circles, and quadrilaterals, and procedures such as determining the areas and volumes of simple figures. Finally, you will be tested on basic principles of trigonometry, including solving trigonometric equations, graphing functions, and understanding the values and properties of functions.

The ACT Assessment Math Test contains 60 multiple-choice questions. The different problem types encompass straight arithmetic problems, word problems, problems in reading and interpreting graphs and charts, algebra problems, geometry problems with and without diagrams, and a few trigonometry problems. Each of the 60 questions will have five possible answers.

Because you have 60 minutes to solve 60 problems, pace yourself. The problems will grow increasingly difficult, so don’t spend too much time on any one problem, especially the beginning ones. You may use the test booklet itself as scratch paper on which to work out your calculations.
There will be a variety of problem types on the test, including the following:

**Straightforward calculations**

If \(3y - 6 = 2 - y\), then the value of \(y^2 + 2y = ?\)

(A) 0  
(B) 2  
(C) 4  
(D) 6  
(E) 8

The correct answer is (E).

**Word problems**

In a group of 20 singers and 40 dancers, 20% of the singers are under 25 years old and 40% of the entire group are under 25 years old. What percent of the dancers are under 25 years old?

(A) 20%  
(B) 30%  
(C) 40%  
(D) 50%  
(E) 60%

The correct answer is (D).
Problems with charts, diagrams, and figures

Given that $l_1$ is parallel to $l_2$ in the figure below, then the value of $x^\circ + y^\circ = ?$

(A) 90° + $x^\circ$
(B) 120° – $y^\circ$
(C) 180° – $z^\circ$
(D) 210°
(E) 270°

A The correct answer is (C).

The Directions

The directions for the ACT Assessment Math Test are similar to the following:

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet. Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first. You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator. Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

STRATEGIES FOR SUCCESS ON THE ACT ASSESSMENT MATH TEST

The ACT Assessment Math sections test your knowledge of basic math principles and procedures that you’ve studied in high school—you don’t have to be a math wizard to succeed on this portion of the test. Timing is critical—you have 60 minutes to answer approximately 60 questions. Timing doesn’t need to be a problem, though; you should be able to answer many
questions in just 15 or 30 seconds. That will leave time for the more involved questions, on which you might spend 2 or 3 minutes. In other words, much of preparing for the math sections of the ACT Assessment involves learning some good strategies and practices in advance. And yes, you’ll try to get a good night’s sleep before the test, you’ll try to eat a healthy breakfast, and you’ll try to stay calm and focused. These tips are great advice for preparing for any test. But the following sections contain some strategies that are designed—and proven—to help you score higher on the ACT Assessment Math Test.

Know What’s Really Being Asked

Read the question carefully. Make sure you know what’s really being asked.

Most problems include a series of interrelated facts. The kinds of facts will vary depending on the kind of question.

Example

Arlene has a block of wood in the form of a rectangular solid 14 inches long with a square base, which is 6 inches on a side. A right circular cylinder is drilled out of the block, as shown below. What is the volume of the wood remaining, to the nearest cubic inch?

(A) 54
(B) 108
(C) 396
(D) 485
(E) 495

The correct answer is (B).
The key to solving a problem like this is to make sure you know which fact is being asked about and what form the answer should take. If you read hastily, you might assume a particular question when, in fact, the test-makers want to focus on a different one. For example, rather than asking about when a train will arrive at City A, they might ask when the train will reach the one-third point of the trip. Rather than asking about the amount of rainfall in any particular month, as shown on a graph, they might ask about the difference between two of the months—a number that does not appear directly on the graph. And in the previous problem, rather than asking about the volume of either the cylinder or the rectangular block, for which you have figures, they have asked about the volume of the odd-shaped region that is the difference between the cylinder and the block.

**Keep Moving within the Problem**

Sitting and staring seldom leads to a solution. Do something, try something. Does the type of problem sound the least bit familiar? Does it at least bring to mind a procedure? Try it. The procedure might prove to be a starting point.

For example, if a problem involves fractions, try simplifying them to the simplest form or finding the least common denominator or renaming the fractions as decimals. If a geometry diagram appears, work from the given, such as the degree measures of certain angles, to fill in other information you don’t know: the complementary angle alongside the angle that’s marked, for example, or the angle on the other side of the transversal that must be congruent to the angle you know. If you’re given a problem involving probability or permutations (varying combinations of things), just start listing all the possibilities.

Quite often, seemingly random experimentation will lead you toward the right answer. That’s because the questions are written so that the numbers themselves are generally “obvious.” After you see the underlying connection among the numbers, the math is usually simple.

If you need to brush up on your math skills and understanding, you have a great opportunity to do so in Chapter 9, “Math Review: From Arithmetic through Geometry.”
Estimate

Because the exact numbers are given for you in the answers, you can often speed through the calculations by estimating. Here’s an example:

The original price of a computer was $1,200. What was the price of the computer after two 10% markdowns?

(A) $960
(B) $972
(C) $980
(D) $1,000
(E) $1,072

The correct answer is (B).

If you understand the logic behind this question, the calculations aren’t difficult. You need to figure out the answer in two steps: first, subtract 10 percent from the original cost of $1,200. This gives you $1,200 – $120 = $1,080. Then subtract 10 percent of this new price of $1,080. This gives you $1,080 – $108 = $972. Using either your calculator or pencil and paper, the math isn’t hard.

However, if you had only minutes left in which to do five more math problems, estimating would be a more useful strategy. Instead of subtracting 10 percent twice in steps, you could simply subtract 20 percent at once in your head, which gives $960. Since you know the answer must be greater than that, you can quickly eliminate choice (A).

Then do the first step: Mentally subtract 10 percent from the original cost, giving you $1,080. You can eliminate choice (E), as $1,072 is too close to $1,080 because the second 10 percent hasn’t been subtracted. Ten percent of $1,080 is $108, close enough to a hundred that you could subtract a hundred from $1,080 for an estimate of $980. Because the actual answer will be less, and you’ve already eliminated $960 as too low, the answer must be $972, choice (B).

Estimating isn’t necessary on most ACT Assessment items; in some cases, the numbers used are so few and so simple that you might as well work with them directly. And, don’t estimate when the choices are very close together. For example, if your five choices are 270, 272, 275, 278, and 282, you’re going to need a precise answer that only full calculation can give. On the other hand, if your five choices are 110, 292, 348, 512, and 721, estimate. You have enough leeway for the “error” that’s built into estimating. Though it’s not always the best route to a solution, estimating is a handy method to use when time is short.
Try One of the Choices

If you have no idea, try one of the choices and work backward. If it doesn’t lead you to the answer, it can often at least alert you to one or two that can be eliminated. Here’s a very simple example:

Margaret has an average of 88 on her four calculus exams. To get an A, she must have a 90 average. What grade must she get on the next exam to bring her average up to 90?

(A) 90  
(B) 92  
(C) 94  
(D) 96  
(E) 98

The correct answer is (E).

Because answers are put in numerical order, choice (C) is always the middle answer and the most logical one to use if you’re trying out possibilities. For an average of 88 on four exams, Margaret must have a total of $4 \times 88 = 352$. Adding 94 to 352 gives 446, and dividing that by 5 gives 89.2, which means it isn’t great enough. By trying one number, you’ve just eliminated choices (A), (B), and (C). You can now try choices (D) or (E) if you have time; if you have no time, pick one—as you have a 50 percent chance of being right—and move on to the next question.

Turn Word Problems into Equations

If word problems are your downfall—if your eyes start to glaze at the mention of planes heading east, gallons of paint being used up, or workers working together at two different speeds—translate the unfamiliar into the familiar. Turn the words into numbers and build an equation for the answer you want.

Surprisingly, the math in most word problems is not difficult. You might have a couple of fractions to multiply or divide or a simple equation to solve, but the computations will be easy. Turning the words into numbers is usually the most difficult part. Here’s how to do it:

What you don’t know is $x$. If the question asks “What fraction of the entire job will be completed after 3 hours?” begin writing your equation with $x =$, where $x$ represents that fraction of the job. Conversely, if the question asks, “How many hours will it take to do $\frac{3}{7}$ of the entire job?” then $x$ will equal the hours of work needed. This way, after you’ve solved the equation, you automatically have your answer, with no further conversions needed.
Even better, instead of $x$, use $J$ for the job and $H$ for the time. These hints are easier to remember and help you focus on what you’re really looking for.

2 Break each phrase into a numerical expression. Divide the problem into its smallest parts. If the part has a known number (such as “3 gallons of paint”), use the number 3. If the part doesn’t have a known number, (“how many gallons”), give it a letter $G$.

3 Create a formula that describes the relationships of the parts. Finally, you’re back on familiar territory!

Example: Paul is 8 years older than Sarah. Four years ago, Sarah was half the age Paul is now. How old is Sarah now?

What you’re looking for is Sarah’s age now. So, set up your equation making $S$ (Sarah’s age now) the unknown for which you will solve. The only other letter we’ll need is $P$, which stands for Paul’s age now. Now, create a couple of simple equations that state in symbols and numbers what the sentences in the problem say.

“Paul is 8 years older than Sarah” becomes: $P – 8 = S$.

“Four years ago, Sarah was half the age Paul is now” becomes $S – 4 = \frac{P}{2}$. To get rid of the fraction (usually a good idea), multiply this equation through by 2: $2S – 8 = P$.

Now you can solve for $S$ by substituting the expression $2S – 8$ for $P$ in the first equation:

\[
(2S – 8) – 8 = S
\]

\[
2S – 16 = S
\]

\[
–16 = –S
\]

\[
S = 16
\]

So Sarah’s age today is 16 (Paul is 24).

Still not sure? Do word problems still make you feel like a visitor to a strange land where you don’t speak the language? Then you’ll want to take along a handy “English-to-Math Dictionary” that will translate key phrases for you.

Translation Guide to Word Problems

The most difficult element of a word problem is trying to translate the relationships into mathematical procedures. A problem says $a + b = x$; solve for $b$ and you immediately understand how $a$, $b$, and $x$ are related and what you have to do. A word problem introduces trains and ticket sales, gallons and miles, pumpkin pies and the ages of three brothers. How are all these people and things related? you want to know. What am I supposed to do?
Following is a mini “Dictionary of Translation” that reveals what commonly used words and expressions in word problems mean in mathematical operations:

<table>
<thead>
<tr>
<th>Word-Problem Word or Phrase</th>
<th>Mathematical Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>added to</td>
<td>addition</td>
</tr>
<tr>
<td>along with</td>
<td>addition</td>
</tr>
<tr>
<td>amounts to</td>
<td>equals</td>
</tr>
<tr>
<td>and</td>
<td>addition</td>
</tr>
<tr>
<td>by</td>
<td>multiplication</td>
</tr>
<tr>
<td>decreased by</td>
<td>subtraction</td>
</tr>
<tr>
<td>difference</td>
<td>subtraction</td>
</tr>
<tr>
<td>divided by</td>
<td>division</td>
</tr>
<tr>
<td>each</td>
<td>multiplication</td>
</tr>
<tr>
<td>fewer than</td>
<td>subtraction</td>
</tr>
<tr>
<td>fraction</td>
<td>division</td>
</tr>
<tr>
<td>greater than</td>
<td>addition</td>
</tr>
<tr>
<td>in addition to</td>
<td>addition</td>
</tr>
<tr>
<td>increased by</td>
<td>addition</td>
</tr>
<tr>
<td>is</td>
<td>equals</td>
</tr>
<tr>
<td>is the same as</td>
<td>equals</td>
</tr>
<tr>
<td>larger than</td>
<td>addition</td>
</tr>
<tr>
<td>less than</td>
<td>subtraction</td>
</tr>
<tr>
<td>more than</td>
<td>addition</td>
</tr>
<tr>
<td>of</td>
<td>multiplication</td>
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<tr>
<td>part of</td>
<td>division</td>
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<tr>
<td>per</td>
<td>multiplication</td>
</tr>
<tr>
<td>piece</td>
<td>division</td>
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<td>portion</td>
<td>division</td>
</tr>
<tr>
<td>product</td>
<td>multiplication</td>
</tr>
<tr>
<td>reduced by</td>
<td>subtraction</td>
</tr>
<tr>
<td>smaller than</td>
<td>subtraction</td>
</tr>
<tr>
<td>take away</td>
<td>subtraction</td>
</tr>
<tr>
<td>times</td>
<td>multiplication</td>
</tr>
<tr>
<td>with</td>
<td>addition</td>
</tr>
<tr>
<td>without</td>
<td>subtraction</td>
</tr>
</tbody>
</table>

If word problems are your problem, try to learn as much of the list as possible. Many of the terms—“take away,” for example—are already associated with subtraction, so there actually won’t be too many “foreign words” you need to translate.

**Change Quantities into the Unit of the Answer**

One common error is to give the answer in terms of the wrong unit. For example, the answer you calculate is 2 quarts; however, because the question asked for how many gallons, the correct answer is really $\frac{1}{2}$ (4 quarts = 1 gallon).
One way to avoid the error is to begin the problem by renaming the units as the units demanded by the answer. So, for example, if you see that the answers are all stated in terms of square feet, while the numbers in the problem are in square yards, change them to square feet before beginning your work. (1 square yard = 9 square feet.)

Consider Diagrams “Treasure Maps” to the Solution

Diagrams, especially for geometry problems, are there for a reason. They are filled with clues to the solution. You can usually leap from what you know—the facts you are given—to what you need to know simply by using the parts of the diagram as “stepping stones.” Here's an example:

In the diagram below, $AB = 3$, $AD = 4$, and $BC = 12$. What is the perimeter of the quadrilateral?

(A) 32  
(B) 30  
(C) 28  
(D) 26  
(E) 24

The correct answer is (A).

Solving a geometry problem like this one is a matter of working methodically. Just fill in the blank parts of the diagram using what you can deduce from the information you're given. (Use your pencil to mark the new facts right in the question booklet.) You'll eventually work your way to the fact about which you're being asked.

Here's how you'd apply the method to this item. This problem uses two well-known right triangles. We see that, in triangle $ABD$, one leg is 3 and one is 4, which makes $BD = 5$ (the famous “Pythagorean triple,” 3-4-5). This tells us that triangle $BDC$ is 5-12-13 (another famous Pythagorean triangle). Thus, $CD$ is 13, and the entire perimeter is $3 + 4 + 12 + 13 = 32$. 

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If There’s No Diagram, Draw One

You don’t need an art degree to sketch a diagram that will be so clear you’ll see the answer at once. Here’s an example:

One side of a rectangle with an area of 18 square inches is the diameter of a circle. The opposite side is tangent to the circle. What is the length of the circumference of the circle?

(A) $2\pi$
(B) $6\pi$
(C) $9\pi$
(D) $12\pi$
(E) $18\pi$

A The correct answer is (B).

Without a diagram, this is a difficult problem; with one, it’s very easy. Just use the margin of your test booklet to quickly sketch a circle. Put a straight line through the center for the diameter. The diameter is also one side of the rectangle. The opposite side of the rectangle is tangent to the circle, so draw that side of the rectangle parallel to the diameter and equal to its length (by definition of being a rectangle) and passing through a point on the circle. Connect the “missing sides” of the rectangle at right angles (again, by definition). Calling the radius of the circle $r$, we see in the picture below that the rectangle has a width of $r$ and a length of $2r$.

Hence, the area of the rectangle is $2r^2 = 18$, which is confirmed by the problem. Thus $r^2 = 9$, and $r = 3$. The circumference of the circle is $2\pi r = 6\pi$. 

TIP

Don’t be stumped by the infamous “shaded region” problem. Many “shaded region” problems can drive you to distraction, asking you to find the area of an odd-looking geometric shape. Like other seemingly difficult geometry problems, these questions become simple after you recognize that subtracting—finding the difference—between two quantities is the key. If you study the diagram, you’ll see that the problem can usually be solved just by finding the areas of two conventional figures (squares, triangles, circles, etc.), and then subtracting one from the other.
Read the Graph Before You Read the Questions

On graph problems, spend 30 seconds analyzing the graph(s) before even looking at the questions. Look at the structural features, labels, and basic contents. This helps you find the relevant information and separate it from the mass of other information in which it is embedded. You can always return to the graph later for the details.

There are many different types of graphs. Three kinds commonly appear on the ACT Assessment: bar graphs, line graphs, and circle graphs.

A Quick Look at Bar Graphs

Bar graphs are good for making simple comparisons, such as comparing a single set of statistics (birth rates, for example) for different countries or different years. Following is an example:

In this graph, each bar represents the annual sales of a different major industrial corporation. A bar graph works well here, because it makes the differences in size from one corporation to another very clear. However, if the data were more complex, this graph would be more difficult to look at and understand. A bar graph also has limitations when it comes to spotting trends.

Sales of the Top Ten Industrial Corporations in the Fortune 500, 1996 (Billions of Dollars)

1. General Motors 6. Royal Dutch/Shell
2. Ford Motor Company 7. Marubeni
3. Mitsui 8. Exxon
4. Mitsubishi 9. Sumitomo
5. Itochu 10. Toyota Motor
A Quick Look at Line Graphs

Line graphs, by contrast, can be both precise and intricate. Large numbers of data points can be shown in one or more lines on a graph, and trends of increase or decrease can be easily and quickly “read” on a line graph. For this reason, line graphs are the kind of graph most often used by scientists and statisticians.

![Motor Vehicle Production, 1950–1990](chart.png)

Both bar and line graphs have certain features in common:

All bar and line graphs have two axes, the horizontal (or $x$) axis and the vertical (or $y$) axis. By convention, the independent variable in an experiment or a statistical study is usually placed on the horizontal axis and the dependent variable on the vertical axis. For example, if a chemist were studying the effect of temperature on the solubility of a substance, the independent variable would be temperature, and the dependent variable would be solubility. When the experiment was documented later, a graph of the data would have temperature along the horizontal axis and solubility on the vertical axis.

Circle Graphs

Circle graphs are used to show the breakdown of some large quantity into smaller quantities. The greater the relative size of a particular “slice of the pie,” the greater the fraction of the overall quantity represented by that sector of the circle. Typical uses of a circle graph would include the division of the budget of a nation, business, or family into portions representing either different sources of income or different types of spending and the division of a general population into particular categories (by age, religion, or occupation, for example).
All properly designed graphs are clearly labeled with the names of the variables being studied and the units of measurement (degrees, centimeters, percent, and so on). The divisions along the axes should be clearly numbered. All graphs should also have a title. Many graphs have a key providing additional information about the graph or the data. The key is usually found in one corner of the graph or outside the limits of the graph altogether. A key is most often used when more than one line (or bar, or set of points) is plotted on one graph. Because it would be otherwise impossible for the viewer to know what is meant by the data in such a case, different sets of data are distinguished from each other by using different shadings or patterns for each line, bar, or set of points. The key explains to the viewer what each of the colors or patterns represents. You should always be sure to examine all of these features carefully whenever you encounter a graph on the ACT Assessment.

Avoid Long Calculations

Don’t get mired in twenty-step calculations using sixteen-digit numbers. Most of the math on the ACT Assessment is simple and more “method” oriented; that is, if you can discover the method, the math is usually easy. If you find yourself getting involved in long, complicated, or tricky calculations—especially ones using big numbers—stop and begin again with a clear mind. You’re probably overlooking the simple shortcut that would make the calculations unnecessary. If you’ve already spent too much time on the question, mark it for later attention and move on. If time allows, you can return to the question later, when the answer might come to you more readily.

Don’t Over-Rely on Your Calculator

The math on the ACT Assessment is specifically designed not to require the use of a calculator. It relies on reasoning and on knowing the correct procedures. If you rely too heavily on calculation, you’re apt to miss the bigger picture behind the question.

You’re also susceptible to certain errors with a calculator, such as hitting the wrong key, hitting the right key twice, and jamming keys. You also don’t leave a visible paper trail to retrace your steps in case of a mistake.

Use a calculator if you must, but don’t depend on it. Calculators work best for arithmetic calculations, square roots, and percentages; if you need to use the calculator, use it for those types of functions. And if you must use one, use one that you’re familiar with, and make sure it has fresh batteries on test day.
SUCCESS STRATEGY ROUNDUP:
A LIST OF DO’S AND DON’TS

Here’s the short version of the previously covered advice, along with a few other miscellaneous tips, arranged in a handy list of Do’s and Don’ts. After you understand each point and the reasoning behind it, you need only know the boldface sentence to jog your memory—whether you’re working on the exercises at the end of this chapter, your full-length practice tests, or the ACT Assessment itself.

A list of Do’s:

✔️ Keep moving within the problem. Sitting and staring seldom leads to a solution. Do something. Try a procedure that seems familiar from class and appropriate to the particular problem. Even if the procedure doesn’t immediately work, it might suggest something else that will.

✔️ Keep moving within the test. Have you been working on one problem forever? There are dozens more waiting. Keep moving at a regular pace. If you’re not working productively on a problem within 20 seconds, move on.

✔️ Know what’s being asked. Read carefully and make sure you know what’s being asked. Also make sure you know what particular form the answer should take. For example, is the answer supposed to be a number, or coordinates for a point on a graph? Is the answer supposed to be a choice that may be true, must be true, or may not be true? Know what’s being asked.

✔️ Round off and guess. It’s not always necessary to work with exact numbers to solve ACT Assessment Math problems. Round off and save time. When should you round off? When the five choices are sufficiently far apart. Answers that are close together require more precise calculation.

✔️ Try one of the choices. If you’re not sure what to do, choose an answer and plug it into the question. This will often lead you to the right answer more quickly. Which answer should you choose? Start with choice (C). Answers are in size order, so choice (C) will always be the middle value. If choice (C) doesn’t work, you might sometimes also be able to eliminate the two greater or two lesser answers, given the information in the problem.

✔️ Turn word problems into equations. Reduce word problems into more easily understood equations. Let x be that for which you want to solve (time to complete a job, distance traveled, etc.). Then turn every element of the problem into a numerical expression. After you have all the numbers and symbols, it’s usually easier to see how you should build the equation that will solve the problem.
PART II: Strengthening Your ACT Assessment Subject Skills

- **Change all units to the units of the answer.** If, for example, a problem gives you information in terms of square feet but asks for an answer in terms of square yards, it will be easier to solve the problem if you first change all the units into yards, and then begin working.

- **Consider diagrams “treasure maps” to the solution.** Diagrams, especially for geometry problems, are filled with clues to the solution. Examine every diagram carefully. It’s there for a reason. If there’s no diagram, draw one of your own. It can make the solution immediately apparent.

- **“Read” a graph before looking at the questions.** Think of this as skimming a reading passage before beginning to work. Look at the structure of the graph (the labels on the axes, the units of measurement, and any information in the key). This is often more important than the data itself. Refer to the graph as often as necessary.

A list of Don’ts:

- **Don’t get paralyzed by lengthy calculations.** Most ACT Assessment Math questions do not require complicated calculations. If you understand the structure of the problem, the solution is usually evident. So if you’re overwhelmed with figuring, stop and move onto the next question.

- **Don’t get involved with large numbers.** They’re difficult to work with and time-consuming. When very large numbers are given in a problem, don’t assume they’re part of the needed calculation. Because no problem requires a calculator, if you’re calculating great numbers, you’re probably overlooking the simple principle that will solve the problem.

- **Don’t over-rely on your calculator.** No ACT Assessment Math problem requires a calculator. Using a calculator opens you to the risk of mistakes. And if you make a mistake, there’s no paper trail to follow to see where the mistake occurred. Limit calculator use to basic arithmetic, percentages, and square roots. And speaking of calculators . . .

- **Don’t bring a new calculator to the test.** Every calculator operates just a bit differently with different keys for different functions. You don’t have time during the test to learn how a new calculator works. If you must use a calculator, bring one you’re familiar working with—and make sure it has fresh batteries.

- **Don’t get fooled by trick questions.** Often a question is like a riddle—it prompts an obvious answer, but the obvious answer is wrong. Other times, the answer apparently is impossible to solve, such as the area of an irregular shape. What are you overlooking? In other words, certain questions ask you to “think outside the box.” However . . .

- **Don’t expect trick questions early in the test.** Because problems are ordered in complexity from the easy to the difficult, the first third of the test will have simple questions, with correspondingly simple answers. Even the middle third will be straightforward, although harder in difficulty. Don’t over-complicate things by looking for trick questions on every line.

---

**ALERT!**

You can use a calculator on the ACT Assessment Math Test but not on the Science Reasoning Test. Further, you can’t use a calculator that includes or is part of a pocket organizer, pen-input device, electronic writing pad, or a keyboard pad. If your calculator needs a power cord, has a paper tape, or emits beeps or other noises during operation, you won’t be allowed to use it during the ACT Assessment (the ACT Assessment regulations governing the use of calculators are published in the official ACT Assessment bulletin and on the ACT Assessment Web site). A scientific calculator (that meets all of the ACT Assessment restrictions) is probably your best bet.

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Don’t assume a guess is right just because it’s one of the answers. Although rounding off and estimating are useful, outright guessing cannot replace calculation. Often the test choices include the most common student errors, so just because “your” answer is listed doesn’t mean it’s right. Work it out. Don’t guess answers until you’re running out of time.

PRACTICE EXERCISES

You’ve just learned some new skills for taking the ACT Assessment Math Test. The following exercises will help you to practice these new skills as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are two Math Test exercises in this chapter. Each exercise contains 12 problems and should be answered in 12 minutes. Do each exercise in one sitting in a quiet place, with no notes or reference material. You may use a calculator. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

Score yourself only on those items you finished. When you’re done, work through the rest of the exercise.
EXERCISES: THE ACT ASSESSMENT MATH TEST

Exercise 1

12 Questions • Time—12 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. The advertised price of potatoes is 35¢ per pound. If a bag labeled “3 pounds” actually weighs 3 1/4 pounds, what is the closest approximation in cents to the actual price per pound for that bag?
   (A) 32
   (B) 33
   (C) 34
   (D) 35
   (E) 36

2. \(P = (-1, 2); Q = (3, 5)\). What is the slope of \(PQ\)?
   (F) \(3/4\)
   (G) \(7/4\)
   (H) \(3/2\)
   (J) \(4/3\)
   (K) \(7/2\)

3. If the larger circle shown below has an area of 36\(\pi\), what is the circumference of the smaller circle?
   (A) \(2\pi\)
   (B) \(4\pi\)
   (C) \(6\pi\)
   (D) \(8\pi\)
   (E) \(12\pi\)
CHAPTER 5: The ACT Assessment Math Test

4. If \( r = -2 \), then \( r^4 + 2r^3 + 3r^2 + r = ? \)
   (F) \(-8\)
   (G) \(-4\)
   (H) \(0\)
   (J) \(6\)
   (K) \(10\)

5. How many liters of 50% antifreeze must be mixed with 80 liters of 20% antifreeze to get a mixture that is 40% antifreeze?
   (A) 80 liters
   (B) 100 liters
   (C) 120 liters
   (D) 140 liters
   (E) 160 liters

6. Horace averaged 70 on his first \( m \) exams. After taking \( n \) more exams, he had an overall average of 75 for the year. In terms of \( n \) and \( m \), what was Horace’s average for his last \( n \) exams?
   (F) \( \frac{5m + 75}{n} \)
   (G) \( \frac{5m}{n} + 75 \)
   (H) \( \frac{5n}{m} + 75 \)
   (J) \( \frac{70m + 75n}{m + n} \)
   (K) \( 80 \)

7. Shayna rolls a six-sided die twice. What is the probability that she rolls the same number both times?
   (A) 0
   (B) \( \frac{1}{36} \)
   (C) \( \frac{2}{36} \)
   (D) \( \frac{1}{12} \)
   (E) \( \frac{1}{6} \)

8. Which of the following is a common factor of both \( x^2 - 4x - 5 \) and \( x^2 - 6x - 7 \)?
   (F) \( x - 5 \)
   (G) \( x - 7 \)
   (H) \( x - 1 \)
   (J) \( x + 5 \)
   (K) \( x + 1 \)

9. The diagram below shows a cube 3 units on a side with a \( 1 \times 1 \) square hole cut through it. How many square units is the total surface area of the cube?

   (A) 52
   (B) 54
   (C) 60
   (D) 64
   (E) 66
Use the following information to answer questions 10 and 11.

The bar graph below shows the payments made by XYZ Corporation on contracts to four different suppliers last month. The same information is displayed in the pie chart.

10. How many degrees are there in the angle of the sector of the pie chart representing Corman?

- (F) 36°
- (G) 60°
- (H) 100°
- (J) 108°
- (K) 120°

11. If Corman goes out of business and XYZ divides up its payments among the three suppliers Ajax, Baker, and Delta in the ratio of 3:2:1, how many degrees in the new pie chart will be in the sector representing Baker?
- (A) 25°
- (B) 45°
- (C) 60°
- (D) 75°
- (E) 90°

12. Which of the following is a correct factorization of $3x^2y^3 - 6xy^2$?
- (F) $3xy^2(x - 2y)$
- (G) $3x^2y(xy + 2)$
- (H) $3x^2y(xy - 2)$
- (J) $3xy^2(x - 2y)$
- (K) $3x^2y^2(x - 2)$

(F) 36°
(G) 60°
(H) 100°
(J) 108°
(K) 120°
CHAPTER 5: The ACT Assessment Math Test

Exercise 2

12 Questions • Time—12 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. For which $n$ is the remainder greatest when 817,380 is divided by $n$?
   (A) 4
   (B) 5
   (C) 6
   (D) 8
   (E) 9

2. Two rectangles have the same area. One is twice as long as the other. If the longer rectangle has a length of $L$ and a width of $W$, what is the perimeter of the shorter rectangle?
   (F) $2L + 2W$
   (G) $2L + 4W$
   (H) $L + 4W$
   (J) $2L + W$
   (K) $4L + 2W$

3. If $4x + 2y = 13$ and $4y - x = 8$, what is the value of $x + 2y$?
   (A) $-7$
   (B) $-3$
   (C) 0
   (D) 5
   (E) 7

4. If the area of the rectangle in the figure below is equal to the area of the triangle, what is the perimeter of the triangle?
   
   ![Diagram](image)

   (F) 17
   (G) $8 + \sqrt{15}$
   (H) $8\sqrt{12}$
   (J) 40
   (K) 42

5. If $2^3 = \sqrt{N}$, what is $N$?
   (A) 8
   (B) 16
   (C) 32
   (D) 64
   (E) 128

6. Four boys own a total of 150 baseball cards. If the first boy owns 28% of the cards, the second owns 24% of the cards, and the third owns three times as many cards as the fourth, what is the greatest number of cards owned by any one boy?
   (F) 28
   (G) 36
   (H) 42
   (J) 54
   (K) 64
7. If \((x - 2)(x + k) = x^2 + mx - 10\), then \(mk = ?\)
   (A) –20
   (B) –15
   (C) 12
   (D) 15
   (E) 20

8. A box contains five blocks numbered 1, 2, 3, 4, and 5. John picks a block and replaces it. Lisa then picks a block. What is the probability that the sum of the numbers they picked is even?
   (F) \(\frac{9}{25}\)
   (G) \(\frac{2}{5}\)
   (H) \(\frac{1}{2}\)
   (J) \(\frac{13}{25}\)
   (K) \(\frac{3}{5}\)

9. If a fleet of \(m\) buses uses \(g\) gallons of gasoline every 2 days, how many gallons will be needed by four buses every 5 days?
   (A) \(\frac{10g}{m}\)
   (B) \(10gm\)
   (C) \(\frac{10m}{g}\)
   (D) \(\frac{20g}{m}\)
   (E) \(\frac{5g}{4m}\)

10. The ratio of the arithmetic mean of two numbers to one of the numbers is 3:5. What is the ratio of the lesser number to the greater?
    (F) 1:5
    (G) 1:4
    (H) 1:3
    (J) 2:5
    (K) 1:2

11. The cost of producing a certain machine is directly proportional to the number of assembly line workers required and inversely proportional to the square of the number of hours of assembly line downtime during production. If the cost was $1,500 when there were 12 workers and only 2 hours of downtime, how many hours of downtime was there when 9 workers were producing machines at the cost of $2,000 per machine?
    (A) 1 hour
    (B) 1.5 hours
    (C) 2 hours
    (D) 2.5 hours
    (E) 3 hours

12. Which of the following is one root of the equation \(x^2 - 4x + 13 = 0\)?
    (F) –1
    (G) 5
    (H) \(4 + 3i\)
    (J) \(2 - 6i\)
    (K) \(2 + 3i\)
1. The correct answer is (A). At 35¢ per pound, the 3-pound bag will be marked $1.05 or 105¢. Dividing this by the weight of the bag, we have $105 \div 3$. Hence, 32 is the closest answer.

2. The correct answer is (F).

3. The correct answer is (C). The larger circle has an area of $A_L = \pi r^2 = 36\pi$. This means that $r^2 = 36$, and $r = 6$. The diameter of the smaller circle equals the radius of the larger one, so its radius is $\frac{1}{2}(6) = 3$. Therefore, its circumference must be $C_S = 2\pi(3) = 6\pi$.

4. The correct answer is (K). Substituting: $(-2)^4 + 2(-2)^3 + 3(-2)^2 + (-2) = 16 - 16 + 12 - 2 = 10$.

5. The correct answer is (E). Let $x$ be the unknown number of liters of 50% antifreeze. The final mixture will have $(x + 80)$ liters, and the amount of antifreeze will be:

   $0.50x + 0.20(80) = 0.40(x + 80)$
   $0.5x + 16 = 0.4x + 32$
   $0.1x = 16; x = 160$

6. The correct answer is (G). Because his average overall was 75, he had a total overall score of $75(m + n) = 75m + 75n$ on $n + m$ exams. Since he averaged 70 on $m$ exams, he had a total of $70m$ on the first $m$. That means that his total on the last $n$ exams was $75m + 75n - 70m = 5m + 75n$, and his average was $(5m + 75n) + n = \frac{5m}{n} + 75$.

7. The correct answer is (E). It really does not matter what number you roll on the first roll; in any case, the chance of matching it the next time you roll is $\frac{1}{6}$.

8. The correct answer is (K). $x^2 - 4x - 5 = (x - 5)(x + 1)$, and $x^2 - 6x - 7 = (x - 7)(x + 1)$. The common factor is $x + 1$.

9. The correct answer is (D). Each side of the square has an area of $3 \times 3 = 9$. Because there are six sides, the original cube had a surface area of 54 square units. Two $1 \times 1$ squares are now missing, making the outside area 52. The “hole” has four $3 \times 1$ rectangular sides with a total area of 12, giving a grand surface area total of 64.

10. The correct answer is (J). Totaling the payments made to all four suppliers, you have $4,500 + 1,500 + 3,000 + 1,000 = 10,000$. Of this total, $3,000 was paid to Corman (that is, 30% of the total). Hence, the sector representing Corman must be $30\%$ of $360^\circ = 108^\circ$.

11. The correct answer is (E). Corman did a total of $3,000 business. When they divided the total into the ratio 3:2:1, which is a total of 6 parts, each part is equal to $500. Baker’s business increased by $1,000. $1,000 + 1,500 = 2,500, which is a quarter of the $10,000 total business represented on the chart. One fourth of $360^\circ$ is $90^\circ$.
12. The correct answer is (H). The first term could be thought of as \(3xy^2(xy)\) and the second as \(3xy^2(–2)\). Hence, we can take out the common factor \(3xy^2\), leaving as the other factor \((xy – 2)\).

Exercise 2

1. The correct answer is (D). \(817,380\) is divisible by all the numbers in the list except 8. Hence, 8 must give the greatest remainder, because it is the only remainder that is not zero. To confirm, start with 5; \(7,380\) is divisible by 5, because its last digit is 0. It is divisible by 2 because it is even and by 4 because 80 is divisible by 4. However, it is not divisible by 8, because 380 isn’t. In addition, the sum of its digits is 27, which is divisible by 3 and by 9. Because it is divisible by both 2 and 3, it is also divisible by 6.

2. The correct answer is (H). The perimeter of the longer rectangle is \(2L + 2W\). The other rectangle must have a length of \(\frac{1}{2}L\) and a width of \(2W\), since the area is the same. Thus, the second rectangle has a perimeter of \(2(\frac{1}{2}L) + 2(2W) = L + 4W\).

3. The correct answer is (E). We could solve the two equations simultaneously to find \(x\) and \(y\). However, it is easier to proceed as follows: Reorder the terms in the second equation so as to start with the \(x\) term. Thus,

\[-x + 4y = 8\]

Add to this the second equation:

\[-x + 4y = 8\]
\[4x + 2y = 13\]
\[3x + 6y = 21\]

Divide by 3:

\[x + 2y = 7\]

4. The correct answer is (J). The area of the rectangle is \(6(10) = 60\). Using the legs of the right triangle as base and height (with the unknown leg called \(h\)), we have \((8)h = 60\); that is, \(4h = 60\), and \(h = 15\). Hence, the triangle is an \(8-15-17\) right triangle (one of the famous “Pythagorean triples”) with a perimeter of 40.

5. The correct answer is (D). \(2^3 = 8\), and 8 is the square root of 64.

6. The correct answer is (J). 28% of 150 = 0.28(150) = 42. 24% of 150 = 0.24(150) = 36. Thus, \(150 – 42 – 36 = 72\) cards, which are divided between the other two boys in the ratio of 3:1. That is, one boy owns \(\frac{1}{3}\) of the 72 cards (18), and the other owns \(\frac{2}{3}\) of them (54).

7. The correct answer is (D). Using the FOIL Method: \((-x – 2)(x + k) = x^2 + (k – 2)x – 2k\). Because \(-2k = –10\), \(k = 5\); and since \((k – 2) = m\), \(m = 3\). Hence, \(km = 15\).

8. The correct answer is (J). Because each person had five choices, there are 25 possible pairs of numbers. The only way the sum could be odd is if one person picked an odd number and the other picked an even number. Suppose that John chose the odd number and Lisa the even one. John had three possible even
numbers to select from, and for each of these, Lisa had two possible choices, for a total of \(3(2) = 6\) possibilities. However, you could have had John pick an even number and Lisa pick an odd one, and there are also six ways to do that. Hence, out of 25 possibilities, 12 have an odd total and 13 have an even total. The probability is \(\frac{13}{25}\).

9. The correct answer is (A). Running \(m\) buses for two days is the same as running one bus for \(2m\) days. If we use \(g\) gallons of gasoline, each bus uses \(\frac{g}{2m}\) gallons each day. So if you multiply the number of gallons per day used by each bus by the number of buses and the number of days, you should get total usage. Thus: \(\frac{g}{2m} \times 4 \times 5 = \frac{10g}{m}\).

10. The correct answer is (F). Calling the numbers \(x\) and \(y\), \(\frac{xy}{x+y} = \frac{3}{5}\). That is, \(\frac{xy}{x+y} = \frac{3}{5}\). Cross-multiplying: \(5x + 5y = 6x; 5y = x\). Hence, one number is five times as great as the other, so their ratio is 1:5.

11. The correct answer is (B). Letting \(C = \) cost, \(w = \) number of workers, and \(t = \) time in hours, we have the relationship \(C = k \frac{w}{t}\). Therefore, when \(w = 12\) and \(t = 2\), we have \(1,500 = k \times \frac{12}{2} = 3k\); therefore, \(k = 500\). Using \(k = 500\) and substituting \(w = 9\) and \(C = 2,000\, \), we have:

\[
2,000 = \frac{500 \times 9}{t} = \frac{4,500}{t}
\]

Multiplying by \(t^2\) and dividing by 2,000, we have:

\[
t^2 = \frac{9}{7}, \quad t = \frac{3}{7} = 1.5
\]

12. The correct answer is (K). Using the quadratic formula with \(a = 1\), \(b = -4\), and \(c = 13\):

\[
x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(13)}}{2(1)} = \frac{4 \pm \sqrt{16 - 52}}{2} = \frac{4 \pm \sqrt{-36}}{2}
\]

\[
x = \frac{4 \pm 6i}{2} = 2 \pm 3i
\]

Hence, one root is \(2 + 3i\).
ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment Math Test? How well have you incorporated your new skills into your test-taking behavior?

After you’ve corrected each exercise, find the number of correct answers below. This will give you an idea of whether you need to go to the Math Review immediately following this chapter or whether you can move on to another subject area.

SCORE KEY FOR EACH PRACTICE EXERCISE

<table>
<thead>
<tr>
<th>Number Correct</th>
<th>Score</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>Poor</td>
<td>Study the review chapter and complete the exercises there. Study this chapter again.</td>
</tr>
<tr>
<td>4–6</td>
<td>Below average</td>
<td>Study problem areas in the review chapter; do at least one exercise. Study this chapter again.</td>
</tr>
<tr>
<td>7–8</td>
<td>Average</td>
<td>Study this chapter again if you wish to and have time. Skim problem areas in the review chapter if you have time.</td>
</tr>
<tr>
<td>9–10</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
</tr>
<tr>
<td>11–12</td>
<td>Excellent</td>
<td>You’re ready for the ACT Assessment Math Test.</td>
</tr>
</tbody>
</table>
CHAPTER 5: The ACT Assessment Math Test

SUMMARY

What You Need to Know about the ACT Assessment Math Test

• The ACT Assessment Math Test includes a total of 60 questions: 24 questions on Pre-Algebra/Elementary Algebra; 18 questions on intermediate algebra/coordinate algebra; and 18 questions on plane geometry/trigonometry. The 60 different questions must be completed in one sitting that is 60 minutes long.

• Read diagrams and graphs before the appropriate question, looking for structural information and analyzing the data given.

• Don’t get paralyzed by lengthy calculations or large numbers. The test is designed to be taken without a calculator. If you’re overwhelmed by calculations and number size, you’re missing the usually simple principle that will solve the problem.

• Translate word problems into equations; give numbers and symbols to every element in the word problem.

• Keep moving, both within a problem and within the test. If you’re at a loss, plug the middle choice (C) into the equation and work backward.

• Round off great numbers and estimate for faster, easier figuring.

• Questions are arranged from the easiest to the hardest, so don’t waste time looking for trick questions early on.

• Substitute numbers for symbols to make calculations easier.

• You may use a calculator, but don’t over-rely on it. The answer usually lies in concepts and shortcuts, not calculations.
The ACT Assessment Reading Test

OVERVIEW

- Learn what to expect on the ACT Assessment Reading Test
- Understand the format and content of ACT Assessment reading questions
- Learn ACT Assessment reading strategies for success
- Practice your ACT Assessment reading skills
- Evaluate your progress

WHAT TO EXPECT ON THE ACT ASSESSMENT READING TEST

The selections on the ACT Assessment Reading Test include the type of sophisticated, complex, and subtle reading that college students are called upon to do. In these selections, you need to do more than just understand the broad facts presented in the passage and identify the main idea. You also need to understand the relationships between the facts, to find the important details, and to see the implications, or the ideas that are suggested rather than directly stated in a piece. You will answer questions that have to do with the writer’s role, such as whether an author’s logic is sound or flawed and if his or her presentation is factual or opinionated. Finally, you also are asked to answer questions about the passage itself—its form, structure, and style.

A Closer Look at ACT Assessment Reading Questions and Their Format

The ACT Assessment Reading Test consists of four passages, from 700 to 900 words each, followed by a group of 10 questions. Both the reading and the answering of all 40 questions must be done in one 35-minute sitting. So plan on spending 8 to 9 minutes on each section, about half of that time on reading, the other half on answering the questions.

The four ACT Assessment Reading passages include one fiction narrative and three nonfiction selections in the areas of the natural sciences, social studies, and humanities. The fiction passage might be a short story, entire in itself, or a
selection from a short story, novella, or novel. The ACT Assessment does not use material from poetry or drama. The nonfiction passages include excerpts from books, magazines, and journals and embrace a wide variety of topics. The area of social studies includes history, political science, economics, anthropology, psychology, and sociology. The natural sciences include the physical sciences, biology, chemistry, and physics. Selections about the humanities might discuss music, the visual arts, theater, dance, architecture, or philosophy. There is only one passage in each main area, and any of these topics may be on a given test. You don’t need to have taken a course in the subject to do well on the exam. The passage contains all of the information you need to answer the questions.

A strong vocabulary will give you a distinct edge when you tackle ACT Assessment Reading questions. For a review of important ACT Assessment vocabulary, see Chapter 10, “Reading Review,” later in this book.

The following example is a paragraph from a larger passage taken from the natural sciences and the corresponding question.

Just shaking a can of mixed nuts can show you how problematic granular material can be. The nuts don’t “mix”; they “unmix” and sort themselves out, with the larger Brazil nuts on top and the smaller peanuts on the bottom. In this activity and others, granular matter’s behavior apparently goes counter to the second law of thermodynamics, which states that entropy, or disorder, tends to increase in any natural system.

The passage suggests that a can of mixed nuts seems to disobey the second law of thermodynamics because it
(A) fails to mix when shaken.
(B) becomes increasingly disordered over time.
(C) sorts smaller nuts to the bottom rather than the top of the can.
(D) does not readily separate into different kinds of nuts.

The correct answer is (A).

As you can see, the passage discusses the properties of granular material and includes references to such scientific principles as the laws of thermodynamics, yet no prior knowledge of the properties of granular material or the laws of thermodynamics are needed to answer the question. In this example, the last sentence of the paragraph describes the second law of thermodynamics, and it tells you that the behavior of the nuts (sorting themselves out when shaken) goes counter to that law.
The Directions

The directions for the ACT Assessment Reading Test are similar to the following:

**Directions:** This test consists of four passages, each followed by several questions. Read each passage, select the correct answer for each question, and mark the oval representing the correct answer on your answer sheet.

**STRATEGIES FOR SUCCESS ON THE ACT ASSESSMENT READING TEST**

In other chapters of this book, you’ve learned general strategies and techniques that will help you prepare for success on the ACT Assessment. Getting a good night’s sleep, eating a healthy breakfast, and staying calm and focused are all important to doing well on the exam. Here are some success strategies specifically designed to help you score higher on ACT Assessment Reading. As with other areas of the ACT Assessment, the Reading Test offers its own challenges. With the preparation you receive here, you can tackle the ACT Assessment Reading Test with confidence and get high scores on this critical portion of the exam.

**The Three-Step Method: Preview, Read, Review**

The reading part of the ACT Assessment Reading Test is so time-consuming that it’s tempting to jump in quickly and rush through it. However, you’ll get much higher scores and remain much calmer if you use two powerful tools—patience and preparation. Do these three steps before answering any of the ACT Assessment Reading questions:

1. **Preview**
2. **Read**
3. **Review**

This three-stage reading method has been proven as the best way of getting the most possible information out of anything in writing. The method seems to take longer than just attacking the page, but with practice, you will actually be able to read more quickly—while at the same time increasing your comprehension.

This three-step method is so important that it’s worth talking a bit more about what is involved in each step.

**1. Preview**

Preview is just another word for skim. There are two effective ways of skimming: You can either let your eyes quickly scan the page, picking up as much information as you can, or you can actually read selected sentences from the passage—specifically, the first sentence of each paragraph in the passage and the last sentence of the entire passage.
Some people read the first and last sentence of each paragraph. Find the method that works for you.

If you’re not used to skimming, use your finger as a guide for your eyes. Sweep your index finger back and forth down the page, with your gaze fixed on your fingertip. Your eyes will follow your finger, moving more quickly than you’re used to, yet you will still pick up information about the passage.

*What sort of information are you looking for?* Look for the general content, the organization, the style. In just a few seconds, you’ll be able to tell, for example, whether an article is about nuclear physics or deep-sea diving, whether it’s organized around an experiment or around a day in the life of a diving instructor, and whether its tone is scholarly or talky and familiar.

Knowing the content, organization, and style—and whatever else you can pick up in those few seconds—prepares you by actually making you more receptive when you read. There are no “surprises” to which to adjust. When you return to the beginning to read, you’re all set for nuclear physics, or whatever.

This first step needn’t take more than 30 seconds for the average ACT Assessment Reading passage. Practice with a watch until you get a feel for it.

2 Read

Having previewed the passage, read it. Because the passage will be about 750 words long and the average high school student reads 250 words a minute, it should only take about 3 minutes.

*How should you read?* With a pencil in hand. Identify key points and logical connections as you find them. Underline them, circle them, or make stars at that point in the margin. The physical act of marking the text strengthens your memory of these ideas. In addition, the marks themselves make it easier to find key parts of the passage if you need to locate them later to answer a question.

Specifically, here’s what to underline: the theme of the passage, the main idea of each paragraph, and the connections between the ideas. The theme of the passage is a sentence that summarizes the content. Though it’s usually at the beginning of a passage, sometimes the theme is more concisely stated in the conclusion. Choose whichever you think is better. Next, each paragraph should somehow develop a point of the theme; when you find the sentence that summarizes that point (often called the topic sentence in writing class), underline it. Finally, look for the way the ideas are connected. Is this a pro-con debate? Mark one paragraph “pro” and the other “con.” Is this a description of a sequence of events? Mark the paragraphs 1, 2, 3, etc; circle dates if a historical event is described.
Review

You skimmed the passage beforehand to prepare yourself. Now skim it again after reading. This helps remind you of the opening, of the main ideas you discovered through reading, and of one or two of the most important details (or at least where the details are located in the passage). Also, if the passage was particularly difficult, going back to the beginning sheds light on earlier paragraphs that you might not have fully understood at the time. Finally, because you have now previewed, then read the material, reviewing helps you better understand the overall organization you might have only glimpsed before. Basically, reviewing is a way of summing up the pieces and making them all come together in your mind.

If you marked the passage properly (which you can easily start to do with a minimum of practice), these notes form the guidelines for your review.

Because reviewing is skimming, it should take approximately the same time as skimming—about 30 seconds. In total, you’ve spent about 4 minutes on the reading process, which still leaves you 4 minutes to answer the questions—usually more than enough time.

Concentrate on Main Ideas

You’ve probably heard the expression “couldn’t see the forest for the trees.” That means being so preoccupied with individual details (the trees) that you lose sight of the overall picture (the forest). The same preoccupation often happens with reading. Certain types of passages contain innumerable details that are not essential to understanding the theme. Although the details support the theory, if you had to edit them, you would probably still have a coherent well-written passage.

It’s important that you be able to distinguish between main ideas and details. The main ideas are worth focusing on; the supporting details are usually not. You can—and should—return to the passage later if a question asks for a specific detail, but the details don’t need your attention up front. How can you tell one from the other? Look for these contrasts:

- **General vs. Specific.** This is the difference between saying “colors” and saying “red, green, ocher, and fuchsia.” Main ideas—whether the main idea of the passage or paragraph—are broad and encompass whole categories; details explore the individual items within each category.

- **First or Last vs. Middle.** Main ideas tend to appear at the very beginning of a paragraph or passage as introduction or at the end as conclusion. Details, on the other hand, tend to appear in the middle: in the middle of paragraphs, in the middle of the passage.

- **Necessary vs. Needless.** The main idea is needed to make sense of what you’re reading. Details, although they support the idea and flesh it out, are not needed for a basic understanding.
Details can be skimmed; main ideas must have your full attention. Here's an example:

Married to Nicholas since 1804, the former Princess Alix of Hesse-Darmstadt and one of Queen Victoria’s numerous grandchildren, the Tsarina (called Alexandra after her marriage), had given birth to four daughters—Olga, Tatiana, Marie, and Anastasia—between 1897 and 1901. But the laws of succession decreed that only a male could succeed the Tsar, so the birth of Alexis, which assured the continuation of the 300-year-old Romanov dynasty, was a cause of great rejoicing for his parents as well as throughout the vast empire.

All the details (which in this case happen to begin the paragraph and extend through the middle) are not needed for basic understanding. You don't need to remember Princess Alix’s lineage, the change in her name, or the names of her daughters. The main idea is at the end: At last a son was born, and the dynasty would live on.

Here is another example, this one from a typical social studies reading passage:

Do women tend to devalue the worth of their work? Do they apply different standards to rewarding their own work than they do to rewarding the work of others? These were the questions asked by Michigan State University psychologists Lawrence Messe and Charlene Callahan-Levy. Past experiments had shown that when women were asked to decide how much to pay themselves and other people for the same job, they paid themselves less. Following up on this finding, Messe and Callahan-Levy designed experiments to test several popular explanations of why women tend to shortchange themselves in pay situations.

The first two sentences in this paragraph state broad questions about women and their attitudes toward work. The sentences that follow delve into the details about the work of two psychologists who tried to explore these questions experimentally. (Subsequent paragraphs of the passage describe the experiments in even more detail.)

Thus, the first two sentences of this paragraph state the main idea—the topic around which the entire paragraph revolves. The remaining sentences give details: the names of the psychologists, the fact that they were doing follow-up work in the wake of previous experiments dealing with the same subject, and so on. The most important point for you to gather from this paragraph is the fact that the psychologists were interested in exploring women’s attitudes toward work and themselves. If you understand this, you can track down specific details as needed to answer the questions.

Here’s a third example, this one from a natural sciences passage:

Urodeles, a class of vertebrates that includes newts and salamanders, have the enviable ability to regenerate arms, legs, tails, heart muscle, jaws, spinal cords, and other organs when these are damaged or lost. Similarly, planaria, a form of simple worm, can be sliced and diced in hundreds of pieces, with each piece giving
rise to a completely new animal. However, while both urodeles and planaria have the capacity to regenerate, they use entirely different means of accomplishing this feat.

The last sentence states the main idea of this paragraph, tying together the details previously stated: Both types of animals being discussed (urodeles and planaria) can regenerate organs, though they do so very differently. (Presumably, the later paragraphs of this passage will explain how.)

In this paragraph, the first sentence, dealing with urodeles, gives many specific facts that you don’t need to master, including a list of some of the organs the urodele can regenerate (arms, legs, tails, and so on). The second sentence gives similar specific facts about planaria. The main idea that gives them their broader significance is the concept of regeneration—the unusual ability that unites urodeles and planaria and on which the passage as a whole focuses.

You can always return to the passage to look up a specific detail on the slim chance it will appear on a question. Don’t try to understand or memorize the details if they’re complicated. In a certain way, the details are a distraction. Only the main idea is fundamental to your basic understanding.

See How the Ideas Are Connected

Another important step in the reading process is to look for how the ideas are connected. A well-written passage does not present random ideas, but rather ideas that are logically connected to the main idea or that somehow proceed from each other. If you understand these ideas and the connections among them, you truly understand the passage as a whole.

Quite often, the structure of ideas will be made very explicit, even obvious. Consider, for example, a reading passage containing five paragraphs. Here are the opening sentences of each paragraph:

1. Historians have long debated the reasons for the defeat of the Confederacy in the American Civil War.
2. For decades, the dominant theory held that the North’s victory was due primarily to the superior economic resources available to the Union armies.
3. A second school of historians pointed instead to the geographic advantages enjoyed by the Northern generals.
4. In recent years, however, more and more historians have begun to claim that, contrary to traditional Southern belief, the Northern generalship was consistently superior.
5. In the end, perhaps the most likely explanation of the Northern victory is that it was caused by a combination of several factors.
Simply by reading these five sentences you get a very good idea of the content and structure of the whole passage. The passage deals with the issue of why the North won the Civil War. Its structure is clear-cut. Paragraph (1) sets forth the question to be discussed. Paragraphs (2), (3), and (4) each suggest a different answer to the question. And paragraph (5) concludes the passage by suggesting a possible resolution of the disagreement.

Why is it helpful to recognize the logical structure of a reading passage? It helps you in several ways:

- **The structure points out the main ideas.** Recognizing the structure makes it easy to see the main ideas of the passage. In the preceding example, the main ideas are the three separate theories being presented and discussed.
- **The structure tells the purpose of the details.** The structure tells you the purpose of the details, even when you don’t know what they are. In this passage, for example, we see only the first sentence of the second paragraph, yet we can still imagine that the details will probably be specific examples of the superior resources enjoyed by the North (coal mines, factories, railroad lines, and so on).
- **The structure organizes the information.** The logical structure organizes the information in the passage, making it easy to locate any detail about which you might be asked. In this passage, if a question focuses on a detail related to the theory of Northern generalship, you’ll be able to find the relevant paragraph quickly.
- **The structure explains the relationship between the ideas.** The structure explains how the main ideas are related to one another. In this case, the main ideas are three different, conflicting explanations of the same historical event.

A passage’s structure is not always this clear-cut and logical, but a structure of some kind is usually present. With practice, you can learn to recognize it.

**Common Types of Logical Structure**

The most common ways of organizing nonfiction prose—especially the nonfiction seen on the ACT Assessment—include the following:

1. **Several theories about one idea**
   
   *Example:* The extinction of the dinosaurs (one idea) might have been caused by an inductee food supply, an ice age, or a catastrophic event, such as a meteor strike or global flood (several theories).
   
   Often one theory will appear in each paragraph.

2. **One idea with several examples**
   
   *Example:* Evidence of a global flood exterminating the dinosaurs (one idea) can be seen in fossilized remains, in abrupt changes in the earth’s structure, and in the universality of the flood myth (several examples).
   
   Again, this is often structured with one example per paragraph.
Pros and cons of one idea

Example: Does the dinosaur record support evolution? Yes, it does (with reasons why), followed by No, it doesn’t (with reasons why).

The ideas supporting the pro side might be gathered into one paragraph or might be developed into a paragraph each, depending on the length and depth of the piece. The con side would be constructed in the same way as the pro side.

Compare or contrast

Example: A comparison between the extinction of the dinosaur and the extinction of the dodo.

Each idea would have to be viewed from both sides: natural extinction vs. man-made extinction, extinction of a whole class vs. extinction of a single species, and so on.

Cause and effect

Example: A meteor strike caused the extinction of the dinosaurs in the following way.

The most straightforward use of cause and effect is to present reasons in chronological order: First, the meteor hit, causing massive local destruction; second, it sent up a huge cloud of dust, obscuring the sun; third, the darkened sky led to a decrease in plant life and lowered temperatures—and so on. Other methods include starting with a later event, because, for example, it’s more dramatic (the final moments of the last dinosaur on Earth). This is a “flashback”; afterward, the passage returns to the chronological order.

Begin with the Type of Passage You Like Best

On the day of the test, open the booklet to the Reading Test and scan the beginning of each of the four sections. You might get such diverse openings as:

1. The periodic table is a listing of each element along with its atomic number (the number of protons in the nucleus or center of the atom) and its atomic mass (the combined weight of protons and neutrons in the nucleus).

2. In the summer of 1904, the great Russian empire was, unlike most of the countries of Europe by that time, still under the control of one man, the 36-year-old Tsar Nicholas II, who had ruled since the death of his father, Alexander III, ten years before.

3. “Give it back,” he said hotly, with one hand wiping the tears from his eyes and with the other reaching for the stuffed bear his sister now held just a few taunting inches from his fingertips.

4. The structure of a building designed by Frank Lloyd Wright—no, even just our first glimpse of it—makes our own homes and offices seem so unnatural as to be accidental; and we wonder how we could have settled for so much less for so long.
Chemistry, history, a story, and architecture: natural science, social science, fiction, and
the humanities. Hopefully at least one of these categories prompted enthusiasm when
you saw it. That’s the first passage you should read, even if it comes later in the test
section. Begin there, being careful to skip to the appropriate number on the answer
sheet.

Why begin with “dessert”? You’ll probably read your favorite type of passage more
quickly, saving you time later. You’ll also remember and understand more of it, thus
answering more questions correctly. Starting with your favorite actually helps you
increase your score.

Don’t Pick the First Answer That Sounds Either Good or Familiar

On non-math questions, answers might have degrees of “rightness and wrongness.”
Choice (A) might be plausible, but if you keep reading, you’ll see that choice (B) sounds
even better and choice (C) best of all. Read every choice.

Also, don’t pick an answer just because it sounds familiar. The right answer is obviously
drawn from the passage; however, the wrong answer might be drawn from the passage,
too. The answer sounds familiar because you’ve just read it, but familiarity alone doesn’t
guarantee accuracy. Refer to the passage.

Don’t Pick an Answer Just Because It’s True

Most of the ACT Assessment passages will be about unfamiliar topics. On occasion,
however, you might encounter a passage on a topic you recognize or even know quite
well. This can be helpful as you’ll probably find the passage easy to understand.

But this can also be dangerous. You cannot bring your own knowledge or opinions to the
questions and answers. You might be tempted to pick an answer choice because you
happen to know it’s true or because you personally agree with it. Don’t do it. The answer
that is correct is the one that is based specifically on the information in the passage—
even if you happen to disagree.
Example

Q The passage suggests that the murder of Rasputin was motivated primarily by
   (A) the growing demand among the Russian populace for true democracy.
   (B) hostility in the popular press against both Rasputin and the imperial couple.
   (C) intrigues and jealousies among the Tsar’s retinue.
   (D) increasing disaffection with the war among many Russians.

A The correct answer is (C).

Perhaps Russian history is your favorite subject or Rasputin your favorite historical character. You’ve read numerous theories explaining his murder and might even have your own theory, which might or might not be reflected in the answers. It does not matter. You can only choose the answer given in the passage. In this case, the correct answer is (C), because that answer was supported by the information in the passage.

Define Words by Their Context

Certain questions will ask what a word means in the context of the passage. The answers might include synonyms for the definition, which under other circumstances could be true, but for the correct ACT Assessment answer, you must look for the meaning that best fits the context of the passage. Refer to the passage to be sure.

Example

Q As used in line 12, the word impress most nearly means
   (A) attract the favorable notice of.
   (B) coerce.
   (C) stamp.
   (D) replace.
After eliminating choice (D), you're confused, because “impress” could mean choices (A), (B), or (C). Or worse, you simply pick choice (A) as the first good answer and read no further. You must return to the passage to get the context. Conceivably, it could be any of these sentences:

• Tony was eager to impress the college admissions officer with his intelligence and charm.
• During the early 1800s, officers of the British Navy would sometimes impress American citizens into serving as sailors on British ships.
• The king’s scribe used a metal seal to impress the hot wax with the royal coat-of-arms.

Only one answer will be right, and to discover that, you must always refer to the word’s context in the passage.

SUCCESS STRATEGY ROUNDUP: A LIST OF DO’S AND DON’TS

Here’s the short version of the above advice, along with a few other miscellaneous tips, arranged in a handy list of do’s and don’ts. After you understand each point and the reasoning behind it, you need only know the boldface sentence to jog your memory—whether you’re working on the exercises at the end of this chapter, your full-length practice tests, or the ACT Assessment itself.

A list of Do’s:

❑✓ Preview, read, review. Begin each of the passages by skimming both the passage and the questions (skip the answer choices at this point). Then read the passage, keeping the questions in mind so you’ll know for what to look. Afterward, quickly review what you’ve just read. When answering questions, return to the passage whenever you need to.

❑✓ Focus on the big ideas. Look for the overall theme of the passage, as well as the main idea of each paragraph. The overall theme should be in the first paragraph of the passage; main ideas of each paragraph should be early in the paragraph as introduction or at the end of the paragraph as summary.

❑✓ Recognize the major ways of structural organization. Most passages will be organized in one of the following ways: several theories about one idea, one idea with several examples, pro-and-con arguments on one idea, a cause-and-effect sequence, or a comparison or contrast between two events, ideas, or people.

❑✓ Read with your pencil in hand. Underline the main idea of the passage and the main points of each paragraph. This will help you remember as well as be an easy way to return to the idea when you’re answering questions. Also note important sequences, historical dates, anything you think will be important.

❑✓ Start with your favorite type of reading. By starting with your favorite type of reading, you’ll read and answer questions more quickly, probably answer more questions correctly, and boost your confidence.
Read every choice before selecting your answer. Don’t stop with the first one that “sounds good” or familiar. There are degrees of rightness. Read each choice.

Define words by their context. Some vocabulary questions will want the meaning of a word. Choose the meaning that’s closest to the meaning of the word in the context of the passage.

Answer every question before going to the next passage. Don’t plan on returning to difficult questions at the end. The question will still be difficult and the passage will be fainter in your memory, requiring that you spend time reading it over again. Answer every question that you can while you’re there, make reasonable guesses about the others, then move on.

A list of Don’ts:

Don’t get stopped by details. Paragraphs might be packed with details that have little to do with what you’ll be asked. Skim the details. If a question does ask about them, you can return to them later.

Don’t preview the answer choices. When skimming over the passage and questions, don’t look at the answers. It’s time-consuming—plus 75 percent of the answers are wrong. You don’t want to be looking for the wrong information when you begin the actual reading.

Don’t try to answer every question from memory. You’ve read the passage quickly and only once. That’s usually not enough to distinguish between subtle differences in the choices. Go back to the passage and check.

Don’t pick an answer simply because it’s true. One of the choices might be a statement you know to be true. Being factual does not necessarily make it the answer to the question. Understand what is being asked.

Don’t be worried by the subject. Never had an economics course? Never studied philosophy? Don’t worry. You don’t need prior knowledge of any subject to do well on the ACT Assessment Reading Test. All the information you need to answer the questions will be contained in the passage.

PRACTICE EXERCISES

You’ve just learned some new skills for taking the ACT Assessment Reading Test. The following exercises will help you to practice these new skills as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are two Reading Test exercises in this chapter. Each exercise contains two passages followed by 10 questions each and should be answered in 18 minutes. Do each exercise in one sitting in a quiet place, with no notes or reference material. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

Score yourself only on those items you finished. When you’re done, work through the rest of the exercise.
EXERCISES: THE ACT ASSESSMENT READING TEST

Exercise 1

20 Questions • Time—18 Minutes

Directions: This exercise consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question.

Passage I—PROSE FICTION

Shipwrecks are a propos of nothing. If men could only train for them and have them occur when they had reached peak condition, there would be less drowning at sea.

Of the four in the dinghy, none had slept any time worth mentioning for two days and two nights previous to embarking in the dinghy, and in the excitement of clambering about the deck of a foundering ship they had also forgotten to eat heartily.

For these reasons, and for others, neither the oiler nor the correspondent was fond of rowing at this time. The correspondent wondered how in the name of all that was sane there could be people who thought it amusing to row a boat. It was not an amusement; it was a diabolical punishment, and even a genius of mental aberrations could never conclude that it was anything but a horror to the muscles and a crime against the back. He mentioned to the boat in general how the amusement of rowing struck him, and the weary-faced oiler smiled in full sympathy. Previously to the foundering, by the way, the oiler had worked double-watch in the engine room of the ship.

“Take her easy, now, boys,” said the captain. “Don’t spend yourselves. If we have to run a surf you’ll need all your strength, because we’ll sure have to swim for it. Take your time.”

Slowly the land arose from the sea. From a black line it became a line of black and a line of white, trees and sand. Finally, the captain said that he could make out a house on the shore.

(5) Of the four in the dinghy, none had slept any time worth mentioning for two days and two nights previous to embarking in the dinghy, and in the excitement of clambering about the deck of a foundering ship they had also forgotten to eat heartily.

(10) For these reasons, and for others, neither the oiler nor the correspondent was fond of rowing at this time. The correspondent wondered how in the name of all that was sane there could be people who thought it amusing to row a boat. It was not an amusement; it was a diabolical punishment, and even a genius of mental aberrations could never conclude that it was anything but a horror to the muscles and a crime against the back. He mentioned to the boat in general how the amusement of rowing struck him, and the weary-faced oiler smiled in full sympathy. Previously to the foundering, by the way, the oiler had worked double-watch in the engine room of the ship.

(15) “Take her easy, now, boys,” said the captain. “Don’t spend yourselves. If we have to run a surf you’ll need all your strength, because we’ll sure have to swim for it. Take your time.”

(20) Slowly the land arose from the sea. From a black line it became a line of black and a line of white, trees and sand. Finally, the captain said that he could make out a house on the shore.

(25) (50) “That’s the house of refuge, sure,” said the cook. “They’ll see us before long, and come out after us.” The distant lighthouse reared high. “The keeper ought to be able to make us out now, if he’s looking through a spyglass,” said the captain. “He’ll notify the lifesaving people.”

(30) “None of those other boats could have got ashore to give word of the wreck,” said the oiler, in a low voice.

(35) “Else the lifeboat would be out hunting us.”

Slowly and beautifully the land loomed out of the sea. The wind came again. It had veered from the northeast to the southeast.

Finally, a new sound struck the ears of the men in the boat. It was the low thunder of the surf on the shore. All but the oarsman watched the shore grow. Under the influence of this expansion, doubt and direful apprehension was leaving the minds of the men. The management of the boat was still most absorbing, but it could not prevent a quiet cheerfulness. In an hour, perhaps, they would be ashore.

Their backbones had become thoroughly used to balancing in the boat, and they now rowed this wild colt of a dinghy like circus men. The correspondent thought that he had been drenched to the skin, but happening to feel in the top pocket of his coat, he found therein eight cigars. Four of them were soaked with sea-water; four were perfectly dry. After a search, somebody produced three dry matches, and thereupon the four waifs rowed impudently in their little boat, and with an
assurance of an impending rescue shining in their eyes, puffed at the big cigars and judged well and ill of all men. Everybody took a drink of water.

But then: “Cook,” remarked the captain, “there don’t seem to be any signs of life about your house of refuge.”

“No,” replied the cook. “Funny they don’t see us!”

The surf’s roar was dulled, but its tone was, nevertheless, thunderous and mighty. As the boat swam over the great rollers, the men sat listening to this roar. “We’ll swamp sure,” said everybody.

It is fair to say here that there was not a lifesaving station within 20 miles in either direction, but the men did not know this fact, and in consequence they made dark and opprobrious remarks concerning the eyesight of the nation’s lifesavers. Four scowling men sat in the dinghy and surpassed records in the invention of epithets.

“Funny they don’t see us.”

The lightheartedness of a former time had completely faded. To their sharpened minds it was easy to conjure pictures of all kinds of incompetency and blindness and, indeed, cowardice. There was the shore of the populous land, and it was bitter and bitter to them that from it came no sign.

“Well,” said the captain, ultimately. “I suppose we’ll have to make a try for ourselves. If we stay out here too long, we’ll none of us have strength left to swim after the boat swamps.”

And so the oiler, who was at the oars, turned the boat straight for the shore. There was a sudden tightening of muscle. There was some thinking.

“If we don’t all get ashore—” said the captain. “If we don’t all get ashore, I suppose you fellows know where to send news of my finish?” They briefly exchanged some addresses and admonitions. The shore was still afar.

1. In the first sentence, the narrator wishes to suggest that shipwrecks (A) occur all too frequently. (B) strike at random. (C) reflect the malign nature of the sea. (D) usually take place at the worst of times.

2. It can be inferred from the passage that the men in the dinghy are tired because they (F) have been rowing the dinghy for the past two days. (G) are unaccustomed to physical labor. (H) have spent the previous two days on a sinking ship. (J) had to swim a long distance to reach the dinghy.

3. In comparing the dinghy to a wild colt (line 69), the narrator suggests that it is (A) bounding roughly on the waves. (B) too small for its four passengers. (C) under no human control. (D) rapidly filling with water.

4. The men in the dinghy experience a sense of quiet cheerfulness (lines 64–65) because they (F) know that the storm that sank their ship is past. (G) see the shore getting closer and closer. (H) believe that the lifeboat is out searching for them. (J) think their dinghy will be able to land safely on shore.

5. When the narrator says the four waifs rode impudently in their little boat (lines 77–78), he is suggesting that the men (A) are enjoying what they know might be their last cigar. (B) are rejoicing over their good fortune at having survived the shipwreck. (C) believe that their skill at seamanship will save them from disaster. (D) feel certain they will soon be rescued.
6. It can be inferred from the passage that the other people who had been aboard the same ship as the four men in the dinghy (F) have already perished. (G) are now safely on shore. (H) are themselves afloat in other dinghies. (J) are clinging to the wreckage of the ship.

7. The passage implies that the greatest danger to the men in the dinghy arises from the fact that (A) their boat is too small to safely navigate the great waves breaking on the shore. (B) their supply of food and drinking water is rapidly being depleted. (C) they are unable to steer their boat in the direction of the shore. (D) they are too exhausted to row their boat toward the land.

8. As it is used in the passage, the word dark (line 98) means most nearly (F) obscure. (G) harsh. (H) muttered. (J) unintelligible.

9. The passage implies that the thinking (line 120) being done by the men in the dinghy primarily concerns (A) what they must do to reach the shore safely. (B) how they might signal their plight to those on shore. (C) the possibility that they may drown. (D) their bitterness over the failure of the lifesavers to rescue them.

10. The passage suggests that the anger felt by the men in the dinghy toward the lifesavers is (F) justified. (G) excessive. (H) ironic. (J) misguided.

Passage II—NATURAL SCIENCE

In the early years of the twentieth century, astrophysicists turned their attention to a special category of stars, known as cepheid variables. A variable star is one whose apparent brightness changes from time to time. Among some variables, the change in brightness occurs so slowly as to be almost imperceptible; among others, it occurs in sudden, brief, violent bursts of energy.

The most impressive form of variable star is the nova, characterized by short-lived, extremely forceful explosions of energy. At its height, a nova may emit as much energy as 200,000 suns, and novas, especially those that are relatively close to our planet, are among the most brilliant objects in the night sky. One or two are noted in our own Milky Way galaxy each year. A nova typically goes through a number of cycles of extreme brightness followed by quiescence, repeatedly giving off huge amounts of energy and mass, until finally its mass is too small to continue the process.

The supernova, an even more spectacular object, is not a variable star but rather an exploding star, which may briefly attain a brightness equivalent to 10 billion suns before fading away forever. The single powerful burst of a supernova may leave behind a bright gaseous cloud of matter known as a nebula; the Crab nebula, first observed as a supernova in A.D. 1054, is a familiar example.

Among the true variable stars, the cepheid variables (which take their name from the constellation Cepheus, where the first such star was discovered) have...
special characteristics that make them an especially useful astronomical tool. It was Henrietta Leavitt, an astronomer at the Harvard Observatory, who first examined the cepheid variables in detail. She found that these stars vary regularly in apparent brightness over a relatively short period of time—from one to three days to a month or more. This variation in brightness could be recorded and precisely measured with the help of the camera, then still a new tool in astronomy.

Leavitt also noticed that the periodicity of each cepheid variable—that is, the period of time it took for the star to vary from its brightest point to its dimmest, and back to its brightest again—corresponded to the intrinsic or absolute brightness of the star. That is, the greater the star’s absolute brightness, the slower its cycle of variation.

Why is this so? The variation in brightness is caused by the interaction between the star’s gravity and the outward pressure exerted by the flow of light energy from the star. Gravity pulls the outer portions of the star inward, while light pressure pushes them outward. The result is a pulsating, in-and-out movement that produces increasing and decreasing brightness. The stronger the light pressure, the slower this pulsation. Therefore, the periodicity of the cepheid variable is a good indication of its absolute brightness.

Furthermore, it is obvious that the apparent brightness of any source of light decreases the further we are from the light. Physicists had long known that this relationship could be described by a simple mathematical formula, known as the inverse square law. If we know the absolute brightness of any object—say, a star—as well as our distance from that object, it is possible to use the inverse square law to determine exactly how bright that object will appear to be.

This laid the background for Leavitt’s most crucial insight. As she had discovered, the absolute brightness of a cepheid variable could be determined by measuring its periodicity. And, of course, the apparent brightness of the star when observed from the earth could be determined by simple measurement. Leavitt saw that with these two facts and the help of inverse square law, it would be possible to determine the distance from Earth of any cepheid variable. If we know the absolute brightness of the star and how bright it appears from the earth, we can tell how far it must be.

Thus, if a cepheid variable can be found in any galaxy, it is possible to measure the distance of that galaxy from Earth. Thanks to Leavitt’s discovery, astronomical distances that could not previously be measured became measurable for the first time.

11. The primary purpose of the passage is to explain

(A) the background and career of the astronomer Henrietta Leavitt.

(B) the development of the inverse square law for determining an object’s brightness.

(C) important uses of the camera as an astronomical tool.

(D) how a particular method of measuring astronomical distances was created.

12. According to the passage, a nova differs from a supernova in all of the following ways EXCEPT that a supernova

(F) emits its energy in a single powerful burst.

(G) may leave behind the gaseous cloud of a nebula.

(H) passes through several cycles of extreme brightness.

(J) is not a true variable star.
13. According to the passage, the cepheid variables are especially useful to astronomers because of the
   (A) regularity with which they vary in brightness.
   (B) unusually great apparent brightness they exhibit.
   (C) slowness of their average cycle of variation.
   (D) ease with which their absolute brightness may be observed.

14. The passage states that Leavitt’s work enabled astronomers to measure the distance from Earth of any galaxy containing a
   (F) nebula.
   (G) variable star.
   (H) nova or supernova.
   (J) cepheid variable.

15. According to the passage, the absolute brightness of a cepheid variable
   (A) depends upon its measurable distance from an observer on Earth.
   (B) may be determined from the length of its cycle of variation.
   (C) changes from time to time according to a regular and predictable pattern.
   (D) indicates the strength of the gravitational force exerted by the star.

16. The passage states that cepheid variables are so named after
   (F) a variable star first observed by Leavitt.
   (G) the first star whose periodicity was studied by Leavitt.
   (H) the constellation containing the first cepheid variable known.
   (J) the first galaxy whose distance from Earth was measured by Leavitt’s method.

17. According to the passage, Leavitt’s work provided astronomers with the means of determining which of the following?
   I. The absolute brightness of any observable cepheid variable
   II. The apparent brightness of any object a given distance from an observer
   III. The distance from Earth of any galaxy containing an observable cepheid variable
   (A) III only
   (B) I and II
   (C) I and III
   (D) I, II, and III

18. It can be inferred from the passage that a cepheid variable of great absolute brightness would exhibit
   (F) a relatively rapid variation in brightness.
   (G) a correspondingly weak gravitational force.
   (H) slow and almost imperceptible changes in brightness.
   (J) a strong outward flow of light pressure.

19. It can be inferred from the passage that it is possible to observe each of the following with the naked eye EXCEPT the
   (A) explosion of a supernova.
   (B) precise brightness of a variable star.
   (C) period of greatest brightness of a nova.
   (D) existence of a nebula.

20. The passage implies that Leavitt’s work on cepheid variables would NOT have been possible without the availability of
   (F) the camera as a scientific tool.
   (G) techniques for determining the distances between stars.
   (H) an understanding of the chemical properties of stars.
   (J) a single star whose distance from Earth was already known.
CHAPTER 6: The ACT Assessment Reading Test

Exercise 2

20 Questions • Time—18 Minutes

Directions: This exercise consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question.

Passage I—SOCIAL STUDIES

When the framers of the Constitution set to work devising the structure of the U.S. government, it was natural for them to consider the forms already existing in the several states. The three most basic patterns may be referred to as the Virginia, Pennsylvania, and Massachusetts models.

The Virginia model borrowed its central principal, legislative supremacy, from the thinking of the English philosopher John Locke. Locke had favored making the legislature the dominant focus of government power, and he stressed the importance of preventing a monarch, governor, or other executive from usurping that power. In line with Locke’s doctrine, Virginia’s constitution provided that the governor be chosen by the assembly rather than by the people directly, as were the members of a special governor’s council. The approval of this council was necessary for any action by the governor.

Also derived from Locke was Virginia’s bicameral legislature, in which both chambers must concur to pass a bill. Thus dividing the legislative power was supposed to prove its domination by any single faction—the so-called “division of powers,” which later became an important feature of the national constitution.

Pennsylvania’s constitution was probably the most democratic of any of the early states. Pennsylvania extended the right to vote to most adult males. (With the exception of Vermont, the other states allowed only property owners to vote; New Jersey alone extended the privilege to women.) Pennsylvanians elected the members of a single-house legislature, as well as an executive council. These bodies jointly selected the council president, who served as the state’s chief executive officer; there was no governor. Neither legislators nor council members could remain in office more than four years out of seven.

The most conservative of the models was found in Massachusetts. The legislature here included two chambers. In the house of representatives, the number of legislators for a given district was based on population; in the “aristocratic” senate, representation was based on taxable wealth. The governor could veto legislation, he appointed most state officials, and he was elected independently of the legislature.

As the delegates to the Constitutional Convention began to debate the merits of these varying models, several fault lines began to appear along which the representatives of the former colonies were divided. One such line was geographic. The economic and social differences between the northern and southern states, which would lead, three generations later, to the cataclysm of the Civil War, were already making themselves felt. Dependent chiefly on the exporting of such raw materials as cotton, tobacco, and rice, the southern states strongly opposed giving Congress the power to regulate international trade, fearing the imposition of onerous taxes or tariffs. Too, the white slaveholders of the south feared federal restrictions on the practice of slavery, which was already a point of controversy between sections of the new nation.
Another dividing line among the states was based on population. The less populous states opposed the notion of allocating political power based on population; they feared having the larger states, especially Virginia, New York, Massachusetts, and Pennsylvania, ride roughshod over their interests. This division to some extent echoed the North-South split, since most of the more populous states were in the North.

The debates over governmental structure quickly focused on the makeup of the legislative branch. The most populous states favored making representation in Congress proportional to population, while the smaller states fought for equality of representation. For a time, it appeared as though the convention might break up over this issue.

The successful resolution was a compromise originally proposed by the delegation from Connecticut, and therefore often referred to as the Connecticut Compromise, or the Great Compromise. According to this plan, which remains in effect to this day, the Congress is a bicameral legislature like those in Virginia and Massachusetts. In the Senate, each state has two representatives, no matter what its size, while seats in the House of Representatives are apportioned by population. Both houses must concur in the passage of legislature, and bills proposing the expenditure of government funds must originate in the House—a precaution demanded by the larger states to protect their financial interests.

The southern states won a series of specific concessions. Although the convention refused to include slaves on an equal basis in the population count for congressional representation—after all, the slaves were neither citizens nor taxpayers nor voters—it was agreed to count \( \frac{3}{5} \) of the slave population, a notorious compromise long regarded as a racist blot on the constitution. The North also accepted constitutional clauses forbidding export taxes and preventing Congress from interfering with the slave trade until at least 1808—over twenty years in the future. The sectional differences between North and South, and the simmering issue of slavery, were thus postponed for future generations to face.

1. The author’s primary purpose in writing the passage is to explain
(A) how various models of state government influenced the debate over the U.S. Constitution.
(B) the differing roles of the legislature in each of the original American states.
(C) the contrasting forms of government found in the various original American states.
(D) the influence of John Locke’s philosophy on the framers of the U.S. Constitution.

2. The state governments described in the passage varied in all of the following respects EXCEPT
(F) the existence of the office of governor.
(G) restrictions on tenure in state offices.
(H) whether the members of the legislature were chosen directly by the people.
(J) restrictions on the eligibility of citizens to vote.

3. According to the passage, the principle purpose of the “division of powers” in the Virginia model was to
(A) allow citizens of every social class to participate fully in government.
(B) prevent any one group from controlling the legislative power.
(C) ensure the independence of the executive from legislative manipulation.
(D) discourage the concentration of power in the hands of the governor.
4. It can be inferred from the passage that those who favored a democratic system of government would most strongly support
   (F) apportioning seats in the legislature on the basis of taxable wealth.
   (G) limitation on the number of terms in office served by legislators.
   (H) establishment of a bicameral legislature.
   (J) granting the power to veto legislation to a popularly elected executive.

5. According to the passage, the philosophy of John Locke most strongly influenced the governmental system of
   (A) Massachusetts.
   (B) New Jersey.
   (C) Pennsylvania.
   (D) Virginia.

6. According to the passage, the right to vote was limited to property owners in all of the states EXCEPT
   I. New Jersey.
   II. Pennsylvania.
   III. Vermont.
   (F) II only
   (G) I and II
   (H) II and III
   (J) I, II, and III

7. In can be inferred from the passage that the southern states most favored which of the following features of the new constitution?
   (A) The apportionment of seats in the Senate
   (B) The apportionment of seats in the House of Representatives
   (C) The requirement that funding bills originate in the House of Representatives
   (D) The restriction of voting privileges to white male citizens

8. As it is used in line 128, the word *notorious* most nearly means
   (F) remarkable.
   (G) infamous.
   (H) ingenious.
   (J) celebrated.

9. According to the passage, the leaders of the southern states were concerned with defending the interests of which of the following?
   I. Slaveholders
   II. Exporters of raw materials
   III. The less-populous states
   (A) I only
   (B) I and II
   (C) II and III
   (D) I, II, and III

10. One of the main ideas of the passage is that
    (F) resentment by the South of its treatment during the Constitutional Convention was an underlying cause of the Civil War.
    (G) most white Americans at the time of the Constitutional Convention rejected the new constitution’s implicit racism.
    (H) the framers of the constitution devised only temporary solutions for the rift between the northern and southern states.
    (J) the issue of slavery nearly caused the failure of the Constitutional Convention.
Passage II—NATURAL SCIENCE

Today, the theory of “continental drift,” which supposes that the earth’s great land masses have moved over time, is a basic premise accepted by most geologists. However, this was not always so. In fact, it was not until the mid-twentieth century that this concept won widespread acceptance among scientists.

Although Alfred Wegener was not the first to propose the idea that the continents have moved, his 1912 outline of the hypothesis was the first detailed description of the concept and the first to offer a respectable mass of supporting evidence for it. It is appropriate, then, that the theory of continental drift was most widely known as “Wegener’s hypothesis” during the more than fifty years of debate that preceded its ultimate acceptance by most earth scientists.

In brief, Wegener’s hypothesis stated that, in the late Paleozoic era, all of the present-day continents were part of a single giant land mass, Pangaea, that occupied almost half of the earth’s surface. About 40 million years ago, Pangaea began to break into fragments that slowly moved apart, ultimately forming the various continents we know today.

Wegener supported his argument with data drawn from geology, paleontology, zoology, climatology, and other fields. He pointed, for example, to the fact that continental margins in several regions of the globe appear to closely match one another, as though they had once been united. The fit between the land masses on either side of the Atlantic Ocean—Europe and Africa on the east and North and South America on the west—is especially close. Furthermore, Wegener also showed that rock formations in Brazil and West Africa, on opposite sides of the Atlantic, are remarkably similar in age, type, and structure. This, too, was consistent with the notion that the continents had once been joined.

So impressive was Wegener’s array of evidence that his hypothesis could not be ignored. However, until the 1960s, most scientists were reluctant to accept Wegener’s ideas. There are several reasons why this was so.

First, although Wegener showed that continental movement was consistent with much of the geological and other evidence—for example, the apparent family relationships among forms of plants and animals now separated by vast expanses of ocean, once geographically united on the hypothetical Pangaea—he failed to suggest any causal mechanism for continental drift sufficiently powerful and plausible to be convincing.

Second, while the period during which Wegener’s theory was propounded and debated saw rapid developments in many branches of geology and an explosion of new knowledge about the nature of the earth and the forces at work in its formation, little of this evidence seemed to support Wegener. For example, data drawn from the new science of seismology, including experimental studies of the behavior of rocks under high pressure, suggested that the earth has far too much internal strength and rigidity to allow continents to “drift” across its surface. Measurements of the earth’s gravitational field made by some of the early scientific satellites offered further evidence in support of this view as late as the early 1960s.

In fact, this data pointed to a genuine flaw in Wegener’s theory. He had assumed that the continental plates floated atop the ocean crust, which was relatively plastic and so would permit the continents to move across its surface. This was false. The true explanation for continental movement was not uncovered until the discovery, through seismic studies, of the existence of asthenosphere, a layer of plastic, slowly-moving material that lies under both the continental plates and the ocean crust at depths of 50 to 150 kilometers (30 to 80 miles). The malleability of the asthenosphere permits movement of the layers above it.
Third, and perhaps most significant, Wegener’s theory seemed to challenge one of the most deeply-held philosophical bases of geology—the doctrine of uniformitarianism, which states that earth history must always be explained by the operation of essentially unchanging, continuous forces. Belief in the intervention of unexplained, sporadic, and massive shaping events—known as catastrophism—was considered beyond the pale by mainstream geologists.

Wegener was not, strictly speaking, a catastrophist—he did not suggest that some massive cataclysm had triggered the breakup of Pangaea—but his theory did imply a dramatic change in the face of the earth occurring relatively late in geologic history. Such a belief, viewed as tainted with catastrophism, was abhorrent to most geologists throughout the first half of this century.

11. It can be inferred from the passage that the majority of geologists today
(A) reject the theory of continental drift.
(B) have softened in their opposition to catastrophism.
(C) question the relevance of most of Wegener’s geological evidence.
(D) disagree with Wegener’s idea that the continents were once united.

12. According to the passage, Wegener believed that Pangaea
(F) was destroyed in a massive cataclysm occurring about 40 million years ago.
(G) consisted of several large land areas separated by vast expanses of ocean.
(H) was ultimately submerged by rising oceans at the end of the Paleozoic era.
(J) contained in a single land mass the basic material of all the continents that exist today.

13. It can be inferred from the passage that by the end of the Paleozoic era,
(A) many forms of plant and animal life existed on Earth.
(B) the land mass of Pangaea no longer existed.
(C) a series of unexplained catastrophes had changed the face of the earth.
(D) most of today’s land forms had taken their current shape.

14. According to the passage, Wegener supported his hypothesis by pointing to the geological similarities between rock formations in West Africa and
(F) Brazil.
(G) North America.
(H) Europe.
(J) the floor of the Atlantic Ocean.

15. The passage provides information to answer which of the following questions?
I. What geological forces caused the breakup of Pangaea?
II. What evidence discovered in the 1960s lent support to Wegener’s hypothesis?
III. When did Wegener’s hypothesis win acceptance by most earth scientists?
(A) I only
(B) III only
(C) I and III
(D) II and III

16. The phrase tainted with catastrophism (line 121) implies that most geologists in the early twentieth century considered catastrophism
(F) fascinating but unproven.
(G) somewhat questionable.
(H) completely incredible.
(J) demonstrably true.
17. The passage implies that the most significant reason for the opposition to Wegener’s hypothesis on the part of many scientists was its
   (A) indirect challenge to a fundamental premise of geology.
   (B) impossibility of being tested by experimental means.
   (C) conflict with data drawn from the fossil record.
   (D) failure to provide a comprehensive framework for earth history.

18. According to the passage, Wegener was mistaken in his beliefs concerning the
   (F) movements of the asthenosphere.
   (G) former existence of Pangaea.
   (H) plausibility of movement by the continental plates.
   (J) malleability of the ocean crust.

19. As used in line 118, the word *dramatic* most nearly means
   (A) exciting.
   (B) violent.
   (C) large-scale.
   (D) rapid.

20. The author refers to the scientific information gathered by satellites in order to suggest the
   (F) philosophical changes that ultimately led to the acceptance of Wegener’s hypothesis.
   (G) dramatic advances in earth science during the 1960s.
   (H) differing directions taken by various earth scientists in the decades following Wegener.
   (J) nature of the some of the evidence that appeared to refute Wegener.
CHAPTER 6: The ACT Assessment Reading Test

ANSWER KEY AND EXPLANATIONS

Exercise 1

1. The correct answer is (B). You need to read the entire paragraph to fully understand the first sentence. The point is that shipwrecks don’t usually take place at convenient times; those on board ship can’t prepare and train for them. Instead, they occur at random times—“a propos of nothing,” as the first sentence says.

2. The correct answer is (H). The second paragraph and the last sentence of the third paragraph combine to answer this question. They make it clear that the weariness of the men in the dinghy is a result of the fact that they have spent the last two days “clambering about the deck of a foundering [that is, sinking] ship.”

3. The correct answer is (A). Look at the rest of the sentence containing this phrase. It says that the men had become “used to balancing in the boat,” and it compares them to “circus men.” The idea is that the boat is bucking and bouncing on the waves like a bronco in a circus.

4. The correct answer is (G). The (temporary) good mood of the men is attributed, in the same paragraph, to “the influence of this expansion”—namely, the growing visibility of the shore as their little boat gets closer and closer to it.

5. The correct answer is (D). The description of the men smoking their cigars includes the explanatory phrase “with an assurance of an impending rescue shining in their eyes.”

6. The correct answer is (F). See the eighth paragraph, where the oiler says, “None of those other boats could have got ashore to give word of the wreck.” It appears from this sentence that several boats were lowered from the sinking ship, of which the dinghy is one, and that none of the others reached safety.

7. The correct answer is (A). The growing fear of the men is attributed to their belief that “We’ll swamp sure” in the mighty surf whose noise they hear. In other words, the waves breaking on the shore are so large and powerful that it will be impossible for them to land their boat safely. The men are exhausted, as choice (D) asserts, but the problem is not that they cannot row toward shore—they can; the problem is that they can’t land safely once they get there.

8. The correct answer is (G). The word “dark” is used in the phrase “dark and opprobrious remarks,” describing the angry comments made by the men in the dinghy toward the lifesavers, who they think are ignoring them. The context makes it clear that the remarks are harshly negative ones—“dark” in that sense only.

9. The correct answer is (C). Immediately after the sentence, “There was some thinking,” the men in the dinghy exchange addresses so that they can notify one another’s next of kin in the event that some of them drown. Obviously, the
“thinking” they are doing is about the possibility that they may not survive.

10. **The correct answer is (J).** The fourteenth paragraph states “that there was not a lifesaving station within 20 miles in either direction.” Thus, it would have been impossible for any lifesavers to see and rescue the shipwreck victims, and the lifesavers are not to blame for the men’s plight.

11. **The correct answer is (D).** The last paragraph of the passage neatly summarizes the significance of Leavitt’s work with cepheid variables.

12. **The correct answer is (H).** It is the nova, not the supernova, that “passes through several cycles of extreme brightness.” As the third paragraph makes clear, all of the other answer choices accurately describe the supernova.

13. **The correct answer is (A).** Because the cepheid variables change in brightness according to a regular pattern, it is possible to determine their absolute brightness—and, from this, their distance. Thus, it is the regularity of their variation that makes them useful to astronomers.

14. **The correct answer is (J).** See the first sentence of the last paragraph.

15. **The correct answer is (B).** The sixth paragraph describes the important relationship Leavitt discovered: that the cepheid variable’s periodicity (its cycle of variation) and its absolute brightness vary together. Thus, each one can be determined from the other.

16. **The correct answer is (H).** The fourth paragraph explains that the cepheid variables are named after the constellation Cepheus, where the first cepheid variable was found.

17. **The correct answer is (C).** As the last sentence of paragraph 6 makes clear, statement I is true; from its periodicity (which is easily observable), we can determine the absolute brightness of a cepheid variable. Statement III is supported by the last paragraph of the passage. Statement II is false because the passage doesn’t suggest that Leavitt developed the method by which astronomers measured stars’ apparent brightness; in fact, in paragraphs 5 and 9, Leavitt appears to take this method for granted and build upon it.

18. **The correct answer is (J).** Paragraph 6 explains that a star with a great absolute brightness is also a star with relatively stronger light pressure—hence, the slower in-and-out pulsation and the longer periodicity that Leavitt observed.

19. **The correct answer is (B).** We’re told in the passage about how brilliant and noticeable both novas and supernovas are; and the existence of the Crab nebula since shortly after 1054 A.D. makes it obvious that it, too, must have been visible without the aid of a telescope. However, the “precise brightness of a variable star” could only be measured with the help of the camera, according to paragraph 5.

20. **The correct answer is (F).** See the last sentence of the fifth paragraph. It seems clear that the camera was a necessary tool for Leavitt’s work to be possible.
Exercise 2

1. **The correct answer is** (A). The first six paragraphs describe the various models of state government available to the framers of the constitution; the last five paragraphs discuss the debates among the framers over how to adapt these models to the needs of the new nation.

2. **The correct answer is** (H). All of the variations mentioned in the other answer choices are noted somewhere in the passage; however, none of the state governments discussed is said to involve a legislature that is not popularly elected.

3. **The correct answer is** (B). The second sentence of the third paragraph makes this point.

4. **The correct answer is** (G). The fourth and fifth paragraphs describe the government of Pennsylvania, which is said to be the “most democratic” among the early states. Of the answer choices, only choice (G) describes a feature of this state’s government.

5. **The correct answer is** (D). See the first sentence of the second paragraph.

6. **The correct answer is** (H). The fourth paragraph explains that only Pennsylvania and Vermont did not restrict voting to property owners.

7. **The correct answer is** (A). Among other demands, the southern states, which were mostly small, wanted to protect their interests by having equal representation for states of all sizes rather than making representation proportional to population. Thus, the equal numbers of legislators in the Senate would have appealed to the southerners at the convention. The passage does not suggest that any of the states favored extension of voting privileges to non-white males, so choice (D) is wrong.

8. **The correct answer is** (G). *Notorious* and *infamous* are near-synonyms; both mean “well-known and much-hated or widely despised.”

9. **The correct answer is** (D). The seventh paragraph states that the white leaders of the southern states wanted to protect their interests as exporters and as slaveholders; the last sentence of the eighth paragraph makes the point that the southern states were, for the most part, less populous than the northern states.

10. **The correct answer is** (H). The last half of the passage develops this theme, especially in the seventh and eleventh paragraphs. It’s clear that the compromises related to slavery were only temporary “band-aids” rather than permanent solutions to the problem.

11. **The correct answer is** (B). Since most geologists today accept Wegener’s hypothesis—despite its flirtation with catastrophism—it’s clear that the abhorrence of catastrophism must have diminished in recent decades.

12. **The correct answer is** (J). See the first sentence of the third paragraph, which summarizes this point neatly.
13. The correct answer is (A). In the sixth paragraph, the passage explains that Wegener used the existence of similar plants and animals on widely separated continents as evidence that all the earth’s land masses were formerly connected in the supercontinent of Pangaea. For this evidence to be valid, it would have to mean that many plants and animals existed prior to the breakup of Pangaea, which paragraph 3 tells us began late in the Paleozoic era.

14. The correct answer is (F). The next-to-last sentence of the sixth paragraph states that rock formations in Brazil are quite similar to those in West Africa.

15. The correct answer is (B). The first paragraph tells us that Wegener’s hypothesis was accepted some fifty years after it was first proposed in 1912—thus, in the early 1960s. This answers question III. Question I is not answered; the passage only says (end of paragraph 6) that Wegener himself had no answer for this question. Question II is not answered; in fact, paragraph 7 refers to evidence from the 1960s that seemed to undermine, rather than support, Wegener’s hypothesis.

16. The correct answer is (H). The word taint implies that most scientists were so opposed to catastrophism that any theory with even a passing resemblance to catastrophism was considered unacceptable.

17. The correct answer is (A). See the first sentence of the ninth paragraph. The “perhaps most significant” reason for many scientists’ discomfort with Wegener’s hypothesis was that it seemed to challenge their deep-seated belief in uniformitarianism.

18. The correct answer is (J). The eighth paragraph explains Wegener’s error. He believed that the ocean crust was “relatively plastic” (that is, flexible or malleable) and that this explained how the continents could drift on its surface. In fact, the ocean crust is quite rigid, as the satellite studies mentioned in paragraph 7 found. The existence of the asthenosphere, which Wegener did not know about, was the correct alternative explanation.

19. The correct answer is (C). As used in this passage, the word dramatic refers to changes on a vast scale—changes in the very shape and appearance of the earth’s continents, in fact.

20. The correct answer is (J). You’ll find this stated in the last sentence of the seventh paragraph.
CHAPTER 6: The ACT Assessment Reading Test

ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment Reading Test? How well have you incorporated your new skills into your test-taking behavior?

After you’ve corrected each exercise, find the number below. This will give you an idea of whether you need to go to the Reading Review or whether you can move on to another subject area.

SCORE KEY FOR EACH PRACTICE EXERCISE

<table>
<thead>
<tr>
<th>Number Correct</th>
<th>Score</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5</td>
<td>Poor</td>
<td>Study the review chapter and do the exercises there; then, study this chapter again.</td>
</tr>
<tr>
<td>6–8</td>
<td>Below average</td>
<td>Study problem areas in the review chapter and do at least one exercise. Study this chapter again.</td>
</tr>
<tr>
<td>9–12</td>
<td>Average</td>
<td>Study this chapter again if you wish to and have time. Skim problem areas in the review chapter if you have time.</td>
</tr>
<tr>
<td>13–15</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
</tr>
<tr>
<td>16–20</td>
<td>Excellent</td>
<td>You’re ready for the ACT Assessment Reading Test.</td>
</tr>
</tbody>
</table>
What You Need to Know about the ACT Assessment Reading Test

- The ACT Assessment Reading Test will have four passages of 700 to 900 words, each followed by 10 questions. You'll have 35 minutes to read the four passages and to answer the 40 questions.
- Preview, read, and review to get the most out of every passage on the ACT Assessment.
- Look for the main ideas; don’t get caught up in the details.
- Read with pencil in hand and mark up key ideas as you find them.
- Begin with the type of reading you like best.
- Don’t choose an answer merely because it seems familiar.
- Don’t try to answer from memory; return to the passage to be sure you’re answering correctly.
- Answer all the questions for each passage before moving on; don’t plan on returning to a passage.
The ACT Assessment Science Reasoning Test

OVERVIEW

- Learn what to expect on the ACT Assessment Science Reasoning Test
- Understand the science reasoning questions and their format
- Learn the best strategies for success on science reasoning questions
- Practice your skills and strategies on science reasoning exercises
- Evaluate your science reasoning skills

WHAT TO EXPECT ON THE ACT ASSESSMENT SCIENCE REASONING TEST

The specific skills tested on the Science Reasoning portion of the ACT Assessment range from your ability to understand tables, graphs, figures, and diagrams, to your ability to recognize hidden assumptions underlying a theory, or to determine whether a particular piece of information strengthens or weakens an unproven hypothesis. You’ll also be asked to make predictions on what might happen next in an experiment given the results so far.

The Science Reasoning Test contains seven passages of about 100 to 300 words on biology, chemistry, physics, and earth science. Each passage is followed by questions; the Science Reasoning portion of the ACT Assessment contains a total of 40 questions. You must read all the passages and answer the total of 40 questions in one 35-minute sitting. Pace yourself, as you have only 5 minutes to spend on each passage together with its questions. Plan to spend about $2 \frac{1}{2}$ minutes reading each passage and $2 \frac{1}{2}$ minutes answering its questions.

The biology passages may include cell biology, botany, zoology, microbiology, ecology, genetics, and evolution. Chemistry passages may include organic chemistry, inorganic chemistry, electrochemistry, biochemistry, atomic theory and properties, and states of matter. Physics passages may include mechanics, energy, thermodynamics, electromagnetism, fluids, solids, and light waves. And
earth science passages may include geology, meteorology, oceanography, astronomy, and environmental sciences.

You don’t need to have taken courses in any of these topics or to have prior knowledge of the field to do well on the questions. All the information you need will be given directly on the test.

Still feeling a bit uncertain about your overall knowledge of science? If so, you might benefit from a crash-course in some of the basics. You can review some of the basic principles of science in Chapter 11, “Science Reasoning Review,” later in this book.

The Science Reasoning Questions and Their Format

No matter what the field, there will be three types of Science Reasoning passages: Data Representation, Research Summaries, and Conflicting Viewpoints. The following sections introduce you to these three question types and show you examples of each.

Data Representation

A Data Representation passage will usually have one or two short paragraphs followed by one to five graphs, charts, tables, diagrams, or pictures.

Example

The periodic table is a listing of each element along with its atomic number (the number of protons in the nucleus or center of the atom) and its atomic mass (the combined weight of protons and neutrons in the nucleus). The atomic mass is approximately equal to the number of protons and neutrons that an element has. The table is arranged into periods vertically and groups (indicated with roman numerals) horizontally. Similar chemical properties are exhibited by elements that are in the same group. Moving across a period from group I to group VII, chemical similarities decrease. Part of the table is reproduced in the following figure.
Q Based on the information in this figure, which of the following statements is true?

(A) Atomic number decreases as period number increases.

(B) Atomic number increases across a period as group number increases.

(C) Increasing period numbers correspond to decreasing atomic masses.

(D) Atomic mass decreases as atomic number increases.

A The correct answer is (B).

Research Summaries

A Research Summaries passage has one or two short paragraphs followed by two or three descriptions of particular scientific research projects; these are usually headed Experiment or Study 1, Experiment or Study 2, and so on and might include a summary graph.

Example

Researchers are interested in optimizing methods for cooling electronic components such as semiconductors (a type of computer chip). Semiconductors generate heat as they operate, but excess levels of heat cause such components to malfunction or might shorten their lifespan. However, cold objects cannot be applied directly to these components, because they are too sensitive.

One cooling method that has been used is the placement of foam material between the semiconductors and a cooling plate. Foam acts as a heat conductor. Heat from the computer chip flows through the foam, toward the
cooling plate. As heat is conducted through the foam in this manner, the semiconductor is cooled, and the temperature difference between the cooling plate and the semiconductor becomes smaller.

Various experiments were performed to determine more about the heat conduction properties of foam.

**Experiment 1**

Foam pads that all had a surface area of 1 inch² but were of various thicknesses were inserted between a semiconductor and a cooling plate. The temperature of the cooling plate was kept constant. The semiconductor was generating 1 watt of heat. The researchers measured the difference in temperature between the semiconductor and the cooling plate. Results appear in the following table.

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Thickness of foam (mm)</th>
<th>Measured temperature difference between computer chip and plate (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3.9</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>7.2</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>11.0</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>14.2</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>16.3</td>
</tr>
</tbody>
</table>

**Experiment 2**

Researchers placed a foam pad between a semiconductor and a cooling plate, but in this experiment the thickness of the pad was 6 mm in all cases, and the surface area of the pad varied. The heat generated by the semiconductor remained at 1 watt. Results appear in the following table.

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Foam surface area (inches²)</th>
<th>Measured temperature difference between computer under chip and plate (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.2</td>
<td>17.4</td>
</tr>
<tr>
<td>2</td>
<td>0.4</td>
<td>13.3</td>
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<tr>
<td>3</td>
<td>0.6</td>
<td>11.0</td>
</tr>
<tr>
<td>4</td>
<td>0.8</td>
<td>8.3</td>
</tr>
<tr>
<td>5</td>
<td>1.0</td>
<td>7.1</td>
</tr>
<tr>
<td>6</td>
<td>1.5</td>
<td>5.3</td>
</tr>
</tbody>
</table>
Which of the following statements is supported by the data from Experiments 1 and 2?

(A) Thicker foam pads are better heat conductors.
(B) Heat conduction is favored by a thin foam pad with a surface area.
(C) Heat dissipation was greatest when the surface area of the foam was 0.2 inches².
(D) Using a piece of foam with a surface area of 0.8 inch² and a thickness of 0.6 mm appears to be equivalent to using a piece with a surface area of 1 inch² and a thickness of 4 mm.

The correct answer is (B).

Conflicting Viewpoints

A Conflicting Viewpoints passage will have one or two paragraphs followed by two or three descriptions of differing theories or ideas about a scientific question; these are usually headed The [X] Hypothesis or The [Y] Theory and, again, might include a graph.

Example

Biologists have discovered certain genes (the basic unit of genetic material found on the chromosomes) that behave very differently depending on whether they are passed down to offspring from the father or the mother. These genes, called imprinted genes, are chemically altered in cells that give rise to eggs and sperm. These alterations result in dramatically different properties. In the imprinted genes that have been most fully studied, the female alters the gene so that certain proteins are not produced. The protein continues to be produced in the father's genes. Researchers have posed numerous theories to explain the evolution of imprinted genes. Two of the theories are presented below.

Anti-Cancer Theory

This theory holds that imprinted genes evolved to prevent cancer. The genes have been found in the placenta (an organ that develops to nourish a growing fetus). Placental tissue grows and burrows into the uterus, where the fetus develops. The ability to grow and invade tissues is also seen in aggressive cancers. Imprinted genes might have developed to ensure that the potentially dangerous placenta will not develop if there is no fetus to nourish. The female might inactivate certain growth genes in her eggs, while the sperm kept them turned on. If no fertilization took place, the growth would not occur. If a sperm did join the egg, the male's gene would ensure that the protein developed.

Protein Control Theory

A second group of biologists holds that imprinted genes developed to ensure the precise regulation of certain proteins. Genes do their work by initiating the production of different proteins. Some proteins involved in the growth of embryos might need to be regulated with great precision to ensure the healthy development of the offspring. Proponents of the protein control theory suggest that this careful regulation might be easier if only one parent is involved. Thus, one parent might turn off such genes, leaving the regulation to the other.
Supporters of the protein control theory believe that
(A) imprinted genes are used to regulate crucial proteins.
(B) imprinted genes are active only in females.
(C) imprinted genes should not be found in monogamous species (ones that mate for life).
(D) only the male passes down imprinted genes to the offspring.

The correct answer is (A).

The Directions

The directions for the ACT Assessment Science Reasoning Test are similar to the following:

Directions: This test consists of seven passages, each followed by several questions. Read each passage, select the correct answer for each question, and mark the oval representing the correct answer on your answer sheet. You may NOT use a calculator on this test.

STRATEGIES FOR SUCCESS ON THE ACT ASSESSMENT SCIENCE REASONING TEST

Much like the Reading portion of the ACT Assessment, the Science Reasoning questions test your ability to comprehend written information. Your success on this portion of the ACT Assessment does not depend upon your scientific knowledge; instead, it depends upon your ability to read and reason. Though the scientific jargon, charts, diagrams, and figures might seem overwhelming at first, you can use some very simple techniques to work through this portion of the ACT Assessment quickly—and accurately. Here are some success strategies specifically designed to help you score higher on ACT Assessment Science Reasoning.

The Three-Step Method: Preview, Read, Review

If you’ve already worked through the English Test chapter, you’ll recognize Preview, Read, Review as the three-step reading method suggested there. Think of the Science Reasoning Test as a special form of reading comprehension. Some of the language might be more technical, and the information is presented not only in words but in graphs, tables, and diagrams. Nonetheless, the basic challenge is the same: to read and digest a mass of information (the “passage”) and answer questions about it.

Therefore, the three-step reading method taught in Chapter 4 is an important foundation for the Science Reasoning Test. (If you haven’t read Chapter 4, read just the section on “Preview, Read, Review” right now.) Here’s how to apply the Preview, Read, Review technique to Science Reasoning.
1 Preview the passage. Spend about 30 seconds glancing through all of the information provided in a passage. Just skim the page, letting your eye move down the columns of type and data, absorbing as much as you can. In particular, try to determine the format of the passage: Is the format Data Representation, Research Summaries, or Conflicting Viewpoints? The different formats are easy to recognize. Because previewing is a brief process, don’t try to absorb a lot of information. You’re about to read the passage in more detail, which will draw you much deeper into its contents.

2 Read the passage. Each one is short, a maximum of about 300 words, and should take no more than a minute or two. For the visual data—tables, charts, graphs, and diagrams—read the labels on the axes or columns, the legends or keys, and explanatory sidebars. Identify the units of measurement (grams, degrees, light-years, and so on). Notice any obvious trends, patterns, or groupings in the data. Then move on. You can always refer to the passage for the details, and in fact you should.

During this step of the reading process, mark up the passage with your pencil. Underline main ideas, star important facts or experimental results, etc. Your sidebars will help you return more quickly to key information in the passage.

3 Review the passage. Spend a final 30 seconds scanning the entire passage one more time. Use this review to solidify in your mind your understanding of how the pieces of the passage fit together: the objective of the experiments, for example, or the idea behind differing theories.

Reviewing will also help you recall where within the passage various details can be found, in the event they’re asked about in the questions.

Look for the Main Idea

Every reading passage is made up of two kinds of elements: main ideas and details. The main ideas are “big” concepts—broad, general ideas that are the most important points being made by the author of the passage. If you were the author, the main ideas would be the handful of concepts you’d want people to remember after reading the passage.

The details, by contrast, are “small” concepts—narrow, specific facts that help to explain, illustrate, or support the main ideas. They’re not as important to understand or remember as the main ideas.

Most Science Reasoning passages include dozens of details: the individual data points on each graph; the specific numbers that fill the grid of a table or chart; and the readings or values obtained in each experiment described. There’s no way you can master or memorize all of them—and there’s no need to. If a question does ask about a detail, you can always return to the passage for the answer. And in fact you should, to make sure you’re answering accurately.

The three different passage formats will express their main ideas in three different ways.
How to Find the Main Idea in Data Representation Passages

In Data Representation passages, focus on what is being measured, relationships among the variables, and trends or patterns in the data. As you remember, a Data Representation passage presents a collection of scientific facts in the form of one or more graphs, tables, charts, or diagrams. To understand the information in this, you need to know what their numbers measure, how different factors affect the numbers, and what trends the numbers reveal.

Example

The optimum population density for the survival and growth of a particular species of animal is often an intermediate one. Excessive crowding produces competition for scarce resources, such as water, food, space, and light, and encourages the spread of infectious diseases. On the other hand, a low population density has its own disadvantages, including diminished protection against attacks by predators, inability to modify the environment in a helpful fashion, and greater vulnerability to changes in temperature.

The following figure, depicting the effect of initial population density upon the rate of population growth in the flour beetle, illustrates this principle.
To begin, look for what is being measured. Reread the first sentence of the passage. It refers to “the optimum population density for the survival and growth of a particular species of animal.” What is being measured is how the rate of growth in the numbers of a species is affected by the population density.

Because the passage focuses on how population density affects or influences the rate of population growth, population density is the independent variable, and rate of growth is the dependent variable. (If these scientific terms aren’t familiar to you, look up the term in the glossary at the end of the Science Reasoning Review chapter in Part 3.)

Next, look for the relationships among the variables. Here is where the graph is essential. As with virtually all line graphs, this one depicts the independent variable (population density) on the horizontal axis and the dependent variable (rate of growth) on the vertical axis. As the dependent variable increases and decreases, the line on the graph rises and falls. While you’re looking at the axes, check the scales. The horizontal scale shows initial numbers of beetles per 32 grams of flour (population density). The further to the right on this scale, the more beetles there were to start with. The vertical scale shows how fast the beetle population grew, measured in baby beetles born per female per day. The higher on this scale, the faster the population growth.

Finally, look for the trends or patterns in the data. In this example, the trend is clearly seen in the shape of the line on the graph. Basically, the shape rises then falls; its high point is in the middle, where the horizontal scale indicates an initial population density of around 5 bugs. That’s the basic trend to recognize: Population growth is greatest not when the initial population density is very low or very high, but in the middle range.

These are the main ideas, and you now probably have all the information you need to answer the questions. If a specific detail is asked about (for example, “What is the rate of population increase when the initial beetle population is 32 beetles/32 grams of flour?”), you can simply look back at the graph to find the answer (4 per female per day).

How to Find the Main Idea in Research Summary Passages

In Research Summary passages, focus on the question asked, the variables being tested, and similarities and differences in the experimental results. As you remember, a Research Summary passage will pose a scientific question then describe two or three experiments or studies that attempt to answer that question. The results of the experiments are described or presented in the form of graphs or tables. The questions that follow require you to compare the experiments, recognize why they were designed as they were, and draw some basic conclusions as to what the experiments prove or don’t prove.
Example

It has long been known that different species of flowering plants flower at various times of the year in response to some environmental stimulus. Botanists have found that the duration and timing of light and dark conditions to which a plant is exposed, known as its photoperiod, is the crucial factor in flowering. Botanists generally classify flowering plants in three groups: long-day plants, which flower when the day length exceeds some critical value, usually in summer; short-day plants, which flower when the day length is below some critical value; and day-neutral plants, which can bloom during either long or short days.

In an effort to define more precisely the critical element in the photoperiod, scientists conducted the following experiments.

Experiment 1

A greenhouse in which conditions of light and darkness were carefully controlled was stocked with several long-day and short-day plants. These were maintained with a light regime of 14 hours of daylight alternating with 10 hours of darkness. Under these conditions, the long-day plants flowered, and the short-day plants did not.

Experiment 2

A similar greenhouse was stocked with several long-day and short-day plants. These were maintained with a light regime of 12 hours of daylight and 12 hours of darkness. The short-day plants flowered, and the long-day plants did not.

Experiment 3

In a similar greenhouse with the same assortment of plants, 12 hours of daylight and 12 hours of darkness were maintained. However, halfway through the dark period, all the plants were illuminated by a momentary flash of white light. Under these conditions, the long-day plants flowered, while the short-day plants did not.

These results are summarized in the following figure.
To begin, look for the question being asked. The sentence immediately preceding the experimental results tells us that the purpose of the experiments was “to define more precisely the critical element in the photoperiod”; in other words, to figure out exactly to what the plants are responding when they either flower or fail to flower.

Next, look for the variables being tested. The experimenters are usually trying to determine how differing variables produce differing results or outcomes. To test this, they’ll keep certain conditions in their experiments unchanged while varying the others (hence the name “variables”). You can recognize the variables being tested by noting what is different from one experiment to the next. Some experiments might vary one condition; others will vary many conditions.

In the sample passage, the number of hours of daylight seems to be the variable tested. Then, Experiment 3 introduces something new: The same number of hours of daylight and darkness, but the darkness is interrupted by a flash of light—with significantly different results. Thus, a careful description of the variable is not “hours of daylight” but rather “hours of uninterrupted darkness.”

Finally, look for similarities and differences in the experimental results. Here, the results of Experiments 1 and 2 are predictable: The long-day plants flower when daylight is long and darkness is short, and the short-day plants flower when daylight is short and darkness is long. Opposite conditions produce opposite results, as you might expect. However, Experiment 3 introduces a new variable. The hours of darkness and light correspond to “short-day” conditions: 12 hours of each. But the flash of light that interrupts the “nighttime” period apparently has the effect of reversing the expected results: Long-day plants flower in Experiment 3, and short-day plants don’t. This suggests that the length of daylight hours isn’t as crucial as the length of uninterrupted darkness.

The main ideas in a Research Summary passage, then, can be found by comparing the experiments. The ways in which they resemble one another—and, more importantly, the ways in which they differ—reveal what the scientists are interested in studying and the conclusions their work suggests.

How to Find the Main Idea in Conflicting Viewpoints Passages

In Conflicting Viewpoints passages, focus on the idea to be explained, on the similarities and differences in the theories presented, and on the hidden assumptions that underlie each theory. As you remember, a Conflicting Viewpoints passage briefly outlines a scientific problem: a disease whose cause must be determined, a geological process whose workings must be described, or an astronomical observation that doesn’t seem to fit with other known facts and that must be explained. Two or three alternative explanations are then offered, each under its own heading.
Example

The salmonids are a family of fish that includes salmon, trout, and char. Many species of salmonids are capable of navigating great distances, and they use this ability in long-range migrations, often involving thousands of miles of both ocean and fresh-water swimming. Salmon, in particular, are known for their homing behavior, in which maturing adults return to their parents’ spawning (egg-laying) sites with 84 to 98 percent accuracy. Two main theories have been proposed to explain how salmon are able to navigate such great distances so successfully.

Chemoreception Theory

Salmon are one of many species of fish that are sensitive to the presence of particular chemicals in their environment, and they use stimuli provided by these chemicals and detected by the sense of smell as navigational clues. These stimuli are sometimes present over large areas of water. For example, it has been demonstrated that sockeye salmon spawned in the Fraser River in Canada can recognize water from that river in the open sea as much as 300 kilometers from its mouth.

To test the hypothesis that smell is the crucial sense for salmon navigation, scientists blocked the nasal cavities of some migrating coho salmon with absorbent cotton and marked the fish to facilitate tracing. Another group of coho salmon was differently marked and not treated in any other way. When the travels of both groups of salmon were studied, it was found that the untreated group returned accurately to their rivers of origin, and the salmon that were unable to smell selected rivers at random.

Magnetic Direction-Finding Theory

Various species of animals navigate using clues provided by the earth’s magnetic field. This field, which generates magnetic lines of force running in a north-south direction, can be used in direction-finding by many birds and, some scientists believe, by some fish, including salmon.

One species of Pacific salmon, the chum, was tested for its sensitivity to magnetism in the following way. An experimental apparatus consisting of two electrical coils was built around a tank housing the salmon. When a current was run through the coils, a magnetic field was generated, capable of intensifying, weakening, or altering the earth’s magnetic field, depending on the positioning of the coils. When this field was rotated 90 degrees from the normal north-south orientation, the chum’s own orientation also rotated, indicating the fish’s ability to directly detect the earth’s magnetic field and its responsiveness to that stimulus.

Unlike in some birds, however, whose skulls have been shown to contain particles of magnetite, a metal sensitive to magnetism, no mechanism for detecting magnetism has yet been discovered in salmon.

In a Conflicting Viewpoints passage, sometimes the theories might flatly contradict one another; other times they might be completely independent of one another or even complementary. In reality, either theory, neither, or both could be true.
To begin, look for the question to be explained. In the sample passage, the key sentence is “Two main theories have been proposed to explain how salmon are able to navigate such great distances so successfully.” This makes it clear that what must be explained is the mechanism whereby salmon can find their way accurately over such long distances.

Next, look for the similarities and differences in the theories presented. For example, in the sample passage, both theories suggest that the salmon respond to environmental stimuli, as opposed, for example, to some purely internal or instinctive mechanism. On the other hand, the theories differ in the nature of the stimulus on which the salmon supposedly rely. One theory considers the sense of smell to be crucial; the other focuses on magnetism. One more difference lies in how the supposed navigational mechanism might be affected by changes in the environment.

Finally, look for the hidden assumptions that underlie each theory. Hidden assumptions are facts or ideas, not stated in the passage, that must be true if a theory is to be considered valid. Assumptions are the secret flaw in many theories. If the assumption is true, the theory might be sound, valid, and convincing. If it is false, the theory is likely to break down completely. And because the assumption is unstated—“hidden”—it is easy to overlook.

For example, in the “smell” hypothesis, one assumption is that whatever chemical gives the water in the spawning ground its distinctive “smell” must persist over time, or else the salmon couldn’t recognize it when they try to return to their “home” river. In the “magnetism” hypothesis, one assumption is that if there’s no magnetite in the salmon, then it must have some other substance or organ that’s sensitive to magnetic fields. If any of these assumptions could be proven to be false, then the theory associated with it would crumble. Because ACT Assessment questions often ask about hidden assumptions, practice looking for them when you read a Conflicting Viewpoints passage.

Know the Four Most Common Question Types

Most of the questions on the ACT Assessment Science Reasoning Test will fall into one of these four categories:

1. Main idea
2. Detail
3. Inference
4. Application

Main idea questions ask about one of the main ideas on which you focused in reading the passage. Earlier sections of this chapter discussed how to find the main idea in each of the Science Reasoning subject areas. These questions should be easy to answer if you’ve read the passage as suggested above, focusing on those elements that are most important to each type of passage.
A detail question focuses on one specific piece of information drawn from the passage. To answer correctly, read the question carefully, return to the passage, and find the answer. Don’t try to answer from memory.

Here’s a sample detail question based on a passage you read earlier in this chapter (beetles-in-the-flour):

> According to the figure, if the initial population density is 16 beetles per 32 grams of flour, what will be the rate of population increase per female per day?
> (A) 3
> (B) 5
> (C) 6
> (D) 8

A The correct answer is (C).

The answer, choice (C), can be read directly from the graph that accompanies the passage.

An inference question requires that you make connections between two or more details that are not explicitly stated in the passage.

Using the flowering-plants passage you read earlier in the chapter, here’s an example:

> On the basis of the information in the figure, the long-day plants used in the study can be expected to flower when they are housed in conditions that include
> (A) a period of daylight at least 12 hours long.
> (B) no period of uninterrupted darkness longer than 11 hours.
> (C) no period of daylight shorter than 12 hours.
> (D) no period of uninterrupted darkness shorter than 10 hours.

A The correct answer is (B).

The correct answer is choice (B). To answer this item correctly, you must not only understand the overall experimental setup and the special features of Experiment 3 in the earlier passage, but also note in the figure that accompanies that passage the dotted vertical line marking what’s called “critical night length.” You can infer that this represents the number of hours of darkness that separate long-day from short-day plants. The line is drawn so as to mark off 11 hours of darkness (or 13 hours of daylight), which we see must be the maximum amount of uninterrupted darkness in which a long-day plant can flower.
An application question requires you to apply the information in the passage to a context beyond the passage. For instance, you might be asked to evaluate a new piece of evidence that could either strengthen or weaken one of the theories presented; you could be called upon to extrapolate from the information provided to a new situation that’s not included in the existing graph or table; or you might be asked how the ideas in the passage might affect some real-world problem.

Here’s an example using the salmon-navigation passage you read earlier in the chapter:

Q The Magnetic Direction-Finding Theory would be most greatly strengthened by the discovery that
(A) chemical-sensitive organs exist in the nasal cavities of coho salmon.
(B) the earth’s magnetic field is too weak to be detected by most species of salmon.
(C) particles of magnetite exist in the skulls of Pacific salmon.
(D) coho salmon are the only species of salmon with a highly sensitive sense of smell.

A The correct answer is (C).

The passage suggests that one weakness of the magnetic theory is the absence of any obvious mechanism by which the magnetic sensing could work. Choice (C) would strengthen the theory by supplying this absence. Choice (B) would weaken the theory rather than strengthening it, and choices (A) and (D) relate only to the Chemoreception Theory rather than the Magnetic Theory.

Don’t Get Lost in Numbers, Jargon, or Details

Most Science Reasoning passages will include information that is not necessary to answer the question. This might be numbers in the text or on the graphs or tables, scientific terminology, or dozens of details. For example, one ACT Assessment Science Reasoning passage dealt with bacterial reproduction and listed twelve different types of bacteria using their Latin names: *Clostridium botulinum*, *Escherichia coli*, *Lactobacillus acidophilus*, and so on. Although those names were repeated on the chart, they could just as well have been labeled bacterium #1 through #12. The Latin names didn’t matter.

So don’t allow yourself to be distracted. Focus on the main ideas of the passage, skim the details, then answer the questions.
SUCCESS STRATEGY ROUNDUP: A LIST OF DO’S AND DON'TS

Here’s the “short version” of the above advice, along with a few other miscellaneous sidebars, arranged in a handy list of do’s and don’ts. After you understand each point and the reasoning behind it, you need only know the boldface sentence to jog your memory—whether you’re working on the exercises at the end of this chapter, your full-length practice tests, or the ACT Assessment itself.

A list of Do’s:

✔ Preview, read, review. Think of the Science Reasoning Test as just a specialized version of the regular ACT Assessment Reading Test. Use the same skills and strategies detailed in that section, mark up the test booklet to underline main ideas, and remember that all the information you need to answer the question is right there.

✔ Read just the labels, legends, and explanatory sidebars. On all forms of data representation, read the labels on the axes, rows, and columns, as well as the legends and sidebars. You don’t have to read the actual point-by-point information. Notice trends, groupings, processes, and sequences, and then move on.

✔ Find the main ideas as you read. In Data Representation passages, focus on what is being measured, on relationships among the variables, and on trends in the data. In Research Summary passages, focus on the question of the hypothesis, on the variables being tested, and on differences in the experimental results. In Conflicting Viewpoints passages, focus on what must be explained, on similarities and differences in the theories presented, and on hidden assumptions that underlie each theory.

✔ Know what’s being asked. Is it Experiment 3 the question asks about or Experiment 4? Table 1 or Table 2? Read carefully. Just a few words can mean the difference between the correct answer and an incorrect one.

✔ Pay close attention to the last sentence of the introductory material. In a Data Representation passage, the last sentence of the introductory material is where the relationship between the variables can usually be found. In a Research Summary passage, it’s where the purpose of the experiments can usually be found. In a Conflicting Viewpoints passage, it’s where the question under consideration can usually be found.

✔ Look for differences in the data. Remember that differences are more important than similarities. When comparing charts, tables, experimental design, experimental results, and so on, look for the differences. Questions are more likely to deal with differences than similarities.
Know the four type of questions. Decide whether a question is about the main idea, details, an inference, or an application. Your approach to each will be slightly different.

Look for the change. In any experiment, look for the variable that changes, then look to see how a change in the variable results in changes in other elements of the experiment.

A list of Don’ts:

Don’t get lost in numbers, scientific jargon, and irrelevant details. Don’t try to memorize the details as you read. Just look for the main ideas. You can then refer to the passage to find the few details needed to answer questions.

Don’t be thrown by math on the Science Reasoning Test. Math on the Science Reasoning Test is very basic, and you won’t be allowed to use a calculator. If you think a particular item calls for extensive calculations, you are probably misreading the question.

Don’t confuse units of measurement. Although math is secondary, it does have its role. You might be asked, for example, to take a relationship expressed in liters and apply it to a quantity of milliliters; remember to change the unit of measurement.

Don’t take sides in Conflicting Viewpoints passages. Deciding which side is right or which side you agree with is irrelevant. Trying to figure that out only wastes time and has nothing to do with the questions being asked. Focus on the information presented and the assumptions supporting each theory.

Don’t accept every assumption as true. Certain experiments will be based on faulty assumptions. If the assumption is faulty, the experimental design is faulty, and the results do not prove what the conclusion claims to prove.

PRACTICE EXERCISES

You’ve just learned some new skills for taking the ACT Assessment Science Reasoning Test. The following exercises will help you to practice these new skills as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are two Science Reasoning Test exercises in this chapter. Each exercise contains two passages and a total of 12 questions and should be answered in 10 minutes. Do each exercise in one sitting in a quiet place, with no sidebars or reference material. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

Score yourself only on those items you finished. When you’re done, work through the rest of the exercise.
EXERCISES: THE ACT ASSESSMENT SCIENCE REASONING TEST

Exercise 1

12 Questions • Time—10 Minutes

Directions: This test consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question. You may NOT use a calculator on this test.

Passage I

*Phytoplankton* are tiny aquatic plants that are an important food source for larger animals and may be an important source of carbon (the element that is a building block of all living organisms). Phytoplankton abundance is dependent on the presence of warm surface waters. Consequently, changes in phytoplankton abundance can be used as an indicator of changes in surface water temperature.

A system for documenting phytoplankton abundance has been developed using filtering silk towed by merchant ships. The organisms color the silk green, and the intensity of the color is correlated with their abundance. The first figure shows data on the average monthly phytoplankton abundance for four decades, as determined by the color index system. Data is given for two ocean areas in the Northern Atlantic just below the Arctic Circle. The boundaries of these areas are depicted in the second figure.

1. Based on the information in the first figure, which of the following statements concerning phytoplankton abundance in the four decades of the study is correct?
   
   (A) There was no discernible change in patterns of phytoplankton abundance in Ocean Area 1.
   
   (B) Annual phytoplankton abundance increased in Ocean Area 2.
   
   (C) Annual phytoplankton abundance increased in Ocean Area 1 and decreased in Ocean Area 2.
   
   (D) The season of high phytoplankton abundance increased in length in both ocean areas.
2. Assuming that the changes in phytoplankton abundance seen in the study occurred solely because of surface water temperature variations, the information in the figures indicates that which of the following statements is true?
   (F) Surface ocean waters above latitude 62° North in the map areas cooled during the study.
   (G) Surface ocean waters above latitude 50° North in the map areas cooled during the study.
   (H) Surface ocean waters east of longitude 10° in the map areas warmed during the study.
   (J) Surface ocean waters west of longitude 10° in the map areas cooled during the study.

3. Which of the following statements best describes typical phytoplankton abundance in Ocean Areas 1 and 2 in the 1950s?
   (A) Abundance increased in October and remained at high levels until about June.
   (B) Abundance increased slowly and fell off rapidly in two distinct periods.
   (C) Abundance increased rapidly in two distinct periods and remained at peak levels for approximately three months during each of these periods.
   (D) Abundance increased and fell off rapidly in two distinct periods.

4. The first figure indicates what about the changes in phytoplankton abundance?
   (F) Changes occurred evenly over the course of the four decades.
   (G) Changes occurred over the course of about a decade.
   (H) Changes occurred over the course of about a year.
   (J) Changes in Ocean Area 1 were apparent earlier than changes in Ocean Area 2.

5. Some researchers hypothesize that the changes in phytoplankton abundance reflect an increase in global temperature over the last century (global warming). Which of the following findings would support this hypothesis and fit the data seen in the first figure?
   (A) A greater abundance of fresh water from melted ice and permafrost has begun flowing south to north from the Antarctic during the last century.
   (B) A greater abundance of fresh water from melted ice and permafrost has begun flowing north to south from the Arctic during the last century.
   (C) Warmer temperatures have been recorded in and around Iceland during the last century.
   (D) Barring a few exceptions, phytoplankton numbers have begun to decrease dramatically in ocean areas around the globe during the last century.

6. Certain species of whales migrate annually in order to take advantage of abundant blooms of phytoplankton, one of their principal food sources. During which of the following months would a whale-watching tour in Ocean Area 1 be LEAST likely to encounter phytoplankton-eating whales?
   (F) January
   (G) April
   (H) May
   (J) August
Passage II

Airplane wings must be designed aerodynamically (with consideration to the airflow over the body of the plane) to ensure efficient flight. Aerodynamic design considers lift and drag.

Lift is the force acting upward on the plane. It is generated because the top of a wing is curved, while the bottom is flat. The air moving over the top of the wings must move faster than the air moving over the bottom. This results in a lower pressure area above the wing.

Drag is the air resistance generated by the plane. This is a force acting in opposition to the plane’s forward movement. The most efficient planes are those with the highest lift to drag ratio.

Researchers testing new wing designs conducted a series of experiments to measure their efficiency.

Experiment 1

Researchers tested aircraft with four wing designs (see the following figure) in a wind tunnel (a tunnel in which air is blown over a craft to simulate flight conditions). This test simulated flight at 400 mph. The lift and drag measured for each wing shape are recorded in Table 7.1.

<table>
<thead>
<tr>
<th>Design</th>
<th>Lift (neutrons)</th>
<th>Drag (neutrons)</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>.15</td>
<td>20:1</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>.2</td>
<td>40:1</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>1</td>
<td>10:1</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>2</td>
<td>9:1</td>
</tr>
</tbody>
</table>

Experiment 2

Aircraft with the four wing types depicted in the figure were tested under similar flight conditions to gauge fuel consumption. After reaching cruising altitude, the planes maintained a speed of 400 mph. The results appear in Table 7.2.

<table>
<thead>
<tr>
<th>Wing Design</th>
<th>Fuel consumption (gal/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>88</td>
</tr>
</tbody>
</table>

Experiment 3

Lift, drag and efficiency are dependent on airspeed. The researchers tested Wing Designs 1 and 2 at different speeds. Efficiency (lift to drag ratio) was recorded (Table 7.3).

<table>
<thead>
<tr>
<th>Airspeed (mph)</th>
<th>Design 1 (Efficiency)</th>
<th>Design 2 (Efficiency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>22:1</td>
<td>43:1</td>
</tr>
<tr>
<td>300</td>
<td>21:1</td>
<td>42:1</td>
</tr>
<tr>
<td>400</td>
<td>20:1</td>
<td>40:1</td>
</tr>
<tr>
<td>500</td>
<td>18:1</td>
<td>12:1</td>
</tr>
<tr>
<td>600</td>
<td>10:1</td>
<td>8:1</td>
</tr>
</tbody>
</table>
7. The most efficient wing tested in Experiment 1 was
   (A) Wing Design 1.
   (B) Wing Design 2.
   (C) Wing Design 3.
   (D) Wing Design 4.

8. A passenger plane is able to carry a fixed weight, including passengers and fuel. Which wing design would be best for such a plane?
   (F) Wing Design 1
   (G) Wing Design 2
   (H) Wing Design 3
   (J) Wing Design 4

9. In cold, damp weather, the buildup of ice on airplane wings can pose significant aerodynamic problems. Which of the following effects would you expect?
   (A) As ice builds up on the top of the wing, drag increases.
   (B) As ice builds up on the top of the wing, lift increases.
   (C) As ice builds up on bottom of the wing, lift decreases.
   (D) All of the above

10. Which of the following test pairs reflects consistent experimental data?
    (F) Experiment 1, Wing Design 2; Experiment 2, Airspeed 200
    (G) Experiment 1, Wing Design 1; Experiment 2, Wing Design 2
    (H) Experiment 1, Wing Design 3; Experiment 3, Airspeed 400
    (J) Experiment 1, Wing Design 1; Experiment 3, Airspeed 400

11. Which of the following statements about airspeed is supported by the data in Experiment 3?
    (A) As airspeed increases, the lift to drag ratio increases.
    (B) As airspeed increases, lift and drag increase at about the same rate.
    (C) As airspeed increases, drag increases faster than lift.
    (D) As airspeed increases, lift increases faster than drag.

12. New fighter jets are being designed so that the wing is modifiable, depending on the speed at which the plane is going. Which of the following would be a logical adjustment of the wing for such jets?
    (F) At speeds above 500 mph, the top of the wing would become flatter.
    (G) At speeds above 500 mph, the top of the wing would become more curved.
    (H) At speeds above 500 mph, the bottom of the wing would become curved.
    (J) None of the above
Exercise 2

12 Questions • Time—10 Minutes

Directions: This test consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question. You may NOT use a calculator on this test.

Passage I

A greenish, potato-sized meteorite discovered in Antarctica is believed to have originated on Mars. Investigations of the meteorite have revealed a number of unusual features. Some scientists believe that these features are evidence of primitive life on Mars, while other scientists believe that they are more probably the result of nonbiological (nonliving) processes, such as hydrothermal synthesis.

Hydrothermal Synthesis Hypothesis

The meteorite crystallized slowly from magma (molten rock) on Mars 4.5 million years ago. About half a million years later, the rock became fractured. This was a time when Mars was much warmer and had abundant water. Deep inside the planet, in a process called hydrothermal synthesis, hot water and carbon seeped into the fractured rock and formed new complex organic compounds called polycyclic aromatic hydrocarbons (PAHs). (Organic compounds, or those that contain carbon, are formed from life processes, such as bacterial decay, as well as processes that are not associated with life, including hydrothermal synthesis and star formation.)

As the chemical environment of the planet changed over time, crystals of magnetite, iron sulfides, and carbonate formed in the rock. The crystallization of the carbonate resulted in the formation of unusual elongated and egg-shaped structures within the crystals.

Primitive Life Hypothesis

The meteorite crystallized slowly from magma (molten rock) on Mars 4.5 million years ago. About half a million years later, the rock became fractured. This was a time when Mars was much warmer and had abundant water. The rock was immersed in water rich in carbon dioxide, which allowed carbon to collect inside the fractured rock, along with primitive bacteria.

The bacteria began to manufacture magnetite and iron sulfide crystals, just as bacteria on Earth do. As generations of bacteria died and began to decay, they created PAHs inside of the meteorite’s carbon molecules. Finally, some of the bacteria themselves were preserved as elongated egg-shaped fossils inside of the rock.

1. About which of the following points do the two hypotheses differ?

(A) The meteorite’s age

(B) The origin of the meteorite’s organic molecules

(C) The conditions on Mars when the meteorite formed

(D) The origin of the fractures in the meteorite
2. Proponents of both theories would agree that which of the following statements is true?
   (F) The meteorite contains some type of fossil.
   (G) Water was important for the original entry of carbon into the meteorite.
   (H) The organic compounds seen in the rock were the result of decay.
   (J) Magnetite crystals from Antarctica seeped into the meteorite.

3. Which of the following represents a difference in opinion between proponents of the two theories?
   (A) Proponents of the Primitive Life Hypothesis maintain that Mars has changed substantially since the meteorite was formed.
   (B) Proponents of the Primitive Life Hypothesis dispute the notion that PAHs can occur from processes other than bacterial decay.
   (C) Proponents of the Hydrothermal Synthesis Hypothesis believe that hot water and carbon formed organic compounds in the rock.
   (D) Proponents of the Hydrothermal Synthesis Hypothesis believe that the fossils found inside the meteorite were probably the remains of an organism other than a bacterium.

4. Which of the following findings would help to bolster the case of proponents of the Hydrothermal Synthesis Hypothesis?
   (F) The magnetite found in the meteorite sometimes occurred in chains, similar to those produced by bacteria on Earth.
   (G) Glass within the meteorite hints that it was probably fractured and launched toward Earth when a meteoroid or comet hit Mars.
   (H) Recent studies indicate that liquid water, one of life’s most fundamental necessities, does not exist on Mars.
   (J) Minerals can grow into shapes that are similar to the elongated egg-shaped structures seen in the meteorite.

5. Researchers analyzing glacial ice found very low concentrations of PAHs. Which of the following additional findings would help the case of proponents of the Primitive Life Hypothesis?
   (A) The meteorite contained only a small number of the thousands of PAHs, and all of the ones found are known to be associated with bacterial decay.
   (B) Organic molecules were also discovered in meteorites known to have originated in the asteroid belt (an area orbiting the sun, which is rich in asteroids).
   (C) Some of the carbonates in which the PAHs were found had element ratios that are similar to those found on Earth.
   (D) Experiments with the weathering of rocks have shown that under certain conditions, molecules in the environment can make their way deep within a rock.

6. Which of the following experiments might help to resolve the question of whether the PAHs in the meteorite actually originated on Mars?
   (F) Examine the ratios of the PAHs found in glacial ice and see if these are similar to those seen in the meteorite.
   (G) Test meteorites known to have come from the moon for PAHs.
   (H) Test for PAHs in meteorites known to have formed on Mars after its era of abundant water ended.
   (J) All of the above
Passage II

Electrical circuits that allow electrical signals with some frequencies (number of waves per second) to pass while suppressing others are called filters. They are used in nearly every electronic device, from computers to VCRs. They may contain resistors, which resist the flow of current through a wire, inductors, which resist change in the current, and capacitors, which store electric charge. The following figure shows the design of three types of filters.

![Diagram of three types of filters]

The effects of a filter can be demonstrated with a frequency response curve. Such a curve depicts the amplitude (wave height) of the output (vertical axis) as one varies the input frequency (horizontal axis), while keeping the input amplitude constant. Several experiments were conducted to test the effects of some filters.

**Experiment 1**

Researchers fed sine waves (oscillating voltage) into an electrical circuit containing the three filters depicted in the figure. The input amplitude was fixed at 2.0 volts. The amplitude of the resulting waves were measured, and the frequency response curves in the following figure were obtained.

![Frequency response curve for Experiment 1]

**Experiment 2**

A sine wave with an amplitude fixed at 2.0 volts was fed into a circuit with a Type 3 filter, but in this experiment the researchers used four different values for the inductance (L). The resulting frequency response curves are shown in the following figure.

![Frequency response curves for Experiment 2]

**Experiment 3**

Again, the researchers fed a sine wave with an amplitude fixed at 2.0 volts into a circuit with a Type 3 filter. The inductance was held at .1 mH, while four different values of capacitance C were used. The resulting frequency response curves are shown in the following figure.
EXERCISES

7. Which of the following statements about the three filters is supported by Experiment 1?
   (A) Type 1 filters out high frequencies.
   (B) Type 1 filters out low frequencies.
   (C) Type 2 filters out high frequencies.
   (D) Type 3 filters out mid-range frequencies.

8. Which of the following accurately described the difference between Experiments 1 and 2?
   (F) The frequency of the input signal wave was varied in Experiment 1 but not in Experiment 2.
   (G) The inductance of Filter 3 was constant in Experiment 1 but varied in Experiment 2.
   (H) The amplitude of the input signal wave remained constant in Experiment 1 but varied in Experiment 2.
   (J) The amplitude of the output signal wave remained constant in Experiment 1 but varied in Experiment 2.

9. When capacitance is increased for Filter 3, which of the following effects occur?
   (A) The output amplitude is increased.
   (B) The range of frequencies that the filter does not suppress increases.
   (C) A smaller range of frequencies are accepted.
   (D) The accepted frequencies are in a higher range.

10. In Experiment 2, the capacitance was most likely set at
    (F) 1µF
    (G) .1µF
    (H) .01µF
    (J) .001µF

11. The frequency response curves suggest possible applications for the three filters. Which of the following applications would be most logical?
    (A) Filter Type 1 used by a radio receiver to screen out radio signals that are at a lower frequency than that of the desired station
    (B) Filter Type 2 used in an audio circuit to eliminate high-frequency audio hum
    (C) Filter Type 2 used in a radio receiver to tune in a particular radio station at a fixed frequency
    (D) Filter Type 3 used in a radio receiver to tune in a particular radio station at a fixed frequency

12. It is often very important to design filters with high Q (a very narrow peak in the frequency response curve). An engineer discovers that the tuned frequency (the frequency at which the frequency response curve peaks) of a circuit with a Type 3 filter is too low. Which of the following should he do in order to raise the tuned frequency and keep a high Q filter circuit?
    (F) Lower the capacitance
    (G) Lower the inductance
    (H) Raise the capacitance and the inductance
    (J) Raise the resistance
1. The correct answer is (C). You can literally “see” the answer to this question merely by glancing at the graphs in the figure. In Ocean Area 1, the two annual periods of phytoplankton abundance grew much longer as the decades passed until they merged into a single long period of abundance lasting half the year. By contrast, in Ocean Area 2, the two peaks got “thinner” as time passed, indicating a steady decrease in the phytoplankton population.

2. The correct answer is (F). Only choice (F) gives information consistent with the data in the graphs. Ocean Area 2 is north of latitude 62°; if the waters there got cooler, it would make sense that phytoplankton abundance would decrease (see the second sentence of the passage).

3. The correct answer is (D). Look at the shapes of the two peak periods in the graphs for the 1950s (roughly similar in both ocean areas). Both feature steep increases with equally steep declines, as described in choice (D).

4. The correct answer is (G). In both ocean areas, the most dramatic change by far appears between the 1960s and the 1970s.

5. The correct answer is (B). This answer would fit both the global warming hypothesis and the data shown in the graphs in several ways. First, the graphs for Ocean Area 1, showing an increase in phytoplankton, certainly fit the notion of global warming. Second, the idea that Arctic ice is melting would fit that idea as well. Finally, the abundance of fresh water newly melted from ice appearing in the northern reaches of the Atlantic could help to explain why phytoplankton has actually declined around Iceland: The water temperature there has gone down slightly as a result of the melting ice.

6. The correct answer is (J). Of the months named, only August is a month with virtually no measurable phytoplankton in any of the four graphs for Ocean Area 1. Therefore, this is the least promising month for observing phytoplankton-eating whales.

7. The correct answer is (B). The answer can easily be found in the fourth column of Table 7.1: The efficiency of design 2 (in terms of lift to drag ratio) was 40:1, a higher ratio than any of the other wings.

8. The correct answer is (G). Since Wing Design 2 is most efficient according to all three experiments, it is the most desirable design.

9. The correct answer is (D). Ice building up on top of the wing would increase lift, since the higher the curved upper surface of the wing, the greater the difference between the speed of air moving under the wing and above it. It would also increase drag, as suggested by the third column of Table 7.1: Notice how the wings with the higher upper surface also have greater drag. Finally, ice building up under the wing would decrease the speed of air moving under the wing and so reduce lift. Thus, all three effects would occur.
10. The correct answer is (J). In both experiments named here, conditions are the same: The same wing design is used, and the airspeed of 400 mph is the same. (Logically enough, the efficiency result is also the same: 40:1.)

11. The correct answer is (C). Remember that “efficiency” is the same as the lift to drag ratio. Since we note in Table 7.3 that efficiency decreases as speed increases, we can tell that drag must be increasing faster than lift.

Exercise 2


1. The correct answer is (B). The Hydrothermal Synthesis Hypotheses states that the PAHs (the organic molecules in the meteorite) were formed by hydrothermal synthesis, while the Primitive Life Hypothesis says that they were formed by the decay of bacteria.

2. The correct answer is (G). See the fourth sentence of each of the sections describing the two hypotheses. In both cases, seeping water is described as the mechanism that allowed carbon to enter the rock.

3. The correct answer is (C). This is the only true statement that also names a difference between the proponents of the two theories. Choice (A) describes a belief that is actually shared by proponents of both theories, while choices (B) and (D) both make false statements about what the proponents of the theories state.

4. The correct answer is (J). If it’s true that minerals can form “egg-shaped structures” like those found in the meteorite, this would strengthen the Hydrothermal Synthesis Hypotheses by providing an alternative explanation for these forms, which the Primitive Life proponents consider evidence of life on Mars.

5. The correct answer is (A). The fact that low concentrations of PAHs were found in glacial ice (mildly) strengthens the Primitive Life Hypothesis by tending to disprove the notion that the PAHs in the meteorite seeped in after the rock landed in Antarctica. The statement in choice (A) would further strengthen that hypothesis by suggesting that the PAHs in the meteorite were more probably produced by bacterial decay than by non-living processes.

6. The correct answer is (F). This test would at least help to eliminate—or confirm—the possibility that the PAHs found in the meteorite actually appeared there as a result of contamination from glacial ice.

7. The correct answer is (A). Look at the line in the figure depicting the frequency response curve for Filter Type 1. It falls off dramatically in the middle of the graph, indicating that low frequencies
8. **The correct answer is (G).** In both experiments, the input amplitude was fixed at 2.0 volts, and the frequency was varied (along the horizontal scale of each graph). However, the inductance was varied in Experiment 2 only.

9. **The correct answer is (C).** Look at the figure. As you go from right to left in the graph, the capacitance figures increase. And as you do so, the graphed lines form “steeper,” “sharper,” more “pointy” curves. This indicates that a narrower range of frequencies is being permitted through by the filter.

10. **The correct answer is (H).** To answer this question, you need to compare Experiments 2 and 3, along with the graphs showing the results. We’re told that the inductance in Experiment 3 was held at .1 mH. This corresponds with the third line from the left in the figure. Since that line most closely resembles the third line from the left in the figure—and since we’re told that, for that line, the capacitance was set at .01 µF—it makes sense to assume that the same capacitance must have been used to produce the matching line in Experiment 2.

11. **The correct answer is (D).** Look at the figure. Since Filter Type 3 “zeroes in” on waves of a very specific frequency, allowing only those waves to pass through, it makes sense that one might use this type of filter to tune in the fixed frequency of a particular radio station (while eliminating all other competing signals).

12. **The correct answer is (G).** As you can see from the figure, the lower the inductance, the higher the frequency at which the response curve attains its peak.
ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment Science Reasoning Test? How well have you incorporated your new skills into your test-taking behavior?

After you’ve corrected each exercise, find the number below. This will give you an idea of whether you need to go to the Science Reasoning Review or whether you can move on to another subject area.

SCORE KEY FOR EACH PRACTICE EXERCISE

<table>
<thead>
<tr>
<th>Number Correct</th>
<th>Score</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>Poor</td>
<td>Study the review chapter and do the exercises there. Study this chapter again.</td>
</tr>
<tr>
<td>4–6</td>
<td>Below average</td>
<td>Study problem areas in the review chapter and do at least one exercise. Study this chapter again.</td>
</tr>
<tr>
<td>7–10</td>
<td>Average</td>
<td>Study this chapter again if you have time. Skim problem areas in the review chapter if you have time.</td>
</tr>
<tr>
<td>11–15</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
</tr>
<tr>
<td>16–20</td>
<td>Excellent</td>
<td>You’re ready for the ACT Assessment Science Reasoning Test.</td>
</tr>
</tbody>
</table>
What You Need to Know about the ACT Assessment Science Reasoning Test

- The ACT Assessment Science Reasoning Test will contain seven passages of about 100 to 300 words long, on biology, chemistry, physics, and earth science, followed by a total of 40 questions. You will have 35 minutes to complete the test.
- Use the “Preview, Read, Review” method to tackle each passage before trying to answer the questions.
- Pay close attention to the last sentence of the introductory material in each passage.
- In Data Representation passages, look for trends (patterns) in the data. In Research Summary passages, look for differences among the experiments described. And in Conflicting Viewpoints passages, look for hidden assumptions underlying each of the theories presented.
- Identify whether questions are main idea, detail, inference, or application questions.
- Read just the labels, the axes, rows, and columns, not every bit of information in a chart. Notice trends, groupings, processes, and sequences, and then move on.
- Don’t get lost in numbers, scientific jargon, and details. Only a handful of details will be asked about in the questions. Lengthy math calculations will not be necessary.
PART III
MASTER ACT ASSESSMENT
SUBJECT REVIEWS

CHAPTER 8  English Review

CHAPTER 9  Math Review

CHAPTER 10  Reading Review

CHAPTER 11  Science Reasoning Review
OVERVIEW

- Master the use of verbs
- Learn what you need to know about modifying phrases
- Learn the proper use of pronouns
- Review the use of connecting clauses
- Review the rules of punctuation
- Master the rules of grammar, logic, and idioms
- Learn to identify and eliminate wordiness
- Learn to write an effective essay
- Practice grammar and punctuation skills
- Practice with essay prompts
- Evaluate your skills and options for further study

MASTERING VERBS

A verb is a word that shows action or a state of being. It tells what someone or something is or does. Every sentence has at least one verb; grammatically, there is no sentence if a group of words has no verb in the main clause. The “doer” of the action—the “someone or something” that “does or is” the verb—is called the subject of the verb.

Example: An assassin killed President Lincoln.

In this sentence, killed is the verb, the word that shows action, and assassin is the subject, the doer of the action.

Example: Howard is a landscape architect.

In this sentence, is is the verb, the word that shows a state of being, and Howard is the subject, the doer of the verb.

In the following sections, you learn the key rules regarding verbs covered in the ACT Assessment English Test.

A Verb Must Agree with Its Subject in Number

In a correct sentence, the verb and subject must agree in number; here, number refers to whether the verb and its subject are singular or plural. A singular subject and verb refer to one person or thing; a plural subject and verb refer to more than one. The number of the subject must match the number of the verb: If the subject is singular, the verb must be singular; if the subject is plural, the verb must be plural.
You can often “hear” an error in number, as in “Howard are a landscape architect” (this sentence combines a singular subject with a plural verb). It would also be wrong to write, “People was very upset by Diana’s death” (a plural subject with a singular verb). In these two examples, the error in subject-verb agreement is easy to spot.

In some sentences, however, it’s not as easy.

Example: Among those who played a crucial role in the Northern victory at Gettysburg were Joshua Chamberlain, a Union colonel from Maine who later enjoyed a distinguished career as an educator and politician.

The verb in the main clause of the sentence (in this example, the clause that appears first) is *were*. The simplest way to find the subject is to ask, “Who or what were?” The answer is *Joshua Chamberlain*. Now ask if the subject is singular or plural. The subject here is singular, since Joshua Chamberlain was one person. Therefore, a singular verb is needed: *were* should be changed to *was*.

The following list reviews some special situations in subject-verb agreement:

- **Collective nouns take a singular verb.** A collective noun is a noun that names a group of people or things, words like *team, group, club, class, family, collection, bunch, platoon, and organization*. Even names of institutions like *Harvard University, IBM, and the U.S. Senate* may be considered collective nouns, because each refers to a large number of individuals.

- **Pronouns ending in -one, -body, and -thing take a singular verb.** These are called indefinite pronouns. There are twelve of them: *someone, anyone, no one, everyone, somebody, anybody, nobody, everybody, something, nothing, anything, and everything*. Although *everybody* and *everyone* refer to all people within a group, the words refer to each person of the group individually.

- **The SANAM pronouns—some, any, none, all, and most—may be either singular or plural, depending on the sentence.** In determining agreement, you usually ignore prepositional phrases that appear between the subject and the verb. A group of pronouns known by their initials (SANAM) is the exception. These pronouns may be either singular or plural, depending on how they are used in the sentence. Often the way to determine their use is to see if a prepositional phrase follows the pronoun.

  Example: If most of the reporters are here, we’ll begin the press conference.

  In this sentence, the SANAM pronoun *most* is followed by the prepositional phrase *of the reporters*. To decide whether *most* is singular or plural, you have to look at the object of the preposition *of*. Because that object is the plural noun *reporters*, the pronoun *most* is plural and the plural verb *are* is used.

  By contrast: If most of the cake is gone, I’ll throw it out.

  In this case, the object of the preposition *of* is the singular word *cake*. Therefore, the pronoun *most* is singular, and the singular verb *is* is used.
The Tense of the Verb Must Accurately Show the Sequence of Events

The tense of the verb shows the time of one event or the sequence of several events. There are six main tenses in English. Past, present, and future tenses (studied, study, will study) are the simplest to understand and usually refer to the time of one event. Past perfect, present perfect, and future perfect tenses (had studied, have studied, will have studied) show sequence. Most ACT Assessment English questions on tenses involve sequence: What is the order in which things happened?

The perfect tenses describe events occurring before other events. For example, an event described in the past perfect tense is one that happened before an event in the past tense happened:

Before she took the ACT Assessment English Test, she had studied for six weeks.

An event described in the present perfect tense is one that both happened before in the past and continues to happen up to the present:

He has studied ACT Assessment Math problems every day for an hour.

Though rarely used, there is also the future perfect tense. An event in the future perfect is one that will happen before another future event:

I will take the ACT Assessment next weekend; by then, I will have studied a total of 47 hours.

On ACT Assessment questions about tense, a sentence or paragraph will describe two or more events occurring in a particular, unmistakable order.

Example: Lincoln announced his controversial Emancipation Proclamation, which declared all slaves held in rebel territory free, only after the North had won a significant military victory.

There are two events in this sentence: Lincoln’s announcement of the Emancipation Proclamation and the North’s winning a significant military victory. What is the time sequence of these two events? The sentence makes it obvious: Lincoln announced the Proclamation in the past, and the North’s victory occurred before that. Therefore, the announcement is in the past tense (Lincoln announced) and the victory is correctly in the past perfect tense (only after the North had won).
Always Use the Past Participle of a Verb with the Helping Verb to Have

In the preceding examples, you might have noticed that the past perfect, present perfect, and future perfect tenses all contain forms of the verb *to have*. When used to create tenses of other verbs, the verb *to have* is called an *auxiliary verb*, or, more casually, a *helping verb*.

The rule to remember is that, when you are using *to have* as an auxiliary, you must be careful to use the proper form of the basic verb. The proper form is called the *past participle*. This is one of the three principal parts of any verb. The other two parts are the *infinitive* and the *past*. The infinitive is the “to” form of the verb—*to laugh*, *to type*, *to work*. The past is the same as the simple past tense. The past participle is the part of the verb used with a form of *to have* to create the perfect tenses.

How is that part created? This is where complications—and ACT Assessment English questions—come in.

Most English verbs form both the past and the past participle the same way: by adding *-d* or *-ed* to the infinitive. Because there is no change between the past and the past participle, these verbs are called *regular* verbs. As an example, the following table gives the parts of three regular verbs.

**EXAMPLES OF REGULAR VERBS**

<table>
<thead>
<tr>
<th>Part</th>
<th>Example</th>
<th>Example</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infinitive</td>
<td>to laugh</td>
<td>to squeeze</td>
<td>to consider</td>
</tr>
<tr>
<td>Past</td>
<td>laughed</td>
<td>squeezed</td>
<td>considered</td>
</tr>
<tr>
<td>Past Participle</td>
<td>laughed</td>
<td>squeezed</td>
<td>considered</td>
</tr>
</tbody>
</table>

However, many verbs form their past differently from adding *-d* or *-ed* to the infinitive. What’s more, many of these verbs change again for the past participle. Because there is such irregularity between the three parts, these verbs are called *irregular* verbs. The following table gives examples of the parts of three irregular verbs.

**EXAMPLES OF IRREGULAR VERBS**

<table>
<thead>
<tr>
<th>Part</th>
<th>Example</th>
<th>Example</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infinitive</td>
<td>to fly</td>
<td>to go</td>
<td>to eat</td>
</tr>
<tr>
<td>Past</td>
<td>flew</td>
<td>went</td>
<td>ate</td>
</tr>
<tr>
<td>Past Participle</td>
<td>flown</td>
<td>gone</td>
<td>eaten</td>
</tr>
</tbody>
</table>

A common error with irregular verbs is to confuse the past and past participle forms, thus using the past tense where the past participle is needed.
Example: By the time Lindbergh’s little plane landed on an airfield outside Paris, the exhausted pilot had flew single-handedly for more than 30 hours without a break.

Because the past perfect tense is being used here, the past participle should be used; the verb should be had flown rather than had flew.

**MASTERING MODIFYING PHRASES**

A *modifying phrase* is a group of words that works as a unit to modify—describe or give more information about—something else in the sentence. Both adjectives and adverbs are considered modifiers; both modify—describe or give more information about—other words in the sentence. Thus, modifying phrases are groups of words that act as adjectives or adverbs. Some modifying phrases work as adjectives and modify nouns or pronouns. Others work as adverbs and modify verbs, adjectives, or adverbs.

*Example:* Six inches of her hair strewn on the beauty parlor’s floor, Paula nervously glanced at her reflection in the mirror.

The phrase *Six inches of her hair strewn on the beauty parlor floor* works as an adjective; it modifies the noun *Paula*.

*Example:* After six o’clock, buses stop here once a hour.

The phrase *After six o’clock* acts as an adverb, modifying the verb *stop* by telling *when* the buses stop. Both phrases are modifying phrases.

To do your best on the ACT Assessment English Test, read through and familiarize yourself with the rules regarding modifying phrases, as discussed in the sections that follow.

**A Modifying Phrase Must Modify a Word or Phrase in the Same Sentence**

The word or phrase being modified—the person or thing being described—must be in the same sentence as the modifying phrase. If no such word or phrase appears in the same sentence, the modifying phrase is called a dangling modifier.

*Example:* Dismayed by the news that a top executive had suddenly accepted a job with a competitor, the price of the company’s stock fell sharply the next day.

In this example, *Dismayed by the news that a top executive had suddenly accepted a job with a competitor* is a modifying phrase, intended to describe or give more information. But information about whom or what? Who or what, exactly, was dismayed by the news? Although we understand that it was Wall Street that was dismayed or stockholders who
were dismayed, neither appears in the sentence itself. In fact, as written, the sentence states that the prices were dismayed. The modifying phrase “dangles”; there is no word or phrase to which it actually refers.

To be correct, the sentence would have to be rewritten to name the person or people who were dismayed. One possible way to rewrite the sentence would be

Dismayed by the news that a top executive had suddenly accepted a job with a competitor, stockholders sold off huge chunks of holdings and drove the stock’s price down sharply. Now the modifying phrase has a clear referent, naming the people it modifies.

**A Modifying Phrase Must Be Next to What It Modifies**

A dangling modifier lacks something clear to modify. A misplaced modifier has something in the sentence to modify, but the two are separated in such a way that the modifier ends up describing the wrong person or thing.

*Example:* A fabled center of monastic life during the Middle Ages, each summer thousands of visitors travel to the island of Iona near the coast of Ireland.

*A fabled center of monastic life during the Middle Ages* is supposed to modify the island of Iona, because that’s what it describes. However, the modifying phrase is misplaced. Rather than being next to what it modifies, the modifying phrase precedes the words *each summer* and *thousands of visitors*, almost as if either of these were the fabled center. . . . One possible way to rewrite the sentence would be as follows:  

*A fabled center of monastic life during the Middle Ages, the island of Iona near the coast of Ireland is visited by thousands of travelers each summer.*

**MASTERING ADJECTIVES AND ADVERBS**

Adjectives modify (describe or give more information about) nouns or pronouns. Adjectives answer such questions as *what kind?*, *how many?*, or *which one?*

*Examples:* the blue dress, a moving object, a few days

Adverbs modify verbs, adjectives, or other adverbs. Adverbs answer such questions as *how?*, *when?*, *where?*, *in what way?*, or *how often?*

*Examples:* he ran quickly, she quietly closed the door, the phone rang repeatedly

The following sections discuss the basic rules for using adjectives and adverbs—information that will help you do your best on the ACT Assessment English Test.
An Adjective Cannot Be Used in Place of an Adverb

A common mistake is to use an adjective where an adverb is needed, or vice versa.

Example: In the 90s, albums by Pearl Jam appeared consistent on the charts even without the exposure of music videos.

The word consistent is an adjective; it could be used to modify a noun (a consistent success) or a pronoun (she is consistent in her habits). However, in this sentence, an adverb is called for, because the word modified is the verb appear. The author wants to answer the question how often did Pearl Jam albums appear on the charts? To answer this question, an adverb is needed. As in many cases, the adverb here is formed by adding -ly to the adjective. The sentence can then easily be corrected by changing consistent to consistently.

Use a Comparative Adjective or Adverb to Compare Two Things; Use a Superlative for Three or More

To compare two things, the “comparative” form of the adjective is used. The usual way to create the comparative form is to add -er to the adjective. To compare more than two things, the “superlative” form of the adjective is used. The usual way to create the superlative is to add -est to the adjective.

Examples:

(Adjective) I am tall.

(Comparative Adjective) I am taller than my sister.

(Superlative Adjective) But my brother David is the tallest in the family.

When an adjective has three or more syllables, adding yet another syllable makes it awkward. In this case the comparative is created by adding the separate word more in front of the adjective and the superlative by adding the word most.

Example: Keri is beautiful. Neve is more beautiful. Sarah Michelle Gellar is the most beautiful woman in the galaxy.

Often a writer becomes confused about whether to use the comparative or superlative form of the adjective. Just a few differences in words can change which form is called for. For example, the following two sentences say the same thing, yet each correctly uses a different form of the adjective:

Of the many strange creatures that inhabit the continent of Australia, the wallaby is more unusual than any other.

Of the many strange creatures that inhabit the continent of Australia, the wallaby is the most unusual.
In the first example, the comparative form is correct because the sentence is literally comparing the wallaby to every other creature, one at a time. Thus at any one time, only two animals are being compared.

In the second example, the superlative form is correct because the wallaby is being compared to all other creatures at once.

Comparative and superlative forms of adverbs are used in much the same way. The comparative form (made with the word *more*) is used when two things are being compared; the superlative form (made with *most*) is used when three or more things are being compared.

*Example:* Jerry swims *quickly*. Paula swims *more quickly* than Jerry. But Karen swims *most quickly* of anyone on the swim team.

**Do Not Confuse the Adjective Good, the Adverb Well, and the Adjective Well**

This trio of words can be confusing, and because they are used quite often, it’s important to get the differences straight. *Good* is an adjective with a broadly positive meaning. *Well* is the adverb form of good; it means, in effect, “in a good way.” But *well* can also be an adjective meaning “healthy” or “the opposite of ill.” Here is an example of each:

- The singing in this high school production sounds as *good* [adjective] as if performed by professionals.
- Carrie, the understudy, sings especially *well* [adverb, that is, she sings *in a good way*].
- She will have the opportunity to play the lead if Irene does not feel *well* tonight [adjective that equals *healthy*].

**MASTERING PRONOUNS**

A *pronoun* refers to and takes the place of a noun. Instead of saying “*Laura* said that *Laura* was planning to go with *Laura’s* friends to Times Square on New Year’s Eve,” you’d want to use the pronouns *she* and *her* rather than repeating the word *Laura* so often. *Laura* said that *she* was planning to go with *her* friends to Times Square on New Year’s Eve. The noun that the pronoun refers to is called its *antecedent*. In this example, the noun *Laura* is the antecedent of the pronouns *she* and *her*.

The following sections outline the “rules” of pronouns and antecedents that you’ll need to learn for the ACT Assessment English Test.
A Pronoun Must Have a Clear and Logical Antecedent

A common problem is when the reader can’t easily tell who or what the antecedent is supposed to be.

Example: Although the hospital administrators interviewed many staff members about the repeated cases of staph infections, they had no explanation for the puzzling pattern of outbreaks.

The second half of this sentence starts with the pronoun they. It’s impossible to tell from the context who they are. From a strictly grammatical point of view, the antecedent should be staff members as the noun closest to the pronoun; however, logically, the antecedent should be hospital administrators. If that was what was meant, the sentence should be rewritten. One possible revision is:

Although they interviewed many staff members about the repeated cases of staph infections, the hospital administrators had no explanation for the puzzling pattern of outbreaks.

Now it is unmistakable who is doing what.

A Pronoun Must Agree with Its Antecedent in Number

Just like a subject and a verb, a pronoun and its antecedent must agree in number. If the antecedent is single, the pronoun must also be single; if the antecedent is plural, the pronoun must also be plural.

This is an example of a common mistake in pronoun-antecedent agreement:

A member of the tour group should have their tickets by the end of this week.

Who or what does the pronoun their refer to? That is, what is the pronoun’s antecedent? Member is the answer, yet member is singular while their is plural. The pronoun does not agree with the noun in number and is therefore incorrect. To correct the sentence, their must be changed to a singular pronoun—he or she. The sentence could also be corrected by changing the noun to a plural form; for example, Members of the tour group should have their tickets . . . .

Use Second- and Third-Person Pronouns Consistently

The three “persons” in grammar refer to first person (I, me, we, etc.), second person (you), and third person (he, she, it, they, etc.). In sentences discussing an indefinite person, English allows either second-person or third-person constructions to be used. A common mistake is to mix the persons and use them inconsistently.

In casual conversation, people often use plural pronouns like they, them, and their to include both genders—while at the same time avoiding awkward constructions such as his or her or s/he. However, although the language is indeed changing in this regard, pairing a plural pronoun with a singular noun is still considered grammatically incorrect by most teachers, editors, and other authorities—including the ACT Assessment test-makers. On ACT Assessment English questions, check pronouns for proper agreement with their antecedents.
Example: If one lives in the northern hemisphere, on most clear winter nights you can easily see the three stars in a row that mark the belt of the hunter in the constellation Orion.

The sentence is describing how an indefinite person, meaning someone or anyone, can see Orion’s belt in the winter sky. The sentence starts by using the indefinite third-person pronoun one. (Other such words that could have been used include the pronouns someone and anyone and expressions like a person or an observer.) However, the sentence shifts in midstream to the second person: you can easily see . . .

To correct the mistake, the sentence should maintain the third person throughout. Or it might use the second person, as long as that, too, is used throughout the entire sentence.

MASTERING CONNECTING CLAUSES

Clauses are groups of words that contain both a subject and a verb. A clause is called a main or independent clause if it can stand alone as a complete sentence, if it expresses a complete thought. A clause is called a subordinate or dependent clause if it cannot stand alone as a complete sentence, if it does not express a complete thought.

Conjunctions are connecting words: They connect words, phrases, or clauses. Coordinating conjunctions connect words, phrases, or clauses that are equal in grammatical importance. Subordinating conjunctions are used mainly to connect clauses. The clause introduced by a subordinating conjunction is a dependent clause. It is less important than a clause without such a conjunction; also its meaning is dependent on the other clause. Therefore, a dependent clause can’t stand alone as a sentence.

The coordinating conjunctions are and, or, for, nor, but, and yet. Subordinating conjunctions are because, although, after, if, when, while, since, until, before, as soon as, unless, and though.

Here are a few examples of dependent clauses introduced by subordinating conjunctions:

although it had begun to rain
when the plumber arrived
because the bicycle was broken

None of the above dependent clauses is a complete thought; none can stand alone. Each needs to be connected to something else to complete the thought. Grammatically, the “something else” is an independent clause. Here are the same dependent clauses connected to an independent clause:

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They stayed on the beach although it had begun to rain.
She locked the dog in the cellar when the plumber arrived.
Because the bicycle was broken, he walked to school.

The following sections discuss the connecting-clauses rules covered by the ACT Assessment English Test.

**The Conjunction Between Clauses Must Be Logical**

Each conjunction, of course, has its own meaning and cannot be used interchangeably. A test question might ask whether you recognize the proper, logical conjunction to connect two particular clauses. The answer depends on the meaning of the conjunction and whether it fits the context or not.

*Example:* The city had fallen into ruins, and fortune-seekers from the countryside continued to pour in.

Here, two independent clauses have been joined by the coordinating conjunction *and*. Should they be? Actually the two clauses are opposed in meaning rather than complementary: *despite the fact* that the city was in ruins, fortune-seekers from the countryside continued to pour in. Given this near-contradiction, the conjunction *and* is not the best choice. Instead, *but* should be used. This more logically fits the opposition in meaning between the two clauses.

**Use a Semicolon (;) to Connect Two Independent Clauses**

Instead of using a conjunction, independent clauses may also be connected using a semicolon (*;*).

*Example:* I have never needed to study more in my life; I have never been more tired.

Both clauses are independent, and both express a complete thought; therefore, a semicolon may be used. If the sentence instead were *I have never needed to study more in my life; because tomorrow’s test affects my whole future*, the use of a semicolon would be wrong. The second part of the sentence is a dependent clause, introduced by the subordinating conjunction *because*. The semicolon should be omitted.

**Avoid Run-on Sentences**

A run-on sentence isn’t necessarily a particularly long sentence. It might also be a sentence in which two (or more) independent clauses are incorrectly connected by being put in the same sentence without either a semicolon or a coordinating conjunction to join them properly.
Example: In addition to being a writer and lecturer, Mark Twain fancied himself an entrepreneur, he made and lost several fortunes backing various business ventures.

If this sentence were divided into two sentences after the word entrepreneur, either half could stand alone as a sentence. Therefore, it’s a run-on sentence. Two possible corrections are to break it into two sentences or to change the comma into a semicolon.

Avoid Sentence Fragments

A sentence fragment is a collection of words that is punctuated as a sentence but that cannot properly stand alone as a sentence. Some sentence fragments lack either a subject or a verb. More often, the sentence fragment has both a subject and a verb, but it is a dependent rather than an independent clause. This usually happens because the clause begins either with a subordinating conjunction or with a type of pronoun called a relative pronoun, which also makes the clause dependent on another clause.

Example: Carbon dating can be used in estimating the age of materials that are of organic origin only. Because the method is based on the predictable decay of carbon-based organic compounds.

The second collection of words, although punctuated as a sentence, is a fragment rather than a true sentence. It contains a subject and a verb, but it is introduced by a subordinating conjunction—the word because. The clause read alone is not a complete thought. To correct this particular fragment, either delete the period and unite this with the previous sentence or drop the word because.

MASTERING PUNCTUATION

Punctuation is the collection of marks that helps turn a string of written words into meaningful thoughts. Speech has pauses and stops, rising and falling tones of voice, and emphasis and speed to connect or separate one word from another. The written word must rely on a written system to do the same thing.

Although there are dozens of ways that punctuation can be used and misused, the ACT Assessment English Test will cover the rules discussed in the following sections.

Use a Colon (:) to Introduce a List or a Restatement

As explained in a previous section, the semicolon is used primarily to separate two independent clauses. The colon cannot be used as an alternative to the semicolon. Instead, the colon should be used to introduce a list or a restatement.

Example: For my term paper, I decided to write about hidden meanings in Nirvana’s album *Nevermind*: references to Cobain’s impending suicide, references to his wife, Courtney Love, and references to major influences in his career.

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The colon is used correctly here. It alerts the reader to the fact that a list is about to be presented. However, if a list is the object of a verb or a preposition, do not use a colon before the list.

Example: For my term paper, I decided to write about hidden meanings in Nirvana’s album *Nevermind*, including references to Cobain’s impending suicide, references to his wife Courtney Love, and references to major influences in his career.

Here’s an example of a colon used to introduce a restatement:

Barbara was named valedictorian for one reason: her exceptional academic achievement.

What follows the colon “restates” what precedes it; the words “her exceptional academic achievement” name the “one reason” mentioned before the colon.

**Use Commas to Separate Items in a List of Three or More Words**

When three or more words, phrases, or clauses are presented in sequence, they should be separated by commas. Here are examples of each. First, look at this example of sequential words:

The Galapagos Islands boast some of the world’s most unusual plants, birds, mammals, reptiles, and fish.

Here is an example of sequential phrases:

We looked for the missing gloves under the sofa, in the closet, and behind the dresser, but we never found them.

Finally, here is an example of sequential clauses:

I studied my ACT Assessment English, I studied my ACT Assessment Math, I studied my ACT Assessment Science Reasoning, and I took aspirin for my headache.

**Use a Pair of Commas to Set Off a Parenthetical Phrase**

A parenthetical phrase is an “interrupter”; it breaks into the flow of the main idea of the sentence, adding one or a few words in a convenient spot and then returning to the main idea. Although parenthetical phrases may literally be set off by parentheses (as this one is), they may also be set off from the rest of the sentence by a pair of commas. If the parenthetical phrase appears at the beginning or end of the sentence, only one comma is needed.
Some parenthetical phrases are frequently used: *for example, as you can see, that is, as I said before,* and so on. Whenever a phrase like this is used, it should be separated from the rest of the sentence by commas.

*Example:* Not all men like cars; my uncle, for example, never learned to drive and can’t tell a Porsche from a Volkswagen.

Another type of parenthetical phrase is an *appositive,* which names or describes a noun.

*Example:* Sandy Koufax, the great left-handed Dodger pitcher, was Jack's idol during his teenage years.

**Don’t Use Commas to Separate Sentence Elements That Naturally Belong Together**

Commas should not separate parts of the sentence that are naturally joined, like subject and verb, verb and object, verb and complement, and preposition and object.

*Example:* The nineteenth-century explorers Lewis and Clark may be, two of America’s most-admired historical figures.

Another common mistake of this kind is the use of a comma to set off the beginning of a parenthetical phrase but the omission of the second comma to “close off” the phrase.

*Example:* I was surprised to find out that Christine, my girlfriend from freshman year had moved back to town.

Thus, the use of only one comma ends up separating the subject *Christine* from the verb *had moved.*

**Use the Apostrophe (’)* Correctly When Forming a Possessive or a Contraction**

The apostrophe is used for two purposes in English, both of which are frequently tested on the ACT Assessment. The first use is to show possession, ownership, or some other close connection between a noun or pronoun and what follows it (“Susan’s car,” “the company’s employees”). Form the possessive as follows:

- For a singular noun, add ’s (the *dog’s* collar).
- For a plural noun that ends in *s,* add an apostrophe (the *Jones’* apartment).
- For a plural noun that does not end in *s,* add ’s (the *children’s* teacher).
- For possessive pronouns, add nothing (*his,* *hers,* *ours,* etc.).

The apostrophe is also used in a contraction, two or more words from which letters have been removed, shortening the words into one. The apostrophe is usually inserted in
place of the letters omitted. If in doubt, mentally “expand” the contraction to determine which letters have been left out; this is often a useful guide to where the apostrophe belongs.

*Examples:*

we’ve got to go = we have got to go
I’d rather not = I would rather not
she won’t mind = she will not mind
it’s your turn = it is your turn
you’re welcome = you are welcome

**MASTERING GRAMMAR AND LOGIC**

Although the rules of grammar might sometimes seem arbitrary, they actually follow strict patterns of logic. It’s like trying to compare apples and oranges. It really can’t be done. One function of grammar is to establish rules so that oranges are compared to oranges and apples are compared to apples. This is logical, consistent thinking.

The following sections discuss the rules regarding grammar and logic that are covered on the ACT Assessment English Test.

**Items in a List Must Be Grammatically Parallel**

In geometry, parallel lines run in the same direction. In grammar, the rule of parallelism requires that every word, phrase, or clause in a list be constructed in the same way.

*Example:* Representatives to the student senate were asked to pursue often contradictory goals: boosting student acceptance of more homework, developing explanations for adding 2 hours to the length of each school day, and the reduction of rampant poor morale.

The sentence lists three goals of the student senate representatives. The first two are written in parallel form—that is, in phrases that begin with *gerunds* (-ing verbs). However, the third goal is written in a different grammatical form. Instead of a beginning with a gerund, the phrase begins with a noun. To correct the sentence, the third item should be revised to match the other two by starting with a gerund: “... and reducing the rampant poor morale.”

**Two Things Being Compared Must Be Grammatically Parallel**

Like items in a list, items that are being compared to one another in a sentence also need to be grammatically parallel.
Example: Because of advertising costs, to run for Congress today costs more than running for governor twenty years ago.

The costs of two kinds of political campaigns are being compared: a race for Congress today and a race for governor twenty years ago. As written, the sentence uses two different grammatical constructions to describe the races:

- *to run for Congress today* (infinitive)
- *running for governor twenty years ago* (gerund)

Either choice is correct, but using both in the same sentence is inconsistent. Correct the problem by using an infinitive in both phrases (“*to run for Congress today costs more than to run for governor*”) or by using a gerund in both phrases (“*running for Congress today costs more than running for governor*”).

**MASTERING THE USE OF IDIOMS**

After so much emphasis on logic and consistency, it seems totally illogical that idioms play such a large part in the proper use of English. An idiom, after all, is a phrase that’s peculiar to a particular language and that often has no logic or rule behind its use. “That’s just the way you say it” is what we tell non-native speakers. Yet despite this lack of logic, the improper use of an idiom is considered a grammatical mistake.

Because there may be no rule attached to the use of particular idioms, listen for the way you expect the idiom to be used, the way you’ve heard it used in countless conversations and lectures.

The following sections cover the rules governing idioms that are covered in the ACT Assessment English Test.

**When Idiomatic Paired Phrases Are Used, Always Complete the Idiom**

Certain idiomatic pairs of phrases must always be used together. When they aren’t, the resulting sentence “sounds wrong,” as if something is missing.

Example: She claims her poor performance on the stage was caused as much by poor direction than by her own stage fright.

This sentence “sounds” incorrect because the idiom demands that the phrase *as much by X* always be followed by *as by Y*. It’s incorrect to use the word *than* where the second *as* should be.
Another idiomatic pair that must always be used together is the more X . . . the more Y.
For example:

The more things change, the more they stay the same.

More and more are often replaced by other comparatives:

The bigger they are, the harder they fall.

The deeper the pocket, the tighter the purse strings.

The stronger the brew, the better the coffee.

Use the Right Idiomatic Preposition

A variation on paired idiomatic phrases is paired idiomatic words; that is, one word is always followed by another. This happens most frequently—and most confusingly, it seems—with prepositions. Certain words always take a certain preposition. For example, one may look at, look in, look through, etc. However, one always disagrees with rather than disagrees against, or has scorn for rather than scorn at.

Example: The quarterback assured the waterboy that he had no intention to encroach on the latter's interest in the captain of the cheerleaders.

According to idiomatic usage, the word intention should be followed by the preposition of, so the preposition must be changed to the correct one. Because the preposition of, like all prepositions, must have an object, and the object must be a noun or pronoun, the verb encroach must also be changed to a noun form—the gerund (the -ing construction) encroaching. The fully corrected sentence then reads as follows:

The quarterback assured the waterboy that he had no intention of encroaching on the latter's interest in the captain of the cheerleaders.

Encroach on rather than encroach against—yet another idiom. The list goes on and on. Even native speakers can find these constructions difficult; non-native speakers must think that all idioms were invented at a drunken New Year’s Eve party; that’s how much sense they make.

The only proven advice is to “listen” carefully as you read test questions. If a preposition on the ACT Assessment sounds “funny,” scan the answer choices to see whether the answers include a change in the preposition. If you spot another preposition that sounds better, choose it.
LEARN TO DISTINGUISH BETWEEN EASILY CONFUSED WORDS

In casual speech, so many people confuse two different words that the “incorrect” one can be mistaken for the grammatically correct one, even in more formal writing. Look over these examples and be sure to choose the right one on the ACT Assessment Test:

EXAMPLES OF EASILY CONFUSED WORDS

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition or Distinguishing Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>likely</td>
<td>definition: probably destined to happen</td>
</tr>
<tr>
<td>liable</td>
<td>definition: legally responsible</td>
</tr>
<tr>
<td>like</td>
<td>function: a preposition that must take an object; cannot be used as a conjunction, as in the <em>He fixed it like he said he would</em>—incorrect</td>
</tr>
<tr>
<td>as</td>
<td>function: a subordinating conjunction, as in <em>He fixed it as he said he would</em>—correct</td>
</tr>
<tr>
<td>much</td>
<td>definition: a large quantity that can’t be counted, as in <em>so much blood, so much sand, so much dissatisfaction</em></td>
</tr>
<tr>
<td>many</td>
<td>definition: a large quantity that can be counted, as in <em>so many pints of blood, so many grains of sand, so many demonstrations of dissatisfaction</em></td>
</tr>
<tr>
<td>less</td>
<td>definition: a decrease that can’t be counted, as in <em>less busy than yesterday</em></td>
</tr>
<tr>
<td>fewer</td>
<td>definition: a decrease that can be counted, as in <em>interrupted fewer times than yesterday</em></td>
</tr>
<tr>
<td>affect</td>
<td>when used as a verb, meaning to influence or to move emotionally</td>
</tr>
<tr>
<td>affect</td>
<td>when used as a noun, meaning a feeling or an emotion</td>
</tr>
<tr>
<td>effect</td>
<td>when used as a verb, meaning to bring about</td>
</tr>
<tr>
<td>effect</td>
<td>when used as a noun, meaning result or consequence</td>
</tr>
<tr>
<td>if</td>
<td>indicates a condition or uncertainty</td>
</tr>
<tr>
<td>whether</td>
<td>indicates a choice</td>
</tr>
<tr>
<td>last</td>
<td>the final item in a series; indicates position</td>
</tr>
<tr>
<td>latest</td>
<td>the most recent; indicates time</td>
</tr>
</tbody>
</table>

MASTER THE ABILITY TO IDENTIFY WORDINESS

The best writing is usually the most concise writing. This is especially true in nonfiction when style and embellishment take second place to the clearest presentation of information. Wordiness can occur in several ways, and you’ll want to be alert for each. The following sections discuss the things you’ll need to know about eliminating wordiness when you take the ACT Assessment English Test.

Avoid Verbosity

Verbosity is the use of too many words. Their construction might be grammatically correct; there are simply too many words. Verbosity on the ACT Assessment Test will be fairly obvious, even exaggerated. An example used in an earlier chapter is worth repeating here:
As I previously mentioned to you when explaining at last week’s meeting the incredible and undisputed advantages of combining our two clubs, *The Poetry Society and Poets Out of the Closet*, I have written up here for your further study my thoughts on the matter, detailing the many benefits that will accrue to both organizations.

There’s nothing “mechanically” wrong with this sentence. It’s a complete sentence and not a fragment; the subjects and verbs within the clauses agree with each other; the punctuation is correct. However, it would be much clearer to write:

At last week’s meeting, I said there were benefits to combining our two clubs.

Here’s a note repeating why.

**Avoid Changing the Meaning When Editing**

Every long sentence is not necessarily verbose. When editing, be sure not to butcher the original style. Even more importantly, editing should not result in a shorter piece of writing that is confusing or that even changes the meaning of the original. Compare the three versions below:

Spielberg’s *Amistad* is the filmmaker’s second attempt to show that someone who is an unexcelled creator of funny, fast-paced action movies can also be a producer of films that try to deal in a serious fashion with weighty historical and moral themes. (42 words)

Spielberg’s *Amistad* is the filmmaker’s second attempt at dealing in a serious fashion with weighty historical and moral themes. (19 words)

Spielberg’s *Amistad* is the filmmaker’s second attempt to show that an unexcelled creator of funny, fast-paced action movies can also produce films dealing seriously with weighty historical and moral themes. (30 words)

Although the second version is less than half the length of the original, it loses the original meaning: the contrast between the two types of movies that Spielberg makes. The third version, being only 29 percent shorter, retains the meaning while expressing it more economically.

**Avoid Redundancy**

Repetition in writing sometimes serves a purpose: it might be intended style, or it might be deliberate emphasis. Needless repetition is called redundancy.

*Example:* He is taller in height than I am.

Is there a way to be taller other than height? *in height* can be deleted.

As much as 125 years ago, the science fiction writer Jules Verne wrote predictions that foretold the future existence of such modern mechanical devices as the airplane, the submarine, and even the fax machine.
We’re told that Jules Verne wrote “predictions that foretold the future existence” of many things. Because foretold and future existence are contained within the meaning of predictions, both can be deleted.

Avoid the Passive Voice When Possible

When the subject of the verb is the doer of the action, a sentence is said to be in active voice: Sharon built the birdhouse. When the subject of the verb receives the action, a sentence is said to be in passive voice: The birdhouse was built by Sharon.

Although passive voice is sometimes appropriate, for example, when the “doer” isn’t known (Our house was vandalized while we were away), active voice is preferable. It is not only shorter, it is more concise and vigorous.

Example: When the basic elements of the theory of natural selection were conceived by Darwin, it was unknown to him that most of the same ideas had already been developed by a rival naturalist, Charles Russel Wallace. (36 words)

Here’s how the improved sentence reads when active verbs are used instead:

When Darwin conceived the basic elements of the theory of natural selection, he didn’t know that rival naturalist Charles Russel Wallace had already developed most of the same ideas. (29 words)

Unless there is a good reason to prefer the passive voice in a particular sentence, choose the active instead.

WRITING A HIGH-SCORING ESSAY

Prompts used for the ACT Assessment Writing test will:
• Center on a topic important to students in high school
• Require you to take a stand on the issue
• Use facts, details, and examples to support your stand

Overall Essay Guidelines

No matter what topic you are given to write on for the ACT Assessment Writing Test, you will use the same writing and thinking skills. The following suggestions can help you do your very best.

1. Rephrase the question in your own words.

Before you start writing, be certain that you understand the topic and your task. The easiest way to make sure that you understand the question is to rephrase it. Here’s a model:

Prompt: Fast-food franchises are installing outlets in some high schools, selling hamburgers, fried chicken, tacos, fries, and sodas. Many soda companies already
pay a great deal of money to be allowed to install soda machines in high schools. The money from these commercial ventures helps fund “extras” such as athletic equipment, field trips, and audio-visual equipment. On the other hand, fast food is greatly contributing to the epidemic of obesity among America’s youth. Placing fast-food outlets in schools encourages students to eat food that is high in salt, fat, and empty calories. In your opinion, should fast-food franchises be allowed in high-schools?

Rephrasing: This question asks me to decide whether or not fast-food restaurants like McDonald’s and Burger King should be allowed to sell food in high schools.

2 Take a position on the issue.

No matter how well you write, your essay will not get credit if you do not take a position on the issue. If you grasp no other point from this chapter, make it this point: Take a position on the prompt that you are given. Here is an example, using the previous prompt:

Position: I think that fast-food restaurants should be allowed to sell food in high schools.

3 Support your stand on the issue with specific examples.

It is not enough to say that you believe in a certain point. Saying the same thing over and over in different ways won’t get you any points, either. Instead of empty air, give specific examples. Here is a model:

Position: I think that fast-food restaurants should be allowed to sell food in high schools.

Reasons:
1. Schools need the income.
2. Students like fast food, so they should be given the food they like.
3. Fast food does not have to be unhealthy. Fast-food restaurants offer healthy foods like salads, milk, and juice, for instance.

4 Plan your essay.

With only 30 minutes to write this part of the ACT Assessment, you don’t have time to see where your thoughts will take you. Instead, take a few minutes to write a simple outline. This will help you stay on track. In the following example, each Roman numeral stands for a paragraph.

Outline
I. Introduction
II. First main point
III. Second main point
IV. Third main point
V. Conclusion

Example
Your position on the issue
Schools need the income.
Students like fast food.
Fast food does not have to be unhealthy.
Restate your position and sum up.

Outlines are covered in depth later in this chapter.

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Use your time well.
Since you have only 30 minutes for your essay, consider spending your time this way:
- 2–3 minutes planning
- 20 minutes writing/revising
- 5–10 minutes editing/proofreading

Begin writing.
Most people start writing at the beginning with the introduction. What should you do if you can’t think of a good topic sentence? Don’t waste time staring off into space. Instead, start where you can, with the body paragraphs. The best ACT Assessment essay in the world won’t get you any points if you don’t get it down on paper within 30 minutes.

If you run out of things to say as you are writing, skip some lines and keep on going. If you can’t keep on writing, take a few deep breaths and gather your wits. Planning carefully can help you stay on track.

Consider your audience.
Always remember that you are writing for a very specific set of readers: ACT Assessment scorers. Do not write anything that will offend them. Offensive topics include racist, sexist, or bigoted comments. Resist the urge to rant and call names; always keep your tone mature and calm. This is especially important if you feel strongly about the topic. Your essay will be much more effective if you keep a professional tone, and you won’t run the risk of alienating your audience.

Write neatly.
If your writing cannot be read, your papers won’t be scored. If your writing is messy, with a lot of cross-outs, your scorer might misread a crucial point. If your handwriting is hard to read, be sure to print neatly and carefully. Make sure that your essay can be read.

Proofread.
No matter how rushed you are for time, always leave a few minutes to proofread your paper. A few minor errors in spelling, grammar, usage, or mechanics are not likely to impact your score seriously. However, if your paper is riddled with serious errors in sentence construction (fragments and run-ons), logic, and unity, you will lose a significant number of points. That’s because errors distract your readers and reduce the effectiveness of your arguments. As you proofread your paper, be as careful as you can to read what is really there, not what you think is there.

Overcome panic.
One of the best ways to deal with panic is to be well prepared. Take all the practice tests in this section of the book, writing the essays and going over them. If you know what to expect and have prepared as well as you can, you will be less likely to lose control during the real ACT Assessment Writing Test.
Always remember that scorers reward you for what you do well. They are not looking for perfection. After all, you have only 30 minutes in which to write your essay. Prepare thoroughly and do the very best you can.

**Writing a Persuasive Essay**

When you take a stand on an issue and support your position with details and examples, you are writing a persuasive essay. *Persuasive essays* argue a point. Your must agree or disagree with the writing prompt and give specific reasons to support your opinion. The ACT Assessment Writing Test requires you to write a persuasive essay.

There are several ways to arrange the information in a persuasive essay. Below are two ways that are especially well suited for the ACT Assessment Writing Test: the “cluster” method and the “point-by-point” method.

**The Cluster Method**

With this method, you deal with the main points in clusters, as follows:

- All of *their* side (the opposition)
- All of *your* side

Study this outline:

<table>
<thead>
<tr>
<th>Persuasive Essay Organized by the Cluster Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
</tr>
<tr>
<td>A. Topic sentence</td>
</tr>
<tr>
<td>B. Summary of opposition</td>
</tr>
<tr>
<td>C. Summary of your side</td>
</tr>
<tr>
<td>D. Lead-in sentence to the next paragraph</td>
</tr>
<tr>
<td>II. Opposition (one to two points)</td>
</tr>
<tr>
<td>A. Topic sentence</td>
</tr>
<tr>
<td>B. Point 1</td>
</tr>
<tr>
<td>C. Point 2</td>
</tr>
<tr>
<td>III. Your side of the argument (two to three points)</td>
</tr>
<tr>
<td>A. Topic sentence</td>
</tr>
<tr>
<td>B. Point 1</td>
</tr>
<tr>
<td>C. Point 2</td>
</tr>
<tr>
<td>D. Point 3</td>
</tr>
<tr>
<td>IV. Conclusion</td>
</tr>
<tr>
<td>A. Topic Sentence</td>
</tr>
<tr>
<td>B. Summarize the opposition</td>
</tr>
<tr>
<td>C. Summarize your side</td>
</tr>
<tr>
<td>D. Make your point</td>
</tr>
</tbody>
</table>
You briefly mention the opposition to show that:

- You understand there are two sides to the issue
- You are an intelligent thinker
- The opposition is not as valid as your opinion

Although you bring up the opposition, you do so only to make your point stronger. Your side of the argument is always more fully developed with details and examples than the opposing side. Be sure to save your strongest point for your side to persuade your readers that your point is deserving of more serious consideration.

Here is a model persuasive essay organized according to the “cluster” method. Follow the sidebars as you read to help you analyze the essay’s structure.

**Prompt:** Increasingly, many high schools are requiring students to attend school year-round. Parents, teachers, and taxpayers who advocate year-round high school argue that students learn more with extended hours. Further, students don’t lose information over the long summer break, necessitating at least two months of review in the fall. Other parents, teachers, and taxpayers do not support year-round schooling because they think students will “burn-out” from too much pressure. In your opinion, should high schools be in session year-round?

In your essay, take a position on this issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.

[1] Recently, there has been a lot of discussion over whether or not students should be required to attend high school year-round. [2] Year-round education helps students learn more and eliminates the need for extended review in autumn. [3] However, forcing students to attend high school year-round may increase the number of drop outs because students cannot deal with the pressure. [4] Let’s start by examining the advantages of year-round high school.

[5] There are several advantages to year-round high school. [6] For example, students will have more instructional time. Rather than attending school 180 days, as is the case now, students will be in classes at least 250 days, resulting in more study time. For example, students will be able to conduct longer chemistry experiments, spend more time in language labs, and drill math problems. [7] Having year-round high school also helps students retain what they learned because they won’t forget information over summer vacation. This way, teachers won’t have to spend most of September and October reviewing the previous year’s work.

[8] The disadvantages of year-round high school outweigh the advantages, however. [9] First, the extra learning that year-round high school provides comes at a very high price:
stress. High school classes are very demanding. Physics, chemistry, calculus, advanced foreign language, world literature, and economics require enormous concentration. Students must have a break from the pressures of these classes in order to recharge their batteries and let the information sink in. Students who burn out are more likely to drop out, which seriously limits their job prospects. Since there wouldn’t be any summer school with year-round high school, students wouldn’t be able to retake classes they failed, either. [10] Further, many high school students need summer vacation to work and earn money. This money is essential to pay for expenses such as cars, to save for college, and to help family members. Many summer jobs also provide invaluable experience in the world of work, which helps students decide which careers to pursue. During the summer, some families have the time to relax together, fishing, camping, and taking vacations. This time is educational as well as fun and builds family unity. [11] Finally, year-round high school is not economically viable. The increased costs of teachers’ salaries, utilities, and security services will strain most municipal budgets. School districts will also lose the income they get from renting the school buildings during the summer to camp programs.

[12] In conclusion, there are both advantages and disadvantages to year-round high school. [13] It seems likely that year-round high school will boost students’ knowledge and achievement. [14] However, year-round high school increases the stress that upsets many high school students. It also robs students of the chance to work during the summer and enjoy vacations and family time. Further, year-round high school does not make good economic sense. [15] For these reasons and others, students should not be forced to attend high school all year round.

The “Point-by-point” Method

With this method of organization, you deal with the main points one at a time, as follows:

- First main point
  The opposition
  Your side

- Second main point
  The opposition
  Your side

- Third main point
  The opposition
  Your side

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The following outline shows how to organize your essay through point-by-point method:

<table>
<thead>
<tr>
<th>Persuasive Essay Organized by the Point-by-Point Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
</tr>
<tr>
<td>A. Topic sentence</td>
</tr>
<tr>
<td>B. Summary of points to follow</td>
</tr>
<tr>
<td>C. Lead-in sentence to the next paragraph</td>
</tr>
<tr>
<td>II. First point</td>
</tr>
<tr>
<td>A. Topic sentence</td>
</tr>
<tr>
<td>B. Opposition</td>
</tr>
<tr>
<td>C. Your side</td>
</tr>
<tr>
<td>III. Second point</td>
</tr>
<tr>
<td>A. Topic sentence</td>
</tr>
<tr>
<td>B. Opposition</td>
</tr>
<tr>
<td>C. Your side</td>
</tr>
<tr>
<td>IV. Third point</td>
</tr>
<tr>
<td>A. Topic sentence</td>
</tr>
<tr>
<td>B. Opposition</td>
</tr>
<tr>
<td>C. Your side</td>
</tr>
<tr>
<td>V. Conclusion</td>
</tr>
<tr>
<td>A. Topic Sentence</td>
</tr>
<tr>
<td>B. Summarize the opposition</td>
</tr>
<tr>
<td>C. Summarize your side</td>
</tr>
<tr>
<td>D. Make your point</td>
</tr>
</tbody>
</table>

Here is the same essay that you read organized according to the “point-by-point” method. Follow the sidebars as you read to help you analyze the essay’s structure. As you read, decide which method of organization you prefer for this question and why.

[1] Should high school be in session all year round? [2] Supporters of year-round high schools argue that it helps students learn more and eliminates the need for extended review in autumn. [3] However, forcing students to attend high school year-round has many disadvantages, including an increase in the number of drop outs, a loss of income from summer jobs, and the end of summer family vacations. [4] Let’s start with the premise that holding high school year-round increases learning.

[5] Those who support year-round high school educations claim it will give students more instructional time, and that’s true—but at what price? [6] The extra learning that year-round high school might provide comes at a very high price: stress. High school classes are very demanding. Physics, chemistry, calculus, advanced foreign language,
world literature, and economics require enormous concentration. Students must have a break from the pressures of these classes in order to recharge their batteries and let the information sink in. Students who burn out are more likely to drop out, which seriously limits their job prospects. Since there wouldn’t be any summer school with year-round high school, students wouldn’t be able to retake classes they failed, either.

[7] People advocating year-round high school education also argue that it helps students learn more and eliminates the need for extended review in autumn. [8] Year-round high school classes would certainly diminish September and October review sessions. [9] However, a few weeks of review is a small price to pay for the opportunities that summer vacation affords. Many high school students need summer vacation to work and earn money. This money is essential to pay for current expenses such as cars, save for future expenses such as college, and help family members meet the rent. Many summer jobs also provide invaluable experience in the world of work, which helps students decide which careers to pursue. During the summer, some families have the time to relax together, fishing, camping, and taking vacations. This time is educational as well as fun and builds family unity.

[10] Third, supporters of year-round high school claim that schools can be operated more efficiently on a full-year schedule. [11] Yes, keeping the school operating all year on a split schedule might reduce the number of new buildings constructed. [12] However, the increased costs of teachers’ salaries, utilities, and security services will strain most municipal budgets and more than overtake any savings. School districts will also lose the income they get from renting the school buildings during the summer to camp programs.

[13] There’s no denying that full-year high school is a hot topic. [14] Those in favor of year-round high school argue that it increases learning, retention, and revenue. [15] Unfortunately, full-year high school is not the cure-all that its supporters claim. Educating high school students all year long increases the stress on high school students. It also robs students of the chance to work during the summer and enjoy vacations and family time. Further, year-round high school does not make good economic sense. [16] For these reasons and others, students should not be forced to attend high school all year round.

Choosing an Organizational Pattern
Both the “cluster” method and the “point-by-point” method are equally well suited for the ACT Assessment Writing Test. Now that you have tried both methods for yourself, you have to decide which method to use for the actual test.

Use the “cluster” organizational pattern when...

- You have more points on your side than the opposition.
- The opposition is weak.
- Your readers don’t have a strong position on the topic.
Use the “point-by-point” organizational pattern when...

- You have the same number of points on your side and on the opposition’s side.
- The opposition has many valid points.
- Your readers have a strong position on the topic—and it’s not your position!

Choose an entirely different method when...

- It makes logical sense with your topic.
- You have been taught an organizational pattern that works for you.

**Support Your Ideas with Specific Details**

It’s not enough to have a clear method of organization: You must also have something specific to say. You must back up your opinion with specific details. Details are small pieces of information that support the main idea. Details answers the questions **who, what, when, where, which, and how** is called a detail. You can provide six different types of details.

1. **Examples**  
   *Examples* help a reader understand a general statement by giving specific information that represents one piece of the whole concept.

2. **Facts**  
   *Facts* are statements that can be proven. For example, the statement “John F. Kennedy was the first Catholic president of the United States” is a fact. It can be verified, and there are no reasonable arguments against it.

3. **Statistics**  
   *Statistics* are numbers used to give additional information. Statistics can be presented in different ways, such as percentages and decimals.

4. **Reasons**  
   *Reasons* are explanations. They tell *why* something happened or explain the cause of someone’s beliefs or actions.

5. **Definitions**  
   *Definitions* are statements that explain what something means.

6. **Descriptions**  
   *Descriptions* are words or phrases that tell *how* something looks, smells, tastes, sounds, or feels. Descriptions use sensory words to help readers visualize the topic.
Here's an example of each type of detail:

<table>
<thead>
<tr>
<th>Types of Details</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>Florida boasts many famous natives and residents, including the singer Gloria Estefan and the author Marjorie Kinnan Rawlings.</td>
</tr>
<tr>
<td>Facts</td>
<td>The capital of New York is Albany.</td>
</tr>
<tr>
<td>Statistics</td>
<td>Pennsylvania has 105 state parks with a total of 215,820 acres.</td>
</tr>
<tr>
<td>Reasons</td>
<td>Many people visit California to enjoy its great tourist attractions and warm weather.</td>
</tr>
<tr>
<td>Definitions</td>
<td>The name Florida comes from a Spanish word that means “feast of flowers.”</td>
</tr>
<tr>
<td>Descriptions</td>
<td>The majestic oak trees swayed gently in the mild Virginia breeze.</td>
</tr>
</tbody>
</table>

**Support Your Opinions with Facts**

It is very important that you back-up your opinions with facts to convince your reader that your point of view is valid.

When writers try to convince you to believe something, they will almost always include a combination of facts and opinions.

- A fact is something that can be proven beyond the point of a reasonable argument.
- An opinion is a statement that a person thinks is true. It is a personal belief, not something that can be proven. Some people may agree with it, but not everyone does.

For example, the statement “The Civil War ended in 1865” is a fact. It can be verified, and no one can argue with it. In contrast, the statement “Studying a foreign language is more important than taking gym class” is an opinion. Some people might argue against this statement, and their opinions could also be valid. You could support either side of the discussion, but you could not prove it conclusively.

Read the following paragraph and then complete the chart that follows. Place an X in the first column if the sentence is a fact or place an X in the second column if the sentence is an opinion. Then write your reason.

(1) In 1950, 400 American sportswriters and broadcasters selected Jim Thorpe as the greatest all-around athlete and football player of the first half of the twentieth century.  
(2) A Sac and Fox Indian, Thorpe was born in Oklahoma in 1888.  
(3) Although he was a very good high school athlete, he stunned the entire world with his brilliant performance at the 1912 Olympic Games in Stockholm.  
(4) There, he won gold medals in both the pentathlon and the decathlon.  
(5) To date, no other athlete has ever duplicated his amazing achievement.  
(6) A year later, the International Olympic
Committee learned that Thorpe had accepted money in 1911 to play baseball in Rocky Mountain, North Carolina. (7) The International Olympic Committee took away Thorpe's amateur status, stripped him of his gold medals, and erased his achievements from the record books. (8) Many people feel that Thorpe had been treated unfairly. (9) In 1982, the International Olympic Committee agreed to restore Thorpe's amateur status and return his medals. (10) Nearly thirty years after his death, the Olympic records that Thorpe established once again stand in the record books.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Fact</th>
<th>Opinion</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td></td>
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<td>(3)</td>
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<td>(7)</td>
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<td>(9)</td>
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<tr>
<td>(10)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Answers**

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Fact</th>
<th>Opinion</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>X</td>
<td></td>
<td>The statement shows a judgment or belief.</td>
</tr>
<tr>
<td>(2)</td>
<td>X</td>
<td></td>
<td>The statement can be proven.</td>
</tr>
<tr>
<td>(3)</td>
<td>X</td>
<td></td>
<td>The statement shows a judgment or belief.</td>
</tr>
<tr>
<td>(4)</td>
<td>X</td>
<td></td>
<td>The statement can be proven.</td>
</tr>
<tr>
<td>(5)</td>
<td>X</td>
<td></td>
<td>The statement shows a judgment or belief.</td>
</tr>
<tr>
<td>(6)</td>
<td>X</td>
<td></td>
<td>The statement can be proven.</td>
</tr>
<tr>
<td>(7)</td>
<td>X</td>
<td></td>
<td>The statement can be proven.</td>
</tr>
<tr>
<td>(8)</td>
<td>X</td>
<td></td>
<td>The statement shows a judgment or belief.</td>
</tr>
<tr>
<td>(9)</td>
<td>X</td>
<td></td>
<td>The statement can be proven.</td>
</tr>
<tr>
<td>(10)</td>
<td>X</td>
<td></td>
<td>The statement can be proven.</td>
</tr>
</tbody>
</table>
As you read the following sample ACT Assessment Writing Test essay, look for facts and opinions. Decide which facts are the most persuasive and why.

Prompt: As international business increases, many high schools are requiring students to take four years of a foreign language. In addition, students must demonstrate mastery of the language as a graduation requirement. Supporters of intensive foreign language instruction claim that Americans must master more than English to be competitive in the global market. Further, with so many immigrants coming to America, we need to be able to communicate with newcomers to our shores. People opposed to this idea believe that Americans don’t need a second language because most people in the world study English. In your opinion, should high school students be forced to take four years of a foreign language and demonstrate competency before being allowed to graduate?

In your essay, take a position on the issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.

Sample Essay
Mastering a foreign language—or even two—is essential today. Nowadays, it is important to know more than one language because it can help you get a job and make you a more valuable employee. If you don’t know a foreign language, you will have a more difficult time when you travel, too. Thus, I believe that high school students should take at least four years of a foreign language.

Some people say that learning a foreign language is a waste of time because so many immigrants speak English, but these people are wrong. My mother, Migdalia, got her job as a medical biller for St. Christopher’s Hospital not only because she is skilled at math but also because she is fluent in Spanish. The hospital is located in a Spanish section of Los Angeles, California. Former patients call my mother’s office with questions about their bills. Since many of these people speak only Spanish even though they have been in America for decades, people like my mother are required to deal with their problems with confidence and skill. Last week, my mother’s boss told her that she is an invaluable employee because of her language skills. She has been promoted twice in the past three years too.

When I used to work at the library, I wished all the time that I had taken Spanish in school. One day, a man said to me, “Donde esta el bano?” which means “Where is the bathroom?” I got lucky that time because my mother had taught me that phrase, so I was able to point the man in the right direction. A week later, another library patron asked me a question in Spanish. I didn’t understand a word he said, so I answered, “Un minuto, por favor” (“One minute, please”) and got my boss, who speaks Spanish. After she helped the patron, she told me that I should feel ashamed that I don’t know Spanish or another foreign language. She’s right. I wish that I had taken a foreign language in high school.
The worst part about not knowing a foreign language occurred when I went to Puerto Rico for the summer of 2003. I stayed with my family, all of whom speak fluent Spanish, but I couldn’t understand anything they said. I missed out on a summer of fun on the basketball court and beach because I couldn’t communicate with my cousins and their friends. I didn’t even enjoy my cousin Juanita’s wedding because I wasn’t able to speak to anyone at my table. I had to use hand signals to ask girls to dance with me. My family was very kind, but I could see that they were ashamed of me because I was poorly educated.

You need to know a foreign language to get ahead on the job market and in your personal life. Speaking a second language can tip the scale in your favor when you apply for a job, and it can get you promoted faster on the job, too. Being fluent in another language also makes travel easier and more fun. As a result, I think that all students should have the opportunity to study a foreign language for at least four years in high school.

Strive for Unity and Coherence

We say that an essay has unity and coherence when every sentence is on the same idea.

• Focus on one topic at a time.
• Link related ideas with transitions.

To achieve unity and coherence in a paragraph, start by writing a topic sentence. Then have every sentence in the paragraph support the topic sentence. To achieve unity and coherence in an essay, introduce the main idea in the first paragraph. In the paragraphs that follow, write examples that illustrate the main idea. Eliminate any word, phrase, or sentence that does not relate to the main idea.

Underline the sentence that does not belong in the following paragraph.

Studying a foreign language is a waste of time because few high school students achieve a useful level of proficiency. Even with four years of concentrated study, most high school students can do little besides ask for directions, order from a menu, and comment on the weather. My cousin Michelle studies French, but I think Italian is much more useful. Having so little language but believing that you have achieved mastery is far worse than having no foreign language at all.

Which sentence does not fit? __________________________________________________

____________________________________________________________________________

Why? _______________________________________________________________________

____________________________________________________________________________

The sentence that does not fit is “My cousin Michelle studies French, but I think Italian is much more useful.” The sentence is not on the topic of this paragraph as stated in the topic sentence: “Studying a foreign language is a waste of time because few high school students achieve a useful level of proficiency.”
**Transitions** are words that connect ideas and show how they are linked. Using transitions helps you create unity and coherence by linking related ideas.

The following chart shows some of these transitions and the relationships they create.

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Transition words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>also and</td>
</tr>
<tr>
<td></td>
<td>besides too</td>
</tr>
<tr>
<td></td>
<td>in addition to</td>
</tr>
<tr>
<td></td>
<td>further</td>
</tr>
<tr>
<td>Example</td>
<td>for example for instance</td>
</tr>
<tr>
<td></td>
<td>thus namely</td>
</tr>
<tr>
<td>Time</td>
<td>next then</td>
</tr>
<tr>
<td></td>
<td>finally first</td>
</tr>
<tr>
<td></td>
<td>second third</td>
</tr>
<tr>
<td></td>
<td>fourth afterwards</td>
</tr>
<tr>
<td></td>
<td>before during</td>
</tr>
<tr>
<td></td>
<td>soon later</td>
</tr>
<tr>
<td></td>
<td>meanwhile</td>
</tr>
<tr>
<td></td>
<td>subsequently</td>
</tr>
<tr>
<td>Contrast</td>
<td>but nevertheless</td>
</tr>
<tr>
<td></td>
<td>yet in contrast</td>
</tr>
<tr>
<td></td>
<td>however still</td>
</tr>
<tr>
<td>Comparison</td>
<td>likewise in comparison</td>
</tr>
<tr>
<td></td>
<td>similarly</td>
</tr>
<tr>
<td>Result</td>
<td>therefore consequently</td>
</tr>
<tr>
<td></td>
<td>as a result thus</td>
</tr>
<tr>
<td></td>
<td>due to this accordingly</td>
</tr>
<tr>
<td>Summary</td>
<td>as a result in brief</td>
</tr>
<tr>
<td></td>
<td>in conclusion hence</td>
</tr>
<tr>
<td></td>
<td>in short finally</td>
</tr>
<tr>
<td>Place</td>
<td>in the front in the back</td>
</tr>
<tr>
<td></td>
<td>here there</td>
</tr>
<tr>
<td></td>
<td>nearby</td>
</tr>
</tbody>
</table>

Use transitions to show how ideas are linked. Add transitions to this paragraph. Write your answer in the margin of the book.
Studying a foreign language is a waste of time because few high school students achieve a useful level of proficiency. Even with four years of concentrated study, most high school students can do little besides ask for directions, order from a menu, and comment on the weather. My cousin Michelle studies French, but I think Italian is much more useful. Having so little language but believing that you have achieved mastery is far worse than having no foreign language at all.

Here is a sample answer. The transitions are underlined.

Studying a foreign language is a waste of time because few high school students achieve a useful level of proficiency. Besides, even with four years of concentrated study, most high school students can do little besides ask for directions, order from a menu, and comment on the weather. In conclusion, having so little language, but believing that you have achieved mastery, is far worse than having no foreign language at all.

Sample Essays and Scoring Rubrics

Below are some simulated ACT Assessment Writing prompts, sample essays, the scores they received, and an explanation of the scores. Follow these directions as you complete this part of the chapter.

• Write the essay yourself.
• Study the model essays, isolating their strengths and weaknesses.
• Read the scores and explanations.
• Evaluate your own essay, based on what you learned.
• Rewrite your essay to prove your point; add details, examples, and facts; achieve unity and coherence; and correct errors.

Prompt: Most American high schools are coed. People who support co-ed education argue that these schools mirror the composition of the real world. Thus, coed education gives students an excellent introduction to the “real world.” People opposed to coed high schools believe that same-sex high schools provide a better education because students can concentrate on their studies rather than getting dates. In your opinion, does a same-sex high school provide a better education than a coed high school?

In your essay, take a position on the issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.
Sample Essay #1

Boys and girls are different. The difference is on many levels, physical, emotional, and mental. Boys and girls develop at different rates and at different times. It is these differences that make life interesting and in the long run make us stronger as a species. As a society, we need to acknowledge and affirm these differences to help our children become the best that they can be in their life. One way to help them would be to have same-sex academic high school classes.

In the past, girls were the discriminated sex in the educational arena. There are centuries of documented accounts on this subject. In the United States, women worked hard in the politics of the country to change the policies that discriminated against gender. The results were Title IX, and the Gender & Equity Act. Girls have been working hard to achieve their goals and have done a phenomenal job in the last 15 years. Girls now exceed boys in earning degrees in college.

Recent studies are now showing that boys are struggling in school. An alarming number of boys are being diagnosed with attention-deficit hyperactivity disorder and are given medication to compensate. The use of medication to control behavior has increased 500% over the past ten years, a truly frightening statistic. In some districts there are schools where 20% to 25% of the boys are on medication to control behavior. With boys receiving this kind of negative reinforcement about a very natural need, is it any wonder they are having problems. Young men are not interested in going to college because they fail to recognize the value of an education.

Educators need to understand and provide an education that acknowledges the different learning abilities of boys and girls. By having same sex academic classes, the teaching methods can be tailored to each learning style. Such classes will provide an optimal learning environment for students and teachers will have more creativity in presenting their lessons. Same-sex academic classes allows the teacher to reach students using their strengths, instead of using teaching methods that only reach some students. Keeping the high schools coed, the students will be able to interact with the opposite sex at lunchtimes, study halls, library times, and during after school clubs and activities. This type of high school combines the strengths of the same-sex high school and the coed high school. There would be no cost to implement such a system. No new school would need to be built. Teachers would need training in new teaching methods, but most teachers are required to do that now on a regular basis.

Studies are proving that the differences between boys and girls are biological in nature, not environmental. The brain works very differently in boys and girls and they need to learn in different ways. In one area both boys and girls are the same; they need encouragement and approval for who they are and what they achieve. By providing an academic environment that values the differences between boys and girls, society will have citizens that are well-adjusted and will become major contributors to a better future for all.
Score: 4

Explanation:

• The writer chose one side of the issue and supports it, but the argument is muddy. Stating that boys and girls are different is not the same as proving it. Without this proof, the assertion that boys and girls have different learning styles is not supported.

• There are other leaps in logic, too. For example, how is medication for ADHD a form of negative reinforcement? Further, we cannot conclude that “Young men are not interested in going to college because they fail to recognize the value of an education” from the information in this passage. Rather, we can conclude that they welcome an education but are frustrated by the poor education they are receiving in high school.

• The style is dull, with little variation in sentence structure, word choice, or punctuation.

Sample Essay #2

The purpose of an education is not just to provide a child with knowledge, but to endow them with useful skills that will allow them to succeed in our society. To do so, the atmosphere in a school should accurately reflect the atmosphere of the society it is preparing children for. Modern America is a non-segregated society: People of both genders freely intermix, interacting with each other constantly in both professional and social settings. I would argue that American high school should remain coed, because this atmosphere better prepares students for both the professional and social aspects of the “real world.” In addition, I will offer a counterargument to the idea that coed schools are more distracting due to students’ romantic inclinations.

School is a child’s primary preparation for a future professional role. It is in the classroom that children acquire a work ethic, problem-solving skills, and a propensity for analytical thinking. The classroom is also where children learn teamwork, cooperation, compromise, and similar social skills that are critical to most job functions. However, these skills are only acquired through practice, and to do some, children must have the opportunity to interact with all manner of people, not just those of the same gender.

The social aspects of modern life are considered by many to be just as rewarding, if not more so, than the professional aspects. The acquisition of friends, the pursuit of romance and marriage, and raising children are highly valued and oft-pursued aspects of our society. Yet all of these things typically hinge upon social interaction with members of the opposite gender. Children must be given the opportunity to acquire confidence, understanding, and level of comfort with the opposite gender in their youth, or they will not be able to use these skills when they’re older.
Finally, restricting high schools to single-sex will not eliminate the threat of romantic distractions, as after all, homosexual relationships are becoming far more accepted in modern times than ever before. Granted, there will be some reduction in the level of distraction, but the problem will still exist. (Perhaps to the unfair detriment of homosexual students as well, but this is not a discussion on equal treatment.)

School is meant to prepare children for life. For the educational system to have succeeded, they must be fully prepared to deal with the world, not just the half of it with similar chromosomes to theirs.

Score: 6

Explanation:

• This essay is clearly focused on the writer’s main point as stated in the topic sentence: “The purpose of an education is not just to provide a child with knowledge, but to endow them with useful skills that will allow them to succeed in our society.”

• The writer brings up the opposition—“the idea that coed schools are more distracting due to students’ romantic inclinations”—and shows that it is not valid.

• The writer provides ample examples to support his point. For instance, note the list of examples in this sentence: “The acquisition of friends, the pursuit of romance and marriage, and raising children are highly valued and oft-pursued aspects of our society. Yet all of these things typically hinge upon social interaction with members of the opposite gender.”

• The essay is well organized, moving through the writer’s points one by one.

• The language is highly sophisticated, and the writer shows originality and imagination.

• This essay leaves the reader convinced of the soundness of the discussion, impressed with the quality of the writing style, and stimulated by the writer’s intelligence and insight.

Prompt: Many people think that high school students should be encouraged to work at least 20 hours a week. Paid work teaches responsibility, these people argue, as well as money-management skills. Teachers and parents opposed to this argue that students are too busy attending school to require the added burden of work. Further, these people say, if high school students have extra time, it should be spent pursuing extracurricular activities, which can teach far more valuable skills than the dead-end “McJobs” that nearly all working teenagers hold. In your opinion, should high school students be encouraged to work during the school year?

In your essay, take a position on the issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.
Sample Essay #1

Society has a tendency to try to fit teenagers into a single mold, as if what is beneficial for one student will be equally beneficial for all her peers. Trying to create an environment in which high school students do not spend all of their time outside of class in front of the television is a laudable goal. Insisting that all high school students should work a minimum of 20 hours a week to ensure this is a heavy-handed solution at best. While high schoolers should be encouraged to fill some of their time productively, the activities they engage in should be chosen to fit the individual.

Some students would indeed benefit from experience in the workplace, even if it is only in a “McJob.” The lowliest position in the grocery store still demands timeliness, professionalism, and hard work. Many teenagers benefit from learning such values. The added responsibility of managing their earnings wisely increases the opportunities for learning real life skills, even in the most humble of positions.

However, these lessons may also be learned elsewhere. Working in the stage crew, running for student government, performing in an orchestra, playing a sport, participating in scouting, or any of the other numerous extracurricular activities available offer similar lessons for those self-motivated enough to join. Taking a role among their peers can inspire leadership and organization qualities that are rarely tapped in lower level jobs.

Furthermore, many college-bound high school students do not have time to hold a 20 hour a week job. For a student taking advanced classes, schoolwork does not end after classes are over. Coming home, they face hours of homework every night. Forcing these students to spend the time they need for their studies flipping burgers may lower their grades, which will have a far greater effect on their futures than any part-time job might.

Finally, society also must recognize that not all of teenagers’ time need be spent doing “constructive” activities. High school is the last breath of childhood. Students should still have some free time to spend on social activities like dating and hanging out with their friends. They are not yet full adults and should not be forced into the full responsibilities of adults. In short, high school students should still have time in their busy schedules for fun.

High school students should indeed have something to do with their time after school that will help prepare them for later life. However, imposing a single set of activities on everyone cannot be a solution. There must be room for individuals to find their own niches. And while it is important to have some structure in their lives, filling up all available time leaves the students no time to be what they actually are—kids.
Score: 6

Explanation:

• This essay is clearly focused on the writer’s main point as stated in the topic sentence.
• The writer brings up the opposition—“Insisting that all high school students should work a minimum of 20 hours a week to ensure this is a heavy-handed solution at best.”—and shows that it is not valid.
• The writer provides ample examples to support her point.
• The essay is well organized, moving through the writer’s points one by one.
• The language is mature, and the writer shows originality. The last sentence is especially effective.
• This essay leaves the reader convinced of the soundness of the discussion, impressed with the quality of the writing style, and stimulated by the writer’s intelligence and insight.

Sample Essay #2

“Teenagers today are spoiled and lazy.” This is a continual refrain of older people. While intoning “I walked to school twenty miles in the snow,” these people bemoan the hordes of American teenagers depicted too often in the popular media as cavalier rule-breakers with nothing to do. These kids should be forced to work, to earn their keep, and collide with a reality previous generations experienced through school paper routes. While obviously exaggerated, there is a truth buried beneath the accusations. Today’s American high school students are far wealthier than their counterparts a generation ago. They are able to benefit in unequaled luxury. The great American middle class—to at least some extent—are able to have MP3 players and cell phones and previously unknown levels of creature comfort.

If this were reality, American teenagers would all be lounging on their couches, bags of potato chips in hand, watching TV after school everyday, but nothing could be farther from the truth. To say that American students should work twenty hours a week earning money is to deny the fact that they are working far more than twenty hours a week at all sorts of other activities. I attend a middle-class suburban high school, and after school the halls are brimming with every imaginable extracurricular activity. In a school of 800 students, one tenth are on the track team alone. The mathletes team—that age-old bastion of the teen movie nerd—boasts an impressive membership of over thirty. Many students volunteer for community service in the food banks and homeless shelters, the hospitals, and day care centers. Most high school kids don’t see their own front doors until six o’clock or later, when they return home to study until well after dark. They help with child care, laundry, meal preparation, and other chores, too. There’s none of the happy outdoor playing of the bucolic days of yore.
Teenagers aren’t lazy. Rather, they are working harder than perhaps ever before. Students are learning responsibility by just getting through their days. They’re learning to manage their time, too. There’s no time for paid employment for today’s high school students.

Score: 6

Explanation:

• This essay is clearly focused on the writer’s main point as stated in the topic sentence:
• The writer brings up the opposition—“These kids should be forced to work, to earn their keep, and collide with a reality previous generations experienced through school paper routes”—and shows that it is not valid.
• The writer provides ample examples to support her point.
• The essay is well organized, moving through the writer’s points one by one.
• The language is extremely sophisticated, and the writer shows originality and imagination.
• This essay leaves the reader convinced of the soundness of the discussion, impressed with the quality of the writing style, and stimulated by the writer’s intelligence and insight.

PRACTICE EXERCISES

You’ve just reviewed the most important points in grammar to know for success in taking the ACT Assessment English Test. The following exercises will help you to practice your new knowledge as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are three English Test exercises in this chapter. Each exercise contains 30 questions and should be answered in 18 minutes. Do each exercise in one sitting in a quiet place, with no notes or reference material. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

There are also sample writing prompts for practice.

Score yourself only on those items you finished. When you’re done, work through the rest of the exercise.
Exercise 1

EXERCISES: THE ACT ASSESSMENT ENGLISH TEST

30 Questions • Time—18 Minutes

Directions: This test consists of two passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box.

Passage I

The Girls Choir of Harlem

It is rare to hear of choirs composed of just girls. In fact, for every girls’ choir in the United States, there are four boys’ and mixed choirs. But the Girls Choir of Harlem in 1977 was founded, to complement the already existing and justly renowned Boys Choir.

To this day, the Boys Choir of Harlem shadows the Girls Choir. They have been around longer (1968 was when they were founded), and have received the attention needed to gain funding and performance opportunities. The boys have appeared in some of...
the world’s most prestigious musical settings. They have sung a sunrise concert for the Pope on the Great Lawn in New York’s Central Park; they have traveled to Washington, D.C. and seen the Lincoln Memorial. Such glorious moments have eluded their female counterparts. During the 1980s, when funds dried up, the Girls Choir temporarily disbanded. However, in 1989, the choir were reassembled, and in November of 1997, they made their debut at Alice Tully Hall at Lincoln Center, performing music by Schumann and Pergolesi before an audience of dignitaries (including the mayor’s wife) and thousands of music lovers.

[1] The choir members speak confidently of someday becoming lawyers, doctors, and politicians—jobs which once appeared out of reach to them. [2] Both the Girls Choir and the Boys Choir of Harlem act as havens for inner-city children, giving kids from broken families and poverty-stricken homes new confidence and hope for their future. [3] The boys and girls in the choirs attend the Choir Academy, a 500-student public school with a strong emphasis on singing. [4] It’s a fine learning

6. (F) NO CHANGE
   (G) more prestigious
   (H) very prestigious
   (J) prestige-filled

7. Which of the alternative clauses would most effectively support the assertion made in the previous sentence about the musical appearances of the Boys Choir?
   (A) NO CHANGE
   (B) They have produced recordings enjoyed by listeners around the world.
   (C) They have sung on the same bill as Luciano Pavarotti, the great Italian tenor.
   (D) They sing a wide variety of music, both classical and popular.

8. (F) NO CHANGE
   (G) it were
   (H) the choir was
   (J) the girls

9. (A) NO CHANGE
   (B) the mayor’s wife
   (C) the mayors’ wife
   (D) a wife of the mayor

10. (F) NO CHANGE
    (G) they give
    (H) thus giving
    (J) and it gives

11. (A) NO CHANGE
    (B) Its
    (C) They offer
    (D) That is
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12. Which of the following sequences of sentences will make the paragraph most logical?
   (F) 1, 4, 3, 2
   (G) 2, 1, 4, 3
   (H) 2, 3, 4, 1
   (J) 3, 4, 1, 2

13. (A) NO CHANGE
   (B) generously for giving
   (C) to give generously
   (D) for generosity in giving

14. (F) NO CHANGE
   (G) because they are lacking money.
   (H) as a result of money being lacking.
   (J) without money.

Item 15 poses a question about the essay as a whole.

15. Suppose the writer had been assigned to write an essay describing the musical achievements of the Girls Choir of Harlem. Would this essay successfully fulfill the assignment?
   (A) Yes, because the concert at Alice Tully Hall is explained in some detail.
   (B) Yes, because the essay makes it clear that the girls in the choir are talented performers.
   (C) No, because the essay discusses the Boys Choir as extensively as it discusses the Girls Choir.
   (D) No, because the music performed by the choir is scarcely discussed in the essay.

16. (F) NO CHANGE
   (G) Your
   (H) One's
   (J) A reader's

Passage II

The Poetry of Economics

“The poetry of economics?” a reader might ask. “How can ‘the dismal science’ be associated with the subtlety and creativity of poetry?” Your skepticism is understandable, but consider the following.

Now that the Girls Choir of Harlem is beginning to receive some of the recognition that the boys have long enjoyed, perhaps corporations and wealthy individuals will be motivated generously to support the choir and ensure it will never again have to shut down for lack of money.

"environment that has given the girls ambitions most of them never before considered."
and perhaps a story from an economist’s life can sketch the poetry of economics at work. Shortly after the Second World War, the agricultural economist Theodore Schultz, later to win a Nobel prize, spent a term based at Auburn University in Alabama, he interviewed farmers in the neighborhood. One day he interviewed an old and poor farm couple. And was struck by how contented they seemed. Why are you so contented, he asked, though very poor? They answered: You’re wrong, Professor. We’re not poor. We’ve used up our farm to educate four children through college, remaking fertile land and well-stocked pens into knowledge of law and Latin. We are rich.

The parents had told Schultz that the physical capital, which economists think they understand, is in some sense just like the human capital of education. The children now owned it, and so the parents did, too.

Once it had been rail fences and hog pens and it was also their mules. Now it was in the children’s brains, this human capital. The farm couple was rich. The average economist was willing to accept the discovery of human capital as soon as he understood it, which is in fact how many scientific and scholarly discoveries get received. It was an argument in a metaphor (or, if you like, an analogy, a simile, a model). A hog pen, Schultz would say to another economist, is “just like” Latin 101.
The other economist would have to admit that there was something to it. Both the hog pen and the Latin instruction are paid for by saving. Both are valuable assets for the earning of income, understanding “income” to mean, as economists put it, “a stream of satisfaction.” Year after year, the hog pen and the Latin cause satisfaction to stream out as water from a dam. Both last a long time, but finally wear out—when the pen falls down and the Latin-learned brain dies. And the one piece of “capital” can be made into the other. An educated farmer, because of his degree in agriculture from Auburn, can get a bank loan to build a hog pen; and when his children grow up he can sell off the part of the farm with the hog pen to pay for another term for Junior and Sis up at Auburn, too.

25. (A) NO CHANGE
(B) Both the hog pen and the Latin instruction
(C) The hog pen, and the Latin instruction as well,
(D) Both the hog pen, and also the Latin instruction,

26. (F) NO CHANGE
(G) for income’s earning,
(H) for earning income,
(J) with which income may be earned,

27. (A) NO CHANGE
(B) causes
(C) produce
(D) makes

28. (F) NO CHANGE
(G) similarly to
(H) as with
(J) like

29. (A) NO CHANGE
(B) due to having a degree from Auburn in agriculture,
(C) as a result of a degree in agriculture from Auburn
(D) OMIT the underlined portion.

30. The writer wants to link the essay’s opening and conclusion. If inserted at the end of the essay, which of the following sentences best achieves this effect?
(F) The wisdom of the farmer is greater, in the end, than the wisdom of the economics professor.
(G) Human capital is a concept based on a metaphor—and metaphor is the essential tool of poetry.
(H) Thus, education is the most valuable form of human capital, even for the farmer.
(J) Physical capital and human capital are ultimately not so different after all.
Exercise 2

30 Questions • Time—18 Minutes

Directions: This test consists of two passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box.

Passage I

Note: The paragraphs that follow may or may not be in the most appropriate order. Item 15 will ask you to choose the most logical sequence for the paragraphs.

A People’s Art, for Good and Ill

[1]
During the early years of movies—say, from 1910 to 1940—the greatness of film as an art form lay in its own ingenuity and invention. And this in every instance originated in cinema’s role as entertaining a large and avid public. Between 1920 and 1930, a generation of filmmakers grew up who were not failed novelists or playwrights who’d had no success but moviemakers, through and through. Their essential vision belonged to no other medium with the exception of the cinema, and this made it vital and exciting.

[2]
Furthermore, their public was a universal audience of ordinary people, spread across

1. (A) NO CHANGE
   (B) —say from 1910, to 1940—
   (C) —from 1910, say to 1940—
   (D) —from 1910 to 1940, say;

2. (F) NO CHANGE
   (G) of entertaining
   (H) to entertain
   (J) as entertainers on behalf of

3. (A) NO CHANGE
   (B) playwrights lacking success
   (C) playwrights without any successes
   (D) unsuccessful playwrights

4. (F) NO CHANGE
   (G) than
   (H) aside from
   (J) from
the world. Comparable to the first dramas of Shakespeare, their art was not a product of the palace, the mansion, or the village square, but rather of the common playhouse where working people sat shoulder to shoulder with the middle class and the well-to-do. This is what gave the early moviemakers the strength and freshness we still perceive in their art.

Thus, today, with movies more popular than ever, and with box-office receipts for the great international hit films running into hundreds of millions of dollars, movies are becoming more and more conventional, unimaginative, and stale. The freshness of the world.

5. (A) NO CHANGE
   (B) As were
   (C) Not dissimilarly to
   (D) Like

6. (F) NO CHANGE
   (G) Shakespeare, some of whose plays have been made into outstanding motion pictures,
   (H) Shakespeare, who also wrote a number of highly-acclaimed narrative and lyric poems,
   (J) Shakespeare, although he lived nearly three centuries before the invention of the movies,

7. Which of the choices is most consistent with the writer's point concerning the style of the early moviemakers?
   (A) NO CHANGE
   (B) the private club,
   (C) the tenements of the poor,
   (D) the athletic arena,

8. Which of the alternative clauses most effectively supports the writer's point concerning the current situation of moviemakers?
   (F) NO CHANGE
   (G) and with movie stars like Harrison Ford known and admired by millions of people around the world,
   (H) and with thriving motion picture industries not only in Hollywood but in many other countries,
   (J) and with more opportunities for talented young filmmakers than ever before,

9. (A) NO CHANGE
   (B) conventional—unimaginative—
   (C) conventionally unimaginative,
   (D) conventional; unimaginative;
earlier moviemakers has been lost.

However, there is a price to be paid for this democratic appeal to the common person. The artist who serves an elite audience has a known patron only, or group of patrons, to satisfy. If he is strong enough, he can, like the painters of the Renaissance, mold their taste in the image of his own. This can also be true of the greater and more resolute artists of the cinema, from Chaplin in the 1920s to, say, Bergman or Antonioni in the 60s. But the larger the audience and the more costly the movies to produce, great become the pressures brought to bear on the less conventional creator to make his work conform to the pattern of the more conventional creator.

**Passage II**

**Regeneration, A Natural Miracle**

Urodeles, a kind of vertebrate that include such small, lizard-like creatures as newts and salamanders, have an enviable ability few other animals enjoy. They can regenerate arms, legs, tails, heart muscle, jaws, spinal cords, and other organs that are injured or

---

10. (F) NO CHANGE
   (G) have been
   (H) are being
   (J) will be

11. (A) NO CHANGE
   (B) Fortunately,
   (C) Surprisingly,
   (D) Therefore,

12. (F) NO CHANGE
   (G) (Move after has)
   (H) (Move after satisfy)
   (J) OMIT the underlined portion.

13. (A) NO CHANGE
    (B) of his taste.
    (C) like his own.
    (D) of his own personal taste.

14. (F) NO CHANGE
    (G) so much greater become
    (H) greater are
    (J) the greater

**Item 15 poses a question about the essay as a whole.**

15. For the sake of the unity and coherence of this essay, Paragraph 3 should be placed
    (A) where it is now.
    (B) before Paragraph 1.
    (C) before Paragraph 2.
    (D) after Paragraph 4.

16. (F) NO CHANGE
    (G) includes
    (H) comprise
    (J) numbers

17. (A) NO CHANGE
    (B) only few
    (C) nearly no
    (D) scarcely no
Planaria, a kind of simple worm, have their own form of regenerative power. A single worm can be sliced and diced into hundreds of pieces, and each piece giving rise to a completely new animal.

However, while both urodeles and planaria have the capacity to regenerate, they use different means to accomplish this amazing feat. In effect, urodeles turn back the clock. When injured, the animal first heals the wound at the site of the missing limb. Then various specialized cells at the site, such like bone, skin, and blood cells, seem to lose...

18. (F) NO CHANGE
   (G) animals who eat them
   (H) predatory animals
   (J) predators

19. Which of the following sentences, if added here, would provide the best transition between the first paragraph and the second?
   (A) Urodeles are not the only creatures with this amazing ability.
   (B) Scientists have long marveled at the regenerative power of urodeles.
   (C) Regeneration affords to those creatures that possess it a kind of immortality.
   (D) There are dozens of different species of urodeles living in North America.

20. (F) NO CHANGE
   (G) Planaria—a kind of simple worm,
   (H) A simple kind of worm, known as planaria,
   (J) Planaria, simply a kind of worm,

21. (A) NO CHANGE
   (B) each piece gives rise
   (C) with each piece giving rise
   (D) each one rising

22. (F) NO CHANGE
   (G) Furthermore,
   (H) And
   (J) Meanwhile,

23. (A) NO CHANGE
   (B) (Place after When)
   (C) (Place after wound)
   (D) (Place after limb)

24. (F) NO CHANGE
   (G) such as
   (H) namely
   (J) as
their identity. They revert into unspecialized cells, like those in the embryo before birth. Ultimate, as the new limb takes shape, the cells take on the specialized roles they had previously cast off.

By contrast, planaria regenerate using special cells called neoblasts. Scattered within the body, these neoblasts remain in an unspecialized state, this enables them to turn into any cell type that may be needed. Whenever planaria are cut, the neoblasts migrate to the site and begin to grow and develop. Soon, an entirely new animal is formed from the broken fragments from an old one.

25. (A) NO CHANGE (B) to the form of (C) to being (D) toward being
26. (F) NO CHANGE (G) So, (H) Thus, (J) Ultimately,
27. (A) NO CHANGE (B) Nonetheless, (C) In fact, (D) Otherwise,
28. (F) NO CHANGE (G) thus able (H) enabling (J) enabled in this way
29. (A) NO CHANGE (B) which are necessary. (C) for which there is a requirement. (D) one may want.
30. (F) NO CHANGE (G) that are part of the old. (H) of the old. (J) out of the old one.
Passage I
Tunnel Vision: The Bane of Business

Businesses don’t always get into trouble because they are badly run or inefficient. Sometimes, well-managed companies fail because their leaders don’t understand, simply, how the world is changing around them. What happened to Wang, the office automation company, is a classic example.

In the early 1980s, Wang represented the preeminent office automation capability in the world—so much so that in many offices the name “Wang” had become a synonym for “office automation.” With a reputation for quality and with proprietary hardware and software that guaranteed the uniqueness of...
Yet in less than a decade, Wang faded to near obscurity. Shrinking dramatically and surviving only by transforming itself to use its software and engineering strengths in completely different ways. In place of Wang's specialized computer systems, versatile personal computers linked together in networks had become the dominant office tools. The new personal computers first transformed the market for office automation networks then wiping out the old market.

Wang had saw itself as a specialized kind of computer company using large machines to serve entire companies. It’s excellence and leadership in innovation was highly respected, and it was important to Wang not to lose that position. That view led Wang to stick to its familiar business until it was too late. It failed to see the opportunity presented by the personal computer. Eventually, Wang did attempt to move into personal computers, but by this time the company’s opportunity to
move forward was gone. **Wang had been badly outmaneuvered and was left with no market.**

12. Which of the following sentences, if added here, would best summarize the point of the paragraph and provide a clear transition to the next paragraph?

- (F) **NO CHANGE**
- (G) Today, Wang is developing new business niches that it hopes will bring it renewed success in the future.
- (H) Wang’s reputation for excellence remained un tarnished.
- (J) The market for personal computers continues to grow.

13. (A) **NO CHANGE**
- (B) and less uncertainty.
- (C) or certainty.
- (D) but a smaller degree of uncertainty.

14. (F) **NO CHANGE**
- (G) is unable for taking
- (H) finds it impossible to perform
- (J) cannot do

15. (A) **NO CHANGE**
- (B) In either case,
- (C) Anyway,
- (D) Because

**Passage II**

The Unblinking Eye

Photography is of course a visual art like many others, including painting, drawing, and the various forms of printmaking. But photography is unique as one of these arts in one respect: the person, place, event, or other subject that have been photographed is always real, captured by a photographer who is an on-the-spot eyewitness to its reality. A

16. (F) **NO CHANGE**
- (G) is, of course, a
- (H) is of course, a
- (J) is—of course, a

17. (A) **NO CHANGE**
- (B) as a member of these
- (C) compared to other
- (D) among these

18. (F) **NO CHANGE**
- (G) that has been
- (H) having been
- (J) OMIT the underlined portion.
painting may depict a scene that is partly or in whole imaginary—a knight battling a dragon, a city beneath the sea, or the features of a woman who never existed. But a photograph is a document reflecting with more or less completeness and accuracy something that was actually happening as the shutter clicked.

Viewers have an awareness concerning this feature of photography, of course, which explains why photos (and, today, film and television footage) of world events can have such a powerful emotional and intellectual impact. The photographed image of a starving child in Africa or India conveys the reality of a tragedy halfway around the world 23.

19. (A) NO CHANGE
(B) in part or entirely
(C) partly or wholly
(D) partly, or in its entirety,

20. (F) NO CHANGE
(G) to reflect
(H) that reflect
(J) for reflecting

21. (A) NO CHANGE
(B) are wary concerning
(C) have awareness of
(D) are aware of

22. (F) NO CHANGE
(G) so much powerful
(H) so powerful
(J) the power of

23. The writer is considering adding the following phrase at this point in the essay:

—its belly distended, eyes sunken, ribs protruding—

Would this phrase be a relevant and appropriate addition to the essay, and why?
(A) No, because the kind of image it conveys is excessively familiar from newspapers and television.
(B) Yes, because it suggests vividly the power of a photographic image to move the viewer emotionally.
(C) No, because it distracts the reader’s attention from the writer’s point about the nature of photography.
(D) Yes, because it encourages the reader to take action on behalf of children starving in distant lands.
with an immediacy and force shared by no purely verbal report.

24. (F) NO CHANGE
   (G) not shared by any report that is purely verbal.
   (H) more than can be had by any purely verbal report.
   (J) beyond that of a report which is verbal, purely verbal report.

25. Which of the following sentences, if added here, would most effectively provide a transition to the new paragraph?
   (A) Words, of course, can be used to deceive.
   (B) Not all photographers are interested in depicting social or political problems.
   (C) This is not to say that the camera never lies.
   (D) It takes true artistry to produce compelling photographs.

26. (F) NO CHANGE
   (G) freezes
   (H) by freezing
   (J) to freeze

27. (A) NO CHANGE
   (B) for the purpose of serving
   (C) so as to promote
   (D) in helping to create interesting in
cial causes, such deceptions are all too common. Nonetheless, no conscientious photographer will be guilty of them. At its best, photography is unequalled as a pur-
veyor of truth, and this is the goal of every self-respecting camera artist.

28. The writer is considering adding the following sentence at this point in the essay: Computer-generated imagery is even more prone to distortion and fabrication than photography. Would this sentence be a relevant and appropriate addition to the essay, and why?

(F) No, because the topic of computer-generated imagery is unrelated to the main theme of the essay.

(G) Yes, because computer-generated imagery is now widely used in advertisements and other commercial presentations.

(H) No, because most people are well aware that computer-generated images are often distorted.

(J) Yes, because, like photography, computer-generated imagery is a form of visual art.

29. (A) NO CHANGE

(B) involved with such.

(C) a party to these things.

(D) among those who take part in them.

30. (F) NO CHANGE

(G) for

(H) yet

(J) so
Practice Writing Prompts

Directions: Complete each of the following writing under test conditions. Be sure to allow yourself no more than 30 minutes for each essay. Pace yourself to make sure you finish the essay in the time required. If you finish with more than a few minutes to spare, you are not spending enough time on details, examples, editing, and proofreading.

1. Should state college tuition be free for all students who graduate high school with a B average? After all, state colleges are funded by tax revenues. On the other hand, education taxes are already very high. Further, why should taxpayers without college-aged children be encumbered by this additional tax burden? In your opinion, should state college tuition be free for all students who graduate high school with a minimum average?

In your essay, take a position on the issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.

2. In some high schools, students are encouraged to study a semester abroad; a few high schools even require foreign study. Proponents of study abroad claim that it makes students more well rounded. Those opposed to the idea say that it disrupts a student’s education, work career, and social ties. Further, study abroad can be little more than an excuse for an extended vacation and can even be dangerous. In your opinion, should high school students study abroad for a semester?

In your essay, take a position on the issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.

3. In some high schools, students are allowed to leave the campus during their lunch and other free periods to eat out, visit friends’ houses, or even shop. Proponents of “open campus” argue that it teaches responsibility and alleviates many discipline problems. Those opposed to open campus argue that it increases the likelihood that students will get into automobile accidents and even commit petty crimes. Further, these people believe that it is the responsibility of school administrators to discipline children during all school hours, including lunch and free periods. In your opinion, should high school campuses be open so students can come and go as they please?

In your essay, take a position on the issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.

4. What books, stories, and poems should students read in English classes? Should they be forced to study from the “canon” of well-recognized writers, or should they be encouraged to read works by lesser-known multicultural writers? Those who
favor the traditional writers such as Shakespeare, Milton, and Dickens argue that reading “classics” prepares students to be truly well educated. These works, they say, are the keys to the kingdom that open doors to a life of culture and success. On the other hand, those who favor newer and perhaps unrecognized multicultural writers believe these books better prepare students for the realities of the modern world of diversity. In your opinion, should high school students read traditional or contemporary writers?

In your essay, take a position on the issue. You may write about either one of the two points of view provided or provide an entirely different vantage point on the topic. Regardless of the point that you argue, be sure to support your opinion with specific facts, details, reasons, and examples.
ANSWER KEY AND EXPLANATIONS

Exercise 1

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1. **The correct answer is (C).** It's more graceful, idiomatic, and clear to leave the prepositional phrase “of girls” intact, putting the modifying adverb “only” in front of the phrase rather than in the middle of it.

2. **The correct answer is (G).** In most sentences, a modifying phrase like “In 1977,” telling when the event described in the sentence takes place, fits best at the beginning. In this case, it would slip in nicely after the introductory conjunction “But.”

3. **The correct answer is (A).** The idiomatic phrase “justly renowned” is perfectly clear and correct as used in the original sentence.

4. **The correct answer is (F).** The other answer choices change the meaning of the phrase in a way that isn’t logical, given the context. The sentence is explaining how and why the Boys Choir overshadows the Girls Choir, given the history of the two organizations. Thus, it makes sense to introduce the sentence with the phrase “To this day,” which says that the Boys Choir still overshadows the younger Girls Choir, even twenty years after the Girls Choir was founded.

5. **The correct answer is (D).** All the answer choices say the same thing; choice (D) does it most concisely.

6. **The correct answer is (F).** Since all of the world’s musical settings are being compared (at least implicitly), the superlative adjective “most prestigious” is needed, rather than the comparative “more prestigious” or some other form.

7. **The correct answer is (C).** The writer is trying to suggest that the Boys Choir has performed on many “prestigious” occasions. The concert for the Pope is an example; so is performing on the same bill as Pavarotti. The other statements, while interesting, don’t describe prestigious occasions for musical performances.

8. **The correct answer is (H).** The collective noun “choir” is normally treated, for grammatical purposes, as a singular word; therefore, it should be paired with the singular verb “was reassembled” rather than the plural “were.”

9. **The correct answer is (B).** The correct form of the possessive here would be “the mayor’s wife.”

10. **The correct answer is (F).** The original wording is grammatically correct and clear. Choice (G) would turn the sentence into a run-on; choice (H) needlessly adds the word “thus”; and choice (J) uses the pronoun “it,” whose antecedent and meaning aren’t clear in the context.
11. The correct answer is (A). The original “It’s” is perfectly correct. In this context, “it’s” means “it is,” so the form of the word including an apostrophe is right.

12. The correct answer is (H). Sentence 1 draws a conclusion based on the rest of the paragraph, so it logically belongs last. Sentence 2 introduces the paragraph’s overall topic, so it makes sense to put that one first. And sentences 3 and 4 clearly belong together, in that order.

13. The correct answer is (C). The idiomatic expression is “motivated to do something” rather than “motivated for doing something.”

14. The correct answer is (F). The phrase “for lack of money” is an idiomatic and familiar one. Choices (G) and (H) are verbose and awkward by comparison; choice (J) is vague and hard to understand.

15. The correct answer is (D). Read the explanation of the assignment carefully: the writer has been asked to “describe the musical achievements” of the choir. The essay we’ve read explains a bit about the choir’s history and its importance in the lives of its inner-city members, but it really doesn’t describe their musical achievements.

16. The correct answer is (G). In this context, what’s needed is the possessive “your” rather than the contraction “you’re” (you are).

17. The correct answer is (B). The logical conjunction here is “but,” since there is a contrast in meaning between the skepticism referred to in the first half of the sentence and the explanation offered in the second half, which is intended to disarm that skepticism.

18. The correct answer is (H). As written, the sentence is a run-on; the second half of the sentence, beginning “he interviewed,” could stand alone as a sentence. Choice (H) fixes this by making the last five words into a modifying phrase that explains what Schultz did in Alabama, tacked neatly on to the rest of the sentence.

19. The correct answer is (B). It’s incorrect to handle this as two sentences, since what follows the period is lacking a subject for the verb “was struck.” As shown in choice (B), the two should be unified, so that “he” becomes the subject for both verbs: “interviewed” and “was struck.”

20. The correct answer is (F). The original word is grammatically correct and logical in meaning.

21. The correct answer is (A). The original wording is more clear and idiomatic than either of the two alternatives, choices (B) and (C). It would be wrong to delete the phrase altogether, choice (D), since it ties into one of the main ideas of the essay: how Schultz used a poetic metaphor to explain a new economic idea through analogy with an old, familiar idea.

22. The correct answer is (J). For the sake of parallelism, eliminate these words. The list should simply read “rail fences and hog pens and mules.”

23. The correct answer is (B). It makes sense to begin a new paragraph here, since the main idea has changed. The previous paragraph summarizes the old farm couple’s concept of “human capital”; the new paragraph, which begins at this point, discusses how metaphors can help to explain new theoretical concepts.
24. The correct answer is (G). The phrase “get received” is very slangy, too much so for the context of this fairly serious, formal essay on economics. “Are received,” which means much the same thing, is more appropriate.

25. The correct answer is (B). The commas in the original are needless; among other flaws, they separate the subject of the sentence (it’s the compound subject “hog pen” and “Latin instruction”) from its verb (“are paid for”). The subject and the verb shouldn’t be separated by commas unless it’s unavoidable.

26. The correct answer is (H). This wording is the most concise and graceful of the four alternatives.

27. The correct answer is (A). The plural verb “cause” is necessary, since the compound subject “hog pen” and “Latin” is plural.

28. The correct answer is (J). What follows the underlined word is the noun phrase “water from a dam.” Therefore, the preposition like is correct. (The conjunction as would be correct only if what followed was a clause, such as “water pours from a dam.”)

29. The correct answer is (A). All three alternatives mean much the same thing, but the original wording is clearest and most graceful. To omit the underlined words would obscure the point of the sentence, which is that the educated farmer can use his knowledge to produce concrete wealth (a hog pen).

30. The correct answer is (G). This sentence serves the stated purpose best because it summarizes the main point of the essay by linking its opening and closing paragraphs, using the concept of “the poetry of economics” as the connecting theme.

Exercise 2

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

1. The correct answer is (A). The punctuation in the original is correct. It sets off the entire parenthetical phrase with a pair of dashes (one correct way to do it) and separates the additional interjection, “say,” from the rest of the phrase with a comma of its own.

2. The correct answer is (G). It’s idiomatic to speak of one’s “role of doing something,” rather than, for example, a “role as doing something” or the other choices.

3. The correct answer is (D). The underlined phrase should be grammatically parallel to “failed novelists.” “Unsuccessful playwrights” fits.

4. The correct answer is (G). The normal idiom is “no other X than Y.”

5. The correct answer is (D). The simple preposition “Like” is the clearest and most concise way of expressing the desired meaning.
6. The correct answer is (F). Choices (G), (H), and (J) all offer parenthetical clauses that could be inserted after the word “Shakespeare” in the essay. However, in each case, the additional information provided is only marginally relevant to the topic of the essay. The original version, with none of these clauses, is the best.

7. The correct answer is (B). The writer is contrasting the humble audiences for the first movies with the elite audience for other forms of art. To fit this notion, “the private club” makes more logical sense than any of the other answer choices.

8. The correct answer is (F). The point of the paragraph—and the major point of the essay—is that the large amounts of money involved in modern movie making have taken away some of the freshness and creativity of movies as an art form. To support this point, the original clause is the best.

9. The correct answer is (A). The original punctuation is correct. The three adjectives, “conventional, unimaginative, and stale,” are being listed in a series, and it’s proper to separate the items in the list by commas.

10. The correct answer is (F). “Has been” is correct; it’s a singular verb, to match the singular subject “freshness.”

11. The correct answer is (A). The conjunction “However” logically introduces this paragraph, which shifts the topic of the essay from the freshness of the early movies to the conventionality produced by the money pressures felt by today’s moviemakers. “However” suggests the change in theme.

12. The correct answer is (G). The adverb only sounds most natural, and its meaning is clearest, when it follows has: The sequence makes it clear that the writer is implying “only a known patron, not a vast collection of unknown patrons like those in the movie audience.”

13. The correct answer is (A). The original wording is understandable, grammatical, and idiomatically correct.

14. The correct answer is (J). The proper idiomatic pairing is “the more costly . . . the greater.”

15. The correct answer is (D). Since paragraph 3 offers a conclusion based on the existence of financial pressures in today’s movie industry, it’s logical to put that paragraph after the paragraph in which those pressures are described—paragraph 4.

16. The correct answer is (G). The subject of the verb “include” is the pronoun “that,” which can be either singular or plural. To tell which it is, refer to its antecedent, which is “kind.” Since “kind” is singular, so is “that”; so the singular verb “includes” is needed.

17. The correct answer is (A). The original wording is best. Each of the other answer choices is non-idiomatic and awkward-sounding.

18. The correct answer is (J). All four answer choices say much the same thing. Therefore, the concise single-word alternative “predators” is better than the other, more wordy versions.

19. The correct answer is (A). This sentence makes for the best transition, since it leads the reader from the topic of urodiles toward the second type of animal being discussed, planaria, which are also capable of regeneration.
20. The correct answer is (F). The apposite phrase “a kind of simple worm,” which briefly describes “planaria,” is appropriately set off from the rest of the sentence by being enclosed within a pair of commas.

21. The correct answer is (C). It’s incorrect to use the conjunction “and” at the start of this phrase. Instead, the preposition “with” links the phrase to the rest of the sentence in a way that makes it meaning and its relation to the other parts of the sentence clear.

22. The correct answer is (F). Up to this point, the essay has described a similarity between urodeles and planaria: Both can regenerate. Now, a difference will be discussed: their varying means of accomplishing this. Thus, the connecting word “However,” which suggests a change in theme, makes sense.

23. The correct answer is (A). This sentence is telling what the animal first does when injured. (Later, we’ll learn what the animal does second.) Thus, the adverb “first” most directly modifies the verb “heals,” which means it should be placed as close as possible to that verb. The original location, therefore, is the best one.

24. The correct answer is (G). “Such like” is not idiomatic; “such as” is.

25. The correct answer is (C). The idiomatic expression to use with the verb *revert* is “to being.”

26. The correct answer is (J). What’s needed in this context is the adverb “ultimately” rather than the adjective “ultimate.” It modifies the entire sentence by telling when the event described takes place: at the end of the entire regeneration process.

27. The correct answer is (A). “By contrast” sets up an appropriate transition from the previous paragraph, which discussed how urodeles regenerate, to this one, which shifts to the topic of how planaria regenerate.

28. The correct answer is (H). The sentence as originally worded is a run-on; the second half of the sentence, beginning with “this enables,” could stand alone as a sentence. Choice (H) fixes the problem by turning the second half of the sentence into a modifying phrase clearly attached to the first half of the sentence.

29. The correct answer is (A). The original wording is the clearest way of stating the idea. Choice (B) is wrong because of the plural verb “are” (it should be singular, to match its subject, “which,” referring to “cell type”); choice (D) is wrong because of the weird use of the pronoun “one.” (Whom could it possibly refer to?)

30. The correct answer is (H). The idiomatic phrasing “of the old” implies “of the old [animal],” grammatically parallel to the phrase “an entirely new animal” earlier in the sentence.
Exercise 3

1. **The correct answer is (A).** The original wording is the best choice. Note that choices (B) and (C) are wrong because they shift to a singular construction ("business" rather than "businesses"), which doesn’t fit with the pronoun *they* later in the sentence.

2. **The correct answer is (J).** Choice (J) is the most concise and graceful alternative. One clue: Note that both the original wording and choice (G) include commas around the adverb "simply," which is often a telltale sign of unnecessary awkwardness.

3. **The correct answer is (A).** The clause in the original sentence does the best job of underscoring Wang’s preeminent position in the office automation marketplace. The other statements suggest vaguely related ideas, but none clearly states that Wang was number one in its field, as the original clause does.

4. **The correct answer is (H).** Choices (F) and (G) are unclear in their reference; choice (J) is wordy and awkward. Choice (H) makes the point clearly and concisely.

5. **The correct answer is (A).** The dramatic shift in tone between the first paragraph (describing Wang’s former greatness) and the second paragraph (describing its later collapse) is appropriately signaled by the “Yet.”

6. **The correct answer is (G).** The sentence in the original essay beginning with the word “shrinking” is actually a fragment. Choice (G) fixes this by attacking it to the previous sentence, where it becomes a long phrase modifying “Wang.”

7. **The correct answer is (A).** All four answer choices say much the same thing; choice (A) does it most concisely and gracefully.

8. **The correct answer is (J).** The subject of the sentence is “computer”; the writer’s intention is to have a compound verb, “transformed” and “wiped out.” Choice (J) sets up this structure and makes the relationship between the various parts of the sentence quite clear.

9. **The correct answer is (B).** The correct past participle of the verb “to see” is “seen”; whenever an auxiliary (helping) verb is used, “seen” should be used, not “saw.”

10. **The correct answer is (G).** In this sentence, “its” is being used as the possessive form of the pronoun “it.” Therefore, no apostrophe should be used. (In this way, of course, “its” and other possessive pronouns, such as "yours" and “hers,” differ from other possessives.)

11. **The correct answer is (C).** The plural verb “were” must be used, since the subject is also plural: the compound “excellence and leadership.”
12. The correct answer is (F). This paragraph describes the missteps that led Wang to ignore the personal computer market until it was too late, severely damaging Wang’s business prospects. Only the sentence in choice (F) summarizes this information accurately.

13. The correct answer is (B). The hypothetical business leader discussed in this sentence is trading time for two other things: “more information” and “a decrease in uncertainty.” Since two similar things are being listed, it would be desirable for them to be described in grammatically parallel terms: “more information and less uncertainty.”

14. The correct answer is (F). It’s perfectly idiomatic to speak of someone being “incapable of [bold] action.” Thus, the original wording is correct.

15. The correct answer is (B). There’s no such word as “regardless.” The answer choice that best fits the context is choice (B); the phrase “in either case” refers to the two causes of business leaders’ hesitation to act described in the previous two sentences.

16. The correct answer is (G). The parenthetical phrase “of course” should be set off from the rest of the sentence by a pair of matching bookends: two commas, one before the phrase and one after.

17. The correct answer is (D). The most concise and graceful wording is choice (D).

18. The correct answer is (G). The singular verb “has been” is needed; its subject, “that,” is singular, since it refers to the singular antecedent “subject.” Choice (J) is wrong because the sentence becomes a bit confusing when the underlined words are eliminated altogether.

19. The correct answer is (C). The two adverbs should be grammatically parallel to one another, as they are in choice (C).

20. The correct answer is (F). The alternative versions are all less idiomatic and “normal-sounding” than the original.

21. The correct answer is (D). This version makes the point in fewer, clearer words than either choice (A) or choice (C). Note that choice (B) distorts the meaning of the sentence: “wariness” and “awareness” are two very different things.

22. The correct answer is (F). The original version is grammatically correct and idiomatic.

23. The correct answer is (B). The point of the paragraph is the emotional impact that a vivid photograph can have. The interjected phrase strengthens this point by calling to mind an image that clearly illustrates this impact.

24. The correct answer is (F). This version is the shortest and most concise way of saying what all four answer choices say.

25. The correct answer is (C). The topic of the new paragraph is the fact that photos—despite their inherent realism—can be used to mislead. Choice (C) establishes a clear transition to this topic by making it clear that the writer does not want to exaggerate the claims for the realism of photography stated previously in the essay.

26. The correct answer is (G). The verb “freezes” should be used in order to maintain grammatical parallelism with the verbs “exaggerates” and “omits” earlier in the sentence.

27. The correct answer is (A). The other answer choices are awkward and less idiomatic than this version.
28. The correct answer is (F). If this were a more general essay on the topic of truth and falsehood in art, then a digression on the new computer-generated imagery and its capacity for deception might be relevant and interesting. However, this essay deals solely with photography; in this context, a sentence on computer images seems out of place.

29. The correct answer is (A). By comparison to this phrasing, the others sound awkward and a little vague.

30. The correct answer is (F). The logical connection between the two halves of the sentence is best conveyed by “and.” There is no sharp contrast between the two, so “yet” is wrong, nor is there a cause-and-effect relationship, which eliminates “for” and “so.”
ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment English Test? How well have you incorporated your review knowledge into your test-taking behavior?

After you’ve corrected each exercise, find the number in the table below. This will give you an idea of whether you still need improvement.

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<td>0–7</td>
<td>Poor</td>
<td>Study Chapters 4 and 8 again. See “Additional Resources for Review,” below.</td>
</tr>
<tr>
<td>8–13</td>
<td>Below average</td>
<td>Study problem areas in Chapters 4 and 8. See “Additional Resources for Review,” below if you have time.</td>
</tr>
<tr>
<td>14–18</td>
<td>Average</td>
<td>Skim problem areas in Chapters 4 and 8 if you wish to and have time.</td>
</tr>
<tr>
<td>19–24</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
</tr>
<tr>
<td>25–30</td>
<td>Excellent</td>
<td>You're ready for the ACT Assessment English Test.</td>
</tr>
</tbody>
</table>

ADDITIONAL RESOURCES FOR REVIEW

After reviewing this chapter and trying to apply your knowledge on additional practice exercises and tests, you might still want help in English grammar, usage, or rhetoric. You might be looking further than the ACT Assessment’s reach. However, get as much help as you think you need.
Math Review

OVERVIEW

• Review the basics of ACT Assessment arithmetic
• Review the basics of ACT Assessment algebra
• Review the basics of ACT Assessment geometry
• Review the basics of ACT Assessment coordinate geometry
• Review the basics of ACT Assessment exercises

ARITHMETIC

Numbers and the Number Line

We can think of the real numbers as points on a line. To represent this, we usually draw a horizontal line, with one point on the line chosen to represent zero. All the positive numbers are to the right of zero, and all the negative numbers are to the left of zero. Therefore, the numbers get greater as you go from left to right.

\[ \cdots -4 -3 -2 -1 0 1 2 3 4 \cdots \]

The absolute value of any number \( N \) is symbolized by \( |N| \) and is simply the number without its sign. Thus, \( |8| = 8 \), \( |-7| = 7 \), and \( |0| = 0 \).

The absolute value can be thought of as the distance of the number from zero. The further you get from zero, the greater the absolute value. So numbers far to the left are negative numbers with great absolute values.

When a number line is shown on the ACT Assessment, you can safely assume that the line is drawn to scale and that any numbers that fall between the markings are at appropriate locations. Thus, 2.5 is halfway between 2 and 3, and \(-0.4\) is four tenths of the way from 0 to \(-1\). However, always check the scale, because the “tick marks” do not have to be at unit intervals!
Example 1: On the number line shown below, where is the number that is less than D and half as far from D as D is from G?

| A | B | C | D | E | F | G | H | I |

Solution: First, any number less than D must lie to the left of D. (Get it? Left = less!) The distance from D to G is 3 units. Thus, the point we want must be $1\frac{1}{2}$ units to the left of D—that is, halfway between B and C.

Example 2: On the number line shown below, which point corresponds to the number 2.27?

Solution: Since the labeled end points are 2.2 and 2.3, the ten intervals between must each be one-tenth of the difference. Hence the tick marks must represent hundredths. That is, A = 2.21, B = 2.22, and so on. Thus, we know that G = 2.27.

Laws of Arithmetic and Order of Operations

In carrying out arithmetic or algebraic operations, you should use the famous mnemonic (memory) device Please Excuse My Dear Aunt Sally to recall the correct order of operations. The operations of Powers, Exponents, Multiplication, Division, Addition, and Subtraction should be carried out in that order, reading from left to right.

If we want to indicate a change in order, we place the operation in parentheses, creating one number. Always calculate the number in parentheses first. Thus, $16 - 3 \times 4 = 16 - 12 = 4$, because we multiply before adding. However, if we want the number 16 − 3 to be multiplied by 4, we must write it this way: $(16 - 3) \times 4 = 13 \times 4 = 52$.

The basic laws of arithmetic were originally defined for whole numbers, but they carry over to all numbers. You should know all of them from past experience. They are:

- **The commutative law.** It doesn’t matter in which order you add or multiply two numbers. That is:
  
  $a + b = b + a$
  
  $ab = ba$

- **The associative law,** also called the regrouping law. It doesn’t matter how you group the numbers when you add or multiply more than two numbers. That is:
  
  $a + (b + c) = (a + b) + c$
  
  $a(bc) = (ab)c$
• **The distributive law** for multiplication over addition. This law can be represented as follows:

\[ a(b + c) = ab + ac \]

It means you can add first and then multiply, or multiply each term in the sum by the same amount and then add the two products. Either way the result is the same.

• **The properties of zero and one.** Zero times any number is zero. Zero added to any number leaves the number unchanged. One times any number leaves the number unchanged.

• **The additive opposite.** For every number \( n \), there is a number \( -n \) such that \( n + (-n) = 0 \). This number is the additive opposite.

• **The multiplicative inverse.** For every number \( n \) except 0, there is a number \( \frac{1}{n} \) such that \( (\frac{1}{n})n = 1 \). Division by \( n \) is the same as multiplication by \( \frac{1}{n} \), and division by zero is never allowed.

**Example:** (a) What is the value of \( \frac{3 + B}{4 \times 3 - 3B} \) if \( B = 3 \)? (b) What value is impossible for \( B \)?

**Solution:** (a) The fraction bar in a fraction acts as a “grouping symbol,” like parentheses, meaning we should calculate the numerator and denominator separately. That is, we should read this fraction as \( (3 + B) ÷ (4 \times 3 - 3 \times B) \). When \( B = 3 \), the numerator is \( 3 + 3 = 6 \), and the denominator is \( 12 - 9 = 3 \). Therefore, the fraction is \( \frac{6}{3} = 2 \).

(b) Since we cannot divide by zero, we cannot let \( 4 \times 3 - 3 \times B = 0 \). But in order for this expression to equal zero, \( 4 \times 3 = 3 \times B \). By the commutative law, \( B = 4 \). Thus, the only value that \( B \) cannot have is 4.

**Divisibility Rules**

A factor or divisor of a whole number is a number that evenly divides the given number, leaving no remainder. For example, the divisors of 24 are 1, 2, 3, 4, 6, 8, 12, and 24 itself.

A proper divisor is any divisor except the number itself. Thus, the proper divisors of 24 are 1, 2, 3, 4, 6, 8, and 12. If you want to know whether \( k \) is a divisor of \( n \), try to divide \( n \) by \( k \) and see whether there is any remainder. If the remainder is zero, then \( n \) is divisible by \( k \).
There are several useful rules for testing for divisibility by certain small numbers. These are summarized in the table below.

**TABLE 9.1: RULES FOR TESTING DIVISIBILITY**

<table>
<thead>
<tr>
<th>Number</th>
<th>Divides a number $N$ if . . .</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>$N$ is even; that is, its last digit is 2, 4, 6, 8, or 0.</td>
</tr>
<tr>
<td>3</td>
<td>The sum of the digits of $N$ is divisible by 3.</td>
</tr>
<tr>
<td>4</td>
<td>The last two digits form a number divisible by 4.</td>
</tr>
<tr>
<td>5</td>
<td>The last digit of $N$ is 5 or 0.</td>
</tr>
<tr>
<td>6</td>
<td>The number is divisible by 2 and 3.</td>
</tr>
<tr>
<td>8</td>
<td>The last three digits form a number divisible by 8.</td>
</tr>
<tr>
<td>9</td>
<td>The sum of the digits of $N$ is divisible by 9.</td>
</tr>
</tbody>
</table>

**Example 1:** Consider the number 7,380. By now many numbers in the table above is 7,380 not divisible?

**Solution:** 7,380 is divisible by all the numbers in the table except 8. Do you see why? To start with, 7,380 is divisible by 10 and 5 because its last digit is 0. It is divisible by 2 because it is even, and by 4 because 80 is divisible by 4. However, it is not divisible by 8 because 380 isn’t. In addition, the sum of its digits is 18, which is divisible both by 3 and by 9. Since it is divisible by both 2 and 3, it is also divisible by 6.

**Example 2:** Which numbers in the following list are divisible by 3, 4, and 5 but not by 9?

- 15,840
- 20,085
- 23,096
- 53,700
- 79,130

**Solution:** The easiest thing to look for is divisibility by 5. Just ask, is the last digit a 5 or 0? By inspection, we can eliminate 23,096, whose last digit is 6. We want the number to be divisible by 4, which means it must be even and its last two digits must form a number divisible by 4. That knocks out the number whose last digit is 5 (which is odd), as well as 79,130, because 30 is not divisible by 4.

This leaves 15,840 and 53,700. The digits of 15,840 add up to 18, while those of 53,700 total 15. Both are divisible by 3, but 15,840 is also divisible by 9. Therefore, only 53,700 meets all the conditions.
Divisibility in Addition, Subtraction, and Multiplication

If you add or subtract two numbers that are both divisible by some number \( k \), then the new number formed will also be divisible by \( k \). Thus, 28 and 16 are both divisible by 4. If you take their sum, 44, or their difference, 12, they too are divisible by 4.

If you multiply two numbers together, any number that divides either one also divides the product. Thus, if \( j \) divides \( M \) and \( k \) divides \( N \), then \( jk \) divides \( MN \).

If two numbers being multiplied have a common divisor, then the product is divisible by the square of that number. Thus, \( 21 \times 15 = 315 \) is divisible by 7, because 7 divides 21, and by 5, because 5 divides 15. It is also divisible by \( 35 = 5 \times 7 \), and by 9, because \( 9 = 3^2 \) and 3 divides both 21 and 15.

Example 1

If \( a \) and \( b \) are whole numbers and \( 3a = 2b \), which of the following must be true?

(A) \( a \) is divisible by 2, and \( b \) is divisible by 3.
(B) \( a \) and \( b \) are both divisible by 2.
(C) \( a \) and \( b \) are both divisible by 3.
(D) \( a \) is divisible by 3, and \( b \) is divisible by 2.
(E) None of the above

Solution: The correct answer is (A). If \( 3a = 2b \), then \( 3a \) must be divisible by 2, which means \( a \) must be divisible by 2, since 3 is not. Similarly, \( 2b \) must be divisible by 3, which means \( b \) must be divisible by 3, since 2 is not.

You should be especially aware of the divisibility properties of even and odd numbers.

- **Even numbers** are those that are divisible by 2: \( 0, 2, 4, 6, \ldots \)
- **Odd numbers** are not divisible by 2: \( 1, 3, 5, 7, \ldots \)

Certain simple but very useful results follow from these definitions:

- If you add or subtract two even numbers, the result is even.
- If you add or subtract two odd numbers, the result is even.
- Only when you add or subtract an odd and an even number is the result odd. Thus, \( 4 + 6 \) is even, as is \( 7 - 3 \). But \( 4 + 3 \) is odd.
- When you multiply any whole number by an even number, the result is even.
- Only when you multiply two odd numbers will the result be odd. Thus, \( 4)(6) \) and \( 4)(7) \) are both even, but \( 3)(7) \) is odd.
Example 2: If $3x + 4y$ is an odd number, is $x$ odd or even, or is it impossible to tell?

Solution: $4y$ must be even, so for the sum of $3x$ and $4y$ to be odd, $3x$ must be odd. Since $3$ is odd, $3x$ will be odd only if $x$ is odd. Hence, $x$ is odd.

Example 3: If $121 - 5k$ is divisible by 3, may $k$ be odd?

Solution: The fact that a number is divisible by 3 does not make it odd. (Think of 6 or 12.) Therefore, $121 - 5k$ could be odd or even. It will be odd when $k$ is even and even when $k$ is odd. (Do you see why?) Thus, $k$ could be odd or even. For example, if $k = 2$, $121 - 5k = 111$, which is divisible by 3; and if $k = 5$, $121 - 5k = 96$, which is divisible by 3.

Comparing Fractions

Two fractions $\frac{a}{b}$ and $\frac{c}{d}$ are defined to be equal if $ad = bc$. For example, $\frac{3}{4} = \frac{9}{12}$ because $(3)(12) = (4)(9)$. This definition, using the process known as cross-multiplication, is very useful in solving algebraic equations involving fractions. However, for working with numbers, the most important thing to remember is that multiplying the numerator and denominator of a fraction by the same number (other than zero) results in a fraction equal in value to the original fraction. Thus, by multiplying the numerator and the denominator of $\frac{3}{4}$ by 3, we have $\frac{3}{4} = \frac{(3)(3)}{(4)(3)} = \frac{9}{12}$.

Similarly, dividing the numerator and denominator of a fraction by the same number (other than zero) results in a fraction equal in value to the original fraction. It is usual to divide through the numerator and the denominator of the fraction by the greatest common factor of both numerator and denominator to simplify the fraction to simplest form. Thus, by dividing the numerator and the denominator of $\frac{15}{25}$ by 5, we have $\frac{15}{25} = \frac{15\div5}{25\div5} = \frac{3}{5}$.

For all positive numbers, if two fractions have the same denominator, the one with the greater numerator is greater. If two fractions have the same numerator, the one with the lesser denominator is greater. For example, $\frac{5}{17}$ is less than $\frac{8}{17}$, but $\frac{5}{19}$ is greater than $\frac{8}{19}$.

Example 1: If $b$ and $c$ are both positive whole numbers greater than 1, and $\frac{5}{b} = \frac{b}{c}$, what are the values of $b$ and $c$?

Solution: Using cross-multiplication, $bc = 15$. The only ways 15 can be the product of two positive integers is as $(1)(15)$ or $(3)(5)$. Since both $b$ and $c$ must be greater than 1, one must be 3 and the other 5. Trying both cases, it is easy to see that the only possibility is that $b = 3$ and $c = 5$, making both fractions equal to 1.

Example 2: Which is greater, $\frac{4}{7}$ or $\frac{3}{5}$?

Solution: The first fraction named has a greater numerator, but it also has a greater denominator. To compare the two fractions, rewrite both with the common denominator 35 by multiplying the numerator and denominator of $\frac{4}{7}$ by 5 and the numerator and denominator of $\frac{3}{5}$ by 7. Then, $\frac{4}{7} = \frac{4\times5}{7\times5} = \frac{20}{35}$ and $\frac{3}{5} = \frac{3\times7}{5\times7} = \frac{21}{35}$. Since $\frac{21}{35}$ is greater than $\frac{20}{35}$, $\frac{3}{5}$ is greater than $\frac{4}{7}$.
denominator of \( \frac{3}{5} \) by 7 to yield \( \frac{20}{35} \) and \( \frac{21}{35} \), respectively. Now, it is easy to see that \( \frac{21}{35} \) is the greater.

**Example 3:** Which is greater, \( \frac{-6}{11} \) or \( \frac{13}{22} \)?

**Solution:** First of all, it does not matter where you put the negative sign—numerator, denominator, or opposite the fraction bar; if there is one negative sign anywhere in a fraction, the fraction is negative.

Next, remember: In comparing negative numbers, the one with the greater absolute value is the lesser number. So start by ignoring the signs, and compare the absolute values of the fractions. If the two fractions had a common denominator or numerator, it would be easy. So, multiply the numerator and denominator of \( \frac{-6}{11} \) by 2 to yield \( \frac{-12}{22} \), and it is easy to see that \( \frac{-12}{22} \) is the greater. Hence, \( \frac{13}{22} \) has the greater absolute value, meaning that \( \frac{-6}{11} \) is the greater number.

Of course, you could have solved either of these last two examples on a calculator. Dividing the numerator by the denominator will yield a decimal. Thus, in Example 2, as a decimal \( \frac{4}{7} = 0.571 \ldots \) and \( \frac{3}{5} = 0.6 \). Try Example 3 this way for yourself.

**Arithmetic with Fractions**

**Multiplication and Division**

When multiplying two fractions, the result is the product of the numerators divided by the product of the denominators. In symbols, \( \frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd} \). Thus, \( \frac{3}{5} \times \frac{10}{11} = \frac{30}{55} \).

Don’t forget that the resulting fraction can be simplified to simplest form by dividing out like factors in numerator and denominator. Thus, \( \frac{3}{5} \times \frac{15}{5} = \frac{3}{5} \).

**DIVIDING:** To divide fractions or mixed numbers, remember to multiply by the reciprocal of the divisor (the number after the division sign).

\[
\text{Divide: } \frac{4}{2} \div \frac{3}{4} = \frac{9}{2} \times \frac{4}{3} = 6
\]

\[
\text{Divide: } 62 \frac{1}{2} \div 5 = \frac{125}{2} \times \frac{1}{5} = 12 \frac{1}{2}
\]

**Example 1:** Jasmine earns \( \frac{3}{7} \) of what Sidney earns, and Sidney earns \( \frac{2}{3} \) of what Paul earns. What fraction of Paul’s salary does Jasmine earn?

Using \( J, S, \) and \( P \) to stand for the people’s earnings respectively, we have:

\[
S = \frac{2}{3} P, \quad J = \frac{3}{4} S
\]
Thus:

\[ J = \frac{3}{4} \times \frac{2}{3} P = \frac{1}{2} P \]

**Example 2:** Pedro has half as many CDs as Andrea has, and Marcia has \( \frac{3}{5} \) as many CDs as Andrea. What fraction of Marcia’s number of CDs does Pedro have?

**Solution:** Using \( P, A, \) and \( M \) to stand for the number of CDs each owns respectively, we have:

\[ P = \frac{1}{2} A; \ M = \frac{3}{5} A \]

Thus:

\[ \frac{P}{M} = \frac{\frac{1}{2} A}{\frac{3}{5} A} = \frac{1}{2} \times \frac{5}{3} = \frac{5}{6} \]

So Pedro has \( \frac{5}{6} \) as many CDs as Marcia.

**Addition and Subtraction**

To add or subtract fractions with the same denominator, simply add or subtract the numerators. For example, \( \frac{5}{17} + \frac{3}{17} = \frac{8}{17} \) and \( \frac{5}{17} - \frac{3}{17} = \frac{2}{17} \).

However, if the denominators are different, you must first rewrite the fractions so they will have the same denominator. That is, you must find a common denominator. Most books and teachers stress that you should use the least common denominator (LCD), which is the least common multiple (LCM) of the original denominators. This will keep the numbers lesser. However, any common denominator will do!

If you are rushed, you can always find a common denominator by just taking the product of the two denominators. For example, to add \( \frac{5}{12} + \frac{3}{8} \), you can multiply the denominators 12 and 8 to find the common denominator 96. Thus:

\[ \frac{5}{12} + \frac{3}{8} = \frac{5 \times 8}{12 \times 8} + \frac{3 \times 12}{8 \times 12} = \frac{40}{96} + \frac{36}{96} = \frac{76}{96} \]

Now you can divide both the numerator and the denominator by 4 to simplify the fraction to its simplest form; that is: \( \frac{76}{96} = \frac{19}{24} \).

To find the least common denominator, you must first understand what a least common multiple is. Given two numbers \( M \) and \( N \), any number that is divisible by both is called a common multiple of \( M \) and \( N \). The least common multiple (LCM) of the two numbers is the least number that is divisible by both. For example, 108 is divisible by both 9 and 12, so 108 is a common multiple; but the LCM is 36.
CHAPTER 9: Math Review

For small numbers, the easiest way to find the LCM is simply to list the multiples of each number (in writing or in your head) until you find the first common multiple. For example, for 9 and 12, we have the following multiples:

9 18 27 36 45 . . .
12 24 36 48 60 . . .

The first number that appears in both lists is 36.

The traditional method for finding the LCM, which is the method that translates most readily into algebra, requires that you find the prime factorization of the numbers.

Every whole number is either prime or composite. A prime is a whole number that has exactly 2 factors, namely 1 and the number itself. Any whole number, greater than 1, that is not prime is composite.

All composite numbers can be factored into primes in an essentially unique way. To find an LCM, you must find the least number that contains all the factors of both numbers. Thus, 9 factors as (3)(3), and 12 factors as (2)(2)(3). The LCM is the least number that has all the same factors: that is, two 3s and two 2s. Since (3)(3)(2)(2) = 36, the LCM is 36.

This definition also extends to sets of more than two numbers. Thus, the LCM of 12, 15, and 20 must contain all the prime factors of all three numbers: (2)(2)(3); (3)(5); (2)(2)(5). So the LCM is (2)(2)(3)(5) = 60. Now to add \( \frac{5}{12} + \frac{3}{8} \) using the least possible numbers, we find the LCM of 12 and 8, which is 24. Then, we write \( \frac{5}{12} = \frac{10}{24} \) and \( \frac{3}{8} = \frac{9}{24} \). Thus,

\[
\frac{5}{12} + \frac{3}{8} = \frac{10}{24} + \frac{9}{24} = \frac{19}{24}
\]

**Example 3:** Find the LCM for 18 and 30.

**Solution:** Using prime factorization, 18 = (2)(3)(3), and 30 = (2)(3)(5). Since the factors 2 and 3 are common to both numbers, we need only multiply in one extra 3 to get the factors of 18 and a 5 to get the factors of 30. Thus, the LCM = (2)(3)(3)(5) = 90.

**Example 4:** Mario figures that he can finish a certain task in 20 days. Angelo figures that he can finish the same task in 25 days. What fraction of the task can they get done working together for seven days?

**Solution:** In seven days, Mario would do \( \frac{7}{20} \) of the entire task. In the same week, Angelo would do \( \frac{7}{25} \) of the entire task. Therefore, together they do \( \frac{7}{20} + \frac{7}{25} \) of the whole job.
Now we have to add two fractions that have the same numerator. Can we add them directly by just summing the denominators? No! To add directly, the denominators must be the same! Instead, we must find a common denominator. The LCD is 100. Thus,

$$\frac{7}{25} + \frac{7}{20} = \frac{28}{100} + \frac{35}{100} = \frac{63}{100}$$

$\frac{63}{100}$ may also be expressed as 0.63 or 63%. Do you know why? If not, read the next section carefully.

**Fractions, Decimals, and Percents**

Every fraction can be expressed as a **decimal**, which can be found by division. Those fractions for which the prime factorization of the denominator involves only 2’s and 5’s will have terminating decimal expansions. All others will have repeating decimal expansions. For example, $\frac{3}{20} = 0.15$, while $\frac{3}{11} = 0.272727 \ldots$

To rename a number given as a decimal as a fraction, you must know what the decimal means. In general, a decimal represents a fraction with a denominator of 10, or 100, or 1,000, . . . , where the number of zeros is equal to the number of digits to the right of the decimal point. Thus, for example, 0.4 means $\frac{4}{10}$; 0.52 means $\frac{52}{100}$; and 0.103 = $\frac{103}{1000}$.

Decimals of the form 3.25 are equivalent to **mixed numbers**; thus, $3.25 = 3 + \frac{25}{100}$. For purposes of addition and subtraction, mixed numbers can be useful, but for purposes of multiplication or division, it is usually better to rename a mixed number as an **improper fraction**. Thus:

$$3 \frac{1}{4} = \frac{13}{4}$$

How did we do that? Formally, we realize that $3 = \frac{3}{1}$, and we add the two fractions $\frac{3}{1}$ and $\frac{1}{4}$, using the common denominator 4. In informal terms, we multiply the whole number part (3) by the common denominator (4), and add the numerator of the fraction (1) to get the numerator of the resulting improper fraction. That is, $(3)(4) + 1 = 13$.

**Example 1:** If $\frac{0.56}{\frac{1}{25}}$ simplified to simplest form is $\frac{a}{b}$, and $a$ and $b$ are positive whole numbers, what is $b$?

**Solution:** Rewriting both numerator and denominator as their fractional equivalents, $0.56 = \frac{56}{100} = \frac{14}{25}$, and $1.26 = 1 + \frac{26}{100} = 1 + \frac{13}{50} = \frac{63}{50}$.

We now accomplish the division by multiplying by the reciprocal of the denominator. Thus,

$$\left(\frac{14}{25}\right)\left(\frac{50}{63}\right) = \frac{4}{9}$$

As you can see, $b = 9$.
Of course, you could also solve this example by renaming the numerator and denominator of the original fraction as whole numbers. You would multiply both the numerator and the denominator by 100 to move both decimal points two places to the right; thus, \( \frac{0.56}{1.26} = \frac{56}{126} \). Now you can divide out the common factor of 14 in the numerator and the denominator to simplify the fraction to \( \frac{4}{9} \).

Percent means per hundred (from the Latin word *centum* meaning “hundred”). So that, for example, 30% means 30 per hundred, or as a fraction \( \frac{30}{100} \), or as a decimal 0.30.

To rename a number given as a percent as a decimal, simply move the decimal point two places to the left. To rename a decimal as a percent, reverse the process—move the decimal point two places to the right.

To avoid confusion, keep in mind the fact that, when written as a percent, the number should look bigger. Thus, the “large” number 45% = 0.45, and the “small” number 0.73 = 73%.

**Example 2:** In a group of 20 English majors and 30 history majors, 50% of the English majors and 20% of the history majors have not taken a college math course. What percent of the entire group have taken a college math course?

**Solution:** Start with the English majors. Since 50% = 0.50, 50% of 20 = (0.50)(20) = 10. For the history majors, 20% = 0.20; 20% of 30 = (0.20)(30) = 6. Hence, a total of 16 out of 50 people in the group have not taken math, which means that 34 have. As a fraction, 34 out of 50 is \( \frac{34}{50} = 0.68 = 68\% \).

**Averages**

There are three common measurements used to define the typical value of a collection of numbers. However, when you see the word *average* with no other explanation, it is assumed that what is meant is the *arithmetic mean*. The average in this sense is the sum of the numbers divided by the number of numbers in the collection. In symbols, \( \bar{x} = \frac{T}{n} \).

So, for example, if on four math exams you scored 82, 76, 87, and 89, your average at this point is \( \frac{82 + 76 + 87 + 89}{4} = \frac{334}{4} = 83.5 \).

**Example 1:** At an art show, Eleanor sold six of her paintings at an average price of $70. At the next show, she sold four paintings at an average price of $100. What was the overall average price of the 10 paintings?

**Solution:** You can’t just say the answer is 85, the average of 70 and 100, because we do not have the same number of paintings in each group. We need to know the overall total. Since the first six average $70, the total received for the six was $420. Do you see why? (70 = \( \frac{T}{6} \); therefore, \( T = (6)(70) = 420 \)). In the same way, the next four paintings must have brought in $400 in order to average $100 apiece. Therefore, we have a total of 10 paintings selling for $420 + $400 = $820, and the average is \( \frac{820}{10} = $82 \).
Example 2: Erica averaged 76 on her first four French exams. To get a B in the course, she must have an 80 average on her exams. What grade must she get on the next exam to bring her average to 80?

Solution: If her average is 76 on four exams, she must have a total of \((4)(76) = 304\). In order to average 80 on five exams, her total must be \((5)(80) = 400\). Therefore, she must score \(400 - 304 = 96\) on her last exam. Study hard, Erica!

The other measurements used to define the typical value of a set of numbers are the median, which is the middle number when the numbers are arranged in increasing order, and the mode, which is the most common number.

Example 3: Which is greater for the set of nine integers \{1, 2, 2, 2, 3, 5, 6, 7, 8\}, the mean minus the median or the median minus the mode?

Solution: The median (middle number) is 3, the mode is 2, and the mean is \((1 + 2 + 2 + 2 + 3 + 5 + 6 + 7 + 8)/9 = 4\). Thus, the mean minus the median is \(4 - 3 = 1\), and the median minus the mode is \(3 - 2 = 1\). The two quantities are equal.

ALGEBRA

Signed Numbers

Addition and Subtraction

To add two numbers of the same sign, just add their absolute values and attach their common sign. So \(7 + 9 = 16\), and \((-7) + (-9) = -16\). You could drop the parentheses and instead of \((-7) + (-9)\) write \(-7 - 9\), which means the same thing. In other words, adding a negative number is the same thing as subtracting a positive number.

When adding numbers of opposite signs, temporarily ignore the signs, subtract the lesser from the greater, and attach to the result the sign of the number with the greater absolute value. Thus, \(9 + (-3) = 6\), but \((-9) + 3 = -6\). Again, we could have written \(9 + (-3) = 9 - 3 = 6\) and \((-9) + 3 = -9 + 3 = -6\).

When subtracting, change the sign of the second number (the subtrahend) and then use the rules for addition. Thus, \(7 - (-3) = 7 + 3 = 10\) and \(-7 - 3 = -7 + (-3) = -10\).

Example 1: Evaluate \(-A - (-B)\) when \(A = -5\) and \(B = -6\).

Solution: All the negative signs can be confusing. However, if you remember that “minus a negative is a plus,” you can do this in two ways. The first is to realize that if \(B = -6\), then \(-B = +6\), and if \(A = -5\), then \(-A = 5\). Thus, \(-A - (-B) = 5 - 6 = -1\).

Alternatively, you can work with the variables first: \(-A - (-B) = -A + B = -(5) + (-6) = 5 - 6 = -1\).

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Multiplication and Division

If you multiply two numbers with the same sign, the result is positive. If you multiply two numbers with opposite signs, the result is negative. The exact same rule holds for division. Thus, \((-4)(-3) = +12\), and \((-4)(3) = -12\). For division, it doesn’t matter which is negative and which positive; thus, \((-6) ÷ (2) = -3\), and \((6) ÷ (-2) = -3\), but \((-6) ÷ (-2) = +3\).

If you have a string of multiplications and divisions to do, if the number of negative factors is even, the result will be positive; if the number of negative factors is odd, the result will be negative. Of course, if even one factor is zero, the result is zero, and if even one factor in the denominator (divisor) is zero, the result is undefined.

Example 2: If \(A = (234,906 - 457,219)(35)(-618)\) and \(B = (-2,356)(-89,021)(-3,125)\), which is greater, \(A\) or \(B\)?

Solution: Don’t actually do the arithmetic! 457,219 is greater than 234,906, so the difference is a negative number. Now, \(A\) is the product of two negative numbers and a positive number, which makes the result positive. \(B\) is the product of three negative numbers and must be negative. Every positive number is greater than any negative number, so \(A\) is greater than \(B\).

Example 3

Q If \(\frac{AB}{MN}\) is a positive number, and \(N\) is negative, which of the following are NOT possible?

(F) \(A\) is positive, and \(B\) and \(M\) are negative.

(G) \(A\), \(B\), and \(M\) are negative.

(H) \(A\), \(B\), and \(M\) are positive.

(J) \(B\) is positive, and \(A\) and \(M\) are negative.

(K) \(M\) is positive, and \(A\) and \(B\) are negative.

Solution: The correct answer is (G). To determine the sign of the fraction, we can just think of \(A\), \(B\), \(M\), and \(N\) as four factors. Knowing that \(N\) is negative, the product of the other three must also be negative in order for the result to be positive. The only possibilities are that all are negative or one is negative and the other two are positive. This works only for choice (G).

Laws of Exponents

In an expression of the form \(b^n\), \(b\) is called the base and \(n\) is called the exponent or power. We say, “\(b\) is raised to the power \(n\)” \((b^1 = b\); hence, the power 1 is usually omitted\(). If \(n\) is any positive integer, then \(b^n\) is the product of \(n\) \(b\)'s. For example, \(4^3\) is the product of three 4's, that is, \(4^3 = 4 \times 4 \times 4 = 64\).
Certain rules for operations with exponents are forced upon us by this definition.

- \( b^m \times b^n = b^{m+n} \). That is, when multiplying powers of the same base, keep the base and add the exponents. Thus, \( 3^2 \times 3^3 = 3^{2+3} = 3^5 = 243 \).

- \((ab)^n = a^nb^n\) and \(\frac{(ab)^n}{\left(\frac{a}{b}\right)^n} = \frac{a^n}{b^n}\)

  That is, to raise a product or quotient to a power, raise each factor to that power, whether that factor is in the numerator or denominator. Thus, \((2x)^3 = 2^3x^3 = 8x^3\), and \(\left(\frac{2}{x}\right)^3 = \frac{2^3}{x^3} = \frac{8}{x^3}\).

- \((b^m)^n = b^{mn}\). That is, to raise a power to a power, retain the base and multiply exponents. Thus, \((2^3)^2 = 2^{6} = 64\).

- \(\frac{b^m}{b^n} = b^{m-n}\) if \(n > m\), and \(\frac{b^m}{b^n} = \frac{1}{b^{n-m}}\) if \(n < m\). That is, to divide powers of the same base, subtract exponents. For example, \(\frac{x^4}{x^2} = x^{4-2} = x^2\), and \(\frac{x^2}{x^4} = \frac{1}{x^{4-2}} = \frac{1}{x^2}\).

For various technical reasons, \(x^0 = 1\) for all \(x\) except \(x = 0\), in which case it is undefined. With this definition, one can define \(b^{-n}\) in such a way that all the laws of exponents given above still work even for negative powers! This definition is \(b^{-n} = \frac{1}{b^n}\).

Now you have the choice of writing \(\frac{x^1}{x^7}\) as \(\frac{1}{x^6}\) or as \(x^{-2}\).

**Example 1:** If \(x = 2\), which is greater, \(1.10\) or \(x^0 + x^{-4}\)?

**Solution:** If \(x = 2\), \(x^0 = 2^0 = 1\), and \(x^{-4} = 2^{-4} = \frac{1}{2^4} = 0.0625\). Hence, \(x^0 + x^{-4} = 1.0625\), which is less than \(1.10\).

**Example 2**

<table>
<thead>
<tr>
<th>(2x^3)</th>
<th>(x^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8x^3)</td>
<td>(\frac{8x^3}{x^4})</td>
</tr>
<tr>
<td>(\frac{8x^3}{x^7})</td>
<td>(\frac{x^4}{8})</td>
</tr>
</tbody>
</table>

**Solution:** The correct answer is \((D)\). Cubing the numerator, we cube each factor. Since \(2^3 = 8\), we have \(\frac{(2x)^3}{x^7} = \frac{8x^3}{x^7}\).

We now divide \(x^3\) by \(x^7\) by subtracting the exponents: \(3 - 7 = -4\). Notice that we could have written \(8x^{-4}\) as \(\frac{8}{x^4}\).
Be alert to the properties of even and odd powers. Even powers of real numbers cannot be negative. This rule applies to both positive and negative integer powers. Thus, $x^2$ is positive, as is $x^{-2}$ except for $x = 0$, when $x^2$ is zero and $x^{-2}$ is undefined (because you cannot divide by zero).

Odd powers are positive or negative, depending upon whether the base is positive or negative. Thus, $2^3 = 8$, but $(-2)^3 = -8$. Zero to any power is zero, except zero to the zero, which is undefined.

**Example 3:** If $x < 0$ and $y > 0$, what is the sign of $-4x^4y^3$?

**Solution:** $x^4$ is positive, because it has an even power. $y^3$ is positive because $y$ is, and $-4$ is obviously negative. The product of two positives and a negative is negative. Thus, $-4x^4y^3$ is negative.

**Example 4:** If $x^4 + 3y^2 = 0$, what is the sign of $2x - 6y + 1$?

**Solution:** Since neither $x^4$ nor $3y^2$ can be negative, the only way their sum can be zero is if both $x$ and $y$ are zero. Therefore, $2x - 6y + 1 = +1$, which is positive.

**Ratio, Proportion, and Variation**

A fractional relationship between two quantities is frequently expressed as a ratio. A ratio can be written as a fraction, $\frac{b}{a}$, or in the form $b:a$ (read “$b$ is to $a$”). A proportion is a statement that two ratios are equal. To say, for example, that the ratio of passing to failing students in a class is 5:2 means that if we set up the fraction representing the relationship between the number of passing and failing students, it should simplify to $\frac{5}{2}$. If we write this statement as $P:F::5:2$, we read it “$P$ is to $F$ as 5 is to 2,” and it means $\frac{P}{F} = \frac{5}{2}$.

Often, a good way to work with information given in ratio form is to represent the numbers as multiples of the same number.

**Example 1**

The ratio of Democrats to Republicans in a certain state legislature is 5:7. If the legislature has 156 members, all of whom are either Democrats or Republicans (but not both), what is the difference between the number of Republicans and the number of Democrats?

- (A) 14
- (B) 26
- (C) 35
- (D) 37
- (E) 49
Solution: The correct answer is (B). Let the number of Democrats be $5m$ and the number of Republicans be $7m$, so that $D : R :: 5m : 7m = 5 : 7$. The total number of legislators is $5m + 7m = 12m$, which must be 156. Therefore, $12m = 156$, and $m = 13$. Thus, the difference is $7m - 5m = 2m = 2(13) = 26$.

When you are told that one quantity, say $y$, varies directly with (or as) $x$, that means simply that $y = kx$, where $k$ is some constant.

To say that $y$ varies directly with $x^2$ or $x^3$ or any given power means that $y = kx^p$. If you are told that $y$ varies inversely with $x$, it means that $y = \frac{k}{x}$. Similarly, if $y$ varies inversely with $x^n$, it means that $y = \frac{k}{x^n}$.

Usually, the problem is to first determine $k$ (the constant of proportionality) and then solve further.

Example 2: The time it takes to run a computer sorting program varies directly with the square of the number of items to be sorted. If it takes 7 microseconds to sort a list of 12 items, how long will it take to sort 40 items?

Solution: Letting $t =$ time in microseconds and $x =$ the number of items to be sorted, the relationship must be $t = kx^2$. When $x = 12$, $t = 7$. Therefore, $7 = k(12)^2 = 144k$. Hence, $k = \frac{7}{144}$. Thus, $t = \frac{7}{144}x^2$. When $x = 40$, $t = \frac{7}{144}(40)^2 = \frac{28000}{144} = \approx 194.4$. When $x = 40$, $t = \frac{7}{144}(40)^2 = \frac{28000}{144} = \approx 194.4$.

Example 3: The time it takes to paint a wall is directly proportional to the area of the wall and inversely proportional to the number of painters. If 3 painters can paint 1,000 square feet of wall in 6 hours, how many square feet can 8 painters paint in 15 hours?

Solution: The relationship must be $t = k\left(\frac{A}{p}\right)$, where $t =$ time, $A =$ area, and $p =$ number of painters. Hence, when $A = 1,000$ and $p = 3$, $6 = k\left(\frac{1000}{3}\right)$. That is, $6 = 125k$ and $k = \frac{6}{125}$. Now we substitute $p = 8$ and $t = 15$ into $t = \left(\frac{6}{125}\right)\left(\frac{A}{8}\right)$, yielding $15 = \left(\frac{6}{125}\right)\left(\frac{A}{8}\right) = \frac{3A}{500}$. Multiplying by 500 and dividing by 3, we have $A = 1,500$.

Solving Linear Equations

To solve a linear equation, remember these rules:

- If you add or subtract the same quantity from both sides of an equation, the equation will still be true and will still have the same roots (solutions).
- If you multiply or divide both sides of an equation by any number except zero, the equation will still be true and will still have the same roots.

Use these two properties to isolate the unknown quantity on one side of the equation, leaving only known quantities on the other side. This is known as solving for the unknown.
Example 1: If $14 = 3x - 1$ and $B = 6x + 4$, what is the value of $B$?

Solution: From the first equation, $3x - 1 = 14$. Add 1 to both sides:

$$3x - 1 = 14$$
$$1 = 1$$
$$3x = 15$$

Divide both sides by 3:

$$\frac{3x}{3} = \frac{15}{3}; x = 5$$

Of course, the question asked for $B$, not $x$. So we substitute $x = 5$ into $B = 6x + 4$ and get $B = 6(5) + 4 = 34$.

Example 2: If $\frac{2x}{3} + 2 = a$ and $y = 2x + 6$, what is the value of $y$ in terms of $a$?

Solution: How do we do this? We realize that if we knew what $x$ was in terms of $a$, then we could substitute that expression for $x$ into $y = 2x + 6$ and have $y$ in terms of $a$. In other words, we want to solve $\frac{2x}{3} + 2 = a$ for $x$.

Multiply through by 3 to clear the fractions. Be careful: Use the distributive law and multiply every term on both sides by 3. You should now have:

$$2x + 6 = 3a$$

Now, add $-6$ to both sides of the equation:

$$2x + 6 = 3a$$
$$-6 = -6$$
$$2x = 3a - 6$$

Now, divide by 2:

$$x = \frac{3a - 6}{2}; x = \frac{3a - 6}{2}$$

Substituting:

$$y = 2 \left( \frac{3a - 6}{2} \right) + 6$$
$$y = 3a - 6 + 6$$
$$y = 3a$$
Solving Linear Inequalities

The statement that a number $M$ is less than another number $N$ means that $N - M$ is positive. In other words, when you subtract a lesser number from a greater number, the result is positive. In symbols, this can be expressed: $M < N$ or $N > M$.

On the number line, if $M < N$, we can infer that $M$ lies to the left of $N$. This means, in particular, that any negative number is less than any positive number. It also implies that, for negative numbers, the one with the greater absolute value is the lesser number.

Inequalities (also called inequations) can be solved in the same way as equations. When working with inequalities, remember these rules:

- If you add or subtract the same quantity from both sides of an inequality, it will still be true in the same sense. Thus, $14 > 7$ and $14 - 5 > 7 - 5$.
- If you multiply or divide both sides of an inequality by the same positive number, the inequality will still be true in the same sense. Thus, $3 < 8$ and $(6)(3) < (6)(8)$
- If you multiply or divide both sides of an inequality by the same negative number, the inequality will still be true but with the sense reversed. Thus, $4 < 9$; but if you multiply by $(-2)$, you get $-8 > -18$. (Remember, for negative numbers, the one with the greater absolute value is the lesser number.)

Notice that these rules hold whether you are working with < (is less than) and > (is greater than) or $\leq$ (is less than or equal to) and $\geq$ (is greater than or equal to). Use them to isolate the unknown quantity on one side of the inequality, leaving only known quantities on the other side. This is known as solving for the unknown. Solutions to inequalities can be given in algebraic form or displayed on the number line.

Example 1: For what values of $x$ is $12 - x \geq 3x + 8$?

Solution: We solve this just like an equation. Start by adding the like quantity $(x - 8)$ to both sides in order to group the $x$ terms on one side and the constants on the other; thus:

\[
12 - x \geq 3x + 8 \\
12 - x - 3x - 8 \geq 0 \\
4 - 4x \geq 0 \\
4 \geq 4x \\
\frac{1}{4} \geq x
\]

Now divide both sides by 4, which does not change the sense of the inequality, yielding:

$1 \geq x$
Hence, the inequality will be true for any number less than or equal to 1 and false for
any number greater than 1. For example, if $x = 3$, $12 - x = 9$, and $3x + 8 = 17$, and the
inequality is not satisfied. Graphically, this can be shown as in the figure below.

Notice that the darkened section is the set of solution values, and the solid dot at $x = 1$
indicates that the value 1 is included in the solution set. By contrast, see the figure below.
It shows the solution set for $x < 2$, where the open circle shows that $x = 2$ is not included.

**Example 2:** If $A < 2 - 4B$, can you tell how great $B$ is in terms of $A$? Can you tell the
least value of $B$?

**Solution:** We are really being asked to solve the inequality for $B$. To start, we add $-2$
to both sides, thus:

\[
A < 2 - 4B \\
-2 = -2 \\
A - 2 < -4B
\]

Next divide by $-4$, remembering to reverse the inequality, thus:

\[
\frac{A - 2}{-4} > B; \frac{2 - A}{4} > B
\]

Notice two things here. When we changed the denominator on the left-hand side from $-4$
to $+4$, we also changed the sign of the numerator, by changing $(A - 2)$ to $(2 - A)$. Of course,
this is the equivalent of multiplying the numerator and the denominator by $-1$.

Also, this tells us what $B$ is less than, nothing about what $B$ is greater than. For example,
if $A$ were 6, then $B < -1$, but $B$ could be $-100$ or $-1000$ or anything else “more negative”
than $-1$.

**Solving Two Linear Equations with Two Unknowns**

Many word problems lead to equations with two unknowns. Usually, one needs as many
equations as there are unknowns to solve for all or some of the unknowns: in other
words, to solve for two unknowns, two independent equations are needed; to solve for
three unknowns, three equations are needed, and so on. However, there are exceptions.
You should know two methods for solving two equations with two unknowns. They are the method of substitution and the method of elimination by addition and subtraction. We shall illustrate both methods by example. The first example uses the method of substitution.

**Example 1:** Mrs. Green and her three children went to the local movie. The total cost of their admission tickets was $14. Mr. and Mrs. Arkwright and their five children went to the same movie, and they had to pay $25. What was the cost of an adult ticket, and what was the cost of a child’s ticket?

**Solution:** Expressing all amounts in dollars, let \( x \) = cost of an adult ticket, and let \( y \) = cost of a child’s ticket.

For the Greens:
\[
x + 3y = 14
\]
For the Arkwrights:
\[
2x + 5y = 25
\]

The idea of the method of substitution is to solve one equation for one variable in terms of the other and then substitute that solution into the second equation. Here, we solve the first equation for \( x \), because that is the simplest one to isolate:
\[
x = 14 - 3y
\]
Substitute this value into the second equation:
\[
2(14 - 3y) + 5y = 25
\]
This gives us one equation with one unknown that we can solve:
\[
28 - 6y + 5y = 25
\]
\[
-y = -3; \ y = 3
\]
Now that we know \( y = 3 \), we substitute this into \( x = 14 - 3y \) to get:
\[
x = 14 - 3(3) = 5
\]
Thus, the adult tickets were $5 each and the children’s tickets were $3 each.

Here is an example using the method of elimination.

**Example 2:** Paula and Dennis both went to the bakery. Paula bought 3 rolls and 5 muffins for a total cost of $3.55. Dennis bought 6 rolls and 2 muffins for a total cost of $3.10. What was the price of one roll?

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Solution: Let us express all amounts in cents. Let $r$ = the cost of a roll; let $m$ = the cost of a muffin. Paula paid:

$$3r + 5m = 355$$

Dennis paid:

$$6r + 2m = 310$$

The idea of the method of elimination is that adding equal quantities to equal quantities gives a true result. So we want to add some multiple of one equation to the other equation such that when the two equations are added together, one variable will be eliminated.

In this case, it is not hard to see that if we multiply the first equation by $-2$, the coefficient of $r$ will become $-6$. Then, if we add the two equations, $r$ will drop out. Here's how it works:

$-2$ times the first equation is: $-6r - 10m = -710$

The second equation is: $6r + 2m = 310$

Adding: $-8m = -400$

Dividing by $-8$, $m = 50$. We now substitute this into either of the two equations. Let's use the second:

$$6r + (2)(50) = 310$$

$$6r = 210; r = 35$$

Thus, muffins are 50¢ each and rolls are 35¢.

Word Problems with One or Two Unknowns

There are word problems of many different types. Many, like age or coin problems, involve only common sense. For others, there are specific formulas or pieces of factual knowledge that can be helpful.

For example, for consecutive integer problems, you need to know that consecutive integers differ by 1; therefore, a string of such numbers can be represented by $n, n + 1, n + 2, \ldots$.

Consecutive even or odd integers differ by 2, so a string of such numbers can be represented as $n, n + 2, n + 4, \ldots$

Travel problems usually require you to use the formula $d = rt$; that is, Distance equals Rate times Time.
Example 1: Sally is 6 years older than Manuel; three years ago, Sally was twice as old as Manuel. How old is Sally today?

Solution: If you have trouble setting up the equations, try plugging in possible numbers. Suppose that Sally is 20 today. If Sally is 6 years older than Manuel, how old is Manuel? He is 14. You get from 14 to 20 by adding 6. So if $S$ is Sally’s age and $M$ is Manuel’s, $S = M + 6$.

Three years ago, Sally was $S - 3$, and Manuel was $M - 3$. So, from the second sentence, we know that $S - 3 = 2(M - 3)$ or $S - 3 = 2M - 6$. Thus, $S = 2M - 3$.

Now, substituting $S = M + 6$, into the second equation:

$$M + 6 = 2M - 3$$

$$M = 9$$

Which means that Sally is $9 + 6 = 15$.

Example 2: Three consecutive odd integers are written in increasing order. If the sum of the first and second and twice the third is 46, what is the second number?

Solution: Calling the smallest number $x$, the second is $x + 2$, and the third is $x + 4$.

Therefore:

$$x + (x + 2) + 2(x + 4) = 46$$

$$x + x + 2 + 2x + 8 = 46$$

$$4x + 10 = 46$$

$$4x = 36; x = 9$$

Hence, the second number is $9 + 2 = 11$.

Example 3: It took Andrew $1 \frac{1}{2}$ hours to drive from Aurora to Zalesville at an average speed of 50 miles per hour. How fast did he have to drive back in order to reach Aurora in 80 minutes?

Solution: The distance from Aurora to Zalesville must be given by $d = rt = (50)(1.5) = 75$ miles. Since 80 minutes is 1 hour and 20 minutes, or $1 \frac{1}{3} = \frac{4}{3}$ hours, we must solve the equation $75 = \frac{4}{3}r$. Multiplying by 3, we have $225 = 4r$; then, dividing by 4, $r = 56.25$ mph.

Monomials and Polynomials

In any group of algebraic and arithmetic expressions, each expression is called a term. Monomial describes a single term; for example, we might say that $2x + 3y^2 + 7$ is the sum of three terms or three monomials.
CHAPTER 9: Math Review

Technically, if we enclose an algebraic expression in parentheses, it becomes one term, so that we could say that \((x + 2y) + (3x - 5y^2)\) is the sum of two monomials. But usually, when we talk about a monomial, we mean a term that is a single product of certain given constants and variables, possibly raised to various powers. Examples might be 7, 2x, \(-3y^2\), \(4x^2z^4\). Each of these is a monomial.

In a monomial, the constant factor is called the coefficient of the variable factor. Thus, in \(-3y^2\), \(-3\) is the coefficient of \(y^2\). If we restrict our attention to monomials of the form \(Ax^n\), the sums of such terms are called polynomials. Polynomials with two terms are called binomials, and those with three terms are called trinomials. Expressions like \(3x + 5\), \(2x^2 - 5x + 8\), and \(x^4 - 7x^2 - 11\) are all examples of polynomials.

In a polynomial, the highest power of the variable that appears is called the degree of the polynomial. The three examples just given are of degree 1, 2, and 5, respectively.

**Example 1:** Find the value of \(3x - x^3 - x^5\) when \(x = -2\).

**Solution:** Substitute \(-2\) every place you see an \(x\), thus:

\[
3(-2) - (-2)^3 - (-2)^5 = -6 - (-8) - (-32) = -6 + 8 + 32 = 24
\]

Monomials with identical variable factors can be added or subtracted by adding or subtracting their coefficients. Thus: \(3x^2 + 4x^2 = 7x^2\), and \(3x^4 - 9x^4 = -6x^4\).

To multiply monomials, take the product of their coefficients and take the product of the variable parts by adding exponents of factors with like bases. Thus:

\[
(-4xy^3)(3x^2y^5) = -12x^3y^8
\]

Monomial fractions can be simplified to simplest form by dividing out any common factors of the coefficients and then using the usual rules for subtraction of exponents in division. For example:

\[
\frac{6x^3y^5}{2x^4y^3} = \frac{3y^2}{x}
\]

**Example 2:** Combine into a single monomial \(9y - \frac{6y^3}{2y^7}\).

**Solution:** The fraction simplifies to \(3y\), and \(9y - 3y = 6y\).

**Combining Polynomials and Monomials**

Polynomials are added or subtracted simply by combining like monomial terms in the appropriate manner. Thus, \((2x^2 + 5x - 3) + (3x^2 + 5x - 12)\) is summed by removing the parentheses and combining like terms, to yield \(5x^2 + 10x - 15\).
Example 1: What is the sum of \((3a^2b^3 - 6ab^2 + 2a^3b^2)\) and \((5a^2b^3 - 2a^3b^2)\)?

Solution: Removing the parentheses, we combine the terms with identical literal parts by adding their coefficients:

\[
(3a^2b^3 - 6ab^2 + 2a^3b^2) + (5a^2b^3 - 2a^3b^2) = 3a^2b^3 - 6ab^2 + 2a^3b^2 + 5a^2b^3 - 2a^3b^2
\]

\[
= 8a^2b^3 - 6ab^2
\]

Notice that the \(2a^3b^2\) and \(-2a^3b^2\) terms exactly cancelled out.

To multiply a polynomial by a monomial, use the distributive law to multiply each term in the polynomial by the monomial factor. For example, \(2x(2x^2 + 5x - 11) = 4x^3 + 10x^2 - 22x\).

When multiplying a polynomial by a polynomial, repeatedly apply the distributive law to form all possible products of the terms in the first polynomial with the terms in the second.

The most common use of this is in multiplying two binomials, such as \((x + 3)(x - 5)\). In this case, there are four terms in the result: \(x \times x = x^2; x(-5) = -5x; 3 \times x = 3x;\) and \(3(-5) = -15;\) but the two middle terms are added together to give \(-2x\). Thus, the product is \(x^2 - 2x - 15\).

\[
(x + 3)(x - 5) = x^2 + (-5x + 3x) - 15
\]

\[
= x^2 - 2x - 15
\]

Be sure to remember these special cases:

- \((x + a)^2 = (x + a)(x + a) = x^2 + 2ax + a^2\)
- \((x - a)^2 = (x - a)(x - a) = x^2 - 2ax + a^2\)

Example 2: If \(m\) is an integer, and \((x - 6)(x - m) = x^2 + rx + 18\), what is the value of \(m + r\)?

Solution: The product of the last terms, \(6m\), must be 18. Therefore, \(m = 3\). If \(m = 3\), then the sum of the outer and inner products becomes \(-6x - 3x = -9x\), which equals \(rx\). Hence, \(r = -9\), and \(m + r = 3 + (-9) = -6\).
Factoring Monomials and the Difference of Squares

Factoring a monomial from a polynomial simply involves reversing the distributive law. For example, if you are looking at $3x^2 - 6xy$, you should see that $3x$ is a factor of both terms. Hence, you could just as well write this expression as $3x(x - 2y)$. Multiplication using the distributive law will restore the original formulation.

**Example 1:** If $x - 5y = 12$, which is greater, $15y - 3x$ or $-35$?

**Solution:** We can see that $15y - 3x = -3(x - 5y)$. Hence, it must equal $-3(12) = -36$, which is less than $-35$.

When you multiply $(a - b)$ by $(a + b)$ using the FOIL method, the middle terms exactly cancel out, leaving just $a^2 - b^2$. Thus, the difference of two squares, $a^2 - b^2 = (a - b)(a + b)$.

For example, $x^2 - 16$ can be thought of as $x^2 - 4^2 = (x - 4)(x + 4)$.

However, the sum of two squares—$b^2 + 16$, for example—cannot be factored.

**Example 2**

If $x$ and $y$ are positive integers, and $x - 2y = 5$, which of the following is the value of $x^2 - 4y^2$?

(A) 0  
(B) 16  
(C) 45

**Solution:** Since $x^2 - 4y^2 = (x - 2y)(x + 2y) = 5(x + 2y)$, $x^2 - 4y^2$ must be divisible by 5. Therefore, 16 is not possible. If the result is to be zero, $x + 2y = 0$, which means that $y = -2x$, so that both numbers cannot be positive. Hence, the expression must equal 45, which you get if $x = 7$ and $y = 1$. So the correct answer is (C).

**Example 3:** If $x$ and $y$ are positive integers, and $y^2 = x^2 + 7$, what is the value of $y$?

**Solution:** If we rewrite the equation as $y^2 - x^2 = 7$ and factor, we have $(y - x)(y + x) = 7$. Thus, 7 must be the product of the two whole numbers $(y - x)$ and $(y + x)$. But 7 is a prime number, which can only be factored as 7 times 1. Of course, $(y + x)$ must be the greater of the two; hence, $y + x = 7$, and $y - x = 1$.

Adding the two equations gives us $2y = 8$; $y = 4$. (Of course, $x = 3$, but we weren’t asked that.)
Operations with Square Roots

The square root of a number $N$, written $\sqrt{N}$, is a number that when squared produces $N$. Thus, $\sqrt{4} = 2$, $\sqrt{9} = 3$, $\sqrt{16} = 4$, and so on.

The symbol $\sqrt{ }$ is called the radical sign, and many people refer to $\sqrt{N}$ as radical $N$. When we write $\sqrt{N}$, it is understood to be a positive number. So when you are faced with an algebraic equation like $x^2 = 4$, where you must allow for both positive and negative solutions, you must write $x = \pm \sqrt{4} = \pm 2$ (where $\pm$ is read as plus or minus).

You should be aware that $\sqrt{0} = 0$ and $\sqrt{1} = 1$. Square roots of negative numbers are not real numbers. All positive numbers have square roots, but most are irrational numbers. Only perfect squares like 4, 9, 16, 25, 36, . . . have integer square roots.

If you assume that you are working with non-negative numbers, you can use certain properties of the square root to simplify radical expressions. The most important of these rules is: $\sqrt{AB} = \sqrt{A} \times \sqrt{B}$.

This can be used to advantage in either direction. Reading it from right to left, we may write $\sqrt{3} \times \sqrt{12} = \sqrt{36} = 6$. But you should also know how to use this rule to simplify radicals by extracting perfect squares from “under” the radical. Thus, $\sqrt{18} = \sqrt{9} \times \sqrt{2} = 3\sqrt{2}$.

The key to using this technique is to recognize the perfect squares in order to factor in a sensible manner. Thus, it would do you little good to factor 18 as $3 \times 6$ in the preceding example, since neither 3 nor 6 is a perfect square.

Example: If $\sqrt{5} \times \sqrt{x} = 10$, which is greater, $\sqrt{x}$ or $2\sqrt{5}$?

Solution: Since $10 = \sqrt{100}$ and $\sqrt{5} \times \sqrt{x} = \sqrt{5x}$, we know that $5x = 100$ and $x = 20$. But $20 = 4 \times 5$, so $\sqrt{20} = 2\sqrt{5}$. Hence, the two quantities are equal.

Trinomial Factoring and Quadratic Equations

When you multiply two binomials $(x + r)(x + s)$ using the FOIL method, the result is a trinomial of the form $x^2 + bx + c$, where $b$, the coefficient of $x$, is the sum of the constants $r$ and $s$, and the constant term $c$ is their product.

Trinomial factoring is the process of reversing this multiplication. For example, to find the binomial factors of $x^2 - 2x - 8$, we need to find two numbers whose product is $-8$ and whose sum is $-2$. Since the product is negative, one of the numbers must be negative and the other positive. The possible factors of 8 are 1 and 8 and 2 and 4. In order for the sum to be $-2$, we must choose $-4$ and $+2$. Thus, $x^2 - 2x - 8 = (x - 4)(x + 2)$. 

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This technique can sometimes be used to solve quadratic equations. If you have an equation like \(x^2 - 7x + 6 = 0\), you can factor the trinomial. To do this, you need two numbers whose product is +6 and whose sum is –7. Since the product is positive, both must be of the same sign, and since the sum is negative, they must both be negative. It is not hard to see that –6 and –1 are the only correct options.

Once the trinomial is factored, the equation becomes \((x – 1)(x – 6) = 0\). Of course, the only way a product of two or more numbers can be zero is if one of the numbers is zero. Thus, either:

\[x – 1 = 0 \text{ or } x – 6 = 0\]

\[x = 1 \text{ or } x = 6\]

**Example:** The area of a rectangle is 60 and its perimeter is 32. What are its dimensions?

**Solution:** The area of a rectangle is determined by the formula \(A = LW\), its perimeter by the formula \(P = 2L + 2W\). In this case, we have \(LW = 60\) and \(2L + 2W = 32\). Dividing by 2, \(L + W = 16\). Therefore, \(L = 16 – W\), which we substitute in \(LW = 60\), giving:

\[(16 – W)W = 60\]

\[16W – W^2 = 60\]

Grouping everything on the right-hand side, we have

\[0 = W^2 – 16W + 60\]

Now, factoring:

\[0 = (W – 10)(W – 6)\]

This yields \(W = 10\) or \(W = 6\).

Of course, if \(W = 6\), \(L = 10\), and if \(W = 10\), \(L = 6\). Either way, the dimensions are \(6 \times 10\).

**The Quadratic Formula**

Some quadratic equations are not solvable by factoring using rational numbers. For example, because \(x^2 + x + 1\) has no factors using whole numbers, \(x^2 + x + 1 = 0\) has no rational roots (solutions).

In other cases, rational roots exist, but they are difficult to find. For example, \(12x^2 + x – 6 = 0\) can be solved by factoring, but the solution is not easy to see:

\[12x^2 + x – 6 = (3x – 2)(4x + 3)\]
Setting each factor equal to zero:

$$3x - 2 = 0 \text{ or } 4x + 3 = 0$$

yields $$x = \frac{2}{3}$$ or $$x = \frac{3}{4}$$.

What can you do when faced with such a situation? You use the quadratic formula, which states that, for any equation of the form $$ax^2 + bx + c = 0$$, the roots are:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

**Example 1:** If $$6x^2 - x - 12 = 0$$, what is the least integer greater than $$x$$?

**Solution:** Use the quadratic formula to solve for $$x$$. We identify $$a$$, $$b$$, and $$c$$ as $$a = 6$$, $$b = -1$$, and $$c = -12$$. We substitute into the formula, yielding:

$$x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(6)(-12)}}{2(6)} = \frac{1 \pm \sqrt{1 + 288}}{12} = \frac{1 \pm 17}{12}$$

Using the plus sign:

$$x = \frac{1 + 17}{12} = \frac{18}{12} = \frac{3}{2}$$

Using the minus sign:

$$x = \frac{1 - 17}{12} = \frac{-16}{12} = -\frac{4}{3}$$

Both possible values of $$x$$ are less than 2.

**Complex Numbers**

Sometimes, when applying the quadratic formula, the **discriminant**, $$d = b^2 - 4ac$$, will be a negative number. In such a case, you have to deal with the square root of a negative number. Such a number is called **imaginary**. In general, if $$N$$ is any positive number, then $$\sqrt{-N}$$ is written as $$i \sqrt{N}$$, where $$i$$ is the square root of $$-1$$.

Numbers of the form $$bi$$, where $$b$$ is a real number, are called **pure imaginary numbers**. For example, $$\sqrt{-4} = i \sqrt{4} = 2i$$ and $$\sqrt{-3} = i \sqrt{3}$$ are both pure imaginary numbers.

Numbers of the form $$a + bi$$, where $$a$$ and $$b$$ are both real numbers are called **complex numbers**. Thus, complex numbers have both a real and an imaginary part.

When doing arithmetic with complex numbers, just think of $$i$$ as an unknown, like $$x$$, except whenever you get an $$i^2$$ in a computation, replace it with $$-1$$. 

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Example 1

If \( z = 4 + 3i \) and \( w = 3 - 4i \), \( zw - \frac{z}{w} = ? \)

(A) 14 - i  
(B) 7 - 25i  
(C) 24 - 6i  
(D) 24 - 8i  
(E) 7 - i

**Solution:** The correct answer is (D). Multiplying \((4 + 3i)(3 - 4i)\) by the FOIL method yields \(12 - 7i - 12i^2\). Replacing \(i^2\) by \(-1\), we have \(12 - 7i + 12 = 24 - 7i\).

To find \( \frac{z}{w} \) in the form \(a + bi\) so that we can subtract it from \(zw\), we need to rationalize the denominator of the fraction by multiplying the numerator and denominator of the fraction by the complex conjugate of \(w\). (The complex conjugate of \(a + bi = a - bi\).) When you multiply these two, the term involving \(i\) drops out, and you end up with just \(a^2 + b^2\). Thus:

\[
\frac{z}{w} = \left(\frac{4+3i}{3-4i}\right) \times \left(\frac{3+4i}{3+4i}\right) = \frac{12 + 25i + 12i^2}{3^2 + 4^2} = \frac{25i}{25} = i
\]

Hence, \(zw - \frac{z}{w} = (24 - 7i) - i = 24 - 8i\).

Example 2

Which of the following is one root of \(x^2 - 4x + 5 = 0\)?

(F) 4 - i  
(G) 2 - i  
(H) 2 + 2i  
(J) 3i  
(K) 2 - 2i

**Solution:** The correct answer is (G). Using the quadratic formula with \(a = 1\), \(b = -4\), and \(c = 5\), we have:

\[
x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(5)}}{2(1)} = \frac{4 \pm \sqrt{16 - 20}}{2} = \frac{4 \pm \sqrt{-4}}{2} = \frac{4 \pm 2i}{2}
\]

Dividing each term in the numerator by the denominator 2 gives us \(x = 2 \pm i\). Since we can choose either + or −, we see that \(2 - i\) is one root.
Higher Roots and Fractional Exponents

The symbol \( \sqrt[n]{x} \) is used to represent the \( n \)th root of the number \( x \). The \( n \)th root of \( x \) is the number that, when raised to the \( n \)th power, gives \( x \) as a result. For example, \( \sqrt[3]{8} = 2 \) because \( 2^3 = 8 \).

Roots can also be represented by using fractional exponents. To be precise, we define \( x^{\frac{1}{n}} = \sqrt[n]{x} \). In particular, the \( \frac{1}{2} \) power of a number is its square root. So, for example:

\[
16^{\frac{1}{2}} = \sqrt{16} = 4
\]

and

\[
125^{\frac{1}{3}} = \sqrt[3]{125} = 5
\]

In addition, other fractional powers can be defined by using the laws of exponents. That is, one can interpret an expression like \( x^{\frac{3}{5}} \) to mean \( \left( x^{\frac{1}{5}} \right)^3 \) because \( \frac{3}{5} = \left( \frac{1}{5} \right)3 \). Thus,

\[
32^{\frac{1}{3}} = \left( \sqrt[3]{32} \right)^3 = 2^3 = 8
\]

Negative fractional powers can be similarly calculated by remembering that \( x^{-n} = \frac{1}{x^n} \).

For example, to calculate \( 8^{-\frac{2}{3}} \), we first find \( 8^{-\frac{2}{3}} = \left( \sqrt[3]{8} \right)^2 = 2^2 = 4 \).

Now, \( 8^{-\frac{2}{3}} \) is the reciprocal of \( 8^{\frac{2}{3}} \); that is, \( \frac{1}{4} \).

**Example:** Find the value of \( \frac{3x^{0} + \sqrt{x}}{2 + x^{-\frac{1}{3}}} \) if \( x = 16 \).

**Solution:** Let’s calculate the numerator and denominator separately. In the numerator, \( x^0 = 1 \) for any \( x \) and, \( \sqrt{x} = \sqrt{16} \). Hence, \( 3(16) + 16^\frac{1}{3} = 3(1) + \sqrt[3]{16} = 3 + 4 = 7 \).

In the denominator, \( 16^\frac{1}{3} = \sqrt[3]{16} \), which means that the denominator is \( \frac{16}{8} + \frac{1}{8} = \frac{17}{8} \). So the original expression is equal to

\[
\frac{7}{\frac{17}{8}} = 7 \left( \frac{8}{17} \right) = \frac{56}{17}
\]

Functions

Two variables, say \( x \) and \( y \), may be related in a number of ways. In a function or functional relationship, one variable, usually \( x \), is called the independent variable. The other, usually \( y \), is the dependent variable. For every choice of \( x \), precisely one \( y \) is defined. As \( x \) varies, \( y \) varies in an exactly predictable fashion.

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In this situation, we say that “y is a function of x,” meaning that the value of y is determined by the value of x. The function itself is denoted by f (or g, or h, . . . ). The collection of possible values of the independent variable is called the domain of f. The y-value associated with a given x-value is denoted by f(x) (read f of x). The collection of possible values of the dependent variable is called the range of f.

If an expression f(x) defines a function, then the y corresponding to any specific x can be found by simply substituting that value for x in the expression y = f(x).

**Example 1:** Suppose that the relation between x and y is given by y = f(x), where f(x) = x\(^2\) + 3x – 4. Find f(1) and f(2 + a).

**Solution:** To find the value of the function for any number, we substitute that number for x in the expression for f(x). In essence, we think of this function as f(•) = (•)\(^2\) + 3(•) – 4, and then we fill in the blanks. So to find f(1), we substitute 1 for x where it appears, thus:

\[
f(1) = (1)^2 + 3(1) – 4 = 1 + 3 – 4 = 0
\]

So, f(1) = 0. In the same manner:

\[
f(2 + a) = (2 + a)^2 + 3(2 + a) – 4
\]

\[
= 4 + 4a + a^2 + 6 + 3a – 4
\]

\[
= a^2 + 7a + 6
\]

**Example 2**

Letting f(x) = x\(^2\) and g(x) = x + 3, find each of the following:

- **(A)** \(g(2)/f(5)\)
- **(B)** \(f(g(1))\)
- **(C)** \(g(f(x))\)

**Solutions:**

- **(A)** \(g(2) = 2 + 3 = 5; f(5) = 5^2 = 25; \(g(2)/f(5) = 5(25) = 125\).**
- **(B)** To find f(g(1)), first find g(1) = 1 + 3 = 4. Now, \(f(g(1)) = f(4) = 4^2 = 16\).**
- **(C)** To find g(f(x)), substitute f(x) every place you see an x in g(x) = x + 3. In other words, \(g(f(x)) = f(x) + 3\). But, since \(f(x) = x^2\), \(g(f(x)) = x^2 + 3\).**

Two functions f and g for which f(g(x)) = g(f(x)) = x are called inverse functions. When this occurs, g(x) is called f-inverse and denoted f(−1(x)). The functions are called inverses because they “undo” one another. That is, for any value x, calculating f(x) and substituting the result into f(−1) brings you right back to the value x, where you started.
Example 3

Which of the following functions is \( f^{-1}(x) \) for \( f(x) = 3x + 2 \)?

(A) \(-3x + 2\)

(B) \( \frac{x-2}{3} \)

(C) \( \frac{1}{3x+2} \)

(D) \( \frac{1}{3x} + 2 \)

(E) \( \frac{1}{3x} + \frac{1}{2} \)

Solution: The correct answer is (B). If you try calling each of these expressions in turn \( g(x) \) and calculate \( f(g(x)) = 3g(x) + 2 \), you will see that only for choice (B) will the result be \( f(g(x)) = x \). Thus, \( f(g(x)) = 3\left(\frac{x-2}{3}\right) + 2 = x - 2 + 2 = x \).

You may want to check for yourself that \( g(f(x)) = x \).

Exponentials and Logarithms

Among the most important examples of inverse functions are the exponential and logarithmic functions. For any constant \( b > 0 \) and \( b \neq 1 \), the exponential functions \( f(x) = b^x \) and \( g(x) = \log_b x \) are inverse functions. That is, \( \log_b (b^x) = x \) and \( b^{\log_b x} = x \). That is, the logarithm is the exponent. \( b \) is called the base of the logarithm.

The two most frequently encountered bases are 10, the base for common logarithms, and \( e \), the base for natural logarithms. You should know that the symbol \( \log x \) with no base shown is assumed to be the logarithm to the base 10. The symbol \( \ln x \) is used as shorthand for the natural logarithm. That is, \( \ln x = \log_e x \). Thus, \( \log 10^x = x \); \( 10^{\log x} = x \); \( \ln e^x = x \); and \( e^{\ln x} = x \).

The main properties of the exponential functional are determined by the laws of exponents. It is important to recognize that the relationships \( b^x = N \) and \( \log_b N = K \) are equivalent. That is, any relationship between the variables written in logarithmic form may be rewritten in exponential form, and vice versa.

Example 1: If \( \log_5 125 = 3 \), what is \( x \)?

Solution: This statement is equivalent to \( x^3 = 125 \), for which we can see by inspection that \( x = 5 \).

There are certain properties of the logarithm that you should know that also follow from the laws of exponents.
• \( \log_b M + \log_b N = \log_b MN \)
• \( \log_b M - \log_b N = \log_b \frac{M}{N} \)
• \( \log_b \frac{1}{M} = -\log_b M \)
• \( k \log_b M = \log_b M^k \)

You should also know that \( \log_b 1 = 0 \), and that the \( \log_b M \) is only defined for positive values of \( M \); that is, the log is undefined for zero or negative values.

**Example 2**

Q If \( f(x) = 6^x \) and \( g(x) = \log_6 x \), what expression is equal to \( f(2g(M)) \)?

\( \begin{align*}
F & : 2^M \\
G & : 6^M \\
H & : M^6 \\
J & : M^2 \\
K & : 6^{2M} \\
\end{align*} \)

**Solution:** The correct answer is (J). \( 2g(M) = 2\log_6 M = \log_6 M^2 \). Hence, \( f(2g(m)) = M^2 \).

**GEOMETRY**

**Angles, Complements, and Supplements**

An angle is formed when two rays originate from the same point. Angles are usually measured in degrees or radians. As on the ACT Assessment exam, we shall use only degree measure.

A straight angle has a measure of 180°. Any two angles that sum to a straight angle are called supplementary. Thus, two angles that measure 80° and 100° are supplementary.
Two equal supplementary angles are $90^\circ$ each, and a $90^\circ$ angle is called a *right angle*. Two angles that sum to a right angle are called *complementary*. Thus, $25^\circ$ is the complement of $65^\circ$.

Angles less than $90^\circ$ are called *acute*, and angles between $90^\circ$ and $180^\circ$ are called *obtuse*. The sum of all the angles around a given point must total to $360^\circ$.

**Example 1:** Find $x$ in the diagram below:

Solution: Since $\angle ABD$ is a right angle, so is $\angle DBC$. Thus, $x + (x + 40) = 90$. Removing parentheses: $x + x + 40 = 90; 2x = 50; x = 25$.

**Example 2:** Find $x$ in the diagram below:
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Solution: $8x^\circ + 48^\circ = 360^\circ; 8x^\circ = 312^\circ; x = 39^\circ$.

Properties of Triangles

The sum of the measures of the three angles in any triangle is $180^\circ$, which is the same as the measure of a straight angle. This fact is usually combined with other properties in the solution of geometric problems.

Example 1: In triangle $ABC$, the degree measure of $\angle B$ is $30^\circ$ more than twice the degree measure of $\angle A$, and the measure of $\angle C$ is equal to the sum of the other two angles. How many degrees are there in the smallest angle of the triangle?

Solution: Calling the measure of $\angle A$ in degrees $x$, we have the following:

$x^\circ = \text{number of degrees in } \angle A$

$2x^\circ + 30^\circ = \text{number of degrees in } \angle B$

$x^\circ + (2x^\circ + 30^\circ) = 3x^\circ + 30^\circ = \text{number of degrees in } \angle C$

Summing, we have $x^\circ + 2x^\circ + 30^\circ + 3x^\circ + 30^\circ = 180^\circ$. Combining like terms: $6x^\circ + 60^\circ = 180^\circ; 6x = 120^\circ; x = 20^\circ$.

Clearly, $2x^\circ + 30^\circ$ and $3x^\circ + 30^\circ$ are greater than $x^\circ$, so the smallest angle is $20^\circ$.

In a triangle, the sum of the lengths of any two sides must exceed the length of the third. Thus, you cannot draw a triangle with sides of lengths 3, 6, and 10, because $3 + 6 < 10$. In addition, in comparing any two sides, the longer side will be opposite the greater angle.

Example 2: A triangle has sides with lengths of 5, 12, and $x$. If $x$ is an integer, what is the minimum possible perimeter of the triangle?

Solution: In any triangle, the sum of the lengths of any two sides must exceed the length of the third. Therefore, $x + 5 > 12$, which means that $x > 7$. The smallest integer greater than 7 is 8. Hence, the minimum possible perimeter is $5 + 12 + 8 = 25$.

Can you see why the maximum perimeter of this triangle is 33?

The Pythagorean Theorem

When one angle in a triangle is a right angle, the triangle is called a right triangle. The longest side of a right triangle, which is opposite the right angle, is called the hypotenuse.
The Pythagorean theorem tells us that the square on the hypotenuse of a right triangle is equal to the sum of the squares on the other two sides (or legs). In symbols, we usually remember this as shown in the figure below.

\[ c^2 = a^2 + b^2 \]

In practice, you should remember some well-known Pythagorean triples, that is, sets of whole numbers such as 3-4-5 for which \( a^2 + b^2 = c^2 \). Right triangles whose sides correspond to the numbers that make up a Pythagorean triple appear commonly on the ACT Assessment. Other less easily recognized Pythagorean triples are 5-12-13, 8-15-17, and 7-24-25. In addition, look for multiples of the triples, such as 6-8-10 or 15-20-25.

There are other important cases that yield non-integer solutions for the lengths of the sides of a right triangle. For example, the hypotenuse of a triangle with one leg of length 1 and the other of length 2 can be found by writing \( c^2 = 1^2 + 2^2 \). Thus, \( c^2 = 5 \) and \( c = \sqrt{5} \).

**Example 1:** Find \( x \) in the diagram below:

**Solution:** Using the Pythagorean theorem in triangle \( ACD \), the theorem tells us that \( 6^2 + 6^2 = c^2 \). Hence, \( c^2 = 72 \). In triangle \( ABC \), letting \( x \) represent the length of \( BC \), \( 72 = c^2 = x^2 + 8^2 \). That is, \( x^2 = 72 - 64 = 8 \). Thus, \( x = \sqrt{8} = 2 \sqrt{2} \).
The Area of a Triangle

In any triangle, you can construct a line from one vertex (point) perpendicular to the opposite side. (Sometimes that side may have to be extended outside the triangle, as shown in the second case below.) This line is called the altitude or height. The area of a triangle is given by the formula \( A = \frac{1}{2}bh \), where \( b \) = the length of the base and \( h \) = the length of the altitude.

Both triangles shown in the diagram above have the same area: \( A = \frac{1}{2}(8)(3) = 12 \).

**Example:** In triangle \( ABC \), \( AB = 6 \), \( BC = 8 \), and \( AB = 10 \). Find the altitude from vertex \( B \) to side \( AC \).

**Solution:** Since the sides are 6-8-10, the triangle is a disguised 3-4-5 right triangle with \( AC \) being the hypotenuse. Drawing the triangle as described produces the diagram below.

By using the two legs as base and height, the area of the triangle must be \( A = \frac{1}{2}(6)(8) = 24 \). By using the hypotenuse and the unknown altitude, the area must be \( A = \frac{1}{2}(10)(h) = 5h \). Therefore, \( 5h = 24 \), and \( h = 4.8 \).

**TIP**

For a right triangle, you can use the two legs as base and altitude. (By definition, they are always perpendicular to one another.) For example, the area of a 5-12-13 right triangle is \( A = \frac{1}{2}(5)(12) = 30 \).
Isosceles and Equilateral Triangles

A triangle with at least two sides of equal length is called an isosceles triangle. If all three sides are equal, it is called an equilateral triangle. The angles opposite the equal sides in an isosceles triangle (as shown in the diagram below) are equal in measure; thus, if at least two angles in a triangle are equal, the triangle is isosceles. If all three angles are equal, the triangle is equilateral. In particular, this tells us that for an equilateral triangle, each angle has a degree measure of 60°.

Here is a good example of how this fact can be used in a problem.

Example 1: If in triangle ABC, as shown in the figure below, AC = BC and x ≤ 50, what is the smallest possible value of y?
Solution: Since sides $AC$ and $BC$ are of equal length, the two base angles, $\angle A$ and $\angle B$, must be equal. As always, the three angles must total $180^\circ$. Hence, $x + 2y = 180$, which means that $y = \frac{180 - x}{2} = 90 - \frac{1}{2}x$.

Now, the smallest possible value for $y$ is achieved when $x$ is as large as possible; that is, when $x = 50$, for which $y = 65$.

Example 2: In the triangle shown below, $AB = BC$. Which is longer, $AC$ or $AB$?

![Triangle](image)

Note: Diagram not drawn to scale

Solution: Since the triangle is isosceles, the base angles are equal. Thus, $\angle A = \angle C = 70^\circ$. This implies that $\angle B = 40^\circ$ (in order to reach the full $180^\circ$ in the triangle). But that means that $AB > AC$, because it is the side opposite the greater angle.

Special Right Triangles

These are two special right triangles whose properties you should be familiar with. The first is the isosceles right triangle, also referred to as the $45^\circ$-$45^\circ$-$90^\circ$ triangle. By definition, its legs are of equal length, and its hypotenuse is $\sqrt{2}$ times as long as either leg.
The other important right triangle is the $30^\circ-60^\circ-90^\circ$ triangle. You can see by dropping an altitude that this is half of an equilateral triangle. Hence, the shorter leg is half the hypotenuse, and the longer leg (the one opposite the $60^\circ$ angle) is $\sqrt{3}$ times the shorter leg.

![Diagram of a 30°-60°-90° triangle]

**Example:** Find the area of the region shown in the diagram below:

![Diagram of a region with two triangles]

**Solution:** Since $BC = 3$ and $AB = 3\sqrt{3}$, we know that triangle $ABC$ is a $30^\circ-60^\circ-90^\circ$ right triangle. Hence, we know that $AC = 6$, and taking one half the product of the legs, the triangle has an area of $\frac{1}{2}(3)(3\sqrt{3}) = \frac{9\sqrt{3}}{2}$.

Since triangle $ADC$ is an isosceles right triangle with a hypotenuse of 6, each leg must be $\frac{6}{\sqrt{2}}$. Again, taking one half the product of the legs, the triangle has an area of $\frac{1}{2}\left(\frac{6}{\sqrt{2}}\right)\left(\frac{6}{\sqrt{2}}\right) = 18 = 9$.

Adding the two areas, we have $9 + \frac{9\sqrt{3}}{2}$.

**Vertical Angles Are Equal**

When two lines intersect, two pairs of *vertical angles* are formed (as shown in the following diagram). The “facing” pairs are equal, and, of course, the two angles that form a pair on one side of either line add up to $180^\circ$. 
Example: In the diagram below, which is greater, \( x + y \) or \( w + z \)?

Solution: We know that the sum of the angles in any triangle is 180°. Letting the measure of \( \angle ABC \) be \( m \), we have, in the upper triangle, \( x + y = 180 - m \).

Similarly looking at the greater triangle, we know that \( w + z = 180 - m \).

Therefore, \( x + y = w + z \). The quantities named are equal.

Parallel Lines and Transversals

If you start with two lines parallel to one another and draw a line that crosses them, the crossing line is called a transversal. The intersection of the transversal with the parallel lines creates several sets of related angles. In particular, the corresponding angles (labeled \( C \) in the diagram below) and the alternate interior angles (labeled \( A \) in the diagram below) are always equal.
Combining these properties with your knowledge about vertical angles and the angles in a triangle can lead to interesting examples.

**Example 1:** In the diagram below, \(l_1\) is parallel to \(l_2\). Find \(x\).

\[
\begin{align*}
\angle DCE &= 26^\circ \\
x^\circ \\
\angle ACB &= 26^\circ \\
\end{align*}
\]

**Solution:** We'll label the diagram as shown below.

\[
\begin{align*}
\angle DCE &= 26^\circ \\
x^\circ \\
\angle ACB &= 26^\circ \\
\end{align*}
\]

We see that \(m \angle DCE = 26^\circ\), which makes \(m \angle ACB = 26^\circ\). Since triangle \(ABC\) is a right triangle, \(x\) is the complement of \(26^\circ\), or \(64^\circ\).

**Example 2:** In the diagram below, \(l_1\) is parallel to \(l_2\). Find \(x\).

\[
\begin{align*}
\angle ACB &= 66^\circ \\
x^\circ \\
\end{align*}
\]

**Solution:** Extend \(AB\) as shown in the diagram below.

\[
\begin{align*}
\angle HCD &= 32^\circ \\
x^\circ \\
\angle ABE &= 66^\circ \\
\end{align*}
\]
Look at the angles in triangle $BCD$. As alternate interior angles, $m\angle BCE = m\angle BAF = 66^\circ$, so its supplement in the triangle, $m\angle C$, must equal $114^\circ$. As vertical angles, $m\angle CDB = m\angle HDG = 32^\circ$. Therefore, in the triangle, $m\angle D = 32^\circ$. Since the three angles in the triangle must sum to $180^\circ$, $m\angle B = 34^\circ$. $x$ is the supplement to $34^\circ$—that is, $140^\circ$.

**Rectangles, Parallelograms, and Other Polygons**

Any geometric figure with straight line segments for sides is called a *polygon*. It is possible to draw a polygon with one or more interior angles greater than $180^\circ$, as illustrated in the figure below.

![Polygon](image)

However, if all the interior angles in the polygon are less than $180^\circ$, we have a *convex polygon*. The sum of the angle measurements in any convex polygon is $180(n - 2)$, where $n$ is the number of vertices. Thus, for a triangle, $n = 3$, and the sum is $180$. For a *quadrilateral* (a four-sided figure), $n = 4$, and the sum is $360$. For a *pentagon* (a five-sided figure), $n = 5$, and the angle sum is $540$, and so on.

To find the *perimeter* of a polygon (the distance around the figure), simply add together the lengths of all the sides. Of course, it may require some thinking to determine each length.

To find its area, connect the vertices by line segments to divide the polygon into triangles; then sum the areas of the triangles.

**Example 1:** Find the area of figure $ABCDE$ shown below.

![Pentagon](image)
Solution: Drawing $BE$ and $BD$ divides the region into three triangles as shown. Triangles $ABE$ and $BCD$ are both $45^\circ$-$45^\circ$-$90^\circ$ right triangles, making $BE = BD = 2\sqrt{2}$.

This makes the central triangle an equilateral triangle. The area of each of the two outer triangles is $\frac{1}{2}(2)(2) = 2$, so the two together have an area of 4. The center triangle has a base whose length is $2\sqrt{2}$. If you draw the altitude, you get a $30^\circ$-$60^\circ$-$90^\circ$ right triangle with a shorter leg whose length is $\sqrt{2}$. This makes the height $\sqrt{3}$ times that, or $\sqrt{6}$. This gives an area of $\frac{1}{2}(2\sqrt{2})(\sqrt{6}) = \sqrt{12} = 2\sqrt{3}$. Hence, the total area of the polygon is $4 + 2\sqrt{3}$.

A parallelogram is a quadrilateral in which the pairs of opposite sides are parallel. The opposite angles in a parallelogram are equal, and the opposite sides are of equal length (see the figure below).

The area of a parallelogram is determined by its length times its height; that is, $A = LH$, as labeled in the diagram.

If the angles in the parallelogram are right angles, we have a rectangle. For a rectangle of length $L$ and width $W$, the area is $A = LW$, and the perimeter is $P = 2L + 2W$.

For example, the area of a rectangular garden that is 20 yards long and 10 yards deep is $(20)(10) = 200$ square yards. However, to put a fence around the same garden (that is, around its perimeter) requires $2(20) + 2(10) = 60$ running yards of fencing. These relatively easy formulas can lead to some tricky questions.

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Example 2: If sod comes in $4 \times 4$ foot squares costing $3.50$ per square, how much will it cost to sod the lawn shown on the following page (all distances indicated in feet)? You may assume that all angles that appear to be right angles are right angles.

Solution: Completing the rectangle as shown in the figure below, we see that the large rectangle $AGEF$ is $40 \times 28 = 1,120$ square feet.

The lesser rectangle $BGDC$ is $12 \times 16 = 192$ square feet. Hence, the area that must be sodded is $1,120 - 192 = 928$ square feet. Now, each $4 \times 4$ foot piece of sod is 16 square feet. Therefore, we need $928 \div 16 = 58$ squares of sod at $3.50$ each. The total cost is $(58)(3.50) = $203.

Example 3: A rectangle has one side whose length is 6 and a diagonal whose length is 10. What is its perimeter?

Solution: Notice that the diagonal of a rectangle divides the rectangle into two identical right triangles. Hence, the other side of this rectangle can be found by the Pythagorean theorem. We recognize that side 6 and diagonal 10 implies that we have a 6-8-10 right triangle, so the unknown side is 8. The perimeter is, therefore, $2(6) + 2(8) = 28$. 
Basic Properties of Circles

A line segment from the center of a circle to any point on the circle is called a *radius* (plural *radii*). All radii of the same circle are equal in length. A line segment that passes through the center of the circle and cuts completely across the circle is called a *diameter*. A diameter is, of course, twice as long as any radius. Thus, \( d = 2r \).

Any line cutting across a circle is called a *chord*, and no chord can be longer than the diameter. A portion of a circle is called an *arc*. Any arc has a degree measure that equals the measure of the *central angle* (an angle whose vertex is the center of the circle) subtended by it, as shown in the figure below.

![Diagram of a circle with a central angle and an arc](image)

**Example:** If the arc \( PS \) in the diagram below has a degree measure of \( 62^\circ \), is the chord \( PS \) longer or shorter than the radius of the circle?

![Diagram of a circle with a central angle and a chord](image)

**Solution:** Since all radii are equal, triangle \( OPS \) is isosceles, and the angles at \( P \) and \( S \) must be equal. Suppose each is \( x \). Now, \( 2x + 62 = 180 \). Hence, \( x = 59 \). Therefore, \( PS \) is opposite the largest angle in the triangle and must be the longest side. That is, \( PS \) is longer than a radius.

The Area and Circumference of a Circle

The distance around a circle (analogous to the perimeter of a polygon) is its *circumference*. For any circle of radius \( r \), the circumference is given by the formula \( C = 2\pi r \); that is, the circumference equals twice the radius times \( \pi \) (a constant, designated by the Greek letter \( \pi \), whose value is approximately 3.1415 or \( \frac{22}{7} \)).
The area of the same circle is given by the formula $A = \pi r^2$; that is, the area equals pi times the radius squared.

**Example 1:** Find the area of the shaded region shown in the diagram below. (The curved side is a *semicircle*; that is, an arc equal to half a complete circle.)

![Diagram of shaded region](image)

**Solution:** The dotted line completes the rectangle, whose area is $12 \times 15 = 180$ square units. The radius of the arc must be 6, since its diameter is 12. The area of the whole circle would be $\pi r^2 = \pi (6^2) = 36\pi$. Hence, the area of the semi-circle is half of that, or $18\pi$. Subtracting, the area of the shaded region is $180 - 18\pi$.

**Example 2:** The larger circle shown in the diagram below has an area of $36\pi$. Find the circumference of the lesser circle.

![Diagram of circles](image)

**Solution:** The larger circle has an area of $A_L = \pi r^2 = 36\pi$. This means that $r^2 = 36$, and $r = 6$. The diameter of the lesser circle equals the radius of the larger one, so its radius is $\frac{1}{2}(6) = 3$. Therefore, its circumference must be $2\pi(3) = 6\pi$.

**Volumes**

A solid (three-dimensional) figure with straight line edges and flat surfaces is called a *polyhedron*. The surfaces bounding the solid are called *faces*. The edges of a polyhedron
have lengths; its faces have areas; and the entire figure has a surface area, which is the sum of the areas of all its faces.

A solid figure also has a volume. Volumes are expressed in cubic units. You should be familiar with the following formulas for volumes of regular polyhedrons:

- A rectangular solid is a polyhedron with rectangular faces at right angles to one another. (Think of a typical cardboard box, like a shoebox.)

\[
V = LWH = \text{Length} \times \text{Width} \times \text{Height}
\]

- A cube is a rectangular solid with all edges of equal length; that is \(L = W = H = s\). (Think of one die from a pair of dice.) Its volume is determined by the formula \(V = s^3\).

- A right circular cylinder is a solid with a circular base and a side perpendicular to the base. (Think of a soda can.) Its volume is the area of the base times the height, or 

\[
V = \pi r^2h.
\]

**Example 1:** Find the length of a rectangular solid with a height of 6 that is twice as long as it is wide, if its volume is the same as that of a cube with a total surface area of 864 square inches.

**Solution:** Let \(x\) = the width of the rectangular solid. Now, \(2x = \text{length}\). The volume of the rectangular solid is 

\[
V = 6(x)(2x) = 12x^2.
\]
Since the cube has six square faces, its total surface area is 6 times the area of one face.
In symbols, $6s^2 = 864$. Dividing by 6, $s^2 = 144$, and $s = 12$. Hence, the volume of the cube
is $12^3 = 1,728$. Since the two solids have the same volume:

$$12x^2 = 1728; \ x^2 = 144; \ x = 12$$

The length of the rectangular solid, which is twice the width, is 24.

**Example 2:** Which has the greater volume, a rectangular solid that is 6 feet long and
has a square base with sides 4 feet long or a cylinder with a length of 7 feet and a
diameter of 4 feet?

**Solution:** The volume of the rectangular solid is $V = (4)(4)(6) = 96$ square feet. The radius
of the cylinder is 2, so its volume is: $V_c = \pi(2)^2(7) = 28\pi$.

Since $\pi = \text{about } \frac{22}{7}$, $28\pi = \text{about } 88$. Therefore, the rectangular solid has the greater volume.

**Right Triangle Trigonometry**

The usual convention is to label the angles of a right triangle $A$, $B$, and $C$, with $C$ as the
right angle. We then label the sides opposite the respective angles as $a$, $b$, and $c$, as
shown in the figure below.

The *trigonometric functions* of the acute angles are then defined in terms of the ratios
of the lengths of the sides. For angle $A$, we have:

$$\sin A = \frac{a}{c}$$
$$\cos A = \frac{b}{c}$$
$$\tan A = \frac{a}{b}$$
$$\cot A = \frac{b}{a}$$
$$\sec A = \frac{c}{b}$$
$$\csc A = \frac{c}{a}$$
The trigonometric functions for angle $B$ are defined similarly. The important things to remember are:

\[
\begin{align*}
\text{sine} &= \frac{\text{opposite}}{\text{hypotenuse}} \\
\text{cosine} &= \frac{\text{adjacent}}{\text{hypotenuse}} \\
\text{tangent} &= \frac{\text{opposite}}{\text{adjacent}}
\end{align*}
\]

It is convenient to also know that for any angle $x$, \( \tan x = \frac{\sin x}{\cos x} \).

The other trigonometric functions can be found by using the following simple identities:

\[
\begin{align*}
\cot x &= \frac{1}{\tan x} \\
\csc x &= \frac{1}{\sin x} \\
\sec x &= \frac{1}{\cos x}
\end{align*}
\]

These relationships between sides and angles make possible the solution of many interesting problems.
Example 1

A 60-foot-long guy wire is attached to the top of a 45-foot pole, as shown in the figure below. Using the table of values given below, which of the following is closest to the angle the wire makes with the ground?

\[ \angle A \]

\[ \text{Pole} = 45 \]

\[ \text{Ground} \]

\[ \text{Wire} = 60 \]

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Angle} & \text{Sin} & \text{Cos} & \text{Tan} \\
\hline
41 & 0.6561 & 0.7547 & 0.8693 \\
42 & 0.6691 & 0.7431 & 0.9004 \\
43 & 0.682 & 0.7314 & 0.9325 \\
44 & 0.6947 & 0.7193 & 0.9657 \\
45 & 0.7071 & 0.7071 & 1 \\
46 & 0.7193 & 0.6947 & 1.0355 \\
47 & 0.7314 & 0.682 & 1.0723 \\
48 & 0.7431 & 0.6691 & 1.1106 \\
49 & 0.7547 & 0.6561 & 1.1504 \\
50 & 0.766 & 0.6428 & 1.1918 \\
\hline
\end{array}
\]

(A) 49°
(B) 47°
(C) 45°
(D) 43°
(E) 41°

Solution: The correct answer is (A). Using the relationship \( \sin A = \frac{a}{c} \) with \( a = 45 \) and \( c = 60 \), we have \( \sin A = \frac{45}{60} = \frac{3}{4} = 0.75 \). Referring to the table, we see that \( \sin 49° = 0.7547 \), which is the closest among the four choices.
Example 2

A vertical pole casts a shadow 50 feet long when the sun is at an angle of elevation of 42°, as shown in the figure below. Using the table on the preceding page, what is the height of the pole to the nearest foot?

(F) 55
(G) 50
(H) 45
(J) 40
(K) 35

Solution: The correct answer is (H). Calling the unknown height $h$, we have $\tan 42^\circ = \frac{h}{50}$. From the table, we see that $\tan 42^\circ = 0.9004$; multiplying by 50, we have $h = 50(0.9004) = 45.02$, or 45 feet to the nearest foot.

COORDINATE GEOMETRY

The Midpoint Formula

Given two points $P(x_1, y_1)$ and $Q(x_2, y_2)$, the midpoint $M$ of $PQ$ has the following coordinates:

$$x_M = \frac{x_1 + x_2}{2}, \quad y_M = \frac{y_1 + y_2}{2}$$

In words: To find the coordinates of the midpoint of a line segment, simply average the coordinates of the end points. For example, the midpoint between $(3,4)$ and $(2,-2)$ is

$$x_M = \frac{3 + 2}{2} = \frac{5}{2}, \quad y_M = \frac{4 + (-2)}{2} = \frac{2}{2} = 1$$

Hence, the midpoint is $\left(\frac{5}{2}, 1\right) = (2.5,1)$.
CHAPTER 9: Math Review

Example 1: If (2,6) is the midpoint of the line segment connecting (–1,3) to \(P(x,y)\), which is greater, \(2x\) or \(y\)?

Solution: We know that the average of \(x\) and –1 must be 2. That is, \(2 = \frac{x + (–1)}{2}\), or \(4 = x – 1; x = 5\).

Similarly, we know that the average of \(y\) and 3 must be 6. Thus, \(6 = \frac{y + 3}{2}\), or \(12 = y + 3; y = 9\).

Since \(2x = 10, 2x > y\).

Example 2: If \(b < 6\), is \((3,b)\) closer to \(P(0,2)\) or \(Q(6,10)\)?

Solution: We see that (3,6) is the midpoint of \(PQ\). Therefore, in the \(x\)-direction, \((3,b)\) will be equidistant from both \(P\) and \(Q\). However, if \(b < 6\), then \(b\) must be closer to 2 than to 10. Therefore, \((3,b)\) is closer to \((0,2)\) than to \((6,10)\).

The Distance Formula and Equations for Circles

Given two points \(P(x_1,y_1)\) and \(Q(x_2,y_2)\), the distance from \(P\) to \(Q\) is given by the formula:

\[d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}\]

In words, the distance is the square root of the sum of the change in \(x\) squared plus the change in \(y\) squared. This can be symbolized as follows:

\[d = \sqrt{(\Delta x)^2 + (\Delta y)^2}\]

For example, the distance from \((6,3)\) to \((3,–1)\) is \(d = \sqrt{(6 - 3)^2 + (3 - (–1))^2}\)

Thus,

\[d = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5\]

Example 1: The point \((4,t)\) is equidistant from points \((1,1)\) and \((5,3)\). What is the value of \(t\)?

Solution: Since the distances from the two given points are the same, we use the distance formula twice and equate the results, thus:

\[\sqrt{(4 - 1)^2 + (t - 1)^2} = \sqrt{(5 - 4)^2 + (3 - t)^2}\]

\[\sqrt{9 + (t^2 - 2t + 1)} = \sqrt{1 + (9 - 6t + t^2)}\]

\[\sqrt{10 - 2t + t^2} = \sqrt{10 - 6t + t^2}\]
Squaring both sides:

\[ 10 - 2t + t^2 = 10 - 6t + t^2 \]

Subtracting \( t^2 + 10 \) from both sides leaves:

\[ -2t = -6t \]

\[ 4t = 0; \ t = 0 \]

Since all points on a circle are equidistant from its center, you can use the distance formula to prove that the equation for a circle whose radius is \( r \) and whose center is at the origin is \( x^2 + y^2 = r^2 \).

Similarly, the equation for a circle whose radius is \( r \) and whose center is at \((h,k)\) is \((x - h)^2 + (y - k)^2 = r^2\).

**Example 2:** The point \((t,-1)\) lies on a circle whose radius is 5 and whose center is at \((4,2)\). What are the possible values of \(t\)?

**Solution:** Since every point on the circle must be 5 units from the center, we know that \((t,-1)\) must be 5 units from \((4,2)\). Using the equation for the circle with \(h = 4\) and \(k = 2\), and \(r = 5\), we have:

\[(x - 4)^2 + (y - 2)^2 = 25\]

Letting \(x = t\) and \(y = -1\):

\[(t - 4)^2 + (-1 - 2)^2 = 25\]

Expanding, we have:

\[ t^2 - 8t + 16 + 9 = 25 \]

We subtract 25 from both sides to yield:

\[ t^2 - 8t = 0 \]

This factors as \(t(t - 8) = 0\), with two possible solutions, \(t = 0\) or \(t = 8\).

**Slope of a Line**

Given two points \(P(x_1,y_1)\) and \(Q(x_2,y_2)\), the slope of the line passing through \(P\) and \(Q\) is given by the formula:

\[ M = \frac{y_1 - y_2}{x_1 - x_2} \]

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In words, this says that the slope is the change in $y$ divided by the change in $x$, or $M = \frac{\Delta y}{\Delta x}$.

For example, the slope of the line passing through $(6,4)$ to $(3,-1)$ is $\frac{4-(-1)}{6-3} = \frac{5}{3}$.

(Notice that it doesn’t matter which point you consider the first point and which the second, as long as you are consistent in the numerator and denominator of the fraction. Try it!)

**Example:** The points $(-1,-1)$, $(3,11)$, and $(1,t)$ lie on the same line. What is the value of $t$?

**Solution:** Since the slope of a line is the same for any two points on the line, and since $M = \frac{y_2 - y_1}{x_2 - x_1}$ using $(-1,-1)$ and $(3,11)$, we must have:

$$M = \frac{11 - (-1)}{3 - (-1)} = \frac{12}{4} = 3.$$  

Now, using the pair $(-1,-1)$ and $(1,t)$, $3 = \frac{t - (-1)}{1 - (-1)} = \frac{t + 1}{2}$.

Multiplying by 2, $6 = t + 1$; $t = 5$.

**Equations of Lines**

The equation that defines a straight line is usually remembered as $y = mx + b$, where $m$ is the slope and $b$ is the $y$-intercept. When $m = 0$, we have the equation $y = b$, which has as its graph a horizontal straight line crossing the $y$-axis at $(0,b)$. The exceptional case is the vertical line, which is defined by the equation $x = a$, where $a$ is the common $x$-value of all the points on the line. (Of course, $x = 0$ is the $y$-axis, and, naturally, $y = 0$ is the $x$-axis.)

Parallel lines have the same slope, and perpendicular lines (other than the vertical and horizontal case) have slopes that are negative reciprocals.

**Example 1:** Find the equation of a straight line parallel to the line with equation $y = 2x - 5$ that passes through the point $(-1,4)$.

**Solution:** By inspection, the given line has slope 2. Any line parallel to it must also have slope 2 and, therefore, must have equation $y = 2x + b$. To determine $b$, we use the fact that any point that lies on the line must satisfy the equation. Therefore, substituting the coordinates of the point $(-1,4)$ into the equation must yield a correct equation. Thus:

$$4 = 2(-1) + b; \ 4 = -2 + b; \ b = 6$$

The equation is $y = 2x + 6$.  

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Example 2: Find the equation of a straight line perpendicular to the line with equation \( y = \frac{2}{3}x - 4 \) that has \( y \)-intercept 9.

Solution: The given line has slope \( \frac{2}{3} \). Any line perpendicular to it must have as its slope the negative reciprocal of \( \frac{2}{3} \), that is, \( -\frac{3}{2} \). Since the line we want has \( y \)-intercept 9, its equation must be \( y = -\frac{3}{2}x + 9 \). It is possible to multiply this equation by 2 to get \( 2y = -3x + 18 \), which could also be written \( 3x + 2y = 18 \).

Example 3: Find the equation of the line that is the perpendicular bisector of the line segment connecting points \( P(-1, 1) \) and \( Q(3, 5) \).

Solution: \( PQ \) has a slope of \( M = \frac{5 - 1}{3 - (-1)} = \frac{4}{4} = 1 \).

Hence, the perpendicular bisector must have as its slope the negative reciprocal of 1, which is \( -1 \). Thus, its equation must be \( y = -x + b \). Since the line bisects the segment, it must pass through the midpoint of \( PQ \), which we find by averaging the coordinates of the endpoints to get \( (1,3) \). Substituting: \( 3 = -1 + b; b = 4 \), and the equation is \( y = -x + 4 \).

Systems of Equations with Non-Unique Solutions

As we mentioned above, any equation of the form \( Ax + By = C \) is the equation of a straight line because (unless \( B = 0 \)), it can be rewritten in the form \( y = mx + b \) by using a little algebra. Hence, when you try to solve two linear equations with two unknowns simultaneously, you could think of the process as trying to find the coordinates of the point of intersection of two lines.

Of course, a problem arises if the two lines have the same slope. In such a situation, there are two possibilities. The first is that the lines are parallel and have no point of intersection. In that case, the equations are called inconsistent (or incompatible) and there is no solution.

The other possibility is that the two equations are really two different forms of the same equation. In that case, you have only one line and there is an infinite number of solutions; any point \((x, y)\) that lies on the line is at the “intersection” of the two (identical) lines.

Example 1: A certain store sells blouses and skirts at a fixed price regardless of style or size. Marla bought 4 blouses and 6 skirts and was charged $380 before taxes. Arlene went to the same store; she bought 2 blouses and 3 skirts and was charged $195 before taxes. What was the price of a blouse?
**Solution:** Letting $b =$ the price of a blouse and $s =$ the price of a skirt, we have for Marla $4b + 6s = 380$ and for Arlene $2b + 3s = 195$.

If we multiply the second equation by $−2$ and add it to the first, we have:

\[ \begin{align*} 
4b + 6s &= 380 \\
−4b − 6s &= −390 \\
0 &= −10
\end{align*} \]

But this is impossible! This means that the two equations represent parallel lines, and there is no solution. Someone must have made a mistake in calculating either Marla’s or Arlene’s bill, so there is no correct way to answer the question as posed.

**Example 2:** Juan has a package containing some 2¢ stamps and some 5¢ stamps with a total value of 62¢. If Juan had 3 more than twice as many 2¢ stamps as he now has, and twice as many 5¢ stamps, the assortment would be worth $1.30. What is the greatest number of 5¢ stamps Juan may have?

**Solution:** Let $x$ be the number of 2’s and $y$ be the number of 5’s. Expressing the given information in cents, we have $2x + 5y = 62$ and $2(2x + 3) + 5(2y) = 130$.

Expanding the second equation:

\[ \begin{align*} 
4x + 6 + 10y &= 130 \\
4x + 10y &= 124
\end{align*} \]

If we attempt to solve by elimination, we can multiply the first equation by $−2$ and add it to the second equation:

\[ \begin{align*} 
−4x − 10y &= −124 \\
4x + 10y &= 124 \\
0 &= 0
\end{align*} \]

It is certainly true that $0 = 0$, but it is not much help! Actually, we see that the second equation is simply double the first. So really we have two equations—two definitions of the same line—yielding an infinite number of solutions.

However, the question posed can be answered. Since the nature of the given information implies that both $x$ and $y$ must be positive integers (there is no way to have a negative number of stamps), the greatest possible value of $y$ is when $x = 1$, for which $y = 12$. 

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Parabolas and Quadratic Equations

The graph of the quadratic function \( y = ax^2 + bx + c \) is a parabola. Visually, the graph of a parabola will "open up" if \( a > 0 \) and will "open down" if \( a < 0 \). In either case, the vertex or turning point of the parabola will be found at \( x = -\frac{b}{2a} \), and the curve will be symmetrical with respect to the line \( x = \frac{b}{2a} \).

Naturally, there is a strong relationship between the graph and the solution to the equation \( ax^2 + bx + c = 0 \), which must be solved to find the \( x \)-intercepts of the graph.

If the equation has two real distinct roots, then the curve crosses the \( x \)-axis at two points. If there are two identical roots, then that value will be the \( x \)-coordinate of the vertex, and the curve will be tangent to the axis at that point. If the roots are both complex, then the curve will never cross the \( x \)-axis.

Example 1: Find the coordinates of the vertex of the parabola \( y = x^2 - 4x + 3 \).

Solution: The \( x \)-coordinate of the vertex is \( x = -\frac{b}{2a} = -\frac{-4}{2} = 2 \).

Substituting, the \( y \)-coordinate is \( y = (2)^2 - 4(2) + 3 = -1 \). Hence, the vertex is \((2, -1)\).

Just for the sake of completeness, you should see that the curve opens up (because \( a = 1 \)) and that it has \( y \)-intercept \((0, 3)\) and \( x \)-intercepts \((1, 0)\) and \((3, 0)\). The graph is shown below.
Example 2: Find the $x$-intercepts and coordinates of the vertex for the parabola $y = -2x^2 - 4x + 6$.

Solution: Finding the $x$-intercepts means finding the values of $x$ for which $y = 0$; that is, the roots of the equation $-2x^2 - 4x + 6 = 0$.

Dividing by $-2$, we have $x^2 + 2x - 3 = 0$, which factors as $(x - 1)(x + 3) = 0$. Therefore, $x = 1$ and $x = -3$. The $x$-intercepts are $(1,0) \text{ and } (-3,0)$. The $x$-coordinate of the vertex is $x = \frac{-b}{2a} = \frac{-(-4)}{2(-2)} = -1$.

By substitution, the $y$-value is 8. Hence, the coordinates are $(-1,8)$. It is not an accident that the $x$-coordinate of the vertex falls halfway between the roots. That is a result of the symmetry of the curve. Again, for the sake of completeness, the graph is shown below. Notice that it opens down because $a = -2$.

![Graph of the parabola $y = -2x^2 - 4x + 6$]

Trigonometric Graphs

The trigonometric functions all have graphs. In particular, you should be comfortable with the sine and cosine curves. Remember that when you look at a function of the form:

$$y = A\sin{kx} \text{ or } y = A\cos{kx}$$

$x$ should be expressed in radian measure.

To rename degrees as radians, divide by 180 and multiply by $\pi$.

The number $A$ is called the amplitude of the curve, and $|A|$ is maximum value that $y$ reaches. $(-|A|)$ is the minimum.) $k$ is called the frequency and tells how many full cycles are completed in the interval $[0, 2\pi]$.
The graphs below illustrate two possibilities.

![Graph of y = 2sinx](image1)

![Graph of y = 3cos2x](image2)

**Example 1**

**Q** What is the smallest possible positive value of \( x \) for which \( 4\cos2x = 2 \)?

- (A) \( \frac{\pi}{12} \)
- (B) \( \frac{\pi}{6} \)
- (C) \( \frac{\pi}{4} \)
- (D) \( \frac{\pi}{3} \)
- (E) \( \frac{\pi}{2} \)

**Solution:** The correct answer is (B). Referring to the graph, we know that the cosine curve starts at its maximum value at \( x = 0 \) and decreases thereafter until it reaches \(-1\), when \( x = \pi \). Since the amplitude of our curve is 4, we want to know when it reaches half its maximum; that is, we want to solve \( \cos2x = \frac{1}{2} \). Since \( \cos60^\circ = \frac{1}{2} \) and \( 60^\circ = \frac{\pi}{3} \), we want \( 2x = \frac{\pi}{3} \) or \( x = \frac{\pi}{6} \).

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Example 2

For which value of $b$ will the graph of $y = \sin 4x$ complete 3 full cycles in the interval $[0, b]$?

- (F) $\frac{\pi}{4}$
- (G) $\frac{\pi}{2}$
- (H) $\frac{3\pi}{4}$
- (J) $\pi$
- (K) $\frac{3\pi}{2}$

**Solution:** The correct answer is (K). The function has a frequency of 4. Therefore, it will complete four full cycles in the interval $[0, 2\pi]$. Hence, it will complete three full cycles in $\frac{3}{4}$ of that time, and $\frac{3}{4} (2\pi) = \frac{3\pi}{2}$.

**OTHER ACT ASSESSMENT MATH TOPICS**

**The Addition Principle for Counting**

If a set $A$ has $m$ elements, and a set $B$ has $n$ elements, and the two sets have no elements in common, then the total number of elements in the two sets combined is $m + n$. But if there are $k$ elements common to the two sets, then the total in the combined set is $m + n - k$. In other words, when summing the two sets, you must take into account the double counting of elements common to both groups.

This kind of situation is usually handled most easily by displaying the given information in a Venn Diagram, as shown in the examples that follow.

**Example 1:** Helena applied to 12 colleges for admission. Sergei applied to 10. Between them, they applied to 16 different colleges. How many colleges received applications from both students?
Solution: Let $H$ be the set of colleges to which Helena applied, and let $S$ be those to which Sergei applied. Letting $x$ be the number that are common to both sets, the diagram shown below displays the data.

![Venn Diagram](image)

The central region is that common to both sets, and we can see that the total is $(12 - x) + x + (10 - x) = 16$. Removing parentheses and combining like terms, we have $22 - x = 16$; $x = 6$.

Example 2: A survey of voters shows that 43% listen to radio news reports, 45% listen to TV news reports, and 36% read a daily newspaper. What is the maximum possible percent that do all three?

Solution: If the three sets were totally disjointed—that is, had no overlap—the sum of the percentages would be 100%. The extent of various kinds of overlap will show up as an excess over 100%. Everyone in two of the three categories will be counted twice, and everyone in all three categories will be counted three times.

If we total 43 + 45 + 36, we find that we have accounted for 124% of the voters, a 24% overcount. Therefore, the number common to all three cannot be greater than one third of that, or 8%. This maximum of 8% is reached only if no one falls into two out of three categories, so that the entire overcount is the result of people in all three categories.

The Multiplication Principle for Counting

Suppose a process can be broken down into two steps. If the first step can be performed in $m$ ways, and if, for each of those ways, the second step can be performed in $n$ ways, then the total number of ways of performing the operation is $T = mn$. This is known as the multiplication principle for counting.

For example, suppose that a jar contains five blocks of different colors. We pick a block, record the color, and then pick a second block without replacing the first. The number of possible color combinations is $(5)(4) = 20$, since there are five possible colors to be drawn from in the first step and four possible colors in the second step. This process extends to more than two steps in the natural way.
Example 1: The diagram shown below is a road map from Abbottsville to Cartersburg.

```
  Batetown
```

```
Abbottsville          Cartersburg
```

How many different routes can you follow to drive from Abbottsville to Cartersburg if you go through Batetown only once?

Solution: You have 3 choices for a road from Abbottsville to Batetown and 4 roads from Batetown to Cartersburg. Hence, by the multiplication principle, the total number of routes is $3 \times 4 = 12$.

Example 2: How many different 3-digit license plate numbers can you form if the first digit cannot be 0?

Solution: By the natural extension of the multiplication principle to a three-step process, we see that you have 9 choices for the first digit (1,2,3,... 9), 10 choices for the second digit (0,1,2... 9), and the same 10 choices for the third digit. Thus, the total is $9 \times 10 \times 10 = 900$.

As a natural extension of the multiplication principle, it is not hard to show that the number of distinct arrangements of $n$ distinguishable objects in a row is $n$ factorial calculated as follows:

$$n! = n(n - 1)(n - 2) \ldots (2)(1)$$

For example, there are $4! = 4 \times 3 \times 2 \times 1 = 24$ ways of arranging the four symbols ♣, ♦, ♥, and♠ in a straight line.

Example 3: If the five starting members of a basketball team are lined up randomly for a photograph, what is the chance that they will be in order of height from shortest to tallest, left to right?

Solution: There are 5 distinguishable people, who can be arranged in $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$ ways. In only one of these ways will they be in the correct order. Therefore, the chance is $\frac{1}{120}$.

Probability

To find the probability of an event, divide the number of outcomes favorable to the event by the total number of possible outcomes. For example, if a bag contains 12 blue marbles and 9 red marbles, the probability that a marble selected at random is blue is the number of blue marbles divided by the total number of marbles, which is $\frac{12}{21} = \frac{4}{7}$.

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Example: A box contains five blocks numbered 1, 2, 3, 4, and 5. Johnnie picks a block and replaces it. Lisa then picks a block. What is the probability that the sum of the numbers they picked is even?

Solution: Since each had 5 choices, there are 25 possible pairs of numbers. The only way the sum could be odd is if one person picked an odd number and the other picked an even number. Suppose that Johnnie chose the odd number and Lisa the even one. Johnnie had 3 possible even numbers to select from, and for each of these, Lisa had 2 possible choices, for a total of (3)(2) = 6 possibilities. However, you could also have had Johnnie pick an even number and Lisa pick an odd one, and there are also 6 ways to do that. Hence, out of 25 possibilities, 12 have an odd total and 13 have an even total. The probability of an even total, then, is \( \frac{13}{25} \).

Arithmetic and Geometric Progressions

A sequence of numbers \( a_1, a_2, a_3, \ldots, a_n \) is said to form an arithmetic progression if there is a constant (unchanging) difference between successive terms. That is, calling this difference \( d \), we have \( a_{k+1} = a_k + d \) for \( k = 1, 2, 3, \ldots \). This means that we can write \( a_k = a_1 + (k - 1)d \). Usually, for simplicity, we write simply \( a \) for \( a_1 \) and write:

\[
a_k = a + (k - 1)d
\]

The last (\( n \)th) term of the sequence is frequently abbreviated \( L \), and we have:

\[
L = a + (k - 1)d
\]

The sum of the terms in the progression is then the average of the first and last terms times the number of terms. As a formula:

\[
S = n\left(\frac{a + L}{2}\right)
\]

or:

\[
S = n\left(\frac{2a + (n-1)d}{2}\right)
\]

Example 1

What is the sum of the first ten terms of the sequence \(-5, -2, 1, 4, \ldots \)?

(A) 17.5
(B) 22
(C) 40.5
(D) 85
(E) 135
**Solution:** The correct answer is (D). The first term is \(-5\). The common difference, \(d = 3\). Hence, the tenth (last) term is \(-5 + 9(3) = 17\), and the first and last terms average 8.5. Therefore, the sum is \(10(8.5) = 85\).

A sequence of numbers \(a_1, a_2, a_3, \ldots, a_n\) is said to form a geometric progression if each term is a constant multiple of the preceding one. That is, the ratio of successive terms is a constant. Calling the common ratio \(r\), we have \(a_{k+1} = a_k r\) for \(k = 1,2,3,\ldots\) which means that we can write \(a_k = a_1 r^{k-1}\). Usually, for simplicity, we use \(a_1\) for \(a_1\) and write:

\[
a_k = ar^{k-1}\text{ for } k = 1,2,3,\ldots, n
\]

The last \((n)\text{th}\) term is \(a_n = ar^{n-1}\). The sum of the terms in the progression is given by the formula:

\[
S = a \left( \frac{1 - r^n}{1 - r} \right)
\]

**Example 2**

Q If the fourth term of a geometric progression is 5 and the seventh term is \(-40\), what is the sum of the first five terms?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(F)</td>
<td>(-\frac{55}{8})</td>
</tr>
<tr>
<td>(G)</td>
<td>(\frac{19}{8})</td>
</tr>
<tr>
<td>(H)</td>
<td>3</td>
</tr>
<tr>
<td>(J)</td>
<td>(\frac{33}{8})</td>
</tr>
<tr>
<td>(K)</td>
<td>(\frac{55}{8})</td>
</tr>
</tbody>
</table>

**Solution:** The correct answer is (F). If the fourth term is 5 and the seventh term is \(-40\), we have two equations: \(ar^3 = 5\) and \(ar^6 = -40\).

Dividing the second by the first, we have:

\[
\frac{ar^6}{ar^3} = \frac{-40}{5} ; r^3 = -8
\]

This yields \(r = -2\). Since \(ar^3 = 5\) and \(r^3 = -8\), \(a = \frac{-5}{8}\). The sum of the first five terms, then, is:

\[
S = -\frac{5}{8} \left( \frac{1 - (-2)^5}{1 - (-2)} \right) = -\frac{5}{8} \left( \frac{33}{3} \right) = -\frac{55}{8}
\]
Matrices

A matrix (plural matrices) is a rectangular array of numbers. The rows of the matrix are numbered from top to bottom, and the columns are numbered from left to right. Matrices with the same “shape,” that is, having the same numbers of rows and columns, can be added and subtracted by adding or subtracting like entries in their positions.

Example 1: Find the sum of these two matrices:

\[
A = \begin{pmatrix} 2 & 6 \\ 3 & -1 \end{pmatrix}, \quad B = \begin{pmatrix} 4 & 0 \\ 2 & 1 \end{pmatrix}
\]

Solution: The two matrices are both the same shape (2 × 2), and we can simply add the entries to get:

\[
A + B = \begin{pmatrix} 6 & 6 \\ 5 & 0 \end{pmatrix}
\]

To multiply a matrix \(A\) by a scalar (number) \(k\), multiply every entry in \(A\) by \(k\). For example:

\[
3 \begin{pmatrix} 2 & 6 \\ 3 & -1 \end{pmatrix} = \begin{pmatrix} 6 & 18 \\ 9 & -3 \end{pmatrix}
\]

To form the product of a row matrix and a column matrix: The product, \(RC\), of a row matrix \(R\) with a column matrix \(C\) can be defined only if the number of entries in each is the same. When this occurs, the product is a number that is the sum of the products of the respective entries.

For example,

if \(R = (1 \ 2 \ 3)\) and \(C = \begin{pmatrix} 4 \\ 5 \\ 6 \end{pmatrix}\), then \(RC = (1 \ 2 \ 3) \begin{pmatrix} 4 \\ 5 \\ 6 \end{pmatrix} = (1)(4) + (2)(5) + (3)(6) = 32.\)

Given two matrices \(A\), which is \(m \times n\), and \(B\), which is \(n \times p\), their product, \(AB\), can be formed because the number of columns in the first matrix is equal to the number of rows in the second. The resulting matrix will be \(m \times p\), and the entry in row number \(i\), column number \(j\) is the product of row \(i\) of \(A\) and column \(j\) of \(B\).
Example 2

If \( A = \begin{pmatrix} 2 & 6 \\ 3 & -1 \end{pmatrix} \) and \( B = \begin{pmatrix} 4 & 3 & -2 \\ 2 & 1 & 5 \end{pmatrix} \), then the entry in the second row, third column of \( AB \) will be

(F) -11
(G) -1
(H) 1
(J) 11
(K) 20

Solution: The correct answer is (F). We need to find the product of the second row of \( A \) and the third column of \( B \), that is:

\[
\begin{pmatrix} 3 & -2 \\ 5 \end{pmatrix} \begin{pmatrix} -2 \\ 5 \end{pmatrix} = (3)(-2) + (-1)(5) = -11
\]

PRACTICE EXERCISES

You’ve just reviewed the most important points in arithmetic, algebra, geometry, and trigonometry for success in taking the ACT Assessment Math Test. The following exercises will help you to practice your new knowledge as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are three Math Test exercises in this chapter. Each exercise contains 12 problems and should be answered in 12 minutes. Do each exercise in one sitting in a quiet place, with no notes or reference material. You may use a calculator. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

Score yourself only on those items you finished. When you’re done, work through the rest of the exercise.
EXERCISES: THE ACT ASSESSMENT MATH TEST

Exercise 1

12 Questions • Time—12 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. If a fleet of seven taxicabs uses 180 gallons of gasoline every 2 days, how many gallons will be used by four taxi cabs during a 7-day week?
   (A) 180
   (B) 240
   (C) 300
   (D) 360
   (E) 420

2. If \( a = -1 \) and \( b = -2 \), what is the value of \( (2 - ab^2)^3 \)?
   (F) 27
   (G) 64
   (H) 125
   (J) 216
   (K) 343

3. If four boxes of books each weighing at least 20 pounds have an average weight of 60 pounds, and if one of the boxes weighs 80 pounds, what is the maximum possible weight of the heaviest box in pounds?
   (A) 90
   (B) 100
   (C) 110
   (D) 120
   (E) 140

4. A quadrilateral has angles in the ratio 1:2:3 and a fourth angle that is 31° larger than the smallest angle. What is the difference in degree measure between the two middle-sized angles in the quadrilateral?
   (F) 16
   (G) 31
   (H) 47
   (J) 51
   (K) 63
5. What is the area of the region shown below, if the curved side is a semicircle?

![Diagram](image)

(A) $20 + 4\pi$
(B) $20 + 6\pi$
(C) $40 + 6\pi$
(D) $60 + 8\pi$
(E) $80 + 8\pi$

6. How many gallons of milk that is 2% butterfat must be mixed with milk that is 3.5% butterfat to yield 10 gallons that is 3% butterfat?

(F) 3
(G) $\frac{10}{3}$
(H) $\frac{7}{2}$
(J) $\frac{11}{3}$
(K) 4

9. What is the greater value of $x$ if $x^2 + 6x + 8 = 0$?

(A) −6
(B) −4
(C) −2
(D) 2
(E) 4

10. In the figure below, $M$ is the midpoint of $RS$. What is the area of triangle $MOP$?

![Diagram](image)

(F) $\sqrt{7}$
(G) 3
(H) 3.5
(J) 4
(K) 4.5
Use the following information to answer questions 11 and 12.

The maximum speed of airplanes has increased from the 30 miles per hour that the Wright Brothers’ first plane flew in 1903 to the much greater speeds possible today. The following graph shows increases in the air speed record from 1903 to 1967.

11. In approximately what year did a plane first fly over 500 miles per hour?
   (A) 1940
   (B) 1941
   (C) 1943
   (D) 1948
   (E) 1950

12. The air distance from New York to Los Angeles is about 3,000 miles. How much longer (in hours) would it take a plane flying at the 1944 record speed to fly that distance than a plane flying the same distances at the 1964 record speed?
   (F) 2
   (G) 2.5
   (H) 3
   (J) 4
   (K) 6
CHAPTER 9: Math Review

Exercise 2

12 Questions • Time—12 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. If 6 drums of oil will heat 5 identical buildings for 3 days, how many days will 10 drums of oil last when heating 2 of the same buildings?
   (A) 10
   (B) 12
   (C) 12.5
   (D) 14.5
   (E) 18

2. In the figure below, the centers of all three circles lie on the same line. The medium-sized circle has a radius twice the size of the radius of the smallest circle, and the smallest circle has a radius whose length is 2. What is the area of the shaded region?
   (F) $3\pi$
   (G) $4\pi$
   (H) $6\pi$
   (J) $8\pi$
   (K) $10\pi$

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3. At a certain bakery, the cost of 4 rolls, 6 muffins, and 3 loaves of bread is $9.10, and the cost of 2 rolls, 3 muffins, and a loaf of bread is $3.90. What is the cost of a loaf of bread?
   (A) $1.05
   (B) $1.10
   (C) $1.20
   (D) $1.25
   (E) $1.30

4. If \(x\) and \(y\) are positive integers, and \(x - 2y = 5\), which of the following could be the value of \(x^2 - 4y^2\)?
   (F) -3
   (G) 0
   (H) 14
   (J) 45
   (K) 51

5. John can vacuum a hotel room in 20 minutes. Armando needs 15 minutes to do the same job. How many hours does it take them working together to vacuum 30 rooms?
   (A) \(\frac{20}{7}\)
   (B) 3
   (C) 4
   (D) \(\frac{30}{7}\)
   (E) \(\frac{50}{7}\)

6. A plane is flying from City A to City B at \(m\) miles per hour. Another plane flying from City B to City A travels 50 miles per hour faster than the first plane. The cities are \(R\) miles apart. If both planes depart at the same time, in terms of \(R\) and \(m\), how far are they from City A when they pass?
   (F) \(\frac{R}{m} + 50\)
   (G) \(\frac{R}{2m} - 50\)
   (H) \(\frac{R}{2m + 50}\)
   (J) \(\frac{R + 50}{m + 50}\)
   (K) \(\frac{m + 50}{R}\)

7. When the units and tens digits of a certain two-digit number are reversed, the sum of the two numbers is 121 and the difference is 9. What is the tens digit of the original number?
   (A) 1
   (B) 3
   (C) 4
   (D) 6
   (E) 7

8. \(\sqrt[3]{\frac{5}{\sqrt{25}}} = ?\)
   (F) \(\frac{\sqrt[3]{5}}{5}\)
   (G) 1
   (H) \(\sqrt{5}\)
   (J) \(2\sqrt{5}\)
   (K) \(m5\sqrt{5}\)

9. If \(x\) and \(y\) are positive integers, and \(x + y = 10\), what is the value of \(|x - y|\) when \(x^2 + y^2\) is as least as possible?
   (A) 0
   (B) 2
   (C) 4
   (D) 6
   (E) 8
10. If \( \log_x(0.001) = 3 \), then \( x = ? \)
   (F) \((.001)^3\)
   (G) 0.01
   (H) 0.1
   (J) 10
   (K) 1,000

11. Which of the following is the inverse function for \( f(x) = \frac{2x}{x-4} \)?
   (A) \( y = \frac{4x}{x-2} \)
   (B) \( y = \frac{4x}{2-x} \)
   (C) \( y = \frac{x-4}{2x} \)
   (D) \( y = \frac{-2x}{x+4} \)
   (E) \( y = \frac{4x}{x+2} \)

12. Which of the following is an equation of the straight line that has y-intercept 2 and is perpendicular to the line \( 3x - 5y = 11 \)?
   (F) \( 5x - 3y = 2 \)
   (G) \( 5x + 3y = 2 \)
   (H) \( 3x - 5y = 9 \)
   (J) \( 3x - 5y = -10 \)
   (K) \( 5x + 3y = 6 \)
Exercise 3

12 Questions • Time—12 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. Andover and Diggstown are 840 miles apart. On a certain map, this distance is represented by 14 inches. Lincoln and Charleston are 630 miles apart. On the same map, what is the distance between them in inches?
   (A) 9 1/7
   (B) 10
   (C) 10 1/7
   (D) 11
   (E) 11 1/7

2. Combined into a single monomial, $10y^2 - \frac{4}{2}y^2 = ?$
   (F) $\frac{5y}{2}$
   (G) $\frac{6}{y}$
   (H) $6y^2$
   (J) $8y^2$
   (K) $-6y^2$

3. In the (x,y) coordinate plane, what is the distance from $P(-2,8)$ to $Q(3,-4)$?
   (A) $\frac{12}{5}$
   (B) $\sqrt{17}$
   (C) $\sqrt{145}$
   (D) 13
   (E) 18

4. In the figure below, what is the area of the region shown?
   (F) $8\sqrt{3}$
   (G) 16
   (H) $12 + 4\sqrt{3}$
   (J) $8 + 8\sqrt{3}$
   (K) $16 + 8\sqrt{3}$
5. The figure below shows a square garden with a 1-yard-wide concrete path around it. If the area of the walkway is 80 square yards, what is the length of one side of the garden in yards?

6. If \( A < 2 - 4B \), which of the following is true?
   - (F) \( \frac{2-A}{4} > B \)
   - (G) \( \frac{2-A}{4} < B \)
   - (H) \( B > 4A + 2 \)
   - (J) \( B < 4A + 2 \)
   - (K) None of the above

7. If \( 9^{2x} = 3^{3x-4} \), then \( x = ? \)
   - (A) \(-4\)
   - (B) \(-\frac{4}{3}\)
   - (C) \(1\)
   - (D) \(\frac{4}{3}\)
   - (E) \(4\)

8. If \( x = 4.04 \), what is the value of \( \frac{(x^2 - 16)}{(4x + 16)} \)?
   - (F) 0.01
   - (G) 0.04
   - (H) 1.01
   - (J) 1.04
   - (K) 4.01

9. If \( x < y < -1 \), which of the following expressions is greatest?
   - (A) \( \frac{x}{y} \)
   - (B) \( \frac{y}{x} \)
   - (C) \( \left( \frac{y}{x} \right)^2 \)
   - (D) 0
   - (E) \( \left( \frac{x}{y} \right)^2 \)

10. The length of a walk-in closet is 4 feet greater than its width. Its area is 60 square feet. How many feet wide is the closet?
   - (F) 4
   - (G) 6
   - (H) 8
   - (J) 10
   - (K) 12

11. If \( \frac{1}{x} - \frac{4}{3} = \frac{2}{x} \), what is the value of \( x \)?
   - (A) \(-3\)
   - (B) \(-\frac{4}{3}\)
   - (C) \(-\frac{3}{4}\)
   - (D) \(\frac{3}{4}\)
   - (E) \(\frac{4}{3}\)
12. Simplified to simplest form, \( \frac{4x^2-9}{2x^2+x-3} = ? \)

(F) \( \frac{2x+3}{x-1} \)

(G) \( \frac{2x-3}{x+1} \)

(H) \( \frac{2x+3}{x+1} \)

(J) \( \frac{2x-3}{x+1} \)

(K) \( \frac{2x^2-9}{x^2+x-3} \)
ANSWER KEY AND EXPLANATIONS

Exercise 1

1. The correct answer is (D). Running 7 cabs for 2 days is the same as running one cab for 14 days, while running 4 cabs for 7 days is the same as running one cab for 28 days. Thus, you simply need twice as much gasoline! Here’s another way to look at this: The fact that we use 180 gallons of gasoline by running 7 cabs for 2 days means that we use 180 gallons running one cab for 14 days. In other words, each cab uses \( \frac{180}{14} \) gallons each day. So if you multiply the number of gallons per day used by each cab by the number of cabs and the number of days, you should get total usage. That is:

\[
\frac{180}{14} \times 4 \times 7 = 360.
\]

2. The correct answer is (J). Substituting, \( [2 – (–1)(–2)^2]^3 = [2 – (–4)]^3 = 6^3 = 216. \)

3. The correct answer is (D). If the boxes have an average weight of 60 pounds, then the four must total 240 pounds. Because one weighs 80, the other three total 160. The largest box could weigh 120, with the other two each weighing 20.

4. The correct answer is (F). Calling the smallest angle \( x \), the others are \( 2x \), \( 3x \), and \( x + 31 \). Because the angles in the quadrilateral must sum to 360, we get:

\[
x + 2x + 3x + (x + 31) = 360
7x + 31 = 360
7x = 329; x = 47
\]

That makes the degree measures of the four angles 47, 94, 141, and 78. The difference between the two in the middle is 94 – 78 = 16.

5. The correct answer is (E). The dotted line divides the region into a rectangle and a semi-circle. Because the radius of the circular arc is 4, the diameter of the circle is 8, and that is the width of the rectangle. The length is 10. Hence, its area is 80. The area of the whole circle would be \( \pi r^2 = \pi (4^2) = 16\pi \). Hence, the area of the semicircle is half of that, or \( 8\pi \). Therefore, the total area is \( 80 + 8\pi \).

6. The correct answer is (G). Let \( g \) be the number of gallons that is 2% butterfat. Then \( 10 – g \) will be the amount that is 3.5% butterfat. The total amount of butterfat is:

\[
0.02g + 0.035(10 – g) = 0.03(10)
0.02g + 0.35 – 0.035g = 0.3
\]

Now, multiply by 1,000 to clear out the decimals:

\[
20g + 350 – 35g = 300
–15g = –50; g = \frac{10}{3}
\]

7. The correct answer is (B). Eight shirts are two sets of three, plus two singles, which will cost $110 plus $44, or $154. Then you get a $15.40 discount (10%), bringing the final cost to $138.60.

8. The correct answer is (H). If you buy five shirts, you get three for $55 plus two more for $22 each, for a total of $99. But if you buy six shirts (two sets of three), you pay $110 less a 10% discount of $11, bringing your cost down to $99. The extra shirt is free!
9. The correct answer is (C). Factoring:
   \[ x^2 + 6x + 8 = (x + 2)(x + 4) = 0. \]
   Therefore:
   \[ x + 2 = 0 \text{ or } x + 4 = 0 \]
   \[ x = -2 \text{ or } x = -4 \]
   The greater root is \(-2\).

10. The correct answer is (K). The midpoint has coordinates that are the average of the end points; that is, (3,3). Hence, the triangle is an isosceles right triangle with legs 3 units long and an area equal to \( \frac{1}{2}bh = \left(\frac{1}{2}\right)(3)(3) = 4.5 \).

11. The correct answer is (C). In 1941, the record was under 500 miles per hour, and in 1944, it was over 500 mph. The line graph seems to cross the 500 grid line at about 1943.

12. The correct answer is (J). The 1964 record was 1,500 mph. To fly 3,000 miles at this speed would take 2 hours. In 1944, the speed record was 500 mph. To fly 3,000 miles at that speed would take 6 hours, or 4 hours longer.

Exercise 2

1. The correct answer is (C). Letting \( x \) be the unknown number of days, we know that the ratio of “number of drums” to “number of building-days” must be constant; that is, \( 6:15 = 10:2x \). Written as a fractional equation:
   \[ \frac{6}{15} = \frac{10}{2x} \]
   Thus, \( \frac{2}{5} = \frac{5}{x} \).
   Cross-multiplying: \( 2x = 25; x = 12.5 \).

2. The correct answer is (J). The smallest circle has a radius of 2, the medium circle has a radius of 4, and the diameter of the large circle must be 12, which makes its radius 6. The area of a semi-circle is half that of the entire circle; that is, \( \frac{1}{2}\pi r^2 \). The area of the shaded region is the area of the largest semi-circle minus the areas of the two lesser ones; that is, \( \frac{1}{2}\pi(36) - \frac{1}{2}\pi(16) - \frac{1}{2}\pi(4) = 8\pi \).

3. The correct answer is (E). Letting \( r, m, \) and \( b \) be the prices in cents of rolls, muffins, and bread, respectively, yields two equations:
   \[ 4r + 6m + 3b = 910 \]
   \[ 2r + 3m + b = 390 \]

4. The correct answer is (J). Because \( x^2 - 4y^2 = (x - 2y)(x + 2y) = 5(x + 2y), x^2 - 4y^2 \) must be divisible by 5. Therefore, \(-3, 14, \) and \( 51 \) are not possible answers (none is divisible by 5). If the result is to be zero, \( x + 2y = 0 \), which means that \( y = -2x \); so both numbers cannot be positive. Hence, the expression must equal 45, which you get if \( x = 7 \) and \( y = 1 \).

5. The correct answer is (D). Since John takes 20 minutes per room, he can do 3 rooms in one hour. Armando can do 4 rooms in an hour. Thus, together they do 7 rooms in one hour. To do 30 rooms will take them \( \frac{30}{7} \) hours, which is greater than 4.
6. The correct answer is (H). The planes pass at the moment when the total distance traveled by both equals $R$. Call this time $t$. The first plane, going $m$ mph, has traveled $mt$ miles. The second plane, going $(m + 50)$ mph, has traveled $(m + 50)t$. The two sum to $R$. Thus,

$$R = mt + mt + 50t$$
$$R = (2m + 50)t$$

Thus,

$$t = \frac{R}{2m + 50}$$

Hence, the planes’ distance from City A is $m$ times this time:

$$mt = \frac{Rm}{2m + 50}$$

7. The correct answer is (D). Calling the number $10t + u$, when we reverse the digits, we get $10u + t$. The sum is then $(10t + u) + (10u + t) = 11t + 11u = 121$. Dividing by 11, we have $t + u = 11$. Taking the difference: $(10t + u) - (10u + t) = 9t - 9u = 9$, and dividing by 9: $t - u = 1$. Finally, adding:

$$t + u = 11$$
$$t - u = 1$$
$$2t = 12; t = 6$$

8. The correct answer is (G). Because

$$\sqrt{25} = 5, \sqrt{\frac{25}{5}} = 1, \text{ and } \sqrt{1} = 1.$$ 

9. The correct answer is (A). If $x = 5$ and $y = 5$, $x^2 + y^2 = 50$. For any other choice—say, 6 and 4—the sum is greater. Hence, the value of $x^2 + y^2$ is least when $x = y$ and $|x - y| = 0$.

10. The correct answer is (H). The logarithmic equation is equivalent to $x^3 = 0.001$; $x = \frac{1}{1000}$, for which $x = \frac{1}{1000}$; $x = \frac{1}{10}$.

11. The correct answer is (A). To find the inverse function, write $y$ for $f(x)$, and then interchange $x$ and $y$ in the original equation and solve for $y$ in terms of $x$. Thus,

$$y = \frac{2x}{x - 2} \quad \rightarrow \quad x = \frac{2y}{y - 4}.$$ 

Multiplying by $(y - 4)$, we have $xy - 4x = 2y$. Bringing $2y$ to the left side and $4x$ to the right gives us: $xy - 2y = 4x; y(x - 2) = 4x$, and dividing by $(x - 2)$, $y = \frac{4x}{x - 2}$.

12. The correct answer is (K). Solving $3x - 5y = 11$ for $y$, we have $5y = 3x - 11$;

$$y = \frac{3}{5}x - \frac{11}{5}.$$ 

Hence, the slope is $m = \frac{3}{5}$. The slope of the perpendicular line must be $m = -\frac{5}{3}$; combined with the $y$-intercept $b = 2$, we have the equation $y = -\frac{5}{3}x + 2$. Multiply by 3: $3y = -5x + 6$; add $5x$ to both sides: $5x + 3y = 6$. 

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Exercise 3

1. **The correct answer is (C).** The actual distance and the distance on the map must be in the same proportion. That is: $630:840 = x:14$, where $x$ is the unknown distance. In fractions: $\frac{630}{840} = \frac{x}{14}$. Cross-multiplying: $4x = 42; x = 10.5$.

2. **The correct answer is (J).** The fraction simplifies to $2y^2$, and $10y^2 - 2y^2 = 8y^2$.

3. **The correct answer is (D).** By the distance formula, $d = \sqrt{(3-[-2])^2 + (-4-8)^2} = \sqrt{25+144} = \sqrt{169} = 13$.

4. **The correct answer is (K).** Because $BC = 4$ and $AC = 8$, we know that triangle $ABC$ is a $30^\circ-60^\circ-90^\circ$ right triangle. Hence, we know that $AB = 4\sqrt{3}$. Taking one half the product of the legs, the triangle has an area of $\frac{1}{2} \times 4 \times (4\sqrt{3}) = 8\sqrt{3}$. Because triangle $ADC$ is an isosceles right triangle with a hypotenuse of 8, each leg must be $\frac{8}{\sqrt{2}}$. Again, taking one half the product of the legs, the triangle has an area of $\frac{1}{2} \times \frac{8}{\sqrt{2}} \times \frac{8}{\sqrt{2}} = \frac{64}{2} = 16$. Adding the two areas, we have $16 + 8\sqrt{3}$.

5. **The correct answer is (B).** Calling the side $x$, then the entire area, including the walkway, is $(x + 2)^2$. The area of the garden is $x^2$, and the difference is the area of the walkway. Thus,

   \[(x + 2)^2 - x^2 = 80\]

   \[x^2 + 4x + 4 - x^2 = 80\]

   \[4x + 4 = 80\]

   \[4x = 76; x = 19\]

6. **The correct answer is (F).** Add $-2$ to both sides, thus:

   \[A < 2 - 4B\]

   \[-2 = -2\]

   \[A - 2 < -4B\]

   Divide by $-4$, remembering to reverse the inequality:

   \[\frac{2 - A}{4} > B\]

7. **The correct answer is (A).** In order to equate exponents, the bases must be the same. We can rewrite: $9^x = (3^2)^{\frac{x}{2}} = 3^{2x}$, and now we can equate $4x = 3x - 4$, yielding $x = -4$.

8. **The correct answer is (F).** Factoring the numerator and denominator of the fraction, we see that we can divide out the common factor $(x + 4)$, thus:

   \[\frac{x^2 - 16}{4x + 16} \cdot \frac{(x-4)(x+4)}{4(x+4)} = \frac{x - 4}{4}\]

   Substituting $x = 4.04$ yields $\frac{0.04}{4} = 0.01$.

9. **The correct answer is (E).** Because $x < y < -1$, the ratios $\frac{x}{y}$ and $\frac{y}{x}$ are both positive numbers, but $\frac{x}{y}$ is less than $\frac{y}{x}$, and must be the lesser.

10. **The correct answer is (G).** Calling the width $w$, the length is $w + 4$, and the area is $w(w + 4) = 60$. Thus, $w^2 + 4w - 60 = 0$. Factoring, $(w - 6)(w + 10) = 0$ gives us two roots: $w = 6$ and $w = -10$. Of course, we need the positive root, 6 (since there’s no such thing as “negative width”).
11. The correct answer is (C). Clear fractions by multiplying each term in the equation by the least common denominator, $3x$, yielding $3 - 4x = 6; -3 = 4x; x = \frac{-3}{4}$.

12. The correct answer is (J). Factoring numerator and denominator: \[
\frac{4x^2 - 9}{2x^2 + 3} = \frac{(2x-3)(2x+3)}{(x-1)(2x+3)}. \]
Dividing out the common factor $(2x + 3)$ yields \[
\frac{2x-3}{x-1}. \]
ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment Math Test? How well have you incorporated your review knowledge into your test-taking behavior?

After you’ve corrected each exercise, find the number of correct answers below. This will give you an idea of whether you still need improvement.

SCORE KEY FOR EACH PRACTICE EXERCISE

<table>
<thead>
<tr>
<th>Number Correct</th>
<th>Score</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>Poor</td>
<td>Study Chapters 5 and 9 again. See Additional Resources for Review below.</td>
</tr>
<tr>
<td>4–6</td>
<td>Below average</td>
<td>Study problem areas in Chapters 5 and 9. See Additional Resources for Review below if you have time.</td>
</tr>
<tr>
<td>7–8</td>
<td>Average</td>
<td>Skim problem areas in Chapters 5 and 9 if you have time.</td>
</tr>
<tr>
<td>9–10</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
</tr>
<tr>
<td>11–12</td>
<td>Excellent</td>
<td>You’re ready for the ACT Assessment Math Test.</td>
</tr>
</tbody>
</table>

ADDITIONAL RESOURCES FOR REVIEW

If you want to review and practice math in greater depth than the information in this book permits, browse the shelf at your local store and find a book that interests you. Scan the introductory material and directions to see if it is clearly written.

Also check the Table of Contents to see that the book covers topics specifically included on the ACT Assessment. Many books do not; other books include much more than you need. You want to be sure that you’re focusing this extra study time on ACT Assessment—specific material.
Reading Review

OVERVIEW

- Learn the top strategies for building your ACT Assessment vocabulary
- Review the ACT Assessment word list
- Review the most common prefixes and suffixes
- Practice your ACT Assessment vocabulary skills
- Evaluate your skills and options for further study

MASTER STRATEGIES FOR BUILDING YOUR VOCABULARY

You might not think strategies and vocabulary building can be said in the same breath. After all, for a bigger vocabulary, what more is involved than memorization? The answer is a great deal more. Memorization will only provide you with a bigger “list” of words; in some ways it’s nothing more than a glorified exercise in spelling. The Master Strategies here help make these words part of your working vocabulary—and that’s the key to scoring higher on the ACT Assessment.

Learn a Few Words Every Day

The saying is “An apple a day keeps the doctor away”—not “Eat a whole bushel of apples the next time you feel sick.” But that’s the approach many students take with vocabulary: They try to cram years’ worth of vocabulary into a few nights’ study or even a single sitting.

This method is ineffective because vocabulary must be learned over time. Unlike, say, spelling, vocabulary takes more than just memorization and several exposures. You need time to “digest” the word and make it part of your vocabulary.

So the first and most basic strategy behind building your vocabulary is simple: Learn just a few words at a time, and work on vocabulary every day. Fifteen minutes a day will put hundreds of new words at your command before you take the ACT Assessment.
Actively Use What You’ve Learned and Learn What You Use

There’s another saying: “Use a word three times and it’s yours forever.” Vocabulary building involves active application of what you’ve learned. Looking up a word’s definition is a start (although most vocabulary tools already provide a definition). Then write original sentences for the word and use it daily. These are the best ways to solidify your memory of its meaning.

If you’re an active “vocabulary builder,” you won’t limit yourself to just the ACT Assessment words below. You’ll want the widest ranging vocabulary possible. To do that, besides looking at the list below, also go through the dictionary at random and pick up a few new words each day. Even better, keep a word journal of both the words below and any unfamiliar word you encounter in reading or in conversation. If you hear or read something unfamiliar, you don’t have to stop right then to grab a dictionary and write a sentence. Just add it to your journal as a source of new words. The extra benefit of adding words you actually read or hear is that you’re learning what you already “use.” These words are part of your actual life, as opposed to opening up the dictionary and finding that your new word for the day, for example, is hermeneutics (the science of interpretation).

Learn to Recognize Root Words

If you’ve studied Latin or even Greek, you have a distinct advantage in learning vocabulary. Many English words have their roots, their beginnings, in Latin and Greek. Other languages share Latin and Greek as roots, so if you know Spanish or Italian, you might be coming at the same Latin root from another angle. And, because English itself has borrowed from so many different sources, any knowledge you have of any other language is also extremely helpful.

Here’s an example of how root words work. Suppose you’ve never heard of the ACT Assessment vocabulary word, discredit. You don’t know what this English word means. However, you do know just from looking at it that the Latin root word is credere, meaning to believe. If you also know that the prefix dis- means the negative of whatever word to which it’s attached, you come up with the word disbelieve. The exact meaning is actually closer to cause disbelief rather than disbelieve itself, but knowing the root and the prefix would enable you to make an excellent guess on an ACT Assessment question.

Another benefit of learning root words is that once you know the root, you usually have the key to not just one but several words, all variations on the root. From credere, for example, comes discredit—and also credential, credible, credit, creo, credulous, and incredible, all of which have to do with belief or believing in some way.
HOW TO USE YOUR ACT ASSESSMENT WORD LIST

Following is a list of the words most commonly used on the ACT Assessment in passages, question stems, and answer choices. There are about 500 primary words likely to appear in one form or another and hundreds more related words using either a variant or the same root. For each primary word, there is a definition and a sample sentence. For many words, the root is also given.

Your vocabulary review should be an active process. Go down the list and check every word you don’t know or about which you feel hesitant. Every day, study the definition of a few of these checked words. Copy the word and its definition into your journal. Jot down its part of speech. Look at its variations. Find the root if it’s not given here. Write an original sentence. Identify it in your reading material. Use it in class, on tests, and in reports.

Seeing and using the word in all these contexts will help you remember it now, then understand it better when you see it again on the ACT Assessment.

WORDS MOST LIKELY TO APPEAR ON THE ACT ASSESSMENT TEST

abbreviate (verb) to make briefer, to shorten. Because time was running out, the speaker had to abbreviate his remarks. abbreviation (noun).

root: from the Latin brevis meaning short. The same root is also found in the word brevity.

abide (verb) to withstand. It’s extremely difficult to abide criticism when you feel that it is undeserved.

abstain (verb) to refrain, to hold back. After his heart attack, he was warned by the doctor to abstain from smoking, drinking, and over-eating. abstinence (noun), abstemious (adjective).

abstract (adjective) intangible; apart from concrete existence. The most difficult concepts for most students to learn are those that are most abstract. abstraction (noun).

absurdly (adverb) in a meaningless or ridiculous manner. Absurdly, the doctor asked the man with the broken arm if he was feeling well. absurd (adjective).

accouterments (noun) accessories or equipment. Other than his weapons, the equipment a soldier carries is considered accouterments.
acrimonious (adjective) biting, harsh, caustic. The election campaign became acrimonious, as the candidates traded insults and accusations. acrimony (noun).

root: from the Latin acer meaning sharp. The same root is also found in the words acerbity, acrid, and exacerbate.

adaptable (adjective) able to be changed to be suitable for a new purpose. Some scientists say that the mammals outlived the dinosaurs because they were more adaptable to a changing climate. adapt (verb), adaptation (noun).

adaptable (adjective) highly skilled or proficient. Although with today’s electronic calculators it’s not absolutely essential, most accountants are nevertheless adept at arithmetic.

admirable (noun) deserving the highest esteem. Honesty has always been considered a particularly admirable trait. admirably (adverb).

adulation (noun) extreme admiration. Few young actors have received greater adulation than did Marlon Brando after his performance in A Streetcar Named Desire. adulate (verb), adulatory (adjective).

adversary (noun) an enemy or opponent. When the former Soviet Union became an American ally, the United States lost its last major adversary.

adversity (noun) misfortune. It’s easy to be patient and generous when things are going well; a person’s true character is revealed under adversity. adverse (adjective).

aeons (noun) immeasurably long periods of time. Although it hadn’t actually been that long, it seemed to the two friends that it had been aeons since they’d seen each other.

allege (verb) to state without proof. Some have alleged that Foster was murdered, but all the evidence points to suicide. allegation (noun).

alleviate (verb) to make lighter or more bearable. Although no cure for AIDS has been found, doctors are able to alleviate the sufferings of those with the disease. alleviation (noun).

root: from the Latin levis meaning light. The same root is also found in the words levitate and levity.

ambiguous (adjective) having two or more possible meanings. The phrase, “Let’s table that discussion” is ambiguous; some think it means, “Let’s discuss it now,” while others think it means, “Let’s save it for later.” ambiguity (noun).

root: from the Latin ambo meaning both. The same root is also found in the words ambidextrous and ambivalent.
**Ambivalent** (adjective) having two or more contradictory feelings or attitudes; uncertain. *She was ambivalent toward her impending marriage; at times she was eager to go ahead, while at other times she wanted to call it off.* ambivalence (noun).

**Anachronistic** (adjective) out of the proper time. *The reference, in Shakespeare’s Julius Caesar, to “the clock striking twelve” is anachronistic, since there were no striking timepieces in ancient Rome.* anachronism (noun).

**Root:** from the Greek *chronos* meaning time. The same root is also found in the words *chronic, chronicle, chronograph, chronology,* and synchronize.

**Anomaly** (noun) something different or irregular. *The tiny planet Pluto, orbiting next to the giants Jupiter, Saturn, and Neptune, has long appeared to be an anomaly.* anomalous (adjective).

**Anonymous** (noun) the state or quality of being unidentified. *Fatigued by years in the public eye, the president had begun to long for anonymity.* anonymous (adjective).

**Anxiety** (noun) apprehension, worry. *For many people, a visit to the dentist is a cause of anxiety.* anxious (adjective).

**Apprenticeship** (noun) a period of time during which one learns an art or trade. *Before the advent of law schools, a young person interested in becoming an attorney generally entered into an apprenticeship with an already established lawyer.*

**Aptitude** (noun) natural ability or talent. *It was clear, even when he was a very young child, that Picasso had an extraordinary aptitude for art.*

**Arable** (adjective) able to be cultivated for growing crops. *Rocky New England has relatively little arable farmland.*

**Arbiter** (noun) someone able to settle dispute; a judge or referee. *The public is the ultimate arbiter of commercial value: It decides what sells and what doesn’t.*

**Root:** from the Latin *arbiter* meaning judge. The same root is also found in the words *arbitrage, arbitrary,* and *arbitrate.*

**Arbitrary** (adjective) based on random or merely personal preference. *Both computers cost the same and had the same features, so in the end I made an arbitrary decision about which to buy.*

**Aristocratic** (adjective) of the nobility. *Having been born a prince and raised to succeed his father on the throne, the young man always had an aristocratic air about him.* aristocracy (noun).
artisans (noun) skilled workers or craftsmen. During the Middle Ages, hundreds of artisans were employed to build the great cathedrals.

assiduous (verb) working with care, attention, and diligence. Although Karen is not a naturally gifted math student, by assiduous study she managed to earn an A in trigonometry. assiduity (noun).

associate (verb) to join or become connected. After many years of working on her own, the attorney decided to associate herself with a large law firm. associate (noun).

astute (adjective) observant, intelligent, and shrewd. Safire’s years of experience in Washington and his personal acquaintance with many political insiders make him an astute commentator on politics.

asymmetrical (adjective) not balanced. If one of the two equal-sized windows is enlarged, the room’s design will become asymmetrical. asymmetry (noun).

audible (adjective) able to be heard. Although she whispered, her voice was picked up by the microphone, and her words were audible throughout the theater. audibility (noun).

root: from the Latin audire meaning to hear. The same root is also found in the words audition, auditorium, and auditory.

auditory (adjective) of, relating to, or experienced through hearing. Attending a symphony concert is primarily an auditory rather than a visual experience.

behavioral (adjective) relating to how humans or animals act. Psychology is considered a behavioral science because it concerns itself with human actions and reactions. behavior (noun).

benevolent (adjective) wishing or doing good. In old age, Carnegie used his wealth for benevolent purposes, donating large sums to found libraries and schools. benevolence (noun).

root: from the Latin bene meaning well. The same root is also found in the words benediction, benefactor, beneficent, beneficial, benefit, and benign.

blithely (adverb) in a gay or cheerful manner. Much to everyone’s surprise, the condemned man went blithely to the gallows, smiling broadly at the crowd. blithe (adjective).

bombastic (adjective) inflated or pompous in style. Old-fashioned bombastic political speeches don’t work on television, which demands a more intimate style of communication. bombast (noun).
buttress (noun) something that supports or strengthens. \textit{The endorsement of the American Medical Association is a powerful buttress for the claims made about this new medicine.} buttress (verb).

candor (noun) openness, honesty, frankness. \textit{In his memoir about the Vietnam War, former defense secretary McNamara describes his mistakes with remarkable candor.} candid (adjective).

capitulate (verb) to surrender or cease resisting. \textit{After many proposals over a number of years, the young woman finally decided to capitulate and marry her suitor.} capitulation (noun).

carnivorous (adjective) meat-eating. \textit{The long, dagger-like teeth of the Tyrannosaurus make it obvious that this was a carnivorous dinosaur.} carnivore (noun).

\textbf{root:} from the Latin \textit{vovare} meaning to eat. The same root is also found in the words \textit{devour, omnivorous, and voracious}.

cataloguing (verb) creating a list or register. \textit{The man was so busy cataloguing his library that he had no time to read.} catalogue (noun).

censure (noun) blame, condemnation. \textit{The news that Senator Packwood had harassed several women brought censure from many feminists.} censure (verb).

characterize (verb) to describe the qualities of. \textit{Although I am reluctant to characterize the man, I must say that he seems to me dishonest and untrustworthy.} characterization (noun).

chauvinism (noun) a prejudiced belief in the superiority of one’s own group. \textit{The company president’s refusal to hire any women for upper management was indicative of his male chauvinism.}

circuitous (adjective) winding or indirect. \textit{We drove to the cottage by a circuitous route so we could see as much of the surrounding countryside as possible.}

circumlocution (noun) speaking in a roundabout way; wordiness. \textit{Legal documents often contain circumlocutions, which make them difficult to understand.}

\textbf{root:} from the Latin \textit{circus} meaning a circle. The same root is also found in the words \textit{circumference, circumnavigate, circumscribe, circumspect, and circumvent}.

circumscribe (verb) to define by a limit or boundary. \textit{Originally, the role of the executive branch of government was clearly circumscribed, but that role has greatly expanded over time.} circumscription (noun).
circumvent (verb) to get around. When Jerry was caught speeding, he tried to circumvent the law by offering the police officer a bribe.

cogent (adjective) forceful and convincing. The committee members were won over to the project by the cogent arguments of the chairman. cogency (noun).

cognizant (adjective) aware, mindful. Cognizant of the fact that it was getting late, the master of ceremonies cut short the last speech. cognizance (noun).

root: from the Latin cognoscere meaning to know. The same root is also found in the words cognition, cognitive, incognito, and recognize.

cohesive (adjective) sticking together, unified. An effective military unit must be a cohesive team, all its members working together for a common goal. cohere (verb), cohesion (noun).

colloquial (adjective) informal in language; conversational. Some expressions from Shakespeare, such as the use of thou and thee, sound formal today but were colloquial English in Shakespeare’s time.

communal (adjective) of or pertaining to a group. Rather than have dinner separately, the members of the team chose to have a communal meal.

conciliatory (adjective) seeking agreement, compromise, or reconciliation. As a conciliatory gesture, the union leaders agreed to postpone a strike and to continue negotiations with management. conciliate (verb), conciliation (noun).

concise (adjective) expressed briefly and simply; succinct. Less than a page long, the Bill of Rights is a concise statement of the freedoms enjoyed by all Americans. concision (noun).

root: from the Latin caedere meaning to cut. The same root is also found in the words decide, excise, incision, and precise.

conditioned (adjective) trained or prepared for a specific action or process. In Pavlov’s famous experiments, by ringing a bell when he was about to feed them, he conditioned his dogs to salivate at the sound of the bell.

condolence (noun) pity for someone else’s sorrow or loss; sympathy. After the sudden death of Princess Diana, thousands of messages of condolence were sent to her family. condole (verb).

root: from the Latin dolere meaning to feel pain. The same root is also found in the words dolorous and indolent.
configuration (noun) the arrangement of the parts or elements of something. The configuration of players on a baseball field is governed both by tradition and by the rules of the game. configure (verb).

conjure (verb) to call to mind or evoke. The scent of magnolia always conjures up images of the Old South.

connoisseur (noun) an expert capable of acting as a critical judge. There was no question that the woman’s discriminating palate made her a connoisseur of vintage wines.

constructive (adjective) serving to advance a good purpose. Although simply complaining about someone’s behavior generally does no good, constructive criticism can sometimes bring about positive change.

consummate (verb) to complete, finish, or perfect. The deal was consummated with a handshake and the payment of the agreed-upon fee. consummate (adjective), consummation (noun).

contaminate (verb) to make impure. Chemicals dumped in a nearby forest had seeped into the soil and contaminated the local water supply. contamination (noun).

contemporary (adjective) modern, current; from the same time. I prefer old-fashioned furniture rather than contemporary styles. The composer Vivaldi was roughly contemporary with Bach. contemporary (noun).

root: from the Latin tempus meaning time. The same root is also found in the words temporal, temporary, and temporize.

contraband (noun) goods or merchandise whose exportation, importation, or possession is illegal. Illegal drugs smuggled across the border are considered contraband by U.S. legal authorities.

convergence (noun) the act of coming together in unity or similarity. A remarkable example of evolutionary convergence can be seen in the shark and the dolphin, two sea creatures that developed from different origins to become very similar in form. converge (verb).

converse (noun) something that is contrary or opposite. While women often wear clothes similar to those of men, the converse is generally not true.

convoluted (adjective) twisting, complicated, intricate. Tax law has become so convoluted that it’s easy for people to violate it accidentally. convolute (verb), convolution (noun).

root: from the Latin volvere meaning to roll. The same root is also found in the words devolve, involve, revolution, revolve, and voluble.
coveted (verb) desired something belonging to another. Although the law firm associate congratulated his coworker on becoming a partner, in his heart he had coveted the position. covetous (adjective), covetousness (noun).

credulity (noun) willingness to believe, even with little evidence. Con artists fool people by taking advantage of their credulity. credulous (adjective).

criterion (noun) a standard of measurement or judgment. (The plural is criteria.) In choosing a design for the new taxicabs, reliability will be our main criterion.

root: from the Greek krinein meaning to choose. The same root is also found in the words criticize and critique.

culpable (adjective) deserving blame, guilty. Although he committed the crime, because he was mentally ill he should not be considered culpable for his actions. culpability (noun).

cultivate (verb) to foster the growth of. She was so impressed on first hearing Bach’s Brandenburg Concertos that she decided to return to school to cultivate her knowledge of Baroque music.

cumulative (adjective) made up of successive additions. Smallpox was eliminated only through the cumulative efforts of several generations of doctors and scientists. accumulation (noun), accumulate (verb).

customary (adjective) commonly practiced or used. It is considered customary for a groom to give his best man a gift either immediately before or after the wedding.

daunting (adjective) intimidating. Many recent college graduates consider the prospect of taking on a full-time job a daunting one. daunt (verb), dauntingly (adverb).

debacle (noun) a great disaster or failure. The French considered Napoleon’s defeat at the hands of the British at Waterloo a debacle of the first magnitude.

decorous (adjective) having good taste; proper, appropriate. The once reserved and decorous style of the British monarchy began to change when the chic, flamboyant young Diana Spencer joined the family. decorum (noun).

decry (verb) to criticize or condemn. Cigarette ads aimed at youngsters have led many to decry the marketing tactics of the tobacco industry.

delegate (verb) to give authority or responsibility. The president delegated the vice president to represent the administration at the peace talks. delegate (noun).
deleterious (adjective) harmful. About thirty years ago, scientists proved that working with asbestos could be deleterious to one's health, producing cancer and other diseases.

    root: from the Latin delere meaning to destroy. The same root is also found in the word delete.

delineate (verb) to outline or describe. Naturalists had long suspected the fact of evolution, but Darwin was the first to delineate a process—natural selection—through which evolution could occur.

demise (noun) death. The demise of Queen Victoria, after more than sixty years on the throne, was followed almost immediately by the coronation of her son Edward as king of England.

denigrate (verb) to criticize or belittle. The firm's new president tried to explain his plans for improving the company without seeming to denigrate the work of his predecessor. denigration (noun).

depicted (verb) represented in a picture, sculpture, or words. In his novel Lincoln, Gore Vidal depicted the president not as the icon we had always known but rather as a shrewd and wily politician. depiction (noun).

derivative (adjective) taken from a particular source. A person's first attempts at original poetry are apt to be derivative of whatever poetry he or she most enjoys reading. derivation (noun), derive (verb).

desolate (adjective) empty, lifeless, and deserted; hopeless, gloomy. Robinson Crusoe was shipwrecked and had to learn to survive alone on a desolate island. The murder of her husband left Mary Lincoln desolate. desolation (noun).

despair (verb) to lose all hope or confidence. Having been unable to find a job for several months, the editor began to despair of ever securing a new position. despair (noun), desperation (noun).

detached (verb) free from involvement. Because judges have no stake in the cases brought before them, they are able to take a detached view of the proceedings. detachment (noun).

deter (verb) to discourage from acting. The best way to deter crime is to insure that criminals receive swift and certain punishment. deterrence (noun), deterrent (adjective).

determined (verb) decided conclusively. After reviewing all the evidence, the jury determined that the defendant was not guilty of the crime. determination (noun), determinedly (adverb).
deviate (verb) to depart from a standard or norm. Having agreed upon a spending budget for the company, we mustn’t deviate from it; if we do, we may run out of money soon. deviation (noun).

devious (adjective) tricky, deceptive. Milken’s devious financial tactics were designed to enrich his firm while confusing or misleading government regulators.

dictate (verb) to speak or act domineeringly. Whether we consider it fair or not, those to whom we report at work generally have the authority to dictate our actions. dictator (noun), dictatorial (adjective).

diffident (adjective) hesitant, reserved, shy. Someone with a diffident personality should pursue a career that involves little public contact. diffidence (noun).

diffuse (verb) to spread out, to scatter. The red dye quickly became diffused through the water, turning it a very pale pink. diffusion (noun).

digress (verb) to wander from the main path or the main topic. My high school biology teacher loved to digress from science into personal anecdotes about his college adventures. digression (noun), digressive (adjective).

diminish (verb) to make less or to cause to appear to be less. By a series of foolish decisions, the committee chairman substantially diminished his authority among the other members. diminution (noun).

diminutive (adjective) unusually small, tiny. Children are fond of Shetland ponies because their diminutive size makes them easy to ride. diminution (noun).

discern (verb) to detect, notice, or observe. I could discern the shape of a whale off the starboard bow, but it was too far away to determine its size or species. discernment (noun).

discipline (noun) control gained by enforcing obedience or order. Those who work at home sometimes find it difficult to maintain the discipline they need to be productive. discipline (verb), disciplinary (adjective).

disclose (verb) to make known; to reveal. Election laws require candidates to disclose the names of those who contribute money to their campaigns. disclosure (noun).

discredit (verb) to cause disbelief in the accuracy of some statement or the reliability of a person. Although many people still believe in UFOs, among scientists the reports of “alien encounters” have been thoroughly discredited.

root: from the Latin credere meaning to believe. The same root is also found in the words credential, credible, credit, credo, credulous, and incredible.
discreet (adjective) showing good judgment in speech and behavior. Be discreet when discussing confidential business matters: For example, don’t talk in the presence of strangers on the elevator. discretion (noun).

discrepancy (noun) a difference or variance between two or more things. The discrepancies between the two witnesses’ stories show that one of them must be lying. discrepant (adjective).

disingenuous (adjective) pretending to be candid, simple, and frank. When Texas billionaire H. Ross Perot ran for president, many considered his “jest plain folks” style disingenuous.

disparage (verb) to speak disrespectfully about, to belittle. Many political ads today both praise their own candidate and disparage his or her opponent. disparagement (noun), disparaging (adjective).

disparity (noun) difference in quality or kind. There is often a disparity between the kind of high-quality television people say they want and the low-brow programs they actually watch. disparate (adjective).

disproportionate (adjective) imbalanced in regard to size, number, or degree. Many people spend a disproportionate amount of their income on housing. disproportion (noun).

dissimulate (verb) to pretend, to simulate. When the police questioned her about the crime, she dissembled innocence.

dissipate (verb) to spread out or scatter. The windows and doors were opened, allowing the smoke that had filled the room to dissipate. dissipation (noun).

dissonance (noun) lack of music harmony; lack of agreement between ideas. Most modern music is characterized by dissonance, which many listeners find hard to enjoy. There is a noticeable dissonance between two common beliefs of most conservatives: their faith in unfettered free markets and their preference for traditional social values. dissonant (adjective).

root: from the Latin sonare meaning to sound. The same root is also found in the words consonance, sonar, sonic, and sonorous.

distinctive (adjective) serving to identify or distinguish. The teams in a football game can be easily distinguished by their distinctive uniforms. distinctively (adverb).

divulge (verb) to reveal. The people who count the votes for the Oscar awards are under strict orders not to divulge the names of the winners.
YOU ARE WHAT YOU SAY

Just as the correctness of your speech can make you be perceived as someone who’s bright or dull, the extent of your vocabulary can make you be perceived as someone who’s interesting or boring. A wider vocabulary adds appeal to your words.

dogmatic (adjective) holding firmly to a particular set of beliefs, often with little or no basis. Believers in Marxist doctrine tend to be dogmatic, ignoring evidence that contradicts their beliefs. dogmatism (noun).

durable (adjective) long-lasting. Denim is a popular material for work clothes because it is strong and durable.

root: from the Latin durare meaning to last. The same root is also found in the words durance, duration, and endure.

duress (noun) compulsion or restraint. Fearing that the police might beat him, he confessed to the crime, not willingly but under duress.

eclectic (adjective) drawn from many sources; varied, heterogeneous. The Mellon family art collection is an eclectic one, including works ranging from ancient Greek sculptures to modern paintings. eclecticism (noun).

ecumenical (adjective) general or worldwide in influence, extent, or application. With hundreds of millions of adherents on every continent, the Roman Catholic Church is truly ecumenical.

eerie (adjective) weird, strange. The cobwebs hanging about its rooms gave the old mansion an eerie quality.

efficacious (adjective) able to produce a desired effect. Though thousands of people today are taking herbal supplements to treat depression, researchers have not yet proved them efficacious. efficacy (noun).

egalitarian (adjective) asserting or promoting the belief in human equality. Although the French Revolution was initially an egalitarian movement, during the infamous Reign of Terror human rights were widely violated. egalitarianism (noun).

egregious (adjective) obvious, conspicuous, flagrant. It’s hard to imagine how the editor could allow such an egregious error to appear.

root: from the Latin grex meaning herd. The same root is also found in the words aggregate, congregate, and gregarious.

elevate (verb) to lift up. When an individual successfully completes a difficult task, it generally tends to elevate his or her self-esteem. elevation (noun).

elliptical (adjective) very terse or concise in writing or speech; difficult to understand. Rather than speak plainly, she hinted at her meaning through a series of nods, gestures, and elliptical half-sentences.

elongate (verb) lengthen, extend. Because the family was having such a good time at the beach, they decided to elongate their stay for several more days. elongation (noun).

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elusive (adjective) hard to capture, grasp, or understand. Though everyone thinks they know what “justice” is, when you try to define the concept precisely, it proves to be quite elusive. elude (verb).

root: from the Latin ludere meaning to play. The same root is also found in the words delude, illusion, interlude, and ludicrous.

embodied (verb) represented, personified. Although his natural modesty would have led him to deny it, Mahatma Ghandi has been said to have embodied all the virtues of which man is capable. embodiment (noun).

emend (verb) to correct. Before the letter is mailed, please emend the two spelling errors. emendation (noun).

eminent (adjective) noteworthy, famous. Vaclav Havel was an eminent author before being elected president of the Czech Republic. eminence (noun).

empathy (noun) imaginative sharing of the feelings, thoughts, or experiences of another. It’s easy for a parent to have empathy for the sorrow of another parent whose child has died. empathetic (adjective).

empirical (adjective) based on experience or personal observation. Although many people believe in ESP, scientists have found no empirical evidence of its existence. empiricism (noun).

emulate (verb) to imitate or copy. The British band Oasis admitted their desire to emulate their idols, the Beatles. emulation (noun).

encirclement (noun) the act of surrounding or going around completely. The greatest fear of the Soviet leadership was the encirclement of their nation by a collection of hostile countries. encircle (verb).

enclave (noun) a distinctly bounded area enclosed within a larger unit. Since the late nineteenth century, New York City’s Greenwich Village has been famous as an enclave for artists.

encroach (verb) to go beyond acceptable limits; to trespass. By quietly seizing more and more authority, Robert Moses continually encroached on the powers of other government leaders. encroachment (noun).

encumbered (verb) burdened or weighed down. Having never worked in the field before, the young architect was not encumbered by the traditions of the profession. encumbrance (noun).

enervate (verb) to reduce the energy or strength of someone or something. The stress of the operation left her feeling enervated for about two weeks.
engage (verb) to hire or employ. *When the entrepreneur recognized that he was unable to handle the day-to-day responsibilities of his business, he engaged an assistant.*

engender (verb) to produce, to cause. *Disagreements over the proper use of national forests have engendered feelings of hostility between ranchers and environmentalists.*

enhance (verb) to improve in value or quality. *New kitchen appliances will enhance your house and increase the amount of money you’ll make when you sell it.*

enlighten (verb) to furnish knowledge to. *Because the young woman knew her parents disliked her boyfriend, she neglected to enlighten them about her plans for marriage.*

enmity (noun) hatred, hostility, ill will. *Longstanding enmity, like that between the Protestants and Catholics in Northern Ireland, is difficult to overcome.*

enthrall (verb) to enchant or charm. *When the Swedish singer Jenny Lind toured America in the nineteenth century, audiences were enthralled by her beauty and talent.*

entice (verb) to lure or tempt. *Hoping to entice her husband into bed, the woman put on a provocative negligee.*

enviable (adjective) extremely desirable. *After months without work, the job-seeker suddenly found himself in the enviable position of having two offers from which to choose.*

envision (verb) to picture in one’s mind. *Despite her best efforts, the mother found it impossible to envision what her son would be like as an adult.*

ephemeral (adjective) quickly disappearing; transient. *Stardom in pop music is ephemeral; most of the top acts of ten years ago are forgotten today.*

epistemological (adjective) of the branch of philosophy that investigates the nature and origin of knowledge. *The question of how we come to learn things is an epistemological one.*

equanimity (noun) calmness of mind, especially under stress. *Roosevelt had the gift of facing the great crises of his presidency—the Depression, the Second World War—with equanimity and even humor.*

root: from the Latin *anima* meaning mind or spirit. The same root is also found in the words *animate, magnanimous, pusillanimous,* and *unanimous.*

equilibrium (noun) a state of intellectual or emotional balance. *Due to the tragedies the man had endured, and their negative effect on his life, it took some time before he could regain his equilibrium.*

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eradicate (verb) to destroy completely. American society has failed to eradicate racism, although some of its worst effects have been reduced.

   root: from the Latin radix meaning root. The same root is also found in the word radical.

espouse (verb) to take up as a cause; to adopt. No politician in America today will openly espouse racism, although some behave and speak in racially prejudiced ways.

   ethic (noun) a moral principle or value. In recent years, many people have argued that the unwillingness of young people to work hard shows that the work ethic is disappearing. ethical (adjective).

evanescence (noun) evanescent (adjective) vanishing like a vapor; fragile and transient. As she walked by, the evanescent fragrance of her perfume reached me for just an instant.

   evident (adjective) obvious, apparent. Since the new assistant clearly had no idea of what her boss was talking about, it was evident that she had lied about her experience in the field. evidence (noun).

evolving (verb) developing or achieving gradually. Although he had been a difficult child, it was clear that the young man was evolving into a very personable and pleasant adult. evolution (noun).

exacerbate (verb) to make worse or more severe. The roads in our town already have too much traffic; building a new shopping mall will exacerbate the problem.

exasperate (verb) to irritate or annoy. Because she was trying to study, Sharon was exasperated by the yelling of her neighbors’ children.

   root: from the Latin asper meaning rough. The same root is also found in the word asperity.

exculpate (verb) to free from blame or guilt. When someone else confessed to the crime, the previous suspect was exculpated. exculpation (noun), exculpatory (adjective).

exert (verb) to put forth or bring to bear. Parents often must exert their power over children, although doing so too often can hurt the child’s self-esteem. exertion (noun).

exhilaration (noun) the act of being made happy, refreshed, or stimulated. Diving into a swimming pool on a hot day generally provides people with a sense of exhilaration. exhilarate (verb).

exonerate (verb) to free from blame. Although Jewell was suspected at first of being involved in the bombing, later evidence exonerated him. exoneration (noun), exonerative (adjective).
expedite (verb) to carry out promptly. As the flood waters rose, the governor ordered state agencies to expedite their rescue efforts.

exploitation (noun) the act of making use of a person or thing selfishly or unethically. The practice of slavery was a cruel case of human exploitation. exploit (verb).

expropriate (verb) to seize ownership of. When the Communists came to power in China, they expropriated most businesses and turned them over to government-appointed managers. expropriation (noun).

root: from the Latin proprius meaning own. The same root is also found in the words appropriate, property, proprietary, and proprietor.

extant (adjective) currently in existence. Of the seven ancient “Wonders of the World,” only the pyramids of Egypt are still extant.

tip: If you don’t know the root, look at the word’s context; the meaning surrounds it. You might not know the word unconscionable. But if it appeared in the sentence, “He was so unconscionable a killer that at the trial he laughed in the face of the victim’s mother,” you’d have a fair understanding of the word.

extenuate (verb) to make less serious. Karen’s guilt is extenuated by the fact that she was only twelve when she committed the theft. extenuating (adjective), extenuation (noun).

extol (verb) to greatly praise. At the party convention, speaker after speaker rose to extol their candidate for the presidency.

extricate (verb) to free from a difficult or complicated situation. Much of the humor in the TV show I Love Lucy comes in watching Lucy try to extricate herself from the problems she creates by fibbing or trickery. extricable (adjective).

extrinsic (adjective) not an innate part or aspect of something; external. The high price of old baseball cards is due to extrinsic factors, such as the nostalgia felt by baseball fans for the stars of their youth, rather than the inherent beauty or value of the cards themselves.

exuberant (adjective) wildly joyous and enthusiastic. As the final seconds of the game ticked away, the fans of the winning team began an exuberant celebration. exuberance (noun).

fabricate (verb) to construct or manufacture. Because the young man didn’t want his parents to know where he’d spent the evening, he had to fabricate a story about studying in the library. fabrication (noun).

facile (adjective) easy; shallow or superficial. The one-minute political commercial favors a candidate with facile opinions rather than serious, thoughtful solutions. facilitate (verb), facility (noun).

root: from the Latin facere meaning to do. The same root is also found in the words facility, factor, facsimile, and faculty.
fallacy (noun) an error in fact or logic. It’s a fallacy to think that “natural” means “healthful”; after all, the deadly poison arsenic is completely natural. fallacious (adjective).

felicitous (adjective) pleasing, fortunate, apt. The sudden blossoming of the dogwood trees on the morning of Matt’s wedding seemed a felicitous sign of good luck. felicity (noun).

fleshiness (noun) fatness or corpulence. Although he had been thin as a young man, as he aged he developed a certain amount of fleshiness that dieting never entirely eliminated. fleshy (adjective).

flexibility (noun) the state of being pliable or adaptable. Because the job required someone who would be able to shift quickly from one task to another, the manager was most interested in candidates who showed flexibility. flexible (adjective).

format (noun) the shape and size of something. The format of a book, i.e., its height, width, and length, is an essential factor in determining how much it will cost to produce.

formidable (adjective) awesome, impressive, or frightening. According to his plaque in the Baseball Hall of Fame, pitcher Tom Seaver turned the New York Mets “from lovable losers into formidable foes.”

fortuitous (adjective) lucky, fortunate. Although the mayor claimed credit for the falling crime rate, it was really caused by several fortuitous trends.

fractious (adjective) troublesome, unruly. Members of the British Parliament are often fractious, shouting insults and sarcastic questions during debates.

fragment (verb) a part broken off or detached. Even though the girl overheard only a fragment of her parents’ conversation, it was sufficient for her to understand that they had decided to get a divorce. fragmentation (noun).

fraternize (verb) to associate with on friendly terms. Although baseball players aren’t supposed to fraternize with their opponents, players from opposing teams often chat before games. fraternization (noun).

root: from the Latin frater meaning brother. The same root is also found in the words fraternal, fraternity, and fratricide.

frenetic (adjective) chaotic, frantic. The floor of the stock exchange, filled with traders shouting and gesturing, is a scene of frenetic activity.

functionally (adverb) in relation to a specific task or purpose. Although the man knew the letters of the alphabet, since he could not read an entire sentence he was considered functionally illiterate. function (noun).
gargantuan (adjective) huge, colossal. *The building of the Great Wall of China was one of the most gargantuan projects ever undertaken.*

genial (adjective) friendly, gracious. *A good host welcomes all visitors in a warm and genial fashion.*

genre (noun) kind or sort. *Surprisingly, romance novels constitute the literary genre that produces more book sales than any other.*

geometric (adjective) increasing or decreasing through multiplication. When two people give birth to two children, who marry two others and give birth to four children, who in turn marry two others and give birth to eight children, the population grows at a geometric rate. geometrically (adverb).

graft (verb) to unite or join two things. *When one uses a computer, it is possible to easily graft two existing documents together.*

grandiose (adjective) overly large, pretentious, or showy. *Among Hitler’s grandiose plans for Berlin was a gigantic building with a dome several times larger than any ever built.* grandiosity (noun).

gratuitous (adjective) given freely or without cause. *Since her opinion was not requested, her harsh criticism of his singing seemed a gratuitous insult.*

gregarious (adjective) enjoying the company of others; sociable. *Marty is naturally gregarious, a popular member of several clubs, and a sought-after lunch companion.*

grotesque (adjective) outlandish or bizarre. *The appearance of the aliens depicted in the film *Independence Day* is so different from that of human beings as to be grotesque.*

guileless (adjective) without cunning; innocent. *Deborah’s guileless personality and complete honesty make it hard for her to survive in the harsh world of politics.*

gullible (adjective) easily fooled. *When the sweepstakes entry form arrived bearing the message, “You may be a winner!” my gullible neighbor tried to claim a prize.* gullibility (noun).

hackneyed (adjective) without originality, trite. *When someone invented the phrase, “No pain, no gain,” it was clever, but now it is so commonly heard that it seems hackneyed.*

hardheadedness (noun) the quality of being stubborn or willful. *Hardheadedness is not a quality most people admire, because those who possess it can be extremely difficult to deal with.* hardheadedly (adverb).

harried (adjective) harassed. *At the height of the Saturday dinner hour, the manager of a restaurant is likely to feel harried and overwhelmed.* harry (verb).
heinous (adjective) very evil, hateful. The massacre by Pol Pot of over a million Cambodians is one of the twentieth century’s most heinous crimes.

hierarchy (noun) a ranking of people, things, or ideas from highest to lowest. A cabinet secretary ranks just below the president and vice president in the hierarchy of the executive branch. hierarchical (adjective).

humanistic (adjective) concerned with human beings and their capacities, values, and achievements. The humanistic philosophers of the Renaissance regarded humankind as the pinnacle of creation. humanism (noun).

humility (noun) the quality of being humble. The president was an extremely powerful man, but his apparent humility made him seem to be very much like everyone else.

iconoclast (noun) someone who attacks traditional beliefs or institutions. Comedian Dennis Miller enjoys his reputation as an iconoclast, though people in power often resent his satirical jabs. iconoclastic (adjective).

idiosyncratic (adjective) peculiar to an individual; eccentric. Cyndi Lauper sings pop music in an idiosyncratic style, mingling high-pitched whoops and squeals with throaty gurgles. idiosyncrasy (noun).

idolatry (noun) the worship of a person, thing, or institution as a god. In Communist China, Chairman Mao was the subject of idolatry; his picture was displayed everywhere, and millions of Chinese memorized his sayings. idolatrous (adjective).

imminent (adjective) about to incur, impending. In preparation for his imminent death, the man called his attorney to draw up a last will and testament. imminence (noun).

impartial (adjective) fair, equal, unbiased. If a judge is not impartial, then all of her rulings are questionable. impartiality (noun).

impeccable (adjective) flawless. The crooks printed impeccable copies of the Super Bowl tickets, impossible to distinguish from the real things.

impetuous (adjective) acting hastily or impulsively. Ben’s resignation was an impetu- ous act; he did it without thinking, and he soon regretted it. impetuosity (noun).

implicit (adjective) understood without being openly expressed; implied. Although most clubs had no written rules excluding blacks and Jews, many had an implicit understanding that no blacks or Jews would be allowed to join.

imposing (adjective) impressive because of bearing, size, or dignity. Because the man was well over six feet tall and weighed in excess of 300 pounds, most people found him to be an imposing figure.

TIP
If a word is totally unfamiliar to you, be sure to look up its pronunciation when you’re looking up its meaning. You want to be able to use it in your speech as well as in writing.
**impunity** (noun) exemption from punishment or harm. *Since ambassadors are protected by their diplomatic status, they are generally able to break minor laws with impunity.*

**impute** (verb) to credit or give responsibility to; to attribute. *Although Sarah’s comments embarrassed me, I don’t impute any ill will to her; I think she didn’t realize what she was saying.* imputation (noun)

**inarticulate** (adjective) unable to speak or express oneself clearly and understandably. *A skilled athlete might be an inarticulate public speaker, as demonstrated by many post-game interviews.*

**root:** from the Latin *articulus* meaning joint or division. The same root is also in the word *articulate*.

**inception** (noun) the beginning of something. *After her divorce, the woman realized that there had been problems from the very inception of her marriage.*

**incipient** (adjective) beginning to exist or appear. *The company’s chief financial officer recognized the firm’s incipient financial difficulties and immediately took steps to correct them.*

**incisive** (adjective) expressed clearly and directly. *Franklin settled the debate with a few incisive remarks that summed up the issue perfectly.*

**inclination** (noun) a disposition toward something. *The young woman had a strong inclination to have as many children as possible, mainly because she came from a large and happy family herself.* incline (verb)

**incompatible** (adjective) unable to exist together; conflicting. *Many people hold seemingly incompatible beliefs: for example, supporting the death penalty while believing in the sacredness of human life.* incompatibility (noun)

**inconsequential** (adjective) of little importance. *When the stereo was delivered, it was a different shade of gray than I expected, but the difference was inconsequential.*

**inconsistency** (noun) the quality of being irregular or unpredictable. *The inconsistency of the student’s work made it extremely difficult for his teachers to accurately gauge his abilities.* inconsistent (adjective)

**incorrigible** (adjective) impossible to manage or reform. *Lou is an incorrigible trickster, constantly playing practical jokes no matter how much his friends complain.*

**incremental** (adjective) increasing gradually by small amounts. *Although the initial cost of the Medicare program was small, the incremental expenses have grown to be very large.* increment (noun)
indelible (adjective) permanent or lasting. Meeting President Kennedy left an indelible desire in young Bill Clinton to someday live in the White House himself.

indeterminate (adjective) not definitely known. The college plans to enroll an indeterminate number of students; the size of the class will depend on the number of applicants and how many accept offers of admission. determine (verb).

indicative (adjective) serving to point out or point to. The fact that when the man got home he yelled at his children for no good reason was indicative of his bad day at the office. indication (noun), indicate (verb).

indifferent (adjective) unconcerned, apathetic. The mayor’s small proposed budget for education suggests that he is indifferent to the needs of our schools. indifference (noun).

indistinct (adjective) unclear, uncertain. We could see boats on the water, but in the thick morning fog their shapes were indistinct.

indomitable (adjective) unable to be conquered or controlled. The world admired the indomitable spirit of Nelson Mandela; he remained courageous despite years of imprisonment.

induce (verb) to cause. The doctor prescribed a medicine that is supposed to induce a lowering of the blood pressure. induction (noun).

indulgent (adjective) lenient. Abraham Lincoln was so indulgent of his children that while he was president, he let them run freely through the Oval Office without reprimanding them. indulgence (noun), indulge (verb).

inevitable (adjective) unable to be avoided. Once the Japanese attacked Pearl Harbor, American involvement in World War II was inevitable. inevitability (noun).

inexhaustible (adjective) incapable of being entirely used up. For many years we believed that the world’s supply of fossil fuels was inexhaustible, but we now know that eventually it will be necessary to find other sources of energy.

inexorable (adjective) unable to be deterred; relentless. It’s difficult to imagine how the mythic character of Oedipus could have avoided his evil destiny; his fate appears inexorable.

influential (adjective) exerting or possessing the power to cause an effect in an indirect manner. While the pope has direct authority only over Roman Catholics, he is also influential among members of other faiths. influence (noun), influence (verb).

inherent (adjective) naturally part of something. Compromise is inherent in democracy, since everyone cannot get his way. inhere (verb), inherence (noun).
initiative (noun) the first step or opening move. At those times when no one seems able to make a decision, someone must take the initiative to get things going. initiation (noun), initiate (verb).

innate (adjective) inborn, native. Not everyone who takes piano lessons becomes a fine musician, which shows that music requires innate talent as well as training.

innocuous (adjective) harmless, inoffensive. I was surprised that Andrea took offense at such an innocuous joke.

innovative (adjective) characterized by introducing or beginning something new. The innovative design of its new computer gave the company an advantage over its competitors. innovation (noun).

insecure (adjective) not confident or sure. The tenth-grade girl was very bright, but because she was not as attractive as some of her classmates she felt insecure about talking to boys. insecurity (noun).

insipid (adjective) flavorless, uninteresting. Most TV shows are so insipid that you can watch them while reading without missing a thing. insipidity (noun).

insistence (noun) firm in stating a demand or opinion. The man’s insistence that Orson Welles—rather than Humphrey Bogart—had starred in Casablanca made it clear that he was quite ignorant about movies. insistent (adjective), insist (verb).

inspiration (noun) the action or power of moving the intellect or emotions. The individual who is able to persevere, despite adversity, often serves as an inspiration to the rest of us. inspire (verb).

instinct (noun) a natural aptitude or ability. The films for children produced by Walt Disney’s studio were invariably successful because Disney had an instinct for what children would like to see. instinctive (adjective).

insular (adjective) narrow or isolated in attitude or viewpoint. New Yorkers are famous for their insular attitudes; they seem to think that nothing important has ever happened outside of their city. insularity (noun).

integrity (noun) honesty, uprightness; soundness, completeness. “Honest Abe” Lincoln is considered a model of political integrity. Inspectors examined the building’s support beams and foundation and found no reason to doubt its structural integrity.

intensity (noun) great concentration, force, or power. The intensity of the emotions evoked by the film Gone With the Wind have for more than fifty years brought viewers to tears. intense (adjective), intensify (verb).
interaction (noun) mutual or reciprocal influence. It is the successful interaction of all the players on a football team that enables the team to win. interact (verb).

interminable (adjective) endless or seemingly endless. Addressing the UN, Castro announced, “We will be brief”—then delivered an interminable 4-hour speech.

root: from the Latin terminare meaning to end. The same root is also found in the words coterminous, exterminate, terminal, and terminate.

interrogation (noun) the act of formally and systematically questioning someone. The results of the jewel thief’s interrogation enabled the police to catch his accomplices before they could flee the country. interrogate (verb).

intimidating (verb) frightening. A boss who is particularly demanding can often be intimidating to members of his or her staff. intimidation (noun).

intransigent (adjective) unwilling to compromise. Despite the mediator’s attempts to suggest a fair solution, the two parties were intransigent, forcing a showdown. intransigence (noun).

intrepid (adjective) fearless and resolute. Only an intrepid adventurer is willing to undertake the long and dangerous trip by sled to the South Pole. intrepidity (noun).

root: from the Latin trepidus meaning alarmed. The same root is also found in the word trepidation.

intricate (adjective) complicated. The plans for making the model airplane were so intricate that the boy was afraid he’d never be able to complete it. intricacy (noun).

intrusive (adjective) forcing a way in without being welcome. The legal requirement of a search warrant is supposed to protect Americans from intrusive searches by the police. intrude (verb), intrusion (noun).

intuitive (adjective) known directly, without apparent thought or effort. An experienced chess player sometimes has an intuitive sense of the best move to make, even if she can’t explain it. intuit (verb), intuition (noun).

inundate (verb) to flood; to overwhelm. As soon as playoff tickets went on sale, eager fans inundated the box office with orders.

root: from the Latin unda meaning wave. The same root is also found in the word undulate.
invariable (adjective) unchanging, constant. *When writing a book, it was her invariable habit to rise at 6 and work at her desk from 7 to 12.* invariability (noun).

root: from the Latin *varius* meaning various. The same root is also found in the words *prevaricate, variable, variance, variegated,* and *vary.*

inversion (noun) a turning backward, inside-out, or upside-down; a reversal. *Latin poetry often features inversion of word order; for example, the first line of Vergil's Aeneid: “Arms and the man I sing.” invert (verb), inverted (adjective).

root: from the Latin *vertere* meaning to turn. The same root is also found in the words *adversary, adverse, reverse, vertical,* and *vertigo.*

inveterate (adjective) persistent, habitual. *It's very difficult for an inveterate gambler to give up the pastime.* inveteracy (noun).

invigorate (verb) to give energy to, to stimulate. *As her car climbed the mountain road, Lucinda felt invigorated by the clear air and the cool breezes.*

invincible (adjective) impossible to conquer or overcome. *For three years at the height of his career, boxer Mike Tyson seemed invincible.*

inviolable (adjective) impossible to attack or trespass upon. *In the president's remote hideaway at Camp David, guarded by the Secret Service, his privacy is, for once, inviolable.*

irresponsible (adjective) lacking a sense of being accountable for one's actions. *The teenager was supposed to stay home to take care of her younger brother, so it was irresponsible for her to go out with her friends.*

irresolute (adjective) uncertain how to act, indecisive. *When McGovern first said he supported his vice president candidate “one thousand percent,” then dropped him from the ticket, it made McGovern appear irresolute.* irresolution (noun).

jeopardize (verb) to put in danger. *Terrorist attacks jeopardize the fragile peace in the Middle East.* jeopardy (noun).

jettison (verb) to discard. *In order to keep the boat from sinking, it was necessary to jettison all but the most essential gear.*

juxtapose (verb) to put side by side. *It was strange to see the old-time actor Charlton Heston and rock icon Bob Dylan juxtaposed at the awards ceremony.* juxtaposition (noun).

laboriously (adverb) in a manner marked by long, hard work. *The convicts laboriously carried the bricks from one side of the prison yard to the other.* laborious (adjective).
latent (adjective) not currently obvious or active; hidden. Although he had committed only a single act of violence, the psychiatrist said he had probably always had a latent tendency toward violence. latency (noun).

laudatory (adjective) giving praise. The ads for the movie are filled with laudatory comments from critics.

root: from the Latin laus meaning praise. The same root is also found in the words applaud, laud, laudable, and plaudit.

lenient (adjective) mild, soothing, or forgiving. The judge was known for his lenient disposition; he rarely imposed long jail sentences on criminals. leniency (noun).

lethargic (adjective) lacking energy; sluggish. Visitors to the zoo are surprised that the lions appear so lethargic, but in the wild, lions sleep up to 18 hours a day. lethargy (noun).

liability (noun) an obligation or debt; a weakness or drawback. The insurance company had a liability of millions of dollars after the town was destroyed by a tornado. Slowness afoot is a serious liability in an aspiring basketball player. liable (adjective).

liberation (noun) the act of freeing, as from oppression. The liberation of the inmates of the Nazi concentration camps was an event long anticipated by the Jews of the world. liberate (verb).

lucid (adjective) clear and understandable. Hawking's A Short History of the Universe is a lucid explanation of modern scientific theories about the origin of the universe. lucidity (noun).

ludicrous (adjective) laughable because of obvious absurdity. The man with the lampshade on his head was a ludicrous sight to the others at the party.

luminous (adjective) emitting or reflecting light. Because of their happiness, brides are often described as being luminous on their wedding days.

malediction (noun) curse. In the fairy tale “Sleeping Beauty,” the princess is trapped in a death-like sleep because of the malediction uttered by an angry witch.

root: from the Latin malus meaning bad. The same root is also found in the words malefactor, malevolence, malice, and malicious.

malevolence (noun) hatred, ill will. Critics say that Iago, the villain in Shakespeare’s Othello, seems to exhibit malevolence with no real cause. malevolent (noun).

maligner (verb) to pretend illness to avoid work. During the labor dispute, hundreds of employees malingered, forcing the company to slow production and costing it millions in profits.
malleable (adjective) able to be changed, shaped, or formed by outside pressures. Gold is a very useful metal because it is so malleable. A child’s personality is malleable and deeply influenced by the things her parents say and do. malleability (noun).

mandate (noun) order, command. The new policy on gays in the military went into effect as soon as the president issued his mandate about it. mandate (verb), mandatory (adjective).

root: from the Latin mandare meaning to entrust or to order. The same root is also found in the words command, demand, and remand.

masquerading (verb) disguising oneself. In Mark Twain’s classic novel The Prince and the Pauper, the prince was masquerading as a peasant boy while the peasant boy pretended to be the prince.

mastery (noun) possession of consummate skill. The brilliance of William Butler Yeats’ poetry exemplifies his mastery of the English language.

mediate (verb) to reconcile differences between two parties. During the baseball strike, both the players and the club owners were willing to have the president mediate the dispute. mediation (noun).

root: from the Latin medius meaning middle. The same root is also found in the words intermediate, media, and medium.

mediocrity (noun) the state of being middling or poor in quality. The New York Mets, who’d finished in ninth place in 1968, won the world’s championship in 1969, going from horrible to great in a single year and skipping mediocrity. mediocre (adjective).

meditative (adjective) characterized by reflection or contemplation. His unusual quietness and the distant look in his eyes suggested that he was in an uncharacteristically meditative mood. meditation (noun).

menacing (adjective) threatening or endangering. When their father gave the children a menacing look, they immediately quieted down and finished their dinner. menace (noun), menace (verb).

mercurial (adjective) changing quickly and unpredictably. The mercurial personality of Robin Williams, with his many voices and styles, made him perfect for the role of the ever-changing genie in Aladdin.

mete (verb) to deal out or dole. As late as the nineteenth century, a leather whip called the “cat-o-nine-tails” was used to mete out punishment in the British navy.

minuscule (adjective) very small, tiny. Compared to the compensation received by the people who head large corporations in the United States, the salary of the average American worker seems minuscule.

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misconception (noun) a mistaken idea. Columbus sailed west under the misconception that he would reach the shores of Asia that way. misconceive (verb).

mitigate (verb) to make less severe; to relieve. Wallace certainly committed the assault, but the verbal abuse he’d received helps to explain his behavior and somewhat mitigates his guilt. mitigation (noun).

modesty (noun) a moderate estimation of one’s own abilities. It’s unusual to find genuine modesty in politicians, as they must have healthy egos if they are to convince others of their abilities to lead. modest (adjective).

modicum (noun) a small amount. The plan for your new business is well designed; with a modicum of luck, you should be successful.

root: from the Latin modus meaning measure. The same root is also found in the words immoderate, moderate, modest, modify, and modulate.

mollify (verb) to soothe or calm; to appease. Carla tried to mollify the angry customer by promising him a full refund.

momentous (adjective) important, consequential. Standing at the altar and saying “I do” is a momentous event in anyone’s life.

monarchical (adjective) of or relating to a ruler, such as a king. Because he was raised with the knowledge that one day he would rule Russia, Czar Nicholas II perceived all that went on around him from a monarchical point of view. monarch (noun).

mosaic (noun) a picture or decorative design made by combining small colored pieces or something resembling such a design. The diversity of America’s population makes it a mosaic of races, religions, and creeds.

mundane (adjective) everyday, ordinary, commonplace. Moviegoers in the 1930s liked the glamorous films of Fred Astaire because they provided an escape from the mundane problems of life during the Great Depression.

munificent (adjective) very generous; lavish. Ted Turner’s billion-dollar donation to the UN is probably the most munificent act of charity in history. munificence (noun).

mutable (adjective) likely to change. A politician’s reputation can be highly mutable, as seen in the case of Harry Truman—mocked during his lifetime, revered afterward.

root: from the Latin mutare meaning to change. The same root is also found in the English words immutable, mutant, and mutation.

mutually (adverb) of or regarding something shared in common. The terms of the contract were so generous to both parties that they considered the deal mutually beneficial. mutual (adjective).
mythical (adjective) of or relating to a traditional story not based on fact. *Although in the Middle Ages people believed in the existence of unicorns, they are mythical beasts.*

nocturnal (adjective) of the night; active at night. *Travelers on the Underground Railroad escaped from slavery to the North by a series of nocturnal flights. The eyes of nocturnal animals must be sensitive in dim light.*

notorious (adjective) famous, especially for evil actions or qualities. *Warner Brothers produced a series of movies about notorious gangsters such as John Dillinger and Al Capone.* notoriety (noun).

novice (noun) beginner, tyro. *Lifting your head before you finish your swing is a typical mistake committed by the novice at golf.*

root: from the Latin *novus* meaning new. The same root is also found in the words innovate, novelty, and renovate.

noxious (adjective) harmful or injurious to health. *Because of the noxious fumes being emitted by the factory, the government forced the owners to shut it down.*

nuance (noun) a subtle difference or quality. *At first glance, Monet’s paintings of water lilies all look much alike, but the more you study them, the more you appreciate the nuances of color and shading that distinguish them.*

nurture (verb) to nourish or help to grow. *The money given by the National Endowment for the Arts helps nurture local arts organizations throughout the country.* nurture (noun).

obdurate (adjective) unwilling to change; stubborn, inflexible. *Despite the many pleas he received, the governor was obdurate in his refusal to grant clemency to the convicted murderer.* obduracy (noun).

root: from the Latin *durus* meaning hard. The same root is also found in the words durable and endure.

objective (adjective) dealing with observable facts rather than opinions or interpretations. *When a legal case involves a shocking crime, it may be hard for a judge to remain objective in her rulings.* objectivity (noun).

oblivious (adjective) unaware, unconscious. *Karen practiced her oboe with complete concentration, oblivious to the noise and activity around her.* oblivion (noun), obliviousness (noun).

obscure (adjective) little known; hard to understand. *Mendel was an obscure monk until decades after his death, when his scientific work was finally discovered. Most people find the writings of James Joyce obscure—hence the popularity of books that explain his books.* obscure (verb), obscurity (noun).
**obstinate** (adjective) stubborn, unyielding. *Despite years of effort, the problem of drug abuse remains obstinate.* obstinacy (noun).

**obtrusive** (adjective) overly prominent. *Philip should sing more softly; his bass is so obtrusive that the other singers can barely be heard.* obtrude (verb), obtrusion (noun).

**officiate** (verb) to perform a function, ceremony, or duty. *Although weddings can be performed by judges, it is customary to have a clergyman officiate at such ceremonies.* official (noun).

**oligarchy** (noun) government by a small faction of people or families. *Saudi Arabia, which is almost entirely controlled by one large family, is a good example of an oligarchy.* oligarchic (adjective).

**onerous** (adjective) heavy, burdensome. *The hero Hercules was ordered to clean the Augean Stables, one of several onerous tasks known as “the labors of Hercules.” onus (noun).

**opportunistic** (adjective) eagerly seizing chances as they arise. *When Princess Diana died suddenly, opportunistic publishers quickly released books about her life and death.* opportunism (noun).

**opulent** (adjective) rich, lavish. *The mansion of newspaper tycoon Hearst is famous for its opulent decor.* opulence (noun).

**ostentatious** (adjective) overly showy, pretentious. *To show off his wealth, the millionaire threw an ostentatious party featuring a full orchestra, a famous singer, and tens of thousands of dollars worth of food.*

**ostracize** (verb) to exclude from a group. *In Biblical times, those who suffered from the disease of leprosy were ostracized and forced to live alone.* ostracism (noun).

**overindulge** (verb) to yield to whims or desires to an excessive degree. *When offered tables laden with food at weddings and other such gatherings, many people overindulge and afterward find that they’ve eaten too much.* overindulgence (noun).

**palatability** (noun) the state of being acceptable to the taste, the mind, or the sensibilities. *The woman had never eaten lobster before, so to test its palatability she took just a tiny bite.* palatable (adjective).

**panacea** (noun) a remedy for all difficulties or illnesses, a cure-all. *Because the snake oil salesman promised that his product would cure everything from lumbago to an unhappy love life, it was considered a panacea by those foolish enough to buy it.*

**pariah** (noun) outcast. *Accused of robbery, he became a pariah; his neighbors stopped talking to him, and people he’d considered friends no longer called.*
**parochial** (adjective) narrowly limited in range or scope; provincial. Those who grow up in small towns, as opposed to large cities, tend to be less worldly and consequently often take a more parochial view of things. parochialism (noun).

**partisan** (adjective) reflecting strong allegiance to a particular party or cause. The vote on the president’s budget was strictly partisan: Every member of the president’s party voted yes, and all others voted no. partisan (noun).

**paternal** (adjective) fatherly. In the past, people often devoted their entire lives to working for one company, which in turn rewarded them by treating them in a paternal manner. paternity (noun).

**pathology** (noun) disease or the study of disease; extreme abnormality. Some people believe that high rates of crime are symptoms of an underlying social pathology. pathological (adjective).

**root:** from the Greek *pathos* meaning suffering. The same root is also found in the words *apathy, empathy, pathetic, pathos,* and *sympathy.*

**patina** (noun) the surface appearance of something grown beautiful with use or age. The patina that had grown over the bridge made it glow in the morning sunlight.

**pellucid** (adjective) very clear; transparent; easy to understand. The water in the mountain stream was cold and pellucid. Thanks to the professor’s pellucid explanation, I finally understand relativity theory.

**root:** from the Latin *lux* meaning light. The same root is also found in the words *elucidate, lucid,* and *translucent.*

**penitent** (adjective) feeling sorry for past crimes or sins. Having grown penitent, he wrote a long letter of apology, asking forgiveness.

**permeate** (verb) to spread through or penetrate. Little by little, the smell of gas from the broken pipe permeated the house.

**perceptive** (adjective) quick to notice, observant. With his perceptive intelligence, Holmes was the first to notice the importance of this clue. perceptible (adjective), perception (noun).

**perfidious** (adjective) disloyal, treacherous. Although he was one of the most talented generals of the American Revolution, Benedict Arnold is remembered today as a perfidious betrayer of his country. perfidy (noun).

**root:** from the Latin *fides* meaning faith. The same root is also found in the words *confide, confidence, fidelity,* and *infidel.*
persevere (adjective) to continue despite difficulties. Although several of her team-mates dropped out of the marathon, Laura persevered. perseveran (noun).

perspective (noun) point of view. Those politicians who are more disposed to change than to tradition are generally thought of as having a liberal rather than a conservative perspective.

perspicacity (noun) keenness of observation or understanding. Journalist Murray Kempton was famous for the perspicacity of his comments on social and political issues. perspicacious (adjective).

root: from the Latin specere meaning to look. The same root is also found in the words circumspect, conspicuous, inspect, introspective, spectacle, spectator, and speculate.

peruse (verb) to examine or study. Mary-Jo perused the contract carefully before she signed it. perusal (noun).

pervasive (adjective) spreading throughout. As news of the disaster reached the town, a pervasive sense of gloom could be felt everywhere. pervade (verb).

pigmented (verb) colored. The artist pigmented his landscape with such variety that the picture was a riot of color. pigment (noun).

placate (verb) to soothe or appease. The waiter tried to placate the angry customer with the offer of a free dessert. placatory (adjective).

plastic (adjective) able to be molded or reshaped. Because it is highly plastic, clay is an easy material for beginning sculptors to use.

plausible (adjective) apparently believable. The idea that a widespread conspiracy to kill President Kennedy has been kept secret for over thirty years hardly seems plausible. plausibility (noun).

pluralist (noun) one who believes in the intrinsic value of all cultures and traditions. Anyone who firmly believes in the advantages of multiculturalism can be said to be a pluralist.

policing (verb) regulating, controlling, or keeping in order. The Federal Communications Commission is responsible for policing the television industry to see that it complies with government regulations.

portability (noun) the quality of being capable of being carried. One of the great advantages of battery-powered radios is their portability. portable (adjective).
**pragmatism** (noun) a belief in approaching problems through practical rather than theoretical means. Roosevelt’s approach toward the Great Depression was based on pragmatism: “Try something,” he said; “If it doesn’t work, try something else.” pragmatic (adjective).

**precision** (noun) exactness. If all the parts of an engine aren’t built with precision, it is unlikely that it will work properly. precise (adjective).

**predatory** (adjective) living by killing and eating other animals; exploiting others for personal gain. The tiger is the largest predatory animal native to Asia. Microsoft has been accused of predatory business practices that prevent other software companies from competing with them. predation (noun), predator (noun).

**predilection** (noun) a liking or preference. To relax from his presidential duties, Kennedy had a predilection for spy novels featuring James Bond.

**predominant** (adjective) greatest in numbers or influence. Although hundreds of religions are practiced in India, the predominant faith is Hinduism. predominance (noun), predominate (verb).

**root:** from the Latin *dominare* meaning to rule. The same root is also found in the words English dominate, domineer, dominion, and indomitable.

**prepossessing** (adjective) attractive. Smart, lovely, and talented, she has all the prepossessing qualities that mark a potential movie star.

**prerequisite** (noun) something that is required as a prior condition. Generally speaking, a high school diploma is a prerequisite for matriculating at a university.

**presumptuous** (adjective) going beyond the limits of courtesy or appropriateness. The senator winced when the presumptuous young staffer addressed him as “Chuck.” presume (verb), presumption (noun).

**pretentious** (adjective) claiming excessive value or importance. For an ordinary shoe salesman to call himself a “Personal Foot Apparel Consultant” seems awfully pretentious. pretension (noun).

**primarily** (adverb) at first, originally. When people have children, their priorities change: they are no longer primarily individuals but, rather, primarily parents. primary (adjective).

**proficient** (adjective) skillful, adept. A proficient artist, Louise quickly and accurately sketched the scene. proficiency (noun).

**proliferate** (verb) to increase or multiply. Over the past fifteen years, high-tech companies have proliferated in northern California, Massachusetts, and other regions. proliferation (noun).
prolific (adjective) producing numerous offspring or abundant works. *With more than one hundred books to his credit, Isaac Asimov was one of our most prolific authors.*

promulgate (verb) to make public, to declare. *Lincoln signed the proclamation that freed the slaves in 1862, but he waited several months to promulgate it.*

propagate (verb) to cause to grow; to foster. *John Smithson’s will left his fortune for the founding of an institution to propagate knowledge, without saying whether that meant a university, a library, or a museum.* propagation (noun).

propriety (noun) appropriateness. *Some people had doubts about the propriety of Clinton’s discussing his underwear on MTV.*

prosaic (adjective) everyday, ordinary, dull. *“Paul’s Case” tells the story of a boy who longs to escape from the prosaic life of a clerk into a world of wealth, glamour, and beauty.*

provocative (adjective) likely to stimulate emotions, ideas, or controversy. *The demonstrators began chanting obscenities, a provocative act that they hoped would cause the police to lose control.* provoke (verb), provocation (noun).

root: from the Latin *vocare* meaning to call. The same root is also found in the words *evoke, invoke, revoke, vocal,* and *vocation.*

proximity (noun) closeness, nearness. *Neighborhood residents were angry over the proximity of the sewage plant to the local school.* proximate (adjective).

root: from the Latin *proximus* meaning near or next. The same root is also found in the word *approximate.*

pseudonym (noun) a fictitious name. *When an author does not want a book to carry his own name, he uses a pseudonym.* pseudonymous (adjective).

pugnacious (adjective) combative, bellicose, truculent; ready to fight. *Ty Cobb, the pugnacious outfielder for the Detroit Tigers, got into more than his fair share of brawls, both on and off the field.* pugnacity (noun).

root: from the Latin *pungere* meaning to jab or to prick. The same root is also found in the words *pugilist, punctuate, puncture,* and *pungent.*

punctilious (adjective) very concerned about proper forms of behavior and manners. *A punctilious dresser like James would rather skip the party altogether than wear the wrong color of tie.* punctilio (noun).

quell (verb) to quiet, to suppress. *It took a huge number of police to quell the rioting.*

querulous (adjective) complaining, whining. *The nursing home attendant needed a lot of patience to care for the three querulous, unpleasant residents on his floor.*
**Words on Words**

“Words may be deeds.”
Aesop, Fables.

**quintessential** (adjective) regarding the purest essence of something. *Tom Clancy, author of The Hunt for Red October and other best-sellers, is the quintessential writer of techno-thrillers.*

**reciprocate** (verb) to make a return for something. *If you’ll baby-sit for my kids tonight, I’ll reciprocate by taking care of yours tomorrow.*

**reclusive** (adjective) withdrawn from society. *During the last years of her life, actress Greta Garbo led a reclusive existence, rarely appearing in public.*

**reconcile** (verb) to make consistent or harmonious. *Roosevelt’s greatness as a leader can be seen in his ability to reconcile the demands and values of the varied groups that supported him.*

**reconstruct** (verb) to build or create again. *Because the South was so thoroughly destroyed during the Civil War, it was necessary to start from scratch and reconstruct the entire region.*

**refinement** (noun) polish, cultivation. *Although the man came from a humble background, by making an effort to educate himself he managed over the years to develop a very high level of refinement.*

**refute** (adjective) to prove false. *The company invited reporters to visit their plant in an effort to refute the charges of unsafe working conditions.*

**reincarnation** (noun) rebirth in a new body or form of life; a fresh embodiment. *Many of those who voted for Bill Clinton for president hoped that he would be a reincarnation of John F. Kennedy.*

**rejoinder** (noun) an answer or reply. *The man’s rejoinder to the accusation that he had murdered his partner was that he had committed no crime.*

**relevance** (noun) connection to the matter at hand; pertinence. *Testimony in a criminal trial may be admitted only if it has clear relevance to the question of guilt or innocence.*

**relinquish** (verb) to surrender or give up something. *In order to run for Congress, the man had to relinquish his membership in the “restricted” country club.*

**renovate** (verb) to renew by repairing or rebuilding. *The television program This Old House shows how skilled craftspeople renovate houses.*

**renunciation** (noun) the act of rejecting or refusing something. *King Edward VII’s renunciation of the British throne was caused by his desire to marry an American divorcee, something he couldn’t do as king.*

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**CHAPTER 10: Reading Review**

**replete** (adjective) filled abundantly. *Graham’s book is replete with wonderful stories about the famous people she has known.*

**reprehensible** (adjective) deserving criticism or censure. *Although Pete Rose’s misdeeds were reprehensible, not all fans agree that he deserves to be excluded from the Baseball Hall of Fame.* reprehend (verb), reprehension (noun).

**repudiate** (verb) to reject, to renounce. *After it became known that Duke had been a leader of the Ku Klux Klan, most Republican leaders repudiated him.* repudiation (noun).

**reputable** (adjective) having a good reputation; respected. *Find a reputable auto mechanic by asking your friends for recommendations based on their own experiences.* reputation (noun), repute (noun).

**root**: from the Latin *putare* meaning to reckon. The same root is also found in the words *compute, dispute, impute, and putative.*

**resilient** (adjective) able to recover from difficulty. *A pro athlete must be resilient, able to lose a game one day and come back the next with confidence and enthusiasm.* resilience (adjective).

**respectively** (adverb) in the order given. *On arriving home, the woman kissed her husband and son, respectively.*

**resurrect** (verb) to bring back to life, practice, or use. *When Rob’s novel became a bestseller, he decided to resurrect one he’d written years before to see if that book would sell as well.* resurrection (noun).

**revitalize** (verb) give new life or vigor to. *Although he had been extremely popular at one time, Frank Sinatra had fallen from favor before his role in the film From Here to Eternity revitalized his career.* revitalization (noun).

**rework** (verb) revise. *After playwrights create first drafts of their plays, they generally rework them until they feel they’re strong enough to be performed.*

**rigorous** (adjective) characterized by strictness or severity. *In order to make sure that they are tough enough, Marine recruits are put through rigorous training before they’re allowed to join the Corps.* rigor (noun).

**romanticize** (verb) to treat in an idealized manner. *Although World War II was one of the grimmest conflicts in history, most films about it romanticized it for propaganda reasons.* romantic (adjective).
sanctimonious (adjective) showing false or excessive piety. The sanctimonious prayers of the TV preacher were interspersed with requests that the viewers send him money.

root: from the Latin sanctus meaning holy. The same root is also found in the words sanctify, sanction, sanctity, and sanctuary.

scrutinize (verb) to study closely. The lawyer scrutinized the contract, searching for any sentence that could pose a risk for her client. scrutiny (noun).

secrete (verb) to emit; to hide. Glands in the mouth secrete saliva, a liquid that helps in digestion. The jewel thieves secreted the necklace in a tin box buried underground.

sedate (verb) to reduce stress or excitement by administering a drug for that purpose. The woman was so upset by the events of the day that she had to be sedated to fall asleep. sedative (adjective).

sedentary (adjective) requiring much sitting. When Officer Samson was given a desk job, she had trouble getting used to sedentary work after years on the street.

root: from the Latin sedere meaning to sit. The same root is also found in the words sedate, sedative, and sediment.

sermonizing (verb) speaking in a didactic or dogmatic manner. Because he was hardly in a position to give advice to anyone, the man’s sermonizing only served to irritate his listeners. sermon (noun).

shortcomings (noun) deficiencies or flaws. Although the woman believed her father had many outstanding qualities, it did not keep her from recognizing his shortcomings.

simplification (noun) the state of being less complex or intricate. As a result of years of complaints by the public, the Internal Revenue Service has embarked on a simplification program designed to make tax forms more understandable to those responsible for filling them out. simplify (verb).

simulated (adjective) imitating something else; artificial. High-quality simulated gems must be examined under a magnifying glass to be distinguished from real ones. simulate (verb), simulation (noun).

root: from the Latin simulare meaning to resemble. The same root is also found in the words similarity, simulacrum, simultaneous, and verisimilitude.

solace (verb) to comfort or console. There was little the rabbi could say to solace the husband after his wife’s death. solace (noun).
sophisticated (adjective) worldly-wise or complex. *While many people enjoy drinking domestic beers, those with more sophisticated tastes often prefer imported brews.*
sophistication (noun).

spurious (adjective) false, fake. *The so-called Piltdown Man, supposed to be the fossil of a primitive human, turned out to be spurious, though who created the hoax is still uncertain.*

squabble (verb) to engage in trivial quarrels. *When he has a bad day at the office, he often goes home and squabbles with his wife.*

stabilizing (adjective) making reliable or dependable. *He was quite wild as a teenager, but since marriage, his wife has had a stabilizing influence on him.*
stabilize (verb).

stagnate (verb) to become stale through lack of movement or change. *Having had no contact with the outside world for generations, Japan’s culture gradually stagnated.*
stagnant (adjective), stagnation (noun).

stimulus (noun) something that excites a response or provokes an action. *The arrival of merchants and missionaries from the West provided a stimulus for change in Japanese society.*
stimulate (verb).

stoic (adjective) showing little feeling, even in response to pain or sorrow. *A soldier must respond to the death of his comrades in stoic fashion, since the fighting will not stop for his grief.*
stoicism (noun).

strenuous (adjective) requiring energy and strength. *Hiking in the foothills of the Rockies is fairly easy, but climbing the higher peaks can be strenuous.*

stylistically (adverb) relating to the way something is said, done, or performed. *While Jim Croce’s music was stylistically close to folk, it was usually categorized as rock.*

sublimate (verb) to divert the expression of an instinctual desire or impulse into one that is socially acceptable. *He was so attracted to the woman when he first met her that he wanted to kiss her, but he knew he had to sublimate that desire if he didn’t want to frighten her away.*
sublimation (noun), subliminal (adjective).

subtle (adjective) not immediately obvious. *Because the aroma of her perfume was so subtle, it took several moments before he even noticed it.*
subtlety (noun).

succumb (verb) to give in or give up. *Although he had serious reservations about joining the company, he knew that if they continued to pursue him, he would eventually succumb to their blandishments.*
superficial (adjective) on the surface only; without depth or substance. Her wound was superficial and required only a light bandage. His superficial attractiveness hides the fact that his personality is lifeless and his mind is dull. superficiality (noun).

superfluous (adjective) more than is needed, excessive. Once you’ve won the debate, don’t keep talking; superfluous arguments will only bore and annoy the audience. superfluity (noun).

suppress (verb) to put down or restrain. As soon as the unrest began, thousands of helmeted police were sent into the streets to suppress the riots. suppression (noun).

surfeit (noun) an excess. Most American families have a surfeit of food and drink on Thanksgiving Day. surfeit (verb).

surreptitious (adjective) done in secret. Because Iraq has avoided weapons inspections, many believe it has a surreptitious weapons development program.

surrogate (noun) a substitute. When the congressman died in office, his wife was named to serve the rest of his term as a surrogate. surrogate (adjective).

surveillance (noun) close observation of someone or something. The detective knew that, if she kept the suspect under surveillance long enough, he would eventually do something for which he could be arrested.

suspend (verb) to stop for a period, to interrupt. When the young man was caught speeding for the third time, the judge suspended his license.

symmetrical (adjective) having balanced proportions. Although the human face appears symmetrical, its component parts are never perfectly balanced. symmetry (noun).

synchronize (verb) to make to occur at the same time. The generals planning the invasion wanted to synchronize the air, sea, and land attacks for maximum power. synchronicity (noun).

tactile (adjective) relating to the sense of touch. The thick brush strokes and gobs of color give the paintings of van Gogh a strongly tactile quality. tactility (noun).

root: from the Latin tangere meaning to touch. The same root is also found in the words contact, contiguous, tangent, and tangible.

tangential (adjective) touching lightly; only slightly connected or related. Having enrolled in a class on African-American history, the students found the teacher’s stories about his travels in South America only of tangential interest. tangent (noun).

tedium (noun) boredom. For most people, watching the Weather Channel for 24 hours would be sheer tedium. tedious (adjective).
temerity (noun) boldness, rashness, excessive daring. Only someone who didn’t understand the danger would have the temerity to try to climb Everest without a guide.

temerarious (adjective).

temperance (noun) moderation or restraint in feelings and behavior. Most professional athletes practice temperance in their personal habits; too much eating or drinking, they know, can harm their performance. temperate (adjective).

temperament (noun) the manner of behaving characteristic of a specific individual. Her temperament was such that she was argumentative and generally difficult to deal with. temperamental (adjective).

tenacious (adjective) clinging, sticky, or persistent. Tenacious in pursuit of her goal, she applied for the grant unsuccessfully four times before it was finally approved. tenacity (noun).

root: from the Latin tenere meaning to hold. The same root is also found in the words retain, tenable, tenant, tenet, and tenure.

tensile (adjective) capable of being extended or stretched. While ropes are not tensile, rubber bands are made to be so.

terrestrial (adjective) of the earth. The movie Close Encounters tells the story of the first contact between beings from outer space and terrestrial humans.

titanic (adjective) huge, colossal. Because of the size of the armies arrayed against each other, the battle of Gettysburg was a titanic one.

transcendent (verb) rising above or going above the limits of. Although she had been baptized as a child, when the young woman underwent a second baptism as an adult, it was a transcendent emotional experience for her. transcendence (noun).

transgress (verb) to go past limits; to violate. If Iraq has developed biological weapons, then it has transgressed the UN’s rules against weapons of mass destruction. transgression (noun).

transient (adjective) passing quickly. Long-term visitors to this hotel pay at a different rate than transient guests who stay for just a day or two. transience (noun).

transition (noun) a passage from one state to another. In retrospect, the young man recognized that his joining the army had served as a transition from childhood to adulthood.

transitory (adjective) quickly passing. Public moods tend to be transitory; people may be anxious and angry one month, relatively contented and optimistic the next.
translucent (adjective) letting some light pass through. Blocks of translucent glass let daylight into the room while maintaining privacy.

transmute (verb) to change in form or substance. In the middle ages, the alchemists tried to discover ways to transmute metals such as iron into gold. transmutation (noun).

trite (adjective) boring because of over-familiarity; hackneyed. Her letters were filled with trite expressions, like “All’s well that ends well,” and “So far, so good.”

triviality (noun) the condition or quality of being of little importance of significance. Lacking anything of interest to talk about, the man’s conversation was a study in triviality. trivial (adjective).

trivium (noun) something that is obvious or self-evident. That one must be careful when driving a car is such a truism that it seems hardly worth mentioning.

truncate (verb) to cut off. The manuscript of the play appeared truncated; the last page ended in the middle of a scene, halfway through the second act.

turbulent (adjective) agitated or disturbed. The night before the championship match, Martina was unable to sleep, her mind turbulent with fears and hopes. turbulence (noun).

root: from the Latin turba meaning confusion. The same root is also found in the English words disturb, perturb, and turbid.

tyrannical (adjective) despotic or oppressive. The American colonists felt so oppressed by King George’s tyrannical rule that they believed it necessary to rebel against him. tyrant (noun), tyrannize (verb).

uncouth (adjective) crude, unrefined. The man behaved in such an ill-mannered and obnoxious way that almost everyone who met him considered him to be uncouth.

unctuous (adjective) characterized by false or affected earnestness. The man’s manner was so unctuous that people felt that he could not be trusted.

undomesticated (adjective) not comfortable with or accustomed to a home environment. Unlike dogs, which have lived with people for centuries, undomesticated animals like wolves do not make good pets.

uneasiness (noun) the state of lacking comfort or a sense of security. The prospective bride’s uneasiness about the plans for the wedding led her to double-check everything that had to be done. uneasy (adjective).

unimagined (adjective) not even conceived of. The author’s first book was so successful that it led to unimagined wealth and fame.
unnerving (verb) upsetting. Being involved in even a minor automobile accident is invariably an unnerving experience.

unpalatable (adjective) distasteful, unpleasant. Although I agree with the candidate on many issues, I can’t vote for her, because I find her position on capital punishment unpalatable.

unparalleled (adjective) with no equal; unique. Tiger Woods’s victory in the Masters golf tournament by a full twelve strokes was an unparalleled accomplishment.

unstinting (adjective) giving freely and generously. Eleanor Roosevelt was much admired for her unstinting efforts on behalf of the poor.

untenable (adjective) impossible to defend. The theory that this painting is a genuine van Gogh became untenable when the artist who actually painted it came forth.

untimely (adjective) out of the natural or proper time. The untimely death of a youthful Princess Diana seemed far more tragic than Mother Teresa’s death of old age.

unveiling (noun) an act of uncovering or making public. The culmination of the ceremony was the unveiling of the statue that had been commissioned to honor the late president.

unyielding (adjective) firm, resolute, obdurate. Despite criticism, Cuomo was unyielding in his opposition to capital punishment; he vetoed several death penalty bills as governor.

usurper (noun) someone who takes a place or possession without the right to do so. Kennedy’s most devoted followers tended to regard later presidents as usurpers, holding the office they felt he or his brothers should have held. usurp (verb), usurpation (noun).

utilitarian (adjective) purely of practical benefit. The design of the Model T car was simple and utilitarian, lacking the luxuries found in later models.

utilize (verb) to make use of. When one does research for a book, it’s not always possible to utilize all the information that’s been gathered in the process. utilization (noun).

utopian (adjective) impractically idealistic. Although there have been many utopian communities founded over the centuries, due to their impractical nature, none has ever survived more than a few years. utopia (noun).

vacillation (noun) inability to take a stand. The young man’s vacillation over getting married made it impossible for him and his girlfriend to set a date for the wedding. vacillate (verb).
TIP

Not all synonyms are equal! When memorizing and using synonyms, be aware of the different “shades of meaning” between the original word and its replacement. Not every synonym, not even those listed in dictionaries, can be used interchangeably. Look at the context.

validate (verb) to officially approve or confirm. The election of the president is validated when the members of the Electoral College meet to confirm the choice of the voters.
valid (adjective), validity (noun).

vanity (noun) excessive pride in one’s appearance or accomplishments. The man’s vanity was so extreme that, despite evidence to the contrary, he believed that everyone else thought as well of him as he did himself.
vain (adjective).

venerate (verb) to admire or honor. In Communist China, Chairman Mao Zedong was venerated as an almost god-like figure.
venerable (adjective), veneration (noun).

vestige (noun) a trace or remainder. Today’s tiny Sherwood Forest is the last vestige of a woodland that once covered most of England.
vestigial (adjective).

vex (verb) to irritate, annoy, or trouble. Unproven for generations, Fermat’s last theorem was one of the most famous, and most vexing, of all mathematical puzzles.
vexation (noun).

vindicate (verb) to confirm, justify, or defend. Lincoln’s Gettysburg Address was intended to vindicate the objectives of the Union in the Civil War.
vindication (noun).

virtually (adverb) almost entirely. As a result of chemotherapy, he was virtually free of the cancer that had threatened his life.
virtual (adjective).

virtuoso (noun) someone very skilled, especially in an art. Vladimir Horowitz was one of the great piano virtuosos of the twentieth century.
virtuosity (noun).

root: from the Latin virtus meaning strength. The same root is also found in the word virtue.

vivacious (adjective) lively, sprightly. The role of Maria in The Sound of Music is usually played by a charming, vivacious young actress.
vivacity (noun).

root: from the Latin vivere meaning to live. The same root is also found in the words revive, vital, vivid, and vivisection.

volatile (adjective) quickly changing; fleeting, transitory; prone to violence. Public opinion is notoriously volatile; a politician who is very popular one month may be voted out of office the next.
volatility (noun).

vulnerable (adjective) open to damage or attack. In baring her soul to her friend, the woman recognized that she was making herself extremely vulnerable.

wield (verb) to exercise or exert (power or influence). Because others tend to be afraid of him, when a dictator wants to wield his authority, he only has to express his desires, and whatever he wants is done immediately.
zealous (adjective) filled with eagerness, fervor, or passion. A crowd of the candidate’s most zealous supporters greeted her at the airport with banners, signs, and a marching band. zeal (noun), zealot (noun), zealotry (noun).

**PREFIX AND SUFFIX TABLES**

Scattered throughout the word list in this chapter are notations about word roots. The root is one of the three word parts that are used to build most words. The suffix and prefix are the other two word parts that you should know in order to deconstruct and define words.

A prefix is an addition before a word that changes the meaning of the root, becoming a variation on the basic meaning. Prefixes shape or give a new direction to the word. Giving direction is perhaps the best way to describe it, because you’ll notice that most prefixes are prepositions. The following table lists some of the more common prefixes that you will encounter in words on the ACT Assessment.

**PREFIXES**

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meanings</th>
</tr>
</thead>
<tbody>
<tr>
<td>a, ab</td>
<td>apart, away, from, off, without</td>
</tr>
<tr>
<td>ad</td>
<td>at, near, to, toward</td>
</tr>
<tr>
<td>ante</td>
<td>before, in front</td>
</tr>
<tr>
<td>anti</td>
<td>against, opposite</td>
</tr>
<tr>
<td>bi</td>
<td>twice, two</td>
</tr>
<tr>
<td>co, com, con</td>
<td>jointly, together, with</td>
</tr>
<tr>
<td>de</td>
<td>away, down, from, off, reversal, undoing</td>
</tr>
<tr>
<td>di</td>
<td>apart; also double or two</td>
</tr>
<tr>
<td>dis</td>
<td>apart, away from, lack of, reversal, undoing</td>
</tr>
<tr>
<td>dys</td>
<td>bad, faulty</td>
</tr>
<tr>
<td>em, en</td>
<td>cause to be in, put into, put upon, restrict</td>
</tr>
<tr>
<td>e, ef, ex</td>
<td>away from, former, out of</td>
</tr>
<tr>
<td>equa, equi</td>
<td>equal, even</td>
</tr>
<tr>
<td>extra</td>
<td>beyond the bounds of, outside</td>
</tr>
<tr>
<td>fore</td>
<td>before, front, preceding</td>
</tr>
<tr>
<td>hyper</td>
<td>excessive, over, undue, unusual</td>
</tr>
<tr>
<td>hypo</td>
<td>less than, under</td>
</tr>
<tr>
<td>im, in</td>
<td>in, into, within; also not or without</td>
</tr>
<tr>
<td>inter</td>
<td>among, between, reciprocal</td>
</tr>
<tr>
<td>mis</td>
<td>mistake, reversal, wrongly</td>
</tr>
<tr>
<td>multi</td>
<td>many</td>
</tr>
<tr>
<td>non</td>
<td>not, absence of</td>
</tr>
<tr>
<td>ob, oc, of, op</td>
<td>against, on, over, toward</td>
</tr>
<tr>
<td>para</td>
<td>beside, beyond, next to</td>
</tr>
<tr>
<td>peri</td>
<td>about, around</td>
</tr>
<tr>
<td>poly</td>
<td>many</td>
</tr>
<tr>
<td>post</td>
<td>after, behind</td>
</tr>
<tr>
<td>pre</td>
<td>before, in advance of, in front</td>
</tr>
<tr>
<td>pro</td>
<td>before, favoring, for, forward</td>
</tr>
</tbody>
</table>
A suffix is an addition *after* a word that changes the meaning of the root, becoming a variation on the basic meaning. Suffixes shape the word, often changing its part of speech from, say, a verb to a noun or a noun to an adjective. The following table lists some common suffixes, many of which are used in words on the ACT Assessment.

### SUFFIXES

<table>
<thead>
<tr>
<th>Suffix</th>
<th>Meanings</th>
</tr>
</thead>
<tbody>
<tr>
<td>able, ible</td>
<td>capable of, fit for, tending to</td>
</tr>
<tr>
<td>age</td>
<td>act, condition, place of, result of</td>
</tr>
<tr>
<td>al</td>
<td>relating to</td>
</tr>
<tr>
<td>ance, ence</td>
<td>act, condition of, process of, relating to</td>
</tr>
<tr>
<td>ary</td>
<td>relating to, connected with</td>
</tr>
<tr>
<td>ate</td>
<td>function of, one who does or is</td>
</tr>
<tr>
<td>en</td>
<td>made of, to make (the root)</td>
</tr>
<tr>
<td>er, or</td>
<td>person or thing that does (the root)</td>
</tr>
<tr>
<td>ful</td>
<td>able to, full of</td>
</tr>
<tr>
<td>hood</td>
<td>condition of, class of persons</td>
</tr>
<tr>
<td>ion</td>
<td>action of, condition of</td>
</tr>
<tr>
<td>ish</td>
<td>belonging to, being like (the root), somewhat</td>
</tr>
<tr>
<td>ism</td>
<td>condition of, practice of, system of</td>
</tr>
<tr>
<td>ist</td>
<td>one who does, one who favors</td>
</tr>
<tr>
<td>ite</td>
<td>person associated with (the root)</td>
</tr>
<tr>
<td>ive</td>
<td>relating to, tending to</td>
</tr>
<tr>
<td>ize</td>
<td>to make, to subject to</td>
</tr>
<tr>
<td>less</td>
<td>not having, without, unable to</td>
</tr>
<tr>
<td>ly</td>
<td>similar in appearance or manner; also every</td>
</tr>
<tr>
<td>ment</td>
<td>act of having done, result of</td>
</tr>
<tr>
<td>ness</td>
<td>having the characteristics of</td>
</tr>
<tr>
<td>ory, tory</td>
<td>relating to, place of</td>
</tr>
<tr>
<td>ous</td>
<td>full of, like, possessing</td>
</tr>
<tr>
<td>tion, sion</td>
<td>act of doing, state of being</td>
</tr>
<tr>
<td>ty</td>
<td>quality, state of being</td>
</tr>
</tbody>
</table>
PRACTICE EXERCISES

You’ve just acquired some powerful new help for taking the ACT Assessment Reading Test. The following exercises will help you to practice these new skills as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are three Reading Test exercises in this chapter. Each exercise contains 2 passages followed by 10 questions each and should be answered in 18 minutes. Do each exercise in one sitting in a quiet place, with no notes or reference material. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

Score yourself only on those items you finished. When you’re done, work through the rest of the exercise.
EXERCISES: THE ACT ASSESSMENT READING TEST

Exercise 1

20 Questions • Time—18 Minutes

Directions: This exercise consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question.

Passage I—HUMANITIES

Often considered the beginning of modernism in painting, the French impressionists of the late nineteenth century—Manet, Degas, Pissarro, (5) Monet, and others—had a far-reaching effect on artists around the world, as much for the philosophy underlying their work as for the new painterly esthetic they pioneered. For although the impressionists expressly disavowed any interest in philosophy, their new approach to art had significant philosophical implications. The view of matter that the impressionists assumed differed profoundly from the view that had previously prevailed among artists. This view helped to unify the artistic works created in the new style.

The ancient Greeks had conceived (10) of the world in concrete terms, even endowing abstract qualities with bodies. This Greek view of matter persisted, so far as painting was concerned, into the nineteenth century. The impressionists, on the other hand, viewed light, not matter, as the ultimate visual reality. The philosopher Taine expressed the impressionist view of things when he said, “The chief ‘person’ in a picture is (15) the light in which everything is bathed.”

In impressionist painting, solid bodies became mere reflectors of light, and distinctions between one object and another became arbitrary conventions; (20) for by light all things were welded together. The treatment of both color and outline was transformed as well. Color, formerly considered a property inherent in an object, was seen to be merely the result of vibrations of light on the object’s colorless surface. And outline, whose function had formerly been to indicate the limits of objects, now marked instead merely the boundary between units of pattern, which often merged into one another.

The impressionist world was composed not of separate objects but of many surfaces on which light struck and was reflected with varying intensity to the eye through the atmosphere, which modified it. It was this process that produced the mosaic of colors that formed an impressionist canvas. “Light becomes the sole subject of the picture,” writes Mauclair. “The interest of the object upon which it plays is secondary. Painting this conceived becomes a purely optic art.” (25)

From this profoundly revolutionary form of art, then, all ideas—religious, moral, psychological—were excluded, and so were all emotions except certain aesthetic ones. The people, places, and things depicted in an impressionist picture do not tell a story or convey any special meaning; they are, instead, merely parts of a pattern of light drawn from nature and captured on canvas by the artist. (30)

Paradoxically, the impressionists’ avowed lack of interest in subject matter made the subject matter of their work particularly important and influential. Prior to the impressionist revolution, particular themes and subjects
had been generally deemed more suitable than others for treatment in art. Momentous historic events; crucial incidents in the lives of saints, martyrs, or heroes; the deeds of the Greek and Roman gods; the images of the noble, wealthy, and powerful—these dominated European painting of the eighteenth and early nineteenth centuries.

The impressionists changed all that. If moral significance is drained from art, then any subject will serve as well as any other. The impressionists painted life as they found it close to hand. The bustling boulevards of modern Paris; revelers in smoky cafes, theatres, and nightclubs; working-class families picnicking by the Seine—these are typical of the images chosen by the impressionists. It was not only their formal innovations that surprised and disturbed the academic critics of their day. The fact that they chose to depict the “low life” of contemporary Paris rather than the exalted themes preferred by their predecessors made some wonder whether what the impressionists created was art at all.

In this regard as in so many others, the impressionists were true precursors of twentieth-century painting. Taking their cue from the impressionists, modernists from the cubists to the pop artists have expanded the freedom of the creator to make art from anything and everything. Picasso, Braque, and Juan Gris filled their still lifes with the machine-made detritus of a modern city, even pasting actual printed labels and torn sheets of newsprint into their pictures and so inventing what came to be called collage. Six decades later, Andy Warhol carried the theme to its logical conclusion with his pictures of Campbell’s soup cans, depicted in a style as grandiose and monumental as any king or prophet in a neo-classical painting. Among its other messages, Warhol’s work is proclaiming, “If art is a game of surfaces—an experiment in color and light—then the beauty and importance of a tin can is equal to that of Helen of Troy.” In this, he was a true kin—if a distant one—to Degas, Renoir, and Pissarro.

1. The author of the passage is primarily concerned with explaining

(A) how new scientific ideas concerning light and color have affected the visual arts.
(B) the philosophical implications of the impressionist style of painting.
(C) the artistic techniques that the impressionist painters were the first to develop.
(D) the influence of thinkers like Taine and Mauclair on impressionist painting.

2. The main point of the last paragraph is that the impressionists deeply influenced twentieth-century painters in their

(F) choice of subject matter.
(G) treatment of light.
(H) use of art to tell stories.
(J) application of collage techniques.

3. According to the passage, the impressionist painters differed from the ancient Greeks in that they

(A) considered color to be a property inherent in objects.
(B) regarded art primarily as a medium for expressing moral and aesthetic ideas.
(C) treated the objects depicted in a painting as isolated, rather than united in a single pattern.
(D) treated light, rather than matter, as the ultimate reality.
4. According to the passage, an impressionist painting is best considered
   (F) a harmonious arrangement of solid physical masses.
   (G) a pattern of lights of varying intensities.
   (H) a mosaic of outlines representing the edges of objects.
   (J) an analysis of the properties of differing geometric forms.

5. The passage suggests that the impressionist painters regarded the distinctions among different kinds of objects to be painted as
   (A) primarily of psychological interest.
   (B) arbitrary and essentially insignificant.
   (C) reflecting social and political realities.
   (D) suggestive of abstract truths.

6. The passage suggests that an impressionist painter would be most likely to depict which of the following scenes?
   (F) A military victory by a Roman general
   (G) A can of Campbell’s soup
   (H) Coffee drinkers in a Parisian restaurant
   (J) The death of a Christian martyr

7. It can be inferred from the passage that the impressionist approach to painting was
   (A) highly objective.
   (B) politically motivated.
   (C) profoundly religious.
   (D) ultimately conservative.

8. It can be inferred that the “low life” mentioned by the author in line 100 refers mainly to the
   (F) activities of the criminal underworld in nineteenth-century France.
   (G) everyday existence of middle-class and working-class Parisians.
   (H) exploits of figures from Greek and Roman mythology.
   (J) hand-to-mouth poverty in which most impressionist painters were forced to live.

9. The author refers to “Helen of Troy” (lines 128-129) as an example of the kind of subject matter preferred by
   (A) many pre-impressionist painters.
   (B) the impressionists.
   (C) Picasso, Braque, and Gris.
   (D) Andy Warhol.

10. It can be inferred from the passage than an impressionist painter would be most likely to agree with which of the following statements?
    (F) A picture is significant primarily as a symbol of the artist’s mental state.
    (G) The highest purpose of art is to teach philosophical truths.
    (H) The quality of a picture has nothing to do with the nature of the objects it depicts.
    (J) An artist should strive to recreate on canvas the inner nature of objects from real life.
Passage II—NATURAL SCIENCE

Community cancer clusters are localized patterns of excessive cancer occurrence. The following passage discusses the difficulties involved in identifying common causes for community cancer clusters.

Community cancer clusters are viewed quite differently by citizen activists than by epidemiologists. Environmentalists and concerned local residents, for instance, might immediately suspect environmental radiation as the culprit when a high incidence of cancer cases occurs near a nuclear facility. Epidemiologists, in contrast, would be more likely to say that the incidences were "inconclusive" or the result of pure chance. And when a breast cancer survivor, Lorraine Pace, mapped twenty breast cancer cases occurring in her West Islip, Long Island, community, her rudimentary research efforts were guided more by hope—that a specific environmental agent could be correlated with the cancers—than by scientific method.

When epidemiologists study clusters of cancer cases and other non-contagious conditions such as birth defects or miscarriage, they take several variables into account, such as background rate (the number of people affected in the general population), cluster size, and specificity (any notable characteristics of the individual affected in each case). If a cluster is both large and specific, it is easier for epidemiologists to assign blame. Not only must each variable be considered on its own, but it must also be combined with others. Lung cancer is very common in the general population. Yet when a huge number of cases turned up among World War II shipbuilders who had all worked with asbestos, the size of the cluster and the fact that the men had had similar occupational asbestos exposures enabled epidemiologists to assign blame to the fibrous mineral.

Furthermore, even if a cluster seems too small to be analyzed conclusively, it may still yield important data if the background rate of the condition is low enough. This was the case when a certain vaginal cancer turned up almost simultaneously in a half-dozen young women. While six would seem to be too small a cluster for meaningful study, the cancer had been reported only once or twice before in the entire medical literature. Researchers eventually found that the mothers of all the afflicted women had taken the drug diethylstilbestrol (DES) while pregnant.

Although several known carcinogens have been discovered through these kinds of occupational or medical clusters, only one community cancer cluster has ever been traced to an environmental cause. Health officials often discount a community's suspicion of a common environmental cause because citizens tend to include cases that were diagnosed before the afflicted individuals moved into the neighborhood. Add to this the problem of cancer's latency. Unlike an infectious disease like cholera, which is cased by a recent exposure to food or water contaminated with the cholera bacterium, cancer may have its roots in an exposure that occurred ten to twenty years earlier. Citizens also conduct what one epidemiologist calls "epidemiologic gerrymandering," finding cancer cases, drawing a boundary around them, and then mapping this as a cluster.

Do all these caveats mean that the hard work of Lorraine Pace and other community activists is for naught? Not necessarily. Together with many other reports of breast cancer clusters on Long Island, the West Islip situation highlighted by Pace has helped epidemiologists lay the groundwork for a well-designed scientific study.
11. The “hope” mentioned in line 23 refers specifically to Pace’s desire to
(A) help reduce the incidence of breast cancer in future generations.
(B) determine the culprit responsible for her own breast cancer case.
(C) refute the dismissive statements of epidemiologists concerning her research efforts.
(D) identify a particular cause for the breast cancer cases in West Islip.

12. The case of the World War II shipbuilders with lung cancer (lines 39–47) is an example of a(n)
(F) occupational cluster.
(G) medical cluster.
(H) radiation cluster.
(J) environmental cluster.

13. The case of six young women with vaginal cancer (lines 53–63) is an example of a cluster that has a
(A) high background rate and is fairly specific.
(B) low background rate and is fairly specific.
(C) high background rate and small size.
(D) low background rate and is non-specific.

14. The passage suggests that the fact that “only one community cancer cluster has ever been traced to an environmental cause” (lines 67–69) is most likely due to the
(F) methodological difficulties in analyzing community cancer clusters.
(G) reluctance of epidemiologists to investigate environmental factors in cancer.
(H) lack of credibility of citizen activists in claiming to have identified cancer agents.
(J) effectiveness of regulations restricting the use of carcinogens in residential areas.

15. As it is used in line 69, the word discount most nearly means
(A) exacerbate.
(B) doubt.
(C) ridicule.
(D) heed.

16. In lines 69–74 (“Health officials . . . into the neighborhood”), the author suggests that activists may mistakenly consider a particular incidence of cancer as part of a community cluster despite the fact that
(F) the affected individual never worked with any carcinogenic material.
(G) the cancer was actually caused by a long-ago exposure.
(H) a high background rate suggests a purely random incidence.
(J) the cancer actually arose in a different geographic location.
17. The reference to cancer’s “latency” in line 75 refers to the tendency of cancer to
(A) exist in a dormant or hidden form.
(B) spread through the body at a surprisingly rapid rate.
(C) pass through phases of apparent cure and recurrence.
(D) be masked by other, unrelated illnesses.

18. The “epidemiological gerrymandering,” which the author describes in line 83, is most closely analogous to a
(F) toddler’s declaring that all the toys in one area of the school playground are now his property.
(G) school principal’s redistributing students in two classrooms so that each classroom has the same number of gifted students.
(H) politician’s drawing of election district boundaries so as to give one political party control of a majority of districts.
(J) nurse’s erasing information on a patient’s chart and substituting false data.

19. As it is used in line 87, the word caveats refers to the
(A) incidence of “gerrymandering” by citizens concerned about cancer.
(B) potential flaws in amateur studies of cancer clusters.
(C) warnings by activists concerning environmental dangers in their communities.
(D) tendencies of activists to assume environmental causes for cancer.

20. The author suggests that the work of concerned citizens who map cancer clusters
(F) has proven the existence of several environmental causes of cancer.
(G) frequently involves the manipulation of data in order to strengthen a case.
(H) has sometimes paved the way for further studies by trained epidemiologists.
(J) is normally of little or no value to the scientific community.

Exercise 2

20 Questions • Time—18 Minutes

Directions: This exercise consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question.

Passage I—PROSE FICTION

Although Bertha Young was thirty, she still had moments like this when she wanted to run instead of walk, to take dancing steps on and off the pavement, to bowl a hoop, to throw something up in the air and catch it again, or to stand still and laugh at—nothing—at nothing, simply.

What can you do if you are thirty and, turning the corner of your own street, you are overcome, suddenly, by a feeling of bliss—absolute bliss!—as though you’d suddenly swallowed a bright piece of that late afternoon sun and it burned in your bosom, sending out a little shower of sparks into every particle, into every finger and toe . . . ?

www.petersons.com/arco
Oh, is there no way you can express it without being "drunk and disorderly"?

How idiotic civilization is! Why be given a body if you have to keep it shut up in a case like a rare, rare fiddle?

“No, that about the fiddle is not quite what I mean,” she thought, running up the steps and feeling in her bag for the key—she’d forgotten it, as usual—and rattling the letter-box. “It’s not what I mean, because—Thank you, Mary”—she went into the hall. “Is nurse back?”

“Yes, M’m.”

“I’ll go upstairs.” And she ran upstairs to the nursery.

Nurse sat at a low table giving Little B her supper after her bath. The baby had on a white flannel gown and a blue woolen jacket, and her dark, fine hair was brushed up into a funny little peak. She looked up when she saw her mother and began to jump.

“Now, my lovey, eat it up like a good girl,” said Nurse, setting her lips in a way that Bertha knew, and that meant she had come into the nursery at another wrong moment.

“Has she been good, Nanny?”

“She’s been a little sweet all the afternoon,” whispered Nanny. “We went to the park and I sat down on a chair and took her out of the carriage and a big dog came along and put its head on my knee and she clutched its ear, tugged it. Oh, you should have seen her.”

Bertha wanted to ask if it wasn’t rather dangerous to let her clutch at a strange dog’s ear. But she did not dare to. She stood watching them, her hands by her side, like the poor little girl in front of the rich little girl with the doll.

The baby looked up at her again, stared, and then smiled so charmingly that Bertha couldn’t help crying:

“Oh, Nanny, do let me finish giving her supper while you put the bath things away.”

“Well, M’m, she oughtn’t to be changed hands while she’s eating,” said Nanny, still whispering. “It unsettles her; it’s very likely to upset her.”

How absurd it was. Why have a baby if it has to be kept—not in a case like a rare, rare fiddle—but in another woman’s arms?

“Oh, I must!” said she.

Very offended, Nanny handed her over.

“Now, don’t excite her after her supper. You know you do, M’m. And I have such a time with her after!”

Thank heaven! Nanny went out of the room with the bath towels.

“Now I’ve got you to myself, my little precious,” said Bertha, as the baby leaned against her.

She ate delightfully, holding up her lips for the spoon and then waving her hands. Sometimes she wouldn’t let the spoon go; and sometimes, just as Bertha had filled it, she waved it away to the four winds.

When the soup was finished Bertha turned round to the fire.

“You’re nice—you’re very nice!” said she, kissing her warm baby. “I’m fond of you. I like you.”

And, indeed, she loved Little B so much—her neck as she bent forward, her exquisite toes as they shone transparent in the firelight—that all her feeling of bliss came back again, and again she didn’t know how to express it—what to do with it.

“You’re wanted on the telephone,” said Nanny, coming back in triumph and seizing her Little B.
1. It can be inferred from the passage that Nanny is afraid that Bertha will make the baby
   (A) overly excited.
   (B) unwilling to finish her supper.
   (C) physically ill.
   (D) unwilling to have a bath.

2. Bertha’s feelings toward Nanny may best be described as a mixture of
   (F) resentment and despair.
   (G) timidity and jealousy.
   (H) contempt and hostility.
   (J) exasperation and affection.

3. When the narrator compares the body to “a rare, rare fiddle” (line 22), she suggests that Bertha feels
   (A) excessively frail and vulnerable.
   (B) precious yet difficult to handle.
   (C) unable to express her feelings.
   (D) giddy, confused, and anxious.

4. It can be inferred from the third paragraph (lines 18–22) that Bertha believes that revealing her emotions openly will
   (F) expose her to social disapproval.
   (G) cause people to doubt her sanity.
   (H) hurt the feelings of those she loves.
   (J) make others think she is intoxicated.

5. The comparison of Bertha to “the poor little girl” (line 57) primarily suggests Bertha’s
   (A) desire to spend more time with Little B.
   (B) wish that her family had more money.
   (C) emotional and psychological immaturity.
   (D) yearning for some sign of friendship from Nanny.

6. We can infer that what the narrator considers “absurd” (line 69) is
   (F) Nanny’s gingerly treatment of Little B.
   (G) the class distinctions that separate Nanny and Bertha.
   (H) the powerful love for Little B that Bertha is feeling.
   (J) Nanny’s haughty attitude toward Bertha.

7. The facial expression worn by Nanny in the eighth paragraph (lines 40–44) suggests that she
   (A) does not enjoy feeding Little B.
   (B) is tired of working as a nurse for another woman’s child.
   (C) dislikes when Bertha visits the nursery.
   (D) wishes to hide the nature of her relationship with Little B.

8. We can infer from the word “triumph” in line 103 that Nanny
   (F) is happy that Little B has finished eating her supper.
   (G) feels proud of her ability to control the activities of the household.
   (H) wishes she had a baby of her own.
   (J) is glad to be able to take Little B out of Bertha’s arms.

9. The passage suggests that the “bliss” (line 12) experienced by Bertha is basically
   (A) a form of maternal love.
   (B) impossible to fully explain.
   (C) a desire to rebel against civilization.
   (D) a sign of her immaturity.

10. Given the way she is presented in the passage, Bertha can best be described as
    (F) emotional and impulsive.
    (G) rigidly self-controlled.
    (H) vain and insecure.
    (J) arrogant and demanding.
Passage II—SOCIAL STUDIES

As the climate in the Middle East changed beginning around 7000 B.C.E., conditions emerged that were conducive to a more complex and advanced form of civilization in both Egypt and Mesopotamia. The process began when the swampy valleys of the Nile in Egypt and of the Tigris and Euphrates rivers in Mesopotamia became drier, producing riverine lands that were both habitable and fertile, and attracting settlers armed with the newly developed techniques of agriculture. This migration was further encouraged by the gradual transformation of the once-hospitable grasslands of these regions into deserts. Human population became increasingly concentrated into pockets of settlement scattered along the banks of the great rivers.

These rivers profoundly shaped the way of life along their banks. In Mesopotamia, the management of water in conditions of unpredictable drought, flood, and storm became the central economic and social challenge. Villagers began early to build simple earthworks, dikes, canals, and ditches to control the waters and reduce the opposing dangers of drought during the dry season (usually the spring) and flooding at harvest time.

Such efforts required a degree of cooperation among large numbers of people that had not previously existed. The individual village, containing only a dozen or so houses and families, was economically vulnerable; but when several villages, probably under the direction of a council of elders, learned to share their human resources in the building of a coordinated network of water-control systems, the safety, stability, and prosperity of all improved. In this new cooperation, the seeds of the great Mesopotamian civilizations were being sown.

Technological and mathematical invention, too, were stimulated by life along the rivers. Such devices as the noria (a primitive waterwheel) and the Archimedes screw (a device for raising water from the low riverbanks to the high ground where it was needed), two forerunners of many more varied and complex machines, were first developed here for use in irrigation systems. Similarly, the earliest methods of measurement and computation and the first developments in geometry were stimulated by the need to keep track of land holdings and boundaries in fields that were periodically inundated.

The rivers served as high roads of the earliest commerce. Traders used boats made of bundles of rushes to transport grains, fruits, nuts, fibers, and textiles from one village to another, transforming the rivers into the central spines of nascent commercial kingdoms. Mud from the river banks originally served as the region’s sole building material, as well as the source of clay for pottery, sculpture, and writing tablets. With the opening of trade, other materials became available. Building stones such as basalt and sandstone were imported, as was alabaster for sculpture, metals such as bronze, copper, gold, and silver, and precious and semi-precious gemstones for jewelry, art, and decoration.

Eventually, Middle Eastern trade expanded surprisingly widely; we have evidence suggesting that, even before the establishment of the first Egyptian dynasty, goods were being exchanged between villagers in Egypt and others as far away as Iran.

By 3500 B.C.E., Mesopotamian society was flourishing. The major archaeological source from which we derive our knowledge of this period is the city of Uruk, site of the modern Al Warka. Two major structures from the time are the so-called Limestone Temple, an immense structure about the size of an American football field (250 × 99 feet), and the White Temple, built on a high platform some 40 feet above the plain. Associated discoveries include several outstanding stone sculptures, beautifully decorated...
alabaster vases, clay tablets, and many cylinder seals, which were both artistic expressions and symbols of personal identification used by Mesopotamian rulers. Clearly, a complex and advanced civilization was in place by the time these artifacts were created. Historians have observed that similar developments were occurring at much the same time along the great river valleys in other parts of the world—for example, along the Indus in India and the Hwang Ho in China. The history of early civilization has been shaped to a remarkable degree by the relationship of humans and rivers.

11. The primary purpose of the passage is to explain
(A) how primitive technologies were first developed in the ancient Middle East.
(B) how climatic changes led to the founding of the earliest recorded cities.
(C) the influence of river life on the growth of early Mesopotamian civilization.
(D) some of the recent findings of researchers into early human history.

12. It can be inferred from the passage that, prior to 7000 B.C.E., relatively more of the Mesopotamian population could be found in
(F) grasslands away from the rivers.
(G) mountainous regions.
(H) villages along the riverbanks.
(J) desert areas far from the rivers.

13. According to the passage, the unpredictability of water supplies in Mesopotamia had which of the following social effects?
   I. It led to warfare over water rights among rival villages.
   II. It encouraged cooperation in the creation of water-management systems.
   III. It drove farmers to settle in fertile grasslands far from the uncontrollable rivers.
   (A) I only
   (B) II only
   (C) II and III
   (D) None of the above

14. As it is used in lines 68–69, the word nascent most nearly means
(F) powerful.
(G) emerging.
(H) crude.
(J) wealthy.

15. According to the passage, the earliest trade routes in the ancient Middle East
(A) were those between various centrally ruled commercial kingdoms.
(B) were those that linked villages in Egypt with others in Iran.
(C) served to link the inhabitants of small villages with the dynastic kings who ruled them.
(D) connected villages that were scattered along the banks of the same river.

16. The author states that the trade goods imported into Mesopotamia included
   I. alabaster.
   II. clay tablets.
   III. semiprecious stones.
   (F) I only
   (G) III only
   (H) I and III
   (J) II and III
17. It can be inferred from the passage that the emergence of complex civilizations in the Middle East was dependent upon the previous development of
(A) basic techniques of agriculture.
(B) symbolic systems for writing and mathematical computation.
(C) a system of centralized government.
(D) a method of storing and transferring wealth.

18. The main purpose of the seventh paragraph (lines 88–107) is to describe the
(F) recent work of archeologists in studying Mesopotamian society.
(G) political and social structures that evolved in Mesopotamia.
(H) artistic styles favored by Mesopotamian craftspeople.
(J) archeological evidence of high Mesopotamian culture.

19. The passage implies that the size of the Limestone Temple suggests which of the following characteristics of Mesopotamian society?
(A) Its access to building materials imported from distant regions
(B) Its fascination with the use of mathematical models in architecture
(C) Its focus on the priesthood as the source of political and economic power
(D) Its ability to marshal significant material and human resources for a building project.

20. The author refers to emerging civilizations in India and China primarily in order to emphasize the
(F) importance of water transportation in the growth of early trade.
(G) relatively advanced position enjoyed by the Middle East in comparison to other regions.
(H) rapidity with which social systems developed in the Middle East spread to other places.
(J) crucial role played by rivers in the development of human cultures around the world.

Exercise 3
20 Questions • Time—18 Minutes

Directions: This exercise consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question.

Passage I—HUMANITIES
It is widely believed that every word has a correct meaning, that we learn these meanings principally from teachers and grammarians (except that most of the time we don’t bother to, so that we ordinarily speak “sloppy English”), and that dictionaries and grammars are the supreme authority in matters of meaning and usage. Few people ask by what authority the writers of dictionaries and grammars say what they say.

I once got into a dispute with an Englishwoman over the pronunciation of a word and offered to look it up in the dictionary. The Englishwoman said firmly, “What for? I am English. I was
born and brought up in England. The way I speak is English.” Such self-assurance about one’s own language is not uncommon among the English. In the United States, however, anyone who is willing to quarrel with the dictionary is regarded as either eccentric or mad.

Let us see how dictionaries are made and how the editors arrive at definitions. What follows applies, incidentally, only to those dictionary offices where first-hand, original research goes on—not those in which editors simply copy existing dictionaries. The task of writing a dictionary begins with reading vast amounts of the literature of the period or subject that the dictionary is to cover. As the editors read, they copy on cards every interesting or rare word, every unusual or peculiar occurrence of a common word, a large number of common words in their ordinary uses, and also the sentences in which each of these words appears, thus:

\[
\begin{align*}
\text{pail} \\
\text{The dairy pails bring home increase of milk} \\
\text{Keats, Endymion, I, 44-45}
\end{align*}
\]

That is to say, the context of each word is collected, along with the word itself. For a really big job of dictionary writing, such as the \textit{Oxford English Dictionary} (usually bound in about twenty-five volumes), millions of such cards are collected, and the task of editing occupies decades. As the cards are collected, they are alphabetized and sorted. When the sorting is completed, there will be for each word anywhere from two to three to several hundred illustrative quotations, each on its card.

To define a word, then, the dictionary editor places before him the stack of cards illustrating that word; each of the cards represents an actual use of the word by a writer of some literary or historical importance. He reads the cards carefully, discards some, rereads the rest, and divides up the stack according to what he thinks are the several senses of the word. Finally, he writes his definitions, following the hard-and-fast rule that each definition must be based on what the quotations in front of him reveal about the meaning of the word. The editor cannot be influenced by what he thinks a given word \textit{ought} to mean. He must work according to the cards or not at all.

The writing of a dictionary, therefore, is not a task of setting up authoritative statements about the “true meanings” of words, but a task of \textit{recording}, to the best of one’s ability, what various words have meant to authors in the distant or immediate past. The writer of a dictionary is a historian, not a lawgiver. If, for example, we had been writing a dictionary in 1890, or even as late as 1919, we could have said that the word “broadcast” means “to scatter” (seed and so on) but we could not have decreed that from 1921 on, the commonest meaning of the word should become “to disseminate audible messages, etc., by radio transmission.”

To regard the dictionary as an “authority,” therefore, is to credit the dictionary writer with gifts of prophecy which neither he nor anyone else possesses. In choosing our words when we speak or write, we can be \textit{guided} by the historical record afforded us by the dictionary, but we cannot be \textit{bound} by it, because new situations, new experiences, new inventions, new feelings, are always compelling us to give new uses to old words. Looking under a “hood,” we should ordinarily have found, five hundred years ago, a monk; today, we find a motorcar engine.

The way in which the dictionary writer arrives at his definitions merely systematizes the way in which we all learn the meanings of words, beginning at infancy, and continuing for the rest of our lives. Let us say that we have never heard the word “oboe” before, and we overhear a conversation in which the following sentences occur:
1. The author describes the attitude of the Englishwoman (lines 12–18) primarily in order to illustrate the fact that the
   (A) English tend to view the language habits of Americans with disdain.
   (B) pronunciation of words is not of great importance.
   (C) dictionary is not an authority on how language should be used.
   (D) English are more careful in their use of language than are Americans.

2. It can be inferred that the author regards the attitude of the typical American toward the dictionary as resulting from
   (F) a misunderstanding of the role of the dictionary writer.
   (G) an unwarranted self-assurance on the part of most people who speak English.
   (H) an excessive sense of respect for those in positions of authority.
   (J) a mistaken belief that the meanings of words never change.

3. The author uses the word context in line 45 to refer to the
   (A) primary meaning of a word.
   (B) sentence in which a word appears.
   (C) significance of the author who uses a word.
   (D) way in which the definition of a word changes through time.

4. The *Oxford English Dictionary* is mentioned in the passage as an example of a dictionary that
   (F) is largely copied from the work of previous dictionaries.
   (G) attempts to describe how words should be used as well as how they have been used.
   (H) reflects the language of England rather than that of the United States.
   (J) is based on very extensive first-hand research.

5. As it is used in line 82, the word *immediate* most nearly means
   (A) instantaneous.
   (B) recent.
   (C) ancient.
   (D) rapid.

6. As it is used in line 36, the word *peculiar* most nearly means
   (F) incorrect.
   (G) unintelligible.
   (H) specific.
   (J) distinctive.

He used to be the best *oboe* player in town . . . Whenever they came to that *oboe* part in the third movement, he used to get very excited . . . I saw him one day at the music shop, buying a new reed for his *oboe* . . . He never liked to play the clarinet after he started playing the *oboe* . . . He said it wasn't much fun, because it was too easy.

Although the word may be unfamiliar, its meaning becomes clear to us as we listen. After hearing the first sentence, "we know that an "oboe" is "played," so that it must be either a game or a musical instrument. With the second sentence the possibilities as to what an "oboe" may be are narrowed down until we get a fairly clear idea of what is meant. This is how we learn by verbal context.

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7. The author’s explanation, in the sixth paragraph (lines 76–92), concerning the meaning of the word “broadcast,” illustrates how language may change as a result of
   (A) the careless misuse of words.
   (B) changes in technology.
   (C) the appearance of a new dictionary.
   (D) new interpretations of linguistic history.

8. The main idea of the seventh paragraph (lines 93–107) is that
   (F) no one can foresee how language will change in the future.
   (G) the dictionary is a largely useless tool for most writers.
   (H) careful writers are guided by the historical meanings of the words they choose.
   (J) most dictionaries are outdated as soon as they are published.

9. The author uses the example of the word “oboe” (line 114) to illustrate how word meanings are learned
   (A) in infancy.
   (B) by those who edit dictionaries.
   (C) from hearing them used in conversation.
   (D) from dictionary definitions.

10. It can be inferred from the passage that the author would most strongly agree with which of the following statements?
   (F) Every word has a correct meaning.
   (G) The writer of a dictionary is basically a historian.
   (H) Anyone willing to quarrel with the dictionary is eccentric or mad.
   (J) Grammars are the supreme authority in matters of usage.

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**Passage II—NATURAL SCIENCE**

(The article from which this passage is excerpted was written in 1986.)

Around the turn of the century, two major innovations in the field of forensic science were added to the repertoire of scientific crime-fighting tools. One was fingerprinting; the other was blood-typing. Only in the last ten years, however, have scientists begun to believe that genetic markers in blood and other body fluids may someday prove as useful in crime detection as fingerprints.

The standard ABO blood typing originated in the work of Austrian pathologist Karl Landsteiner. He found in 1901 that four basic blood types existed and that these were transmitted from generation to generation according to the recently rediscovered laws of inheritance developed by Gregor Mendel earlier in the century.

The four blood types classified by Landsteiner are known as A, B, AB, and O. Their names derive from the presence or absence of two substances, designated A and B, found on the surface of some blood cells. Persons with blood type A have red blood cells with substance A on their surface. Their blood also contains an antibody that reacts defensively against blood cells with substance B on their surface. Conversely, persons with blood type B have substance B on the surface of their red blood cells, as well as an antibody against substance A.

When a person of either of these blood types is transfused with blood of the opposite type, the antibodies swing into action, destroying the transfused cells. (Indeed, it was the failure of many blood transfusions that had first led physicians to suspect the existence of mutually incompatible blood groups.)

Blood type AB contains both substances and neither antibody; it can harmlessly receive a transfusion of any blood type. Hence its designation as the
“universal recipient.” Blood type O contains neither substance and both antibodies; it reacts negatively to blood types A, B, and AB, and can receive only type O blood. However, type O blood may be safely transfused into any recipient, since it lacks any substance that could cause a negative reaction; therefore, type O is the “universal donor.”

In addition to their obvious importance in medical treatment, the four basic blood types of the ABO system have long been used by police as a form of negative identification. Testing traces of blood found in or around a crime scene could help rule out suspects who were members of a different blood group.

Added sophistication came with the discovery of additional subgroups of genetic markers in blood (such as Rh factor, by which an individual’s blood type is generally designated as either positive [+] or negative [–], depending on whether or not the factor is present) and with the discovery that genetic markers are present not only in blood but in other body fluids, such as perspiration and saliva.

These discoveries were still of limited use in crime detection, however, because of the circumstances in which police and scientists must work. Rather than a plentiful sample of blood freshly drawn from a patient, the crime laboratory is likely to receive only a tiny fleck of dried blood of unknown age from an unknown “donor” on a shirt or a scrap of rag that has spent hours or days exposed to air, high temperature, and other contaminants.

British scientists found a method for identifying genetic markers more precisely in small samples. In this process, called electrophoresis, a sample is placed on a tray containing a gel through which an electrical current is then passed. A trained analyst reads the resulting patterns in the gel to determine the presence of various chemical markers.

Electrophoresis made it possible to identify several thousand subgroups of blood types rather than the twelve known before. However, the equipment and special training required were expensive. In addition, the process could lead to the destruction of evidence. For example, repeated tests of a blood-flecked shirt—one for each marker—led to increasing deterioration of the evidence and the cost of a week or more of laboratory time.

It remained for another British researcher, Brian Wrexall, to demonstrate that simultaneous analyses, using inexpensive equipment, could test for ten different genetic markers within a 24-hour period. This development made the study of blood and fluid samples a truly valuable tool for crime detection.

11. The author of the passage is mainly concerned with describing
(A) how advances in crime detection methods have led to new discoveries in science.
(B) various ways in which crime detection laboratories assist the police.
(C) the development of new scientific tools for use in crime detection.
(D) areas of current research in the science of crime detection.

12. According to the passage, a person of blood type AB could safely donate blood to a person of which blood type?
   I. Type A
   II. Type B
   III. Type AB
   IV. Type O
   (F) III only
   (G) I and III
   (H) II and III
   (J) III and IV
13. According to the passage, a person of blood type B– would have blood cells containing which of the following?
   I. Substance A
   II. Substance B
   III. Antibodies against substance A
   IV. Rh factor
   (A) I only
   (B) II only
   (C) II and III
   (D) II and IV

14. The passage implies that the practice of transfusing blood from one patient to another began
   (F) prior to the twentieth century.
   (G) after the work of Landsteiner.
   (H) when electrophoresis became widely available.
   (J) around the middle of the twentieth century.

15. It can be inferred from the passage that blood typing is useful to forensic scientists only in cases where
   (A) the crime victim’s blood is readily accessible.
   (B) the blood type of every potential suspect is previously known.
   (C) blood from the perpetrator is found at the crime scene.
   (D) a fresh sample of blood from the suspect is available.

16. At the time this passage was written, blood-typing as a crime-detection tool, by comparison with fingerprinting, was
   (F) less costly.
   (G) more precise.
   (H) less effective.
   (J) more widely used.

17. It can be inferred from the passage that electrophoresis resembles fingerprinting in that both
   (A) provide a form of negative identification in crime detection.
   (B) may be used to help identify those who were present at the time of a crime.
   (C) were developed by scientists at around the same time.
   (D) must be employed almost immediately after a crime to be effective.

18. The passage implies that electrophoresis may help scientists determine
   (F) whether or not a sample of blood could have come from a particular person.
   (G) the age and condition of a dried specimen of blood or other body fluid.
   (H) the means by which the victim of a violent crime was probably attacked.
   (J) the age, gender, and ethnic background of an unknown criminal suspect.

19. According to the passage, Wrexall’s refinement of electrophoresis led to
   (A) more accurate test results.
   (B) easier availability of fluid samples.
   (C) wider applicability of the tests.
   (D) more rapid testing.

20. According to the passage, all of the following may reduce the usefulness of a fluid sample for crime detection EXCEPT
   (F) the passage of time.
   (G) discoloration or staining.
   (H) exposure to heat.
   (J) exposure to contaminants.
1. The correct answer is (B). The first sentence of the passage announces this topic, and the whole passage sticks closely to it.

2. The correct answer is (F). The last three paragraphs of the passage discuss the influence of the impressionists on the choices of subject matter made by later artists; and, we are told, at the start of the last paragraph, “In this regard as in so many others, the impressionists were true precursors of twentieth-century painting.”

3. The correct answer is (D). The second paragraph of the passage expresses this idea: see the third sentence in particular (“The Impressionists, on the other hand, viewed light, not matter, as the ultimate visual reality”).

4. The correct answer is (G). The third and fourth paragraphs make this point clear, especially the first sentence of the fourth paragraph, which refers to “light ... reflected with varying intensity to the eye.”

5. The correct answer is (B). The first sentence of the third paragraph states this point explicitly.

6. The correct answer is (H). This scene is most similar to the typical impressionist scenes listed in the seventh paragraph. Choices (F) and (J) sound like typical subjects of the pre-impressionists (see paragraph 6), and the Campbell’s soup can, of course, is associated with Andy Warhol, six decades after the impressionists (paragraph 8).

7. The correct answer is (A). This summarizes the fifth paragraph, which explains how the impressionists excluded all ideas and most emotions from their art. If virtually all human feelings and thoughts are eliminated, the result is an extreme objectivity.

8. The correct answer is (G). This answer seems to best fit the list of typical impressionist subjects given in the fourth sentence of paragraph six.

9. The correct answer is (A). Helen of Troy, a heroine of Greek legend, would epitomize the kind of subject European painters in the eighteenth and early nineteenth centuries might have favored (according to paragraph 6).

10. The correct answer is (H). The fifth paragraph is the key. It tells us that the impressionists were not interested in the “meaning” of the things they painted—only in the pattern of light they created. Hence, the nature of the objects depicted is irrelevant.

11. The correct answer is (D). Refer to the sentence in which the word “hope” appears. It says that Pace wanted to “correlate” something in the environment with the incidence of cancer, which is the same idea paraphrased in choice (D).
12. The correct answer is (F). Since the workers were all exposed to asbestos on the job, it seems clear that their cancers were an example of an occupational cluster.

13. The correct answer is (B). The story told in the third paragraph involves a “low background rate” because the number of people in the general population who suffer from this kind of cancer is very small; it is a “fairly specific” cluster (according to the definition given in the second paragraph) because of the notable characteristic shared by all the victims—all had taken DES while pregnant.

14. The correct answer is (F). Paragraph four, from which this observation is taken, is devoted to describing the difficulties experts have in gathering and interpreting information about cancer clusters with suspected environmental causes.

15. The correct answer is (B). We’re told that health officials “discount” local suspicions because of the imprecision with which community members gather data. In other words, the officials are dubious about these suspicions.

16. The correct answer is (J). As the sentence says, “citizens tend to include cases that were diagnosed before the afflicted individuals moved into the neighborhood.”

17. The correct answer is (A). Read the sentence after the one in which the word “latency” is used; it explains exactly what is meant by this concept.

18. The correct answer is (H). The “gerrymandering” described in the passage involves community activists drawing boundaries to fit their preconceived ideas or wishes, just as a politician does when he draws an election district boundary to produce a particular electoral result.

19. The correct answer is (B). The sentence in which the word “caveats” appears refers to the previous paragraph, which describes the doubts the experts have about the work amateurs do in studying cancer clusters.

20. The correct answer is (H). This re-states the idea found in the very last sentence of the passage.

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**Exercise 2**

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

1. **The correct answer is** (A). The fourteenth and eighteenth paragraphs make this point: “It unsettles her; it’s very likely to upset her,” and “Now, don’t excite her after her supper.”

2. **The correct answer is** (G). Paragraph 12 provides good evidence for both points. Bertha “does not dare to” criticize Nanny’s handling of the baby, even indirectly; and we’re told that she feels “like the poor little girl in front of the rich little girl with the doll” when she sees Nanny with Little B. Later, she expresses unhappiness over the fact that her baby is “in another woman’s arms.” Clearly, Bertha is both a little jealous of Nanny and a little intimidated by her.
3. The correct answer is (C). Reread the third paragraph, which contains the metaphor being asked about. Bertha is frustrated over keeping her body “shut up in a case like a rare, rare fiddle” because she is eager to find some way of expressing the feeling of “bliss” she is experiencing.

4. The correct answer is (F). The key sentence is “How idiotic civilization is!” which makes it clear that Bertha restrains her emotions out of concern about the judgment “civilization” (i.e., society) would pass upon her if she expressed them openly.

5. The correct answer is (A). Bertha is clearly well-to-do (since she employs a nanny and, apparently, another servant—Mary, from paragraph four). Thus, the literal choice (B) cannot be correct. The rest of the scene between Bertha, Nanny, and Little B makes it clear that Bertha longs for a closer connection to her own child and that she and Nanny are subtly competing to “own” the baby.

6. The correct answer is (F). The exclamation “How absurd it was” is made in response to Nanny’s expression of concern that Little B will be “unsettled” or “upset” by Bertha.

7. The correct answer is (C). The sentence states that Nanny’s pursed lips indicate that Bertha “had come into the nursery at another wrong moment.” (Note the word “another,” which suggests that she is forever “intruding” into the nursery.) Clearly Bertha is somehow unwelcome in her own child’s room.

8. The correct answer is (J). Nanny is “triumphant” in the final sentence because she is able to send Bertha away (to answer the telephone) and can reclaim “her Little B.” As we’ve already seen, much of the passage deals with the subtle competition between these two women for the attention and love of the baby.

9. The correct answer is (B). The first two paragraphs of the passage describe this emotion rather fully. Both make it clear that the “bliss” Bertha feels is caused by no specific event but rather is something that happens “suddenly,” “turning the corner of your own street”—with no apparent explanation.

10. The correct answer is (F). The passage describes Bertha as overwhelmed by her own feelings, struggling to control her expression of her emotions, unable to refrain from “crying” out her wishes (though somewhat afraid to do so). The words “emotional and impulsive” seem appropriate to summarize Bertha’s personality—at least, on the day when this passage takes place.

11. The correct answer is (C). The first sentence of the second passage neatly summarizes its main theme. Note how virtually all of the ideas and details in the passage relate to the influence of the rivers on early Mesopotamian civilization.

12. The correct answer is (F). See the next-to-last sentence of the first paragraph, which says that people moved to the riverbanks as “the once-hospitable grasslands” turned into deserts.

13. The correct answer is (B). The third paragraph of the passage describes how the need for water-management systems encouraged cooperation among large groups of Mesopotamian villagers. Statement I is not supported by the passage, and Statement III is contradicted by the last sentence of the first paragraph.

14. The correct answer is (G). Nascent means “being born.” It is generally used figuratively, as it is here, to mean “newly emerging” or “taking shape.”
15. The correct answer is (D). See the first sentence of the fifth paragraph.

16. The correct answer is (H). See the fifth paragraph, which lists the items that the Mesopotamians imported. Clay tablets, we’re told there, were not imported goods; rather, they were made out of “mud from the river banks,” which of course was available locally.

17. The correct answer is (A). In the first paragraph, we’re told that the development of great civilizations in the Middle East began when the river valleys attracted “settlers armed with the newly developed techniques of agriculture.”

18. The correct answer is (J). This paragraph describes the archeological findings from the city of Uruk, from which “we derive our knowledge of this period” (i.e., the high point of Mesopotamian culture).

19. The correct answer is (D). The last sentence of the seventh paragraph summarizes the point: “a complex and advanced civilization was in place by the time these artifacts were created.” The great size of the Limestone Temple would support this idea because it suggests that the Mesopotamians were able to bring together large amounts of money, raw materials, talent, and power in order to complete so enormous a project.

20. The correct answer is (J). The last paragraph, where India and China are mentioned, is used to make the point that life along river valleys has played a crucial role in the development of civilization in many parts of the world.

Exercise 3


1. The correct answer is (C). The Englishwoman described in the anecdote feels that she has no need to consult the dictionary because she is as much of an authority on the proper use of language as any reference book. The author seems to agree with her.

2. The correct answer is (F). The first paragraph explains the mistaken attitude that most Americans have toward the “authority” of the dictionary, and the rest of the passage is devoted to explaining why it is wrong by showing the reader what the true function of the dictionary writer is.

3. The correct answer is (B). As the example (showing how the poet Keats used the word “pail” in a sentence) illustrates, the context collected by the dictionary editors is simply the sentence in which the word appears.

4. The correct answer is (J). Notice the second sentence of the third paragraph, in which the author mentions that his purpose is to explain what first-hand dictionary research is like. He then alludes to the Oxford English Dictionary as an example of a project for which such research was undertaken.
5. The correct answer is (B). The author draws a contrast between “the distant past” and “the immediate past.” Thus, he is using the word immediate to mean the opposite of distant—that is, “recent.”

6. The correct answer is (J). According to the author, dictionary editors strive to collect “every unusual or peculiar occurrence of a common word.” The context makes it clear that peculiar is being used here to mean “distinctive” or “special.”

7. The correct answer is (B). As you can see by rereading the last sentence of the sixth paragraph, the new meaning of “broadcast” came about as a result of the invention and popularity of radio. Therefore, the story illustrates how new technology may create the need for a new word meaning. (The example of the word “hood” in the very next paragraph illustrates the same point.)

8. The correct answer is (F). As the paragraph states, “new situations, new experiences . . . are always compelling us to give new uses to old words.” Therefore, a dictionary writer cannot predict how language will change and shouldn’t be expected to do so.

9. The correct answer is (C). The author quotes several sentences from an imaginary overheard conversation that illustrate the meaning of the word “oboe.” The anecdote shows how one might learn such a word by listening to a similar conversation. Although the author says that we learn words in this way “beginning at infancy,” this particular example doesn’t relate to infancy, since babies don’t normally talk about oboes; thus, choice (A) is wrong.

10. The correct answer is (G). The italicized sentence in the sixth paragraph states this very point. The other three answer choices are all stated in the first two paragraphs as elements of the mistaken attitude the author attributes to most Americans.

11. The correct answer is (C). The passage deals with the development and use of blood-typing as a crime-fighting tool; other aspects of blood-typing, such as its role in medical treatment, are mentioned only as side issues.

12. The correct answer is (F). A person of blood type AB has blood cells with both substance A and substance B on their surface. Thus, types A, B, and O would all react badly to AB blood, since they all contain some antibodies that would be triggered by it. Only type AB can safely receive an AB blood transfusion.

13. The correct answer is (C). Cells of blood type B– (B negative) would contain substance B and antibodies against substance A; they would not contain Rh factor (otherwise, they would be designated B+, as stated in paragraph 6).

14. The correct answer is (F). The parenthetical sentence in the fourth paragraph says that Landsteiner’s investigation into blood types was triggered by the “failure of many blood transfusions.” If this is so, then blood transfusion must have been a well-known practice prior to 1901, when Landsteiner made his major discovery.

15. The correct answer is (C). Since the object of the forensic scientist is to discover the perpetrator of a crime, blood-typing can only be useful when a sample of blood from the (presumed) criminal is found at the crime scene.
16. The correct answer is (H). The last sentence of the first paragraph makes it clear that, at the time the passage was written, fingerprinting was more useful in crime detection than blood-typing.

17. The correct answer is (B). Both fingerprinting and electrophoresis can be used as means of identifying the person who produced a given sample of blood, from which their presence at a crime scene may be inferred. Choice (A) is wrong because only fingerprinting is referred to in the passage as a “negative” form of identification (see paragraph 6).

18. The correct answer is (F). The ninth paragraph of the passage suggests this idea. The fact that electrophoresis can identify thousands of blood subgroups suggests that this method is capable of narrowing down the identity of a blood “donor” quite specifically.

19. The correct answer is (D). The last paragraph explains that Wrexall showed how “simultaneous analyses” could produce useful results within 24 hours—in other words, “more rapid testing.”

20. The correct answer is (G). All of the answer choices except choice (G) are explicitly mentioned somewhere in the passage.
ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment Reading Test? How well have you incorporated your new vocabulary into your test-taking behavior?

After you’ve corrected each exercise, find the number below. This will give you an idea of whether you still need improvement.

**SCORE KEY FOR EACH PRACTICE EXERCISE**

<table>
<thead>
<tr>
<th>Number</th>
<th>Correct Score</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5</td>
<td>Poor</td>
<td>Study Chapters 6 and 10 again. See “Additional Resources for Review” below.</td>
</tr>
<tr>
<td>6–8</td>
<td>Below average</td>
<td>Study problem areas in Chapters 6 and 10 again. See “Additional Resources for Review” below if you have time.</td>
</tr>
<tr>
<td>9–12</td>
<td>Average</td>
<td>Skim problem areas in Chapters 6 and 10 if you have time.</td>
</tr>
<tr>
<td>13–15</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
</tr>
<tr>
<td>16–20</td>
<td>Excellent</td>
<td>You’re ready for the ACT Assessment Reading Test.</td>
</tr>
</tbody>
</table>

**ADDITIONAL RESOURCES FOR REVIEW**

After reviewing this chapter and trying to apply your knowledge on additional practice exercises and tests, you might still want help in Reading. “Real” reading—of newspapers, magazines, journals, and books—is always helpful.
Science Reasoning Review

OVERVIEW

- Learn a simple method for using the “Scientific Method” to think like a scientist
- Review the basics of reading research summaries
- Understand how scientists compare conclusions
- Learn the basics of how to read conflicting viewpoints passages
- Review the scientific terms and concepts most likely to appear on the ACT Assessment test
- Practice your ACT Assessment Science Reasoning skills and review your performance

HOW TO READ TABLES, GRAPHS, AND CHARTS

When a scientist shares data, he or she faces the challenge of how to present the information in the best way. The presentation must describe the phenomenon being observed in unambiguous, concrete terms, usually involving numbers: How many? How large? How hot? How fast? How bright? and so on. In a well-designed, properly performed experiment, the data cannot be disputed, even when conclusions drawn from the data are. The presentation of data must also make it possible for experiments to be duplicated exactly (an important criterion for the acceptance of any new discovery or theory) and for variations or discrepancies to be quantified.

There are many ways to present data. One is to simply describe the separate points of information within a paragraph in a list-like fashion. However, a long list of numbers within a block of text is difficult to grasp; surrounded by words, the numbers lose their relationships to each other, making patterns and trends nearly impossible to observe. Also, if a specific number is sought, it cannot be easily found, except through reading the entire text.

A much better way of presenting numerical data is through a pictorial representation that’s largely non-verbal—the use of tables, graphs, and charts.
Suppose you wanted to present the mean distances of the solar system’s nine planets from the sun, as the distances relate to each planet’s orbital period (the time it takes for a planet to orbit the sun) and its orbital speed. You could begin a rather lengthy paragraph saying that Mercury is 36,000,000 miles from the sun, having an orbital period of 88 days, and an orbital speed of 29.75 miles per second. Venus is next closest, being 67,000,000 miles from the sun and having an orbital period of 225 days and an orbital speed of 21.76 miles per second. Earth is the third planet from the sun, a distance away of 93,000,000 miles, with an orbital period of 1 year and an orbital speed of 18.51 miles per second. Mars is next, being 141,000,000 miles from the sun, with an orbital period of 1 year and 323 days, and an orbital speed of 14.99 miles per second . . . and so on. Even though in this instance the relationships here are fairly obvious, the information is neither immediately apparent nor readily accessible.

On the other hand, you could put all of the same information into a table. A table puts forth the data in a clear, easy-to-follow fashion, as well as makes the relationships between the variables very clear. See the following table.

<table>
<thead>
<tr>
<th>Mean Distance from the Sun (miles)</th>
<th>Orbital Period</th>
<th>Orbital Speed Planet (miles per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>36,000,000</td>
<td>29.75</td>
</tr>
<tr>
<td>Venus</td>
<td>67,000,000</td>
<td>21.76</td>
</tr>
<tr>
<td>Earth</td>
<td>93,000,000</td>
<td>18.51</td>
</tr>
<tr>
<td>Mars</td>
<td>141,000,000</td>
<td>1 yr. 323 days</td>
</tr>
<tr>
<td>Jupiter</td>
<td>480,000,000</td>
<td>12 years</td>
</tr>
<tr>
<td>Saturn</td>
<td>900,000,000</td>
<td>29.5 years</td>
</tr>
<tr>
<td>Uranus</td>
<td>1,800,000,000</td>
<td>84 years</td>
</tr>
<tr>
<td>Neptune</td>
<td>2,800,000,000</td>
<td>164 years</td>
</tr>
<tr>
<td>Pluto</td>
<td>3,600,000,000</td>
<td>247.7 years</td>
</tr>
</tbody>
</table>
The information as presented in the table is in a much more useful format than mere description. Rather than being forced to read through a paragraph to find one particular set of data—say, for Saturn—we can now find the values in which we are interested with a glance. We find the name Saturn in the left-most column and simply follow the row of information to find its distance from the sun (900,000,000 miles), its orbital period (29.5 years), and its orbital speed (5.99 miles per second). More importantly, information in a table reveals patterns, trends, and relationships between the different variables.

**Variables and Trends**

How do variables relate to each other? When one variable increases and the other increases, or when one variable decreases and the other decreases, we say that the relationship between the two variables is a *direct relationship*. When one variable increases and the other decreases, we say that the relationship between the two variables is an *inverse relationship*.

The table makes it fairly easy to see three relationships among the variables in the example. First, we can see that as a planet’s mean distance from the sun increases, its orbital period also *increases*. Second, we can see that as a planet’s mean distance from the sun increases, its orbital speed *decreases*. Finally, we can see that as the orbital speed decreases, the orbital period *increases*. So the table shows one direct relationship (mean distance and orbital period) and two inverse relationships (mean distance and orbital speed, as well as orbital period and orbital speed).

If the increase or decrease in one variable is proportional to the increase or decrease in another variable, the relationship is called a *proportional relationship*. This means that the ratio between two variables is constant. For example, if for every 50,000-mile increase from the sun, the orbital period increased 100 days, we could call this a proportional relationship. The ratio between the two variables is always the same.

**AN IN-DEPTH REVIEW OF GRAPHS**

Any series of numbers can be represented by a line. This is the basis of all graphs. When variables such as the corresponding sets of numbers from a table are plotted on a line, the trends and relationships become even more apparent than when those same numbers are in that table. See the following figure, which plots just the relationship between the distance from the sun and orbital speed.
Fig. 11.1

The relationship shown in this figure is an inverse relationship: As distance increases, speed decreases. However, it is not a proportional relationship. The relationship or ratio between the two variables changes. If the ratio were constant, we could connect the points on the graph and form a straight line. However, because in reality the line would be curved if we connected the points, the relationship is not proportional. The rate of decrease in orbital speed diminishes with distance from the sun. In other words, the farther away from the sun a planet is, the less its orbital speed is decreased from that of its neighbor nearer the sun—hence, the gradual “flattening out” of the curve as it moves toward the right side of the graph.

A common format of ACT Assessment questions is to give you a graph and to ask for results based on information not given on the graph. The answer can be easily calculated because, if a relationship between variables is proportional, you can extend the straight line indefinitely until the information “appears.”

Practically speaking, you can physically extend the line in the test booklet only so far. Fortunately, however, there’s a simple equation for calculating a straight line. This will enable you to predict what the dependent variable \( y \) will be, when the independent variable \( x \) is given. The formula is \( y = mx + b; \) \( x \) and \( y \) are the variables, \( m \) is the slope (the ratio or the simple linear relationship between the variables), and \( b \) is the \( y \)-intercept (the value of \( y \) when the value of \( x \) is zero). The \( y \)-intercept is often zero itself. (Look over the topic “Equations of Lines” in your Math Review if this is not familiar from coordinate geometry.)
Use this formula to predict results. The ACT Assessment question will give you one variable, which you put into the formula to produce the other variable.

Bar Graphs

There are many different types of graphs. Scientists generally use only two: bar graphs and line graphs. Bar graphs are good for making simple comparisons, such as comparing a single set of statistics (birth rates, for example) for different countries or different years.

Figure 11.2 shows the effect on the growth of six plants using water contaminated with a pollutant.

In Figure 11.2, each bar represents the growth of a different plant fed with a different concentration of a pollutant in water. The height of each bar represents the amount each plant grew.

This type of graph makes the differences in growth caused by varying the concentration of pollutant very clear. However, if the data were more complex, this graph would be more difficult to look at and understand. For example, if a hundred different pollutants were tested, the results would be too complex for a bar graph and still have recognizable trends.

![Figure 11.2](image-url)

**NOTE**

The formula for a straight line \((y = mx + b)\) calculates \(y\) when \(x\), the independent variable, is given. Sometimes, however, an ACT Assessment question might give you \(y\), the dependent variable, and ask you to calculate \(x\). Be careful to note which variable you’ve been given. If you’re given \(y\), you must rearrange the formula (beginning \(x = \)) for the answer to be in terms of \(x\).
Line Graphs

By contrast, line graphs can be both precise and intricate, even when multiple variables are measured. For this reason, line graphs are the kind of graph most often used by scientists.

For example, if a chemist was studying the effect of temperature on the solubility of several substances, the independent variable would be temperature, and the dependent variable would be solubility. With all other factors constant (such as the volume of the solvent, the pressure, etc.), any changes in the solubility of each substance clearly and unambiguously could be attributed to temperature. To document the experiment, a graph of the data would have temperature along the horizontal axis and the solubility on the vertical axis, as shown in Figure 11.3.

![Figure 11.3](image-url)

By noting the independent and dependent variables in this graph, we can tell that the question the graph is designed to answer is, “How does temperature affect the solubility of these four different substances?” After you know this, the specific details provided by the data—the answers to the ACT Assessment questions, in effect—are easy to look up if you need them.

Notice that the above figure has more than one line. Each line shows the solubility of a different solute, with the name of the solute next to the line. The lines could also have
been drawn using different colors or using different styles (dots, dashes, solid, wavy) to make the contrast between substances clearer. In that case, the grapher could have identified each line separately in a legend or key (such as used in the next example). Because the independent and dependent variables are the same for each solute—temperature and solubility—they can be placed on the same axes. Presenting all the lines on the same graph allows comparisons between substances to be made easily.

Whether bar or line, all properly designed graphs have axes clearly labeled with the names of the variables being studied and the units of measurement used (degrees, centimeters, percent, and so on). The divisions along the axes should be clearly numbered. All graphs should also have a title. Many graphs have a legend or key providing additional information about the graph or the data. The key is usually found in one corner of the graph or outside the limits of the graph altogether. A key is most often used when more than one line (or bar, or set of points) is plotted on one graph. See the example below:

![Graph Example]

**Fig. 11.4**

Because it would be otherwise impossible for the viewer to know what is meant by the data in such a case, different sets of data are distinguished from each other by using different colors or patterns for each line, bar, or set of points. The key explains to the viewer what each of the colors or patterns represents. Always be sure to examine all of these features carefully whenever you encounter a graph.

The structural features of a graph—the labels on the axes, the units of measurement, and any information in the key—are more important than the specific data presented. If you understand the structure of the graph, you’ll understand the kind of information it presents and the nature of the questions that the graph is designed to answer.

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Scatter Graphs

As we've seen, a line graph is created by plotting data points on graph paper (or by entering these points into a computer that creates the graph automatically). These points are then connected to create a line. If these points are not connected, the graph is called a scatter graph. This style of graph is often used when the points cannot be connected into a smooth line, perhaps because the relationship between the independent and dependent variables is complex or influenced by other, secondary factors.

For example, we know that, in a general way, a person's height and weight tend to vary together: NBA basketball players, who are usually very tall, usually weigh a lot as well, while professional jockeys are usually both short and light. But other factors (like diet) play a role in determining height and weight, and there are certainly exceptions to the general relationship: There are some people who are quite tall but very thin and some people who are short and fat. Thus, a graph depicting the height and weight data sets for twenty randomly chosen people would yield not a neat line, but rather a scattering of points that only roughly reflects a direct relationship between the two variables. An example of a scatter graph is shown in Figure 11.5.

![ Scatter Graph Example](image_url)

**Fig. 11.5**

It is sometimes difficult to interpret trends from a scatter graph. To help, a “best-fit” line can be drawn in (see Figure 11.6). The best-fit line is designed to lie as close as possible to each of the data points. Some points might lie right on the line, others might lie on either side of it, but in general all the points should come close to it.
Interpolation and Extrapolation

We mentioned previously that certain ACT Assessment questions might ask you to predict results given one of the variables. When data form a continuous line (that is, a smooth line, either straight or curved), it can be represented by an equation. When this is the case, you can “work backward” by using the equation to determine specific values. Thus, you can use such a line (or its equation) to get values for points beyond those that have been determined experimentally.

The name for this procedure is either interpolation or extrapolation, depending on where the new values lie. Interpolation is calculating a value between experimentally tested points. Extrapolation is calculating a value beyond experimentally tested points.

For example, from the bar graph we saw earlier in Figure 11.2, we can assume that if the concentration of pollutant had been 0.25 percent for a seventh plant, this plant would have grown 9 inches. Although this concentration wasn’t tested, the graph and its equation can be used to infer this result. And because the results of this seventh plant would fall between the results of the 0.0 percent concentration and the 0.5 percent concentration actually tested, calculating for this seventh plant is interpolation.

Another example of interpolation is shown in Figure 11.7. The known data points—that is, those points determined experimentally—lie on the curved line. Interpolation, again, is calculating a result that lies between points actually tested.
Similarly, the lines on graphs can be extended beyond the limits of the experimentally tested values. Extending the line in this way is called extrapolation (see Figure 11.8). This is part of the power of graphs.
**The Dangers of Extrapolation**

It's not always valid to make predictions by simply extending a trend line into infinity. Doing this makes the sometimes faulty assumption that the relationship will continue unchanged indefinitely. If the line shows the results of a carefully controlled laboratory experiment, for example, then the assumption is safer to make. But an observation of natural phenomenon might not always be predicted as easily. Sometimes a quantitative change somewhere “off the graph” produces a qualitative change, bringing new factors to bear that can dramatically alter an observed relationship at a particular point on the trend line.

Population growth is a classic example of the limitations of extrapolation. As long as the resources of food, water, and living space are plentiful, a population (whether human, animal, or plant) might continue to grow over time in accordance with predictable ratios, based on the number of offspring generated by each individual. Figure 11.9 graphs a theoretical line for projected population growth.
Fig. 11.9 Protected Population Growth

But because this isn’t a carefully controlled lab experiment, the same line in reality can’t be extended forever. At some point, resources will begin to be scarce; food, water, and even clean air might run out. Famine and disease will take their toll. Among humans, there will also be the important, though somewhat unpredictable, results of warfare and artificial contraception—birth control. In reality, the trend line could eventually take a dramatic turn, as shown in Figure 11.10 on the following page.
CHAPTER 11: Science Reasoning Review

Fig. 11.10 Actual Population Growth

So scientists must be cautious when extrapolating trend lines, which means that you should be cautious when answering questions about extrapolation. An intelligent assessment of limiting factors that could influence the trend must be part of any analysis that goes beyond what has been directly observed in nature or demonstrated in a laboratory.

Advantages and Disadvantages of Graphs

Graphs share with tables the advantage of making data points easily accessible. As we’ve seen, values can be found on one axis. By then tracing from the axis to the line and from this point on the line to the other axis, we can determine the corresponding value on the other axis. The superiority of the graph over the table lies in its clear visual representation of a trend, tendency, or underlying relationship. When there is no such trend or relationship, then a table of values is probably more useful and appropriate than a graph.

As an example, perhaps someone studied the relationship between height and ACT Assessment scores. Because there’s no tendency for taller (or shorter) people to score higher (or lower) on the ACT Assessment, there’s no true trend line here—just a bunch of random points, which, when connected, produce no coherent shape. The resulting graph might look something like the one shown in Figure 11.11, with the experimental results literally “all over the map.” In other words, there’s no clear relationship between
the independent and dependent variables. This data would be more meaningful if presented in table form.

![Graph showing data points and lines.](image)

**Fig. 11.11**

Although graphs and tables each have their place in the representation of data, graphs have some basic advantages. Lines and patterns are easier to remember than numbers and are capable of catching the eye and stimulating the imagination. Many people do not respond to numbers but have an immediate response to pictures.

Also, graphs can condense a large amount of information into a small space. If the experiment of the plants watered with a pollutant had been conducted using hundreds of different concentrations and the results listed in a table, the table containing all those values would have to be hundreds of lines long. But all the concentrations could be represented on a single line graph no larger than any of those we’ve already seen.

Now, how about the disadvantages of presenting information in graphs? A major disadvantage of graphs is that they can be less accurate than the numbers they represent. One reason is that values are sometimes rounded, either to make plotting easier or (a little less honestly) to better fit the pattern that the scientist has found—or hoped to find. The condensation of data, just described as an advantage, can also lead to imprecision. When a single graph is used to illustrate hundreds of thousands of individual pieces of data, any one case, or handful of cases, will be hard to pick out.

Graphs are also subject to subtle manipulation. One way of doing this is by adjusting the scale of values or the *baseline* of the graph. The baseline is the line
from which any increase or decrease in a variable is measured. To see this manipulation in action, look at the two graphs shown in Figures 11.12 and 11.13. The baseline forms, literally, the “bottom line” of the graph and usually has a value of zero, as in the top graph in the figure. However, sometimes the baseline is set at a different value, as shown in the bottom graph.

**Fig. 11.12**

**Fig. 11.13**

**ALERT!**

The data in graphs should always be carefully examined. Don’t attribute too much significance to the patterns or trends you observe on a graph before you also consider the underlying numerical data, units of measurement, baseline, and so on.
In the second graph, the baseline has been shifted up to emphasize the decline in the value of the dependent variable. The drop from 70 to around 52, which is noticeable but modest in the first graph, appears dramatic in the second graph. Such manipulation can be completely innocent, intending to make the data easier to read, for example, or to highlight crucial variations. However, an adjustment like this can also emphasize certain features of the data, sometimes in a misleading manner. If the variable in these graphs represented, for example, the quantity of air pollutants being produced by a certain factory, the company managing the factory would probably prefer having the second graph published in the local newspaper, because it makes the decline in emissions appear to be so much greater.

Honest scientists do not intentionally present data in a false or misleading way. Sometimes, though, because they have such a good idea of the effect they hope to demonstrate even before they examine the data, scientists will emphasize certain portions of the data or certain trends without fully realizing what they are doing. Similarly, journalists, social and political activists, and others with biased opinions also have been known to deliberately manipulate graphic presentations to force a particular conclusion.

A SIMPLE GUIDE TO THE SCIENTIFIC METHOD

Mere mention of “the scientific method” makes some people feel as if they have the most illogical minds in the world, with no ability to follow the step-by-step analytical process used by scientists. How to proceed from hypothesis to theory (never mind how to get a hypothesis in the first place) is mysterious, uncomfortable, and totally beyond the “normal” person.

Well, scientists are “normal” too, and the scientific method is nothing more than a highly formalized procedure for applying common sense. At its heart, the scientific method itself is very simple: identify a problem or phenomenon, collect information about it, form a hypothesis about it, and test the hypothesis.

Understanding a few points that go into scientific thinking is necessary before moving on to the next two types of ACT Assessment Science Reasoning questions, Research Summary passages and Conflicting Viewpoints passages.

Inductive and Deductive Reasoning

Scientists employ two types of logic to explain the natural and physical world, known as inductive and deductive reasoning.

*Inductive reasoning* moves from the specific to the general. Scientists do this when they use data from experiments or observations as the basis for a more general theory. Gregor Mendel (1822–84) developed his theory of genetics based on his observations on many generations of pea plants. Mendel collected extensive data regarding the charac-
teristics of more than 28,000 of these plants and the ways in which those characteristics were transmitted from one generation to the next, with particular traits emerging as dominant and others receding in importance over time.

Needing a way to explain what he saw, Mendel was able to find certain statistical relationships among the data he collected, from which he determined that independent units of heredity, now called genes, formed the basis by which traits were continually recombined from one generation to the next. Mendel’s mental leap from specific observation to a general theory that explained those observations was a classic example of inductive reasoning.

**Deductive reasoning**, on the other hand, involves applying general laws to specific cases. Scientists do this when they use existing theories to explain experimental results or observations. Suppose a scientist observed that a particular characteristic in humans—for example, the hereditary condition known as sickle-cell anemia—was transmitted from one generation to the next following the same statistical relationships that Mendel observed in his pea plants. This scientist could use deduction to determine that Mendel’s Laws of Heredity apply to the inheritance of the sickle-cell trait and on this basis make specific predictions about who is or is not likely to develop the disease.

Induction and deduction, in combination, form the underpinnings of the scientific method. As you’ll see, both processes are involved in the development of a scientific theory.

**Starting with a Hypothesis**

The scientific method, in simple terms, involves first forming a hypothesis and then testing that hypothesis through observation, experimentation, and/or prediction.

A hypothesis is a tentative explanation for some natural phenomenon, one which has not been tested or verified in any way. Think of a hypothesis as an educated guess about why something happens or about the nature of the relationship between two or more variables. Nearly all scientific research starts with a hypothesis.

On reflection, you might think it odd to start with a proposed explanation. Why not simply gather data at random first and wait until later to develop a hypothesis? Forming a hypothesis first sets out a clear direction and goal for the subsequent observations and experiments. It also forces the scientist to think at length about what factors are likely to be influential and what scientific elements are involved.

Starting with a poor hypothesis usually leads to time-wasting, dead-end experiments. A good hypothesis must pass certain tests. Generally, it must fit into the totality of the existing scientific framework. A hypothesis that runs contrary to the current body of scientific thinking is unlikely to gain favor in the scientific community, unlikely even to be examined, debated, or tested. This is because the theorems and laws in all the
branches of science are highly interdependent. If a new hypothesis is based on the assumption that some major element in the dominant world view of science is wrong, it’s likely that many other elements must be assumed to be wrong as well. Most scientists would consider this both unlikely and too difficult to be worth testing.

Because much of what we believe today about the natural world has been demonstrated over time by extensive experimentation and a generally consistent body of observations, scientists are reluctant to accept a hypothesis that would require either a drastic rethinking of basic scientific principles or a wholesale junking of previously observed results. This helps to explain, for example, why few serious scientists are interested in experiments to test the existence of psychic phenomena (ESP, telekinesis, clairvoyance, and so forth). There is so much evidence, experience, and theory suggesting the physical impossibility of these phenomena that it seems to be a waste of precious limited resources to invest time and effort in studying them.

Nonetheless, it is true that hypotheses, which dramatically diverge from the common body of knowledge, will occasionally be proven true through experimentation or observation. Darwin’s Theory of Evolution and Einstein’s Theory of Relativity are two examples. Both were revolutionary in that they forced scientists to rethink certain basic assumptions they had previously taken for granted—the immutability of species in the case of Darwin and traditional ideas about the nature of gravity, matter, and energy in the case of Einstein. Such theories are rare, but they are integral to scientific advancement.

Another requirement for a good hypothesis is that it may not disagree with any observed phenomena. Furthermore, anything that can be deduced logically from the hypothesis also may not disagree with any observable phenomena. This test can often be used to rule out an incorrect hypothesis before any experimentation is done. Galileo (1564–1642), the Italian physicist and astronomer, used this test when attempting to form a hypothesis regarding the motion of falling bodies. He had initially hypothesized that the speed of a falling body would be proportional to the distance the body traveled; in other words, the greater the height from which an object fell, the faster it would fall. However, a logical deduction from this hypothesis was that the time required for two objects to fall different distances would be the same, which is contradicted by actual observation of falling objects. Thus, Galileo was able to eliminate this as a working hypothesis.

Testing a Hypothesis

After a good hypothesis has been chosen, the next step is to test the hypothesis through experiment, observation, and/or prediction. The method(s) to be used will depend on the nature of the hypothesis. Mendel was able to perform genetic experiments using pea plants because of their short life cycle, which made it possible to study many generations of plants in just a few years. Similar experiments in human genetics are impossible, because of the length of human generations and because of ethical and moral considerations.
In some fields of science, prediction is the crucial test of a hypothesis. The Copernican model of the solar system (with the sun at its center) was largely confirmed because of its success in predicting such phenomena as eclipses. Similarly, Einstein’s General Theory of Relativity was strongly supported in 1919 when, during a solar eclipse, starlight was observed to bend in the vicinity of the sun in a manner predicted by Einstein.

The Basics of Experimental Design

Modern scientific observation and experimentation are generally very rigorous, strictly ordered, and highly accurate. To achieve this, it is important that experiments be well designed, carefully executed, and precisely documented. The experimental methods and techniques must be consistent and clear. An experiment’s crucial goals are objectivity and reproducibility.

Objectivity refers to the need to design an experiment so as to eliminate the effects of personal bias on the part of any experimenter or of anyone who participates in analyzing the resulting data. Bias need not be conscious; in fact, the most insidious and difficult-to-eliminate forms of bias are so subtle that the experimenter is unaware they exist. For example, even if the experimenter has no “preference” for a particular outcome to an experiment, he or she might unconsciously hope merely that the experiment will yield results that are clear and “interesting.” A bias as slight as this might influence how an experimenter “reads” the results, producing slight errors in the observation or recording of data that, cumulatively, might have a major impact on the accuracy of the research.

To reduce or eliminate such bias, experiments are often designed to be “blind.” In a blind experiment, the experimenter is prevented from knowing which test subjects represent the variable and which represent the control. For example, suppose an experiment is being performed to test the effect of a new drug on laboratory rats. The new drug will be placed in the food of the test group but not in the food of the control group. If this experiment were blind, then the experimenter would have no knowledge about which rat is being fed the drug until after all the data has been collected. By doing this, the experimenter will have no way of knowing what results to expect from each individual rat.

Blind experiments are especially common in research involving human subjects. Such experiments are often designed to be “double blind,” meaning that neither the experimenter nor the subjects know who represents the control group. If a new drug was tested on people, the test group would receive a pill containing the drug, and the control group would receive a pill containing no active ingredients (known as a placebo), but all subjects would believe that they were receiving the new drug.

Besides the experimental design, the experimental protocol, or written procedure to be followed in conducting the experiment, must be carefully planned so as to remove any opportunity for experimental bias to affect the results. For example, decisions as to the timing of steps in the experiment, the selection of subjects, and other methodologies
must not be left to the discretion of the experimenter but must be deliberately
determined. For example, if an experimenter needed seedlings from a nursery, he
or she might arbitrarily choose “a representative sampling”; in truth, however, the
experimenter might consciously or unconsciously choose very healthy or very sickly
plants, whichever would help prove the particular hypothesis. Experimental protocol,
written beforehand, would eliminate this flaw by instituting a random selection
process: Every tenth seedling would be chosen for the experiment.

The second crucial goal in experimental design is reproducibility. Reproducibility means
that an experiment must be capable of being reproduced exactly so as to test the validity
of the results. One hallmark of scientific knowledge is that, within specified parameters,
it is broadly and generally applicable. Subject to specified conditions such as air pressure,
pure water will boil at exactly the same temperature everywhere in the world.

Several years ago, some scientists claimed to have successfully produced the phenomenon
known as “cold fusion.” If true, this would have been an epochal scientific discovery
with enormous practical implications; fusion is a powerful energy source, and cold
fusion (i.e., fusion at a temperature close to normal room temperature) would have the
potential of being an incredibly cheap, virtually unlimited form of energy. The excitement
quickly turned to disappointment and anger when the scientists’ description of
their experiments proved to be too vague to be reproducible, and attempts to duplicate
their work failed to yield any noteworthy amount of energy. It was understood that
reproducibility was the crucial test of the significance of these remarkable claims—and
they failed.

Generally speaking, the more reproducible the experiment, the more likely the results
are to be accepted by the scientific community at large and, in time, integrated into the
scientific canon. However, each branch of science has its own acceptable level of
reproducibility. In the social and psychological sciences, “human factors” are so
pervasive—indeed, they are the very subject matter of these sciences—that true
reproducibility and universality of results is almost never achieved.

WHAT YOU NEED TO KNOW ABOUT VARIABLES

Nearly all experiments are designed with certain elements in common. Two of these
basic elements are the independent and dependent variables.

The independent variable is so named because it is adjusted independently of other
factors. Usually the independent variable is controlled by the experimenter, although
there are many instances in which it is not under any control and may only be observed.
A planet’s distance from the sun in the first table in this chapter is an obvious example.
In any case, it’s desirable to have one and only one independent variable in a given
experiment. Experiments with two or more independent variables are harder to
reproduce. It’s also difficult to draw reliable conclusions from them because it’s usually
impossible to determine with certainty the relative importance of each variable—or the unpredictable ways that two or more variables might affect each other. Ideally, scientists need to be able to account for all the phenomena they observe, or else they cannot say for sure why changes occur.

**The Role of the Control**

Another element used in nearly all experiments is the control. The control is an experimental subject for which all the relevant variables, including the independent variable, are held constant. Because the independent variable is held constant, any changes observed in the control must be caused by other factors. These changes can then be accounted for throughout the rest of the experiment.

For example, in testing a new experimental therapy for AIDS, researchers might study two groups of patients: a group receiving the new treatment and a control group that is not receiving the new treatment. It would be important to match the two groups as closely as possible in every other way. The average age, the severity of AIDS symptoms, and the nature of any other health problems suffered should be as similar as possible in both groups. If this is done, and if the experimental group shows a markedly better rate of recovery than the control group, it would be reasonably good evidence that the improvement is due to the new therapy rather than any other factor.

**HOW TO READ RESEARCH SUMMARIES**

Having reviewed the steps of the scientific method and what goes into solid experimental design, you’re now ready to look at the way Research Summaries will be presented on the ACT Assessment test and what to look for in a passage so as to be able to answer the questions. Read the sample below:

*Enzymes* are special proteins that act as catalysts to speed up chemical reactions in cells. Enzymes catalyze reactions by first having their active site bind to its substrate, usually the molecule that is undergoing reaction. The ability of an enzyme to bind substrate is called its activity. Thus, activity is also a measure of how well an enzyme catalyzes a reaction. The active site of an enzyme is very specific for its substrate. This specificity is created by the three-dimensional shape of the enzyme. However, this three-dimensional shape is dependent upon environmental factors, such as temperature and pH, a measure of acidity.

If the shape of the enzyme is changed, the enzyme might no longer be able to bind to its substrate. In this case, the enzyme is said to be *denatured*. Extremes of either temperature or pH can cause enzymes to denature.

A scientist isolated three enzymes from a mammalian cell. These enzymes will be denoted Enzyme A, Enzyme B, and Enzyme C.
**Experiment 1**

A scientist placed samples of Enzyme A into twelve different tubes. Each tube contained a buffer solution at a different pH such that the first tube was at pH = 1, the second tube at pH = 2, the third tube at pH = 3, and so on up to the twelfth tube, which was at pH = 12. The scientist then added an indicator that would turn the solution yellow if bound by the enzyme. Thus, the solution would turn more yellow when more indicator was bound. The temperature for all the tubes was 25°C. This procedure was repeated for Enzyme B and Enzyme C. The scientist was then able to create the following graph:

![Graph of Enzyme Activity vs. pH](image)

**Experiment 2**

A sample of Enzyme A was placed into a single tube containing a buffer solution at the pH that gave the greatest activity in Experiment 1. The tube was then brought to near freezing, and a sample was taken and tested for activity by addition of the same indicator above. The tube was then gradually warmed, with samples taken every 5 degrees and tested for activity. The process was repeated for Enzyme B and Enzyme C. The scientist was then able to create the graph on the following page.
Five terms are defined within the first experiment: enzyme, substrate, activity, denaturation, and pH. An enzyme catalyzes reactions; that is, it speeds them up. The reactant that the enzyme catalyzes is the substrate. Activity, in the special sense in which the word is used here, is the ability of an enzyme to bind substrate. To denature is to change the three-dimensional shape of an enzyme in such a way that it is no longer able to bind to its substrate. And finally, pH is a measure of the acidity of a substance.

The first paragraph explains that certain relationships exist among these five terms. If the three-dimensional shape of the enzyme is changed, then the ability of the enzyme to bind the substrate is lessened. If the enzyme’s ability to bind the substrate is lessened, then its ability to catalyze the reaction (i.e., activity) is lessened. Therefore, there is a relationship between the three-dimensional shape of the enzyme and its activity. Furthermore, we learn that, in certain circumstances, there is a relationship between the three-dimensional shape and temperature and between the three-dimensional shape and pH.

In both experiments, the scientist is observing the enzyme’s activity. We know this by combining the information in the first paragraph of the passage with the description of the two experimental protocols. Activity, we’ve seen, is defined as the ability to bind substrate. In both experiments, the degree of yellow in the solution is used to measure how much enzyme binds the indicator; thus, the degree of yellow indicates the enzyme’s activity. The activity, then, is the dependent variable. In Experiment 1, the independent variable is pH. In Experiment 2, the independent variable is temperature.

What is the hypothesis for each experiment? You’ll notice that none is given. The hypothesis is implicit in the independent and dependent variables being tested and the relationships among the various elements in the experiment. This is how the Research
Summaries will be set up, so you must train yourself to look at an experiment and determine the hypothesis yourself.

In Experiment 1, because the scientist is measuring the effect of varying levels of pH on enzyme activity, we can infer that the hypothesis being tested here is the following: *The activity of Enzymes A, B, and C is dependent to a greater or lesser extent upon the pH level of the surrounding solution.*

In Experiment 2, the scientist is hypothesizing as follows: *The activity of Enzymes A, B, and C is dependent to a greater or lesser extent upon the temperature of the surrounding solution.*

Because pH and temperature are the independent variables of their respective experiments, in the first graph, pH appears on the horizontal or x-axis, and in the second graph, temperature appears on the horizontal or x-axis. In both experiments, enzyme activity is the dependent variable and appears on the vertical or y-axis.

**What are the results of the experiments?** The first graph shows that each enzyme shows the tendency first to increase in activity as pH rises, then to decrease in activity as pH rises further. Thus, each enzyme has a pH at which it displays maximum activity. This differs for each enzyme. For Enzyme A, the pH at which maximum activity occurs is around 2; for Enzyme B, it is around 6; for Enzyme C, it is around 10. The second graph shows that each enzyme has the tendency to slowly increase in activity as temperature rises. This increase eventually levels out, and the enzyme activity is stable over a range of temperatures. Then it suddenly drops off, quickly falling to no activity. The temperatures at which the enzyme activity rises and suddenly falls differ from enzyme to enzyme. In addition, Enzymes A and B attain a markedly higher level of activity than Enzyme C.

**How are the two graphs similar and different? Does the information in each graph support the other?** The graphs are similar in that they both present data regarding the activity levels of the same three enzymes (A, B, and C). However, the independent variable is different in each. There is no direct relationship between the two graphs; each shows the effect of enzyme activity on a different key variable. Therefore, the graphs do not support or contradict each other because each shows activity as a function of a different variable.

**UNDERSTANDING HOW SCIENTISTS COMPARE CONCLUSIONS**

Earlier, we said that data, if compiled and recorded accurately, cannot be disputed, but the conclusions drawn from data can be. Scientists often disagree with the conclusions of their peers. The level of disagreement varies from time and time and sometimes even between the different branches of science. This represents the third type of passage you’ll see on the Science Reasoning Test. You’ll be tested on your ability to understand and compare the conflicting viewpoints.

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Currently, for example, the field of paleontology (the study of ancient life, as recorded in fossil remains) is one in which disagreement even about fairly fundamental matters is frequent. The origins of the human species are still hotly debated, and each new discovery seems to create a new controversy. In this case, one cause of the debate lies in the fact that the data (the fossils) can be interpreted in a variety of ways. And because of the random destruction wrought by time, and the inaccessibility of many fossils, there are also many gaps in the fossil record that can be filled at present only by speculation and educated guesses.

By contrast, there is currently relatively little debate about fundamental principles among chemists. This is because the field of chemistry as presently conceived appears to be fairly complete. Almost every new discovery can be explained in a way that agrees with the current body of knowledge. Only on the rare occasion when a new discovery seems to disagree with previous theories or ideas do chemists sometimes argue.

However, this isn’t to suggest that everything that can be known about chemistry is known. On occasion, a particular field, which appears to be a more or less settled body of knowledge, is revolutionized by a new theory or a dramatic series of discoveries. For example, the field of earth science had been relatively calm for almost two centuries until the 1960s when the new theory of plate tectonics exploded onto the scene. Then earth science became a hotbed of scientific controversy. Perhaps a similar upheaval might someday shake the virtual unanimity that chemistry enjoys today.

The Scientific View of Complex Systems

Sometimes different conclusions are possible when scientists examine a complex system in which there are several interrelated variables. Because of the complexity of living systems—referring not only to individual creatures but also to the interconnected webs of life that make up an ecological system—there is often disagreement among biologists concerning cause and effect, the forces behind ecological change, and so on. Biological complexity is difficult to eliminate even under experimental conditions because eliminating variables often upsets the equilibrium of the system. As a result, ecologists often argue. The different conclusions they draw about the systems they study might all be logically correct and consistent with the data. The differences are due to the fact that different ecologists will give different weights to the same complexly interconnected variables.

How Scientists Identify Significant Factors

When you think like a scientist in an effort to form a conclusion about the cause of some observed phenomenon, you must first decide what factors are important in the situation under scrutiny. When there are many different factors to consider, this might be difficult. The process of isolating the most significant factors is often best managed...
through gradual elimination of the unimportant or irrelevant factors. Consider the following situation:

Jane was walking to school one day in November when she noticed that about two dozen small orange fish, which she had previously seen swimming in the pond next to the school, were floating on top of the water, dead. Looking more closely, Jane could find no other sign of animal life in the pond, but she did observe that there were dozens of frogs on the lawn next to the pond. (She couldn’t recall noticing frogs near the pond before.)

The day was sunny and mild, but Jane knew that the previous night there had been a severe storm of rain mixed with sleet; the local temperature had plummeted below freezing for the first time that autumn. Jane also noticed that the Squmb River emptied into the pond. She knew that the Squmb River flowed past an operational nuclear power plant about 2 miles upstream. Jane went to school. Later that morning, when she happened to glance outside during history class, she saw the school’s custodian emptying yesterday’s lunch leftovers into the pond.

Here is a mystery. What caused the death of the fish in the pond? Let’s consider each element in the situation, beginning by eliminating all the factors which are unlikely to be relevant. Could the frogs somehow be responsible for the death of the fish? This seems implausible. Frogs are obviously not predators of fish. And although it is possible that the frogs and the fish might compete for some resources—they might both eat some of the same insects, for example—it seems unlikely that dozens of fish would die suddenly because the frogs managed to eat up all of their food. We can probably eliminate the frogs as a relevant factor in this case.

Next, consider the role that the weather could have played. It is possible that the sudden cold killed the fish. However, two factors make this unlikely. First, we know that water usually acts as an insulator; water temperatures change much more slowly than air temperatures, which is why the pond did not freeze overnight, despite the cold weather. (Remember, Jane saw the dead fish floating on the liquid surface of the pond.) The fact that the frogs are alive also tends to weaken this hypothesis. If the cold had killed the fish, it probably would have killed the frogs, too.

That leaves us with two other pieces of evidence: the existence of the nuclear power plant upstream and the dumping of cafeteria wastes in the water. It’s possible that either cause might have killed the fish, because either could have introduced some unhealthful chemicals into the pond. How could Jane determine which factor was responsible?

It would be pretty tough to set up experimental conditions, controlling for all but a single variable, in the real world, as in Jane’s pond. Thus, Jane would probably need to make an educated guess about the cause of the dead fish. Additional data could certainly be gathered. Jane could ask the custodian about the nature of the refuse he had dumped into the pond. His answer, if accurate, could help clarify whether any toxic substances were involved.
Jane could also conduct some research into the activities of the nuclear power plant. How recently did it begin operating? If the plant had been on line for several years, with the fish thriving until now, it would tend to weaken the argument that the plant is the cause of the fish’s demise. What pollutants, if any, are known to be emitted into the stream by the plant? Government records are likely to exist that might shed light on this question. Did any substantive change in the plant’s operations occur just prior to the death of the fish? If so, it could be relevant to an explanation.

As you can see, the mystery of the fish pond is unlikely to have an easy-to-find solution. Real-life scientific issues like this one generally lead to disagreements among researchers. However, disagreement is not necessarily a bad thing. Very often, disagreement spurs on research, as scientists in the different camps search for the proof that their theory is correct.

**HOW TO READ CONFLICTING VIEWPOINTS PASSAGES**

The mystery of the dead fish is just a simple example of possibly conflicting conclusions that might arise given the same data. Here is an ACT Assessment Conflicting Viewpoints passage, as well as what you should look for so as to be able to answer the questions. Read the sample below:

The origin of modern humans and the evolutionary path by which our ancestors first emerged has long been the subject of heated debate. Of particular interest is exactly where and when modern humans (Homo sapiens) evolved and the relationship between modern humans and so-called Neanderthal man (generally considered to be a primitive form of Homo sapiens). Three varying theories concerning these issues are presented below.

**Theory 1**

*Homo erectus* (a primitive ancestor of Homo sapiens—modern humans) evolved in Africa about 1.6 million years ago and soon after spread to all parts of the Old World. The Neanderthals and all other primitive forms of *Homo sapiens* then evolved from *Homo erectus*. In time, these primitive forms evolved into modern humans. This was the first proposed theory, based originally on fossil dating, which suggested a continuous time line leading, one by one, from *Homo erectus* to the various primitive forms (including Neanderthal) and, from these, on to modern humans. Since then, new fossil discoveries have been accounted for (with varying success) by using this theory.

**Theory 2**

*Homo erectus* evolved in Africa about 1.6 million years ago and soon spread to all parts of the Old World. Neanderthals are evolutionarily descended from those *Homo erectus* individuals that migrated to the Old World. However, the Neanderthals did not evolve into modern humans. Rather they represent a now-extinct side
branch on the evolutionary tree of the genus *Homo*. *Homo sapiens* evolved independently of Neanderthals in the Old World, eventually supplanted the Neanderthal population, and later evolved into modern humans. This is based on fossil evidence that suggests that the Neanderthals were too primitive (based primarily upon cranial measurements taken of fossilized skulls) to possibly have been ancestors of modern humans. However, the skulls of other early *Homo sapiens* show traits that seem to follow the evolutionary line to modern humans.

**Theory 3**

*Homo erectus* evolved in Africa about 1.6 million years ago and soon spread to all parts of the Old World. The Neanderthals are evolutionarily descended from those *Homo erectus* individuals that migrated to the Old World, as are the other primitive *Homo* forms, which were determined to be direct ancestors of *Homo sapiens* according to the evidence in Theory 2. However, according to this theory, modern humans actually evolved separately in Africa and did not spread to the rest of the world until about 90,000 years ago. This is based on evidence taken from mitochondrial DNA (DNA that resides in the mitochondria and that passes undisturbed from mother to child). Mitochondrial DNA suggests that all modern humans can trace their lineage to a single group of individuals living in southern Africa about 90,000 years ago.

As with all Conflicting Viewpoints passages, look for the assumptions beneath each theory. Theory 1 assumes that the *Homo sapiens* evolution must have been a continuous event, stemming from the first *Homo erectus* to enter the Old World. Theory 2 also assumes that *Homo sapiens* evolved from the *Homo erectus* population in the Old World. However, it assumes that the Neanderthals were too primitive to have been an ancestor of modern humans. Thus, there were two branches on the evolutionary tree. Theory 3 assumes that modern humans evolved in Africa and are not related to primitive *Homo sapiens* in the Old World, including Neanderthal. This assumes that there are three or more branches on the human evolutionary tree and that these evolutionary changes took place in drastically different places.

The three different theories rely on three different sources of evidence. Theory 1 cites the evidence of fossils with weight given to dating techniques. Theory 2 cites the evidence of fossils, but this time weight is given to features (mainly of skulls), not dating. Theory 3 cites the evidence of mitochondrial DNA.

Note the assumptions behind each theory and the evidence relied on by each theory. This will help you better understand the questions on this part of the Science Reasoning Test.
CHAPTER 11: Science Reasoning Review

SCIENTIFIC TERMS AND CONCEPTS MOST LIKELY TO BE ON YOUR ACT ASSESSMENT

The following terms and concepts have been chosen as those most likely to appear on the ACT Assessment Science Reasoning Test. The terms are drawn from the fields of biology, chemistry, earth sciences, and physics. The test-makers know you might not have studied a specific field—for example, physics. However, in the minimum two years of high school science you’ve presumably taken, you have probably been exposed to most of these words. You should have the broad background of scientific knowledge necessary to give you some understanding of the term when it’s put in the context of a Science Reasoning passage.

This list is a helpful way to refresh your memory of crucial science topics you’ve studied throughout your high school years. It’ll also highlight for you the topics or areas in which your background is strongest and weakest.

How to Use Your Scientific Terms List

Go down the list and check every word you don’t know or are hesitant about. If the following definition is not sufficient to jog your memory, you might want to review the relevant topics using your favorite science textbook or study guide. Because you tend to remember information you like, the terms have been broken down into the four fields of biology, chemistry, earth sciences, and physics. This way you can quickly pinpoint areas that need attention.

Assuming you’ve allowed yourself three months or more, work on about 10 minutes’ worth of words each day. If you wish, write the definition of each unfamiliar word into a notebook to make your own Scientific Terms journal.

Putting the definition in your journal will help you remember the word better when you see it again on the ACT Assessment.

Scientific Terms and Concepts Glossary

Chemistry

acid—a substance capable of donating hydrogen ions. This is called the Bronsted-Lowry definition. Alternately, the Lewis definition says that an acid is any species that accepts electron pairs. This definition is more general. Acids have a sharp, sour taste; vinegar is an example.

activation energy—the minimum energy required between two molecules for a reaction to occur.
atom—the smallest unit of an element, composed of electrons, protons, and neutrons, that still has all the properties of that element.

atomic mass—the average mass of the atoms of a given element. Atomic mass is measured in atomic mass units. One atomic mass unit has been set at one twelfth the mass of the carbon-12 atom.

Avogadro’s constant—the number of atoms in one mole of pure substance.

Avogadro’s number—the number of atoms in 12 grams of carbon-12, equal to $6.022 \times 10^{23}$. This constant is used in various chemical and physical calculations and formulas.

base—a substance capable of accepting hydrogen ions. This is known as the Bronsted-Lowry definition. (By corollary, bases dissolved in water increase the amount of hydroxide ion [OH$^-$.] Alternately, the Lewis definition says that a base is any species that donates lone-pair electrons. This definition is more general. Bases are slippery.

boiling point—the temperature at which the liquid and gas phases of a substance are in equilibrium.

buffer—a solution that maintains a constant pH despite the addition of small amounts of acid or base. A buffer is usually made by mixing a weak acid with its conjugate weak base.

calorie—the amount of heat required to raise one gram of water one °C. 1 calorie = 4.184 J.

catalyst—a substance that speeds up a chemical reaction. The catalyst itself is not a reactant and undergoes no chemical change.

chromatography—a method of fractionation in which a mobile phase containing the mixture to be separated is passed over a stationary phase that displays some affinity for the materials in the mobile phase. This affinity may be based upon polarity, size, or some form of reversible binding ability (such as between an enzyme and its substrate). The stationary phase must be carefully chosen so as to maximize the differences in affinity for the various substances in the mobile phase.

compound—a substance containing two or more elements.

concentration—the ratio between solute and solvent in a solution.

conservation of mass—the law that states that in every chemical reaction, there must be an equal quantity of matter before and after the reaction.

covalent bond—a bond formed between two atoms by the sharing of electrons.

crystal—a solid in which the particles are arranged in a repeating geometrical pattern.
**electron**—a negatively charged subatomic particle.

**empirical formula**—the chemical formula of a compound that shows the relative number of moles of each element in terms of the smallest integers. Thus, the empirical formula shows the ratio of elements within a compound.

**energy**—a property of matter that describes the ability to do work. Energy takes many forms, including potential energy and kinetic energy (see enthalpy).

**enthalpy**—a measurement of the energy of a system due to the movement of its particles. At constant pressure, the enthalpy change of a system is equal to the heat absorbed or released.

**entropy**—a measurement of the disorder of a system. A fundamental law is that the entropy of the universe is constantly increasing. However, in many reactions, the entropy is decreased (i.e., the system is more ordered after the reaction than before). (Biological systems tend to employ reactions that increase the order of the system. To do this, they must create more disorder in the surrounding environment. This is one of the reasons many reactions in biological systems require a great input of energy.)

**fractional distillation**—the separation of two or more components of a liquid solution on the basis of their different boiling points. This is done by repeated evaporation and recondensation of the components.

**fractionation**—the separation of a mixture into its parts.

**free energy**—the chemical potential energy of a chemical substance or system.

**functional group**—a group of atoms in a molecule (usually organic) that exhibit characteristic properties. Examples of functional groups commonly encountered are alcohols (–OH), aldehydes and ketones (–C=O; in ketones, this group is internal), carboxylic acid (–COOH), and amines (–NH₂).

**gas**—a phase of matter having no definite shape and a volume that is defined only by the size of the container. The gaseous phase is the most energetic phase for a given substance.

**heat**—the means by which energy is transferred from a hot object/substance to a colder object/substance.

**hydrogen bond**—the strong dipole-dipole interaction that forms between a hydrogen atom bonded to a strongly electronegative atom (such as oxygen) and a lone-pair electron on a nearby electronegative atom. Hydrogen bonds are very weak. (Millions of hydrogen bonds are constantly forming and unforming in a glass of water. These bonds are responsible for the special properties of water, such as its elevated boiling point.)
inhibitor—a substance that slows the rate of a reaction. There are three main types of inhibitors: competitive, uncompetitive, and mixed inhibitors.

ion—an atom or group of atoms that has gained or lost one or more electrons. This causes the atom or group of atoms to become either negatively or positively charged.

ionic bond—a bond formed through the attraction of two ions of opposite charge.

isomers—two forms of a chemical compound that have the same chemical formula but a different spatial configuration or structure.

liquid—a phase of matter in which a substance has no definite shape but has a definite volume. Matter in the liquid phase has a kinetic energy intermediate between that of mass in solid phase and mass in the gaseous phase.

lone-pair electrons—an unshared pair of electrons in the outermost orbital of an atom.

mass—the measure of the amount of matter.

matter—anything that has mass and takes up space.

melting point—the temperature at which the liquid and solid phases of a substance are in equilibrium.

molality—the number of moles of solute present per kilogram of solvent. Because one kilogram of water has a volume of one liter, molality is also the number of moles of solute present per liter of water, and the molality and molarity of such solutions are equal.

molarity—the number of moles of solute present per liter of solution.

mole—the amount of a substance consisting of Avogadro’s number of elementary particles (atoms or molecules). Therefore, one mole of any substance contains \(6.022 \times 10^{23}\) elementary particles.

molecule—the smallest particle of a substance that retains the chemical and physical properties of that substance and is composed of two or more atoms.

molecular formula—the chemical formula of a compound that specifies the actual number of atoms of each element in a compound.

molecular mass—the mass of a molecule, found by summing the atomic masses of each of the atoms within the molecule.

neutron—a neutrally charged subatomic particle.
nucleus—the small, positively charged center of an atom composed of protons and neutrons.

orbital—one of several spaces around the nucleus of an atom, each of which can be occupied by up to two electrons. All the electrons in a given orbital must have the same energy level, energy sublevel, and spatial orientation.

oxidation—the loss of electrons.

pH—a measure of the hydronium ion concentration in a solution. pH = –log[H₃O⁺].

polarity—asymmetrical charge distribution over a molecule. Such a molecule is called a dipole.

pressure—the force exerted by moving particles on a specified unit area. Thus, pressure may be expressed as pounds (the force) per square inch (the unit area).

proton—a positively charged subatomic particle.

reaction rate—the speed at which reactants are converted into products in a chemical reaction.

reduction—the gain of electrons.

salt—a compound consisting of the positive ion of a base and the negative ion of an acid.

solid—a phase of matter in which a substance has definite shape and volume. The atoms in a solid have the lowest kinetic energy of the three phases, because their molecules are relatively fixed in space.

solution—a homogeneous mixture of a solute and solvent. The solute is that which is dissolved in the solvent.

temperature—a measure of the average kinetic energy of molecules.

titration—a technique in which small amounts of an acid or base of known concentration and pH are added to a solution in order to determine the pH of the solution. By using an indicator or a pH meter, the experimenter can observe the change in pH caused by these additions, and from this data and from the known pH and volume of acid or base added, the pH of the solution can be determined.

van der Waals forces—weak forces of attraction between two molecules. These forces do not result in a bond. Rather, they represent the attraction of the electrons of one atom for the protons of another, in much the same way opposite poles of a magnet attract each other.
Biology

alternation of generations—the succession of haploid and diploid phases in a sexually reproducing organism. In most animals, only the gametes are in the haploid phase. In fungi, algae, and plants, the haploid phase may be the dominant phase, although in vascular plants the diploid is dominant.

amino acid—a compound made up of carbon, hydrogen, nitrogen, and oxygen and containing one of more than 20 different possible side groups. The general formula for amino acids is $\text{H}_2\text{N–CHR–COOH}$, where $R$ is the side group.

asexual reproduction—reproduction involving the cells of only one parent. As such, there is no fusion of nuclei and no transfer of genetic material. Thus, the offspring is genetically identical to the parent. There are five types of asexual reproduction: binary fission, budding, sporulation, regeneration, and vegetative reproduction.

autotroph—an organism that manufactures organic food from inorganic sources. Plants are autotrophs.

carbohydrate—a compound made up of carbon, hydrogen, and oxygen with the general formula $\text{C}_n(\text{H}_2\text{O})_m$. Carbohydrates are commonly known as sugars and are the primary sources of cellular energy. Examples of carbohydrates are starch and cellulose.

cell—the basic unit of organization in all living things. Any cell is surrounded by a plasma, or cell, membrane, which separates the interior environment from the exterior and regulates the passage of materials into and out of the cell. All cells also must contain the hereditary material of the cell and some structures capable of processing energy. There are two distinct types of cells: prokaryotic cells and eukaryotic cells.

chemosynthesis—the process by which chemical energy is trapped and converted into usable forms of energy. Nitrogen-fixing bacteria do this.

chromosome—a structure composed of DNA and protein that contains some or all of the genetic material of a cell.

circulation—the process by which materials are transported throughout the body. The circulatory system in humans consists of the blood vessels (arteries, veins, and capillaries) and the heart. This system is a closed circulatory system. Some lower animals, such as the hydra, have an open circulatory system.

diffusion—the process by which molecules pass across a porous membrane. Diffusion may be passive, in which case the molecules cross from the region of highest concentration to the region of lowest concentration, or either facilitated or active, in which cases the passage is helped in some way so as not to be entirely dependent upon the concentration.
**CHAPTER 11: Science Reasoning Review**

**digestion**—the process by which large, insoluble molecules are broken down into small, soluble molecules. Digestion may be intracellular or extracellular.

**DNA**—the fundamental hereditary material of all living organisms. George Watson and Francis Crick elucidated the double-stranded nature of the DNA molecule and the helix structure it assumes. DNA molecules make up the gene. DNA molecules are composed of nucleotides, which consist of a 5-carbon sugar (deoxyribose), a phosphate, and a nitrogen base. The nitrogen base determines the nucleic acid. In DNA, there are four types of nitrogen bases (adenine, thymine, guanine, and cytosine) and therefore four types of nucleic acids. These four bases also are the basis for the genetic code. Key to the continuation of life is the fact that DNA can reproduce with a high degree of accuracy.

**egestion**—the removal of undigested material.

**enzyme**—a protein that acts as a catalyst in chemical reactions. Enzymes have binding sites on their surface, which is generally where the reaction occurs.

**eukaryote**—an organism whose genetic material is contained within a nucleus. All life-forms other than viruses and bacteria are eukaryotes.

**evolution**—the process by which organisms change from generation to generation. Evolution is a gradual change involving random genetic mutations. Charles Darwin suggested that genetic mutations resulting in physiological changes will sometimes confer an advantage to the organism over its competitors. This advantage leads to natural selection, which is the driving force behind all evolutionary change.

**excretion**—the removal of cellular waste products from an organism.

**gene**—a unit of a chromosome that contains all the genetic information to create a single polypeptide or codes for a trait.

**genetics**—the study of heredity, founded by Gregor Mendel. There are three main laws in genetics that Mendel developed. The first is the Law of Dominance, which states that when organisms containing pure contrasting traits are crossed, only one of the traits will be expressed in the offspring. The trait that is expressed is the dominant trait; the trait not expressed is the recessive trait. The second law is the Law of Segregation, which states that alleles segregate during gamete formation and then recombine. The third law is the Law of Independent Assortment, which states that alleles on different genes assort independently during gamete formation.

**genotype**—the exact description of the genetic makeup of an organism.

**heterotroph**—an organism that obtains premade organic food from other sources. These organisms are unable to make organic food from inorganic sources. Animals are heterotrophs.

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**WORDS ON SCIENCE**

“Science is the most intimate school of resignation and humility, for it teaches us to bow before the seemingly most insignificant of facts.”

Miguel de Unamuno, *Tragic Sense of Life*, 1913.
homeostasis—the maintenance of a steady state.

ingestion—the process of taking in food.

lipid—a large, oily organic molecule composed of carbon, hydrogen, and oxygen, which functions as energy storage and insulation. Examples are fats, oils, and steroids. Lipids can be converted into twice the cellular energy of carbohydrates and are therefore used to store energy in the body.

meiosis—the process by which specialized reproductive cells in sexually reproducing organisms are created. These reproductive cells are called gametes, and they are special in that they are haploid (having only one set of chromosomes). Because normal cells are usually diploid (having two sets of chromosomes), meiosis involves the halving of the number of chromosomes. Meiosis occurs in two phases and results in four haploid cells.

metabolism—the process by which complex, high-energy compounds are broken down by organisms into usable forms of energy; includes catabolism and anabolism.

mitosis—the process of cell division in which the chromosomes replicate so that there are two exactly similar sets of genetic material in the cell. The cell then divides into two cells, with each cell taking one set of chromosomes. The result is two cells that are genetically identical.

nucleus—the centrally located chamber in eukaryotic cells that contains the chromosomes. It is bounded by a double membrane and is the information center of the cell.

nutrition—all the activities by which an organism obtains and processes materials necessary for energy, growth, reproduction, and regulation.

osmosis—the process by which water passes across a porous membrane. In osmosis, water will flow from a region with a low concentration of dissolved molecules to a region with a high concentration of dissolved molecules.

phenotype—the description of the observable traits in an organism. These traits are the result of the genetic makeup of the organism as well as environmental factors.

photosynthesis—the process by which visible light is trapped and converted into usable forms of energy. Plants and green algae do this. Photosynthesis occurs in two reactions, the light and dark reactions. A by-product of the light reaction is oxygen. Photosynthesis occurs in the chlorophyll of plants.

prokaryote—an organism whose genetic material is not contained within a nucleus, but rather free in the cytoplasm. This is the simplest form of cell. Bacteria and viruses are prokaryotes.
protein—a compound made up of many amino acids linked together end to end. Proteins are integral to building many structural features in the cell. Enzymes are also proteins.

regulation—the coordination and control of life activities. In all animals, regulation involves chemical control. In higher animals, regulation also involves nerve control.

reproduction—there are two types of reproduction, asexual and sexual. Asexual reproduction involves only one parent. There are three main types of asexual reproduction: fission, budding, and spore formation. Sexual reproduction involves two parent cells. If these cells are the same, then the joining of these cells is called conjugation. If these cells are different, then the joining of these cells is called fertilization.

respiration—the conversion of chemical energy in food by oxidation into forms that can be used to drive the chemical reactions essential to life. The two types of respiration are aerobic and anaerobic respiration.

RNA—the material through which the genetic information in DNA is converted into the proteins for which it codes. RNA has a different 5-carbon sugar (ribose), and instead of the nitrogen base thymine, it has uracil. RNA is single stranded. There are three main types of RNA: messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA).

sexual reproduction—reproduction in which the cells of two parents combine through the process of fertilization to produce a fertilized egg cell that develops into a new, genetically unique organism. During the process of fertilization, there is an exchange of genetic material that allows for genetic variation.

synthesis—the process by which materials necessary for energy, growth, reproduction, and regulation are made by an organism from energy sources obtained from the environment.

tissue—a group of similar cells that are organized into a single unit and that perform the same function. Tissue types in animals include epithelial (such as skin and the linings of the lungs, digestive tract, and blood vessels), muscle, nerve, connective/supportive, blood, and reproductive tissue. Tissues in animals group together to form organs. Tissue types in plants include conducting (xylem and phloem), growing, supporting, storage, and reproductive tissue.

transport—the process by which materials are absorbed and circulated throughout an organism.

vitamin—a compound that the body cannot synthesize for itself but that is necessary in small quantities for life functions. Vitamins come in a variety of structurally unrelated forms. Many vitamins work as co-enzymes (i.e., they are necessary to make certain enzymes active).

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asteroid—a large celestial body composed mostly of rock. Asteroids usually are under the influence of a star’s gravitational field but have larger, more eccentric orbits than planets.

atmosphere—the gaseous layer that envelops the earth. The thickness of the earth’s atmosphere is about 1,100 km. It consists of three layers: the troposphere, the stratosphere, and the mesosphere. The earth’s atmosphere is important in that it shields the earth from harmful radiation and excessive heat. It also prevents the earth from cooling too rapidly at night.

biosphere—the portion of the earth that supports life, including most of the hydrosphere, the lower portions of the atmosphere, and nearly all of the earth’s surface.

climate—all the characteristics of weather, including precipitation, temperature, and humidity, which a particular region experiences over a long period of time. The averages of all these factors constitute the climate for a particular place.

community—all the microorganisms, plants, and animals inhabiting a given location that interact and are ecologically integrated.

compression cementation—the process by which sediment is cemented together into sedimentary rock due to the large compression forces exerted by heavy layers of overlying material.

condensation—the changing of water from a gas to a liquid, involving the removal of heat from the water. The heat is then released into the atmosphere in the form of latent heat, so called because the temperature remains the same during this process.

conduction—the transfer of heat through solids. This occurs because, when a solid is heated, its atoms will move faster. Random collisions between these atoms and those neighboring will cause the neighboring atoms also to move faster. This process repeats until the heat has transferred across the solid.

convection—the transport of heat and moisture by the movement of a fluid.

crystallization—the process by which igneous rock is formed from molten magma.

depression—an area of low atmospheric pressure around which winds travel counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Depressions tend to occur when warm air meets cold air. Because the cold air is heavier than the warm air, the warm air rises above the cold, causing winds as well as cloud formation.

earthquake—a shifting of the rock layers of the earth’s crust, most commonly caused by either the movement of tectonic plates or the eruption of volcanoes. Earthquakes
emit two kinds of shock waves: P-waves and S-waves. P-waves travel through both liquids and solids, while S-waves travel only through solids.

**ecosystem**—all of the organisms of a particular habitat together with the environment in which they live.

**electromagnetic energy**—the energy exhibited by the earth due to its magnetic field.

**environment**—all of an organism's surroundings. This includes all of the species that influence the organism as well as temperature, humidity, light, and so on.

**erosion**—the physical process by which rocks are corroded and converted into other forms by the action of heat, cold, gases, water, wind, gravity, and plant life. The process of erosion is key to the formation of sedimentary rock and soil.

**evaporation**—the changing of water from a liquid to a gas. Heat must be added to the water in this process. (This is why your skin feels cooler when water evaporates from it.)

**galaxy**—a grouping of hundreds of millions of stars. All these stars interact gravitationally and orbit around a common center. The galaxy in which the earth exists is called the Milky Way galaxy.

**geocentric model**—the model of the solar system that sets the earth at the center of the solar system and has all of the celestial bodies rotating around the earth. This model is unnecessarily complicated and was eventually abandoned in favor of the heliocentric model.

**geomagnetism**—the magnetic phenomena exhibited by the earth and its atmosphere. The study of geomagnetism often centers on the study of the earth's gravitational field and the changes that occur in it.

**greenhouse effect**—the effect of atmospheric carbon dioxide, water, and other trace gases on the average temperature at the surface. This effect is caused by the absorption by these substances of energy radiated from the earth.

**heliocentric model**—the model of the solar system that has the sun at the center with the planets rotating around it. In this model, the apparent motion of the stars is explained by the rotation of the earth.

**hydrological cycle (water cycle)**—the cycle whose primary components are (1) the evaporation of moisture from the surface of the earth, due to the warming of the sun's rays; (2) the carrying of this moisture into higher levels of the atmosphere; (3) the condensation of water vapor into clouds; and (4) the return of water to the surface as precipitation.

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**WORDS ON SCIENCE**

“Everything in space obeys the laws of physics. If you know these laws, and obey them, space will treat you kindly.” Werner von Braun, *Time*, 1958.

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“It is the nature of a hypothesis, when once a man has conceived it, that it assimilate every thing to itself as proper nourishment, and, from the first moment of your begetting it, it generally grows the stronger by every thing you see, hear, read, or understand.” Lawrence Sterne, *Tristam Shandy*, 1759–67.
WORDS ON SCIENCE
“Science is the attempt to make the chaotic diversity of our sense-experience correspond to a logically uniform system of thought.”
Albert Einstein, Out of My Later Years, 1950.

hydrosphere—the layer of water on the surface of the earth. This includes all the oceans, as well as the rivers, lakes, etc. It is estimated to cover about 70.8 percent of the earth’s surface.

igneous rock—rock formed during the cooling and crystallization of a hot, molten fluid from the earth’s core, called magma. Igneous rock makes up more than 95 percent of the earth’s crust.

infiltration—the process by which water passes into the earth through the soil.

lithosphere—the layer of the earth’s crust composed of rock and extending for about 100 km below the surface. The lithosphere is composed of two shells, known as the crust and the upper mantle. These are in turn divided into tectonic plates. See Tectonic Plate Theory.

mantle and core—the heavy interior of the earth, which constitutes most of the earth’s mass. The core is composed of a molten layer surrounding a solid center. It is the source of much of the earth’s heat. The mantle, on the other hand, is solid and rigid.

metamorphic rock—rock formed by the process of metamorphism, which involves partial melting and recrystallization of sedimentary or igneous rock. An example is marble, which is caused by the metamorphosis of limestone.

metamorphism—a process of structural change in rocks induced by heat and pressure.

meteorology—the study of the earth’s atmosphere, specifically the day-to-day variations of weather conditions.

moon—a large celestial body travelling in orbit around a planet.

orbit—the path an object takes when travelling around a large body due to its gravitational force.

permeability—a measure of the rate at which water passes through particles. Permeability is dependant upon porosity, which is a measure of the amount of space between particles. Larger particles have a greater porosity and therefore a greater permeability.

planet—a large celestial body travelling in orbit around a star. There is currently much debate as to what exactly differentiates a planet from other large bodies in space, such as asteroids.

pollutant—any substance found in the environment in levels above that normally found and that may cause harm.

population—all the members of a species inhabiting a given location.
precipitation—the moisture that falls to the earth’s surface. Examples are rain, snow, sleet, and hail.

radiation—energy absorbed by the earth’s atmosphere from space. Most of the radiation we are subjected to comes from the sun, called insolation (short for incoming solar radiation).

runoff—the water that is unable to infiltrate the surface of the earth and thus runs down into streams, rivers, lakes, and so on.

satellite—any object that travels around a large body (such as a planet or a sun) due to the gravitational forces exerted by that body upon the object.

sedimentary rock—rock formed from the products of weathering on other rocks. This happens when water and carbon dioxide break up and dissolve small pieces of rock.

solar energy—the energy released by the sun in the form of light, heat, and other types of radiation.

star—a large celestial body composed of incandescent gases, largely hydrogen and helium. A star radiates energy created by internal nuclear fusion reactions, in which two lighter atoms are fused to create a single heavier atom and a release of energy. Thus, hydrogen nuclei are fused to create helium (a process called hydrogen burning), and then helium nuclei are fused to eventually create carbon (helium burning). As a result of these reactions, the density of a star is constantly increasing as it ages, and its increasingly powerful gravitational field constantly causes it to contract.

sublimation—the change from a solid to a gas without passing through the liquid phase.

sun—a star that has planets orbiting within its gravitational field.

system—a grouping of planets, all rotating around a star (sun) due to the gravitational forces exerted by it.

Tectonic Plate Theory—the theory that states that the tectonic plates of the earth’s crust and upper mantle move about, collide, and separate over time. Tectonic Plate Theory explains the relative positions of the continents and the formation of large mountain ranges such as the Himalayas, as well as natural phenomena such as earthquakes.

terrestrial radiation—the radiation of energy from the earth’s surface into space. This generally occurs at night when temperatures are cooler.

transpiration—the process by which plants release moisture to the atmosphere.
weather—the state of the atmosphere at a particular time and place. Elements of weather include temperature, humidity, cloudiness, precipitation, wind, and pressure.

Physics

acceleration—the rate of velocity change over a given period of time. This is given by the equation $a = \Delta v / \Delta t$. Because velocity is a component of acceleration, acceleration is a vector quantity (see vector).

amplitude—the distance from the crest or the trough to the center of a wave.

angular acceleration—the change in angular velocity.

angular velocity—velocity around a circular path.

centripetal acceleration—acceleration toward a central point. When bodies move in a circular motion, their velocity at any one time is tangential to the circle. Thus, for the body to continue to move circularly, the velocity must constantly be moving toward the center. Thus, it is accelerating toward the center. This acceleration is what accounts for centripetal force.

conductor—something through which electric charges may move. Conductors, however, vary in terms of how easily they allow charge to move through. This is because of resistance.

diffraction—the bending of waves caused when a wave encounters an opening that is the same size as its wavelength.

efficiency—as applied to an engine, the ratio of the net work done by the system to the heat added to the system at the higher temperature.

electric charge—a fundamental measure based upon the idea that the electron represents a negative charge. Charge is measured in coulombs, where one coulomb equals $6.25 \times 10^{18}$ electrons. Charge can either be negative or positive, depending upon whether it is likely to repel or attract electrons.

electric current—in a circuit, the amount of charge flowing past a certain point per unit of time. Current is represented by the letter $I$ and is measured in amperes or coulombs per unit time. Thus, $I = \frac{Q}{t}$, where $Q$ is charge.

electric field—that region in space in which a charge can experience an electric force. Electric fields can act to move charges from one point to another.

electric force—the force generated between charges as a result of the repulsive or attractive characteristics described in the Law of Electrostatics.

WORDS ON SCIENCE

“Science is nothing but trained and organized common sense.” Thomas Henry Huxley, The Method of Zadig, 1878.

“Science is the knowledge of consequences, and dependence of one fact upon another.” Thomas Hobbes, Leviathan, 1651.
**ele**

**magn**

**ic field**—the region in space in which a charge can experience a magnetic force. Magnetic fields flow out of the North Pole and into the South Pole.

**magnetism**—the property of a charge in motion, caused by the revolution of atoms around the nucleus of an atom. The direction of the magnetic effect is determined by the direction in which the electron spins around its axis.

**momentum**—the quantity of motion an object possesses, dependent upon the mass of the object and the velocity at which it travels. Thus, $p \ (\text{momentum}) = mv$. If two objects of unequal size are traveling at the same speed, the object with the greater mass has more momentum. Likewise, if two objects of equal size are traveling at different speeds, then the object with the greater speed has more momentum. Momentum is dependent upon velocity (a vector quantity) and is thus a vector quantity.

**period**—shortest length of time it takes a periodic motion to repeat.

**polarization**—the selective passage of waves that only vibrate in a particular plane.

**potential energy**—energy dependent upon relative position as opposed to motion. Potential energy is caused by gravity or elasticity. Thus, an object’s potential energy is dependent upon either its distance from the earth or the degree to which a coiled spring...
attached to the object has been stretched. Potential energy can be changed into kinetic energy either by dropping the object or releasing the spring.

**reflection**—the bouncing of a wave off a surface. Reflection of light is responsible for the formation of images in mirrors.

**refraction**—the bending of light as it passes from one medium to a second medium. Because different media will allow light to pass through at different speeds (i.e., different optical densities), there will be a change in velocity when light makes such a transition. This velocity change is responsible for refraction.

**resistance**—the opposition of current flow. When resistance occurs in a conductor, some of the kinetic energy from the moving particles is converted into heat.

**scalar**—a quantity that has magnitude but no direction. Examples of scalars are mass, length, time density, energy, and temperature.

**speed**—the distance traveled by a body over a given period of time. \( S \) (speed) = \( d/t \) (distance/time).

**thermodynamic efficiency**—the ideal efficiency an engine would have if it could be operated in a purely reversible fashion.

**torque**—the force that causes the rotation of a mass about a fixed point. Net torque changes an object’s angular momentum.

**vector**—a quantity that has both magnitude and direction. Examples of vectors are velocity, force, acceleration, momentum, electric field strength, and magnetic field strength. It is very important when describing vector quantities that both the magnitude and direction be described. The magnitude of force, for example, is important, but without knowing the direction of the force, we cannot know how the force acts on the body. Because vectors have direction, we must be able to quantify the directional qualities of a vector. This is done by breaking a vector into two components. These components are given by the formula: \( A_x = A \cos \theta \) and \( A_y = A \sin \theta \), where \( \theta \) is the angle at which the vector is traveling relative to its origin or the body on which it acts.

**velocity**—the combination of the magnitude of speed with its direction. Thus, the equation for the magnitude of velocity is the same as that for speed, \( dlt \). However, some direction must also be specified using the components found above (see vector).

**wave**—any disturbance that propagates through a material medium (mechanical waves) or space (electromagnetic waves).

**wavelength**—the distance between a point on a wave to the same point on the next wave.

**work**—done on an object whenever a force moves the object some distance. Work is the product of the force causing the motion and the distance the object moves, or \( W = F \Delta d \).
PRACTICE EXERCISES

You've just reviewed the most important points in science for success in taking the ACT Assessment Science Reasoning Test. The following exercises will help you to practice your new knowledge as well as to continue to familiarize yourself with the contents and format of the ACT Assessment.

There are three Science Reasoning Test exercises in this chapter. Each exercise contains two passages and no more than 12 questions and should be answered in 10 minutes. Do each exercise in one sitting in a quiet place, with no notes or reference material. Use a stopwatch or kitchen timer or have someone else watch the clock. When time is up, stop at once.

Score yourself only on those items you finished. When you're done, work through the rest of the exercise.

EXERCISES: THE ACT ASSESSMENT SCIENCE REASONING TEST

Exercise 1

12 Questions • Time—10 Minutes

Directions: This test consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question. You may NOT use a calculator on this test.

Passage 1

Environmental levels of the organic volatile chemical benzene are of concern to public health officials because studies have shown that continual exposure to high concentrations of this compound can cause leukemia. Organic volatile chemicals are carbon-containing compounds, which are easily vaporized and therefore are present in the air. Experiments to test for the presence of such chemicals were devised.

Experiment 1

Researchers outfitted individuals in urban, suburban, and rural areas with monitoring instruments that they could wear throughout the day. These instruments recorded the concentrations of benzene they were exposed to as they went about their normal activities. Other monitoring devices were used to record the benzene output of various known sources in the participants’ environment. The average percentage of total benzene that participants were exposed to from various sources as well as the average percentage of total output from these sources are given in Table 11.1.
TABLE 11.1

<table>
<thead>
<tr>
<th>Sources</th>
<th>% of total benzene emissions</th>
<th>% of total benzene exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Industry</td>
<td>15%</td>
<td>4%</td>
</tr>
<tr>
<td>Household sources (e.g., stored paints and gasoline)</td>
<td>4.5%</td>
<td>35%</td>
</tr>
<tr>
<td>Cigarettes</td>
<td>0.5%</td>
<td>41%</td>
</tr>
</tbody>
</table>

**Experiment 2**

The researchers decided to look at whether other volatile organic compounds were found in greater concentrations indoors or outdoors. Residents from two areas wore monitoring devices, which recorded the levels of a number of volatile organic compounds that they were exposed to during outdoor and indoor activities for several days. The first area was a highly industrial New Jersey city and the other was a rural township in Maine. The average exposure levels of residents in these areas are listed in Table 11.2.

<table>
<thead>
<tr>
<th>Volatile chemical</th>
<th>NJ Industrial (m/m³)</th>
<th>Maine Rural Township (µ/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>indoor</td>
<td>outdoor</td>
</tr>
<tr>
<td>Trichloroethane</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Chloroform</td>
<td>5</td>
<td>0.2</td>
</tr>
<tr>
<td>O-oxylene</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Styrene</td>
<td>5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Experiment 3**

Fine particles in the air, particularly breathable particles (those that are 10 microns or smaller and are able to penetrate into the lungs), are another environmental concern. Large population studies have suggested that elevated outdoor concentrations of fine particles are associated with premature death. Most fine particles form through processes of combustion, such as cooking, burning candles, smoking, or burning firewood. Researchers wanted to see what the total levels of such particles were indoors and outdoors and how these levels compared with an individual's exposure levels. Monitors that recorded levels of breathable particles were put inside and outside the homes of one individual from both of the communities in Experiment 2. These individuals were also asked to wear monitoring devices for one day and one night. The results from this experiment are shown in Table 11.3.
CHAPTER 11: Science Reasoning Review

TABLE 11.3

<table>
<thead>
<tr>
<th></th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Personal Exposure Levels µ/m³</td>
<td>Indoor Levels µ/m³</td>
</tr>
<tr>
<td>NJ Industrial City</td>
<td>152</td>
<td>98</td>
</tr>
<tr>
<td>Maine Rural Township</td>
<td>149</td>
<td>95</td>
</tr>
</tbody>
</table>

1. The results of Experiment 1 indicate that which of the following statements is true?
   (A) Automobiles and industrial pollution are not significant sources of benzene emissions.
   (B) The largest sources of benzene output were also the sources that caused the highest individual exposures.
   (C) Cigarettes caused more benzene exposure than any other source tested.
   (D) An individual’s highest exposure to benzene was more likely to occur indoors than outdoors.

2. One of the differences between Experiment 1 and Experiment 2 is that Experiment
   (F) 1 did not investigate a volatile compound.
   (G) 2 showed that people are exposed to higher levels of volatile organic compounds indoors, a finding that was contradicted by Experiment 1.
   (H) 1 looked at compound emission levels, while Experiment 2 looked only at compound exposure levels.
   (J) 2 looked at the average compound exposure levels from a pool of data, while Experiment 1 looked at individuals’ compound exposure levels.

3. Which of the following hypotheses would best explain the results seen in Experiment 3?
   (A) Moving about stirs up a personal cloud of breathable particles.
   (B) Industrial sites tend to perform most combustion activities in the night hours, thus raising particle levels at night.
   (C) Particles formed during cooking and smoking tend to remain suspended for at least 24 hours, so that daytime levels generally do not drop off at night.
   (D) Exposure to breathable particles is largely attributable to automobile exhaust.

4. If the researchers conducting Experiment 3 added another study subject and found that he had a daytime indoor exposure level of 75 micrograms/meter³, which of the following would be the most likely daytime personal exposure level for this individual?
   (F) 65 micrograms/meter³
   (G) 75 micrograms/meter³
   (H) 85 micrograms/meter³
   (J) 125 micrograms/meter³
5. Researchers hypothesized that volatile organic compounds follow the same pattern of personal exposure versus indoor exposure levels as that seen with breathable particles in Experiment 3. If this hypothesis is correct, which of the following is probably closest to the actual indoor level of trichloroethane in the rural Maine township?

(A) 1 micrograms/meter$^3$
(B) 6 micrograms/meter$^3$
(C) 15 micrograms/meter$^3$
(D) 19 micrograms/meter$^3$

6. To prove the hypothesis in Question 5, researchers would need to do which of the following?

(F) Conduct Experiment 2 again, but ask the subjects to wear monitoring devices only during the day.

(G) Conduct Experiment 3 again, this time asking all of the subjects from Experiment 2 to participate.

(H) Conduct Experiment 2 again, but this time, place monitors in the indoor settings in addition to those worn by individuals.

(J) Conduct Experiment 2 again, but break down the individual exposure levels into those encountered during the day and during the night.

Passage II

In small communities, infectious organisms such as Varicella-zoster virus, which causes chickenpox, occasionally become extinct. The threshold at which such extinctions occur is known as the critical community size. Extinctions are followed by a period in which there are no new reported cases of the infection. They then attempted to develop computer models of the patterns of fadeouts seen using information about the dynamics of the infection. The first of the following figures shows the real data on chickenpox versus the data generated by two different computer models. The second of the figures demonstrates the different assumptions made by the two models concerning the duration of the infectious period (the period in which an individual can transmit the infection to another individual). This was the only difference between the two models.
7. The critical community size for chickenpox is
   (A) more than 1 million.
   (B) about 700,000.
   (C) about 400,000.
   (D) less than 100,000.

8. The difference between Models 1 and 2 is
   (F) Model 1 predicts a more concentrated infectious period, compared with Model 2.
   (G) Model 1 predicts more individuals will be infectious after six days, compared with Model 2.
   (H) Model 2 predicts a greater number of individuals will be infectious in the early days of the infectious period, compared with Model 1.
   (J) All of the above

9. Which of the following statements is best supported by the first figure?
   (A) As the number of viruses climbs toward 1 million, the number of fadeouts per year declines.
   (B) As a community population increases, the discrepancy between the predictive abilities of the two models increases.
   (C) Model 1 is better at predicting annual fadeouts for communities under 300,000, while Model 2 is better at predicting annual fadeouts for communities more than 300,000.
   (D) Both models overestimate the number of annual fadeouts for chickenpox.

10. In a community with a population of 300,000, the number of fadeouts per year is
    (F) below 1.
    (G) above 1.
    (H) more variable than in a population below 100,000.
    (J) lower than in a population of 500,000.

11. Which of the following statements might explain the difference in the abilities of Models 1 and 2 to predict the actual number of annual fadeouts of chickenpox?
    (A) Model 2 predicts that there will be more individuals spreading infection in the early infectious period, resulting in a lower number of predicted fadeouts, compared with Model 1.
    (B) Model 1 predicts that there will be some individuals spreading infection in the late infectious period, reducing the number of predicted fadeouts, compared with Model 2.
    (C) Model 2 predicts that there will be a longer infectious period in larger communities, increasing the number of predicted fadeouts, compared with Model 1.
    (D) Model 2 assumes a more constant rate of movement from an infectious to a non-infectious status.
12. If the researchers used another computer model for chickenpox, using the assumption about the infectious period depicted below (see the following figure, Model 3), what could you expect this model to predict?

(F) Model 3 would predict more annual fadeouts than Model 1.

(G) Model 3 would predict more annual fadeouts than Model 2 but less than Model 1.

(H) Model 3 would underestimate the number of annual fadeouts.

(J) Model 3 would predict a better correlation between fadeouts and population size than Models 1 or 2.
CHAPTER 11: Science Reasoning Review

Exercise 2

11 Questions • Time—10 minutes

Directions: This test consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question. You may NOT use a calculator on this test.

Passage I

Individuals usually have two copies of each gene (the basic unit of genetic material, found on the chromosomes), one from their mother and one from their father. Genetic or inherited diseases are those that can be passed down to the next generation through the genes. These diseases follow a number of patterns. Two of the basic ones are dominant and recessive inheritance.

In a genetic disease with a recessive inheritance pattern, an individual will not be affected by the disease unless he or she is passed two copies of the disease gene, one from each parent. An individual who is passed one copy of the disease gene is called a healthy carrier. He or she will not have the disease but can still pass the gene on to an offspring. The first of the following figures shows a family with this type of genetic disease.

In a disease with a dominant inheritance pattern, any individual with a copy of the disease gene will have the disease. (Depending on the disease, individuals with two copies may have an accelerated or more severe disease course or may be unable to survive). There is no such thing as a healthy carrier with this type of disease. The second figure shows a family with this type of genetic disease.

1. Which of the following is the correct number of healthy carriers in the third generation of the family depicted in the first figure?
   (A) None
   (B) 2
   (C) 5
   (D) 6
2. Which of the following is the correct number of family members with the disease in the first figure?
   (F) 0
   (G) 2
   (H) 10
   (J) 12

3. Which of the following statements about the first figure is true?
   (A) The mother in the first generation had to have at least one parent with the disease.
   (B) The father in the first generation had to have at least one parent who had one or more of the disease genes.
   (C) The children of the healthy carriers in the family could end up with the disease, even if the other parent is not a carrier.
   (D) The daughter marked with an asterisk in the third generation could pass the disease on to her children.

4. Which of the following statements about the family in the second figure is true?
   (F) Either the mother or father of the first generation father must have had the disease.
   (G) Either the mother or father of the first generation mother must have been a carrier of the disease gene.
   (H) There are three healthy carriers in the second generation.
   (J) The couple marked with an asterisk in the second generation will be unable to have any healthy children.

5. What is the correct number of individuals with the disease in the second figure?
   (A) 5
   (B) 6
   (C) 7
   (D) It cannot be determined.

6. If the Generation 3 daughter marked with an asterisk in the family in the second figure was planning on having children, which of the following would be accurate advice for her regarding genetic testing?
   (F) She should be tested to rule out the possibility that one or more of her children would be carriers of the disease gene, but she could be sure that none of them would develop the disease.
   (G) Both she and her husband need to be tested to rule out the possibility that they are healthy carriers of the disease gene.
   (H) Testing is unnecessary for the daughter; she is not carrying the disease gene.
   (J) Testing one of the parents is sufficient to rule out the disease in their children.
7. The family in the following figure has a genetic disease that follows either the dominant or recessive pattern. Which of the following statements concerning this family is true?

(A) Either the father or mother in the first generation is not carrying the disease gene.

(B) The family is definitely not suffering from a dominantly inherited genetic disorder.

(C) The healthy son in the second generation would have no reason to undergo genetic testing before having children.

(D) We can be sure that both of the affected son’s daughters will have the disease.

Passage II

Interferometry is a highly sensitive method of measuring distances that are close to the wavelength of light. An interferometer (depicted in the following figure) uses a partially reflecting mirror (one that reflects half the light and allows the other half to continue through) to split a coherent light source, such as a laser beam.

Coherent light consists of a single frequency. After the light is split, the two components will continue until they are reflected backward by Mirrors 2 and 3. After this reflection, they proceed to the partially reflecting mirror again, and each path has a component (about a half) that proceeds to the light detector. The detector receives the sum of the two components of light, each with its own phase (shift of the wave with respect to a fixed spot).

Two experiments using an interferometer were conducted.

Experiment 1

In Experiment 1, researchers moved Mirror 2 backward slowly, thereby lengthening the path that one component of the light travels and changing its phase. The light received by the detector was recorded at a number of positions. The following figure shows some of their findings along with the phase relationship of the waves that they deduced from these results.
Experiment 2

In Experiment 2, researchers used various light sources with different frequencies (number of waves per second). With each source, they moved Mirror 2 backward slowly, recording the light received by the light detector at each position. The results of this experiment are shown in the following figure.

8. The factor that was varied in Experiment 1 is the
   (F) angle of the partially reflecting mirror.
   (G) wavelength (distance from one peak to the next) of one component of the light.
   (H) frequency of one component of the light.
   (J) phase of one component of the light.

9. Experiment 1 demonstrates that the lowest light intensity values occur in which situation?
   (A) Only when Mirror 2 is at 0 nanometers
   (B) When the two light components have different frequencies
   (C) When the light component waves are 180 percent out of phase (troughs occur in one component where peaks occur in the other)
   (D) When the light component waves are in phase (troughs and peaks match)

10. Which of the following statements about the light sources in the figure for Experiment 2 is most accurate?
    (F) Light Source 1 is always in phase.
    (G) Light Source 2 has the longest wave length.
    (H) Light Source 3 has a shorter wave length than Light Source 1.
    (J) The greatest light intensity was detected from Light Source 1.

11. In the figure, peak light detection should occur when the distance from
    (A) the laser to Mirror 1 is the same as the distance from the laser to Mirror 2.
    (B) the laser to Mirror 1 is the same as the distance from the laser to the light detector.
    (C) Mirror 1 to Mirror 2 is the same as the distance from Mirror 1 to Mirror 3.
    (D) the laser to Mirror 3 is the same as the distance from Mirror 1 to the light detector.
Exercise 3

12 Questions • Time—10 Minutes

Directions: This test consists of two passages, each followed by several questions. Read each passage and select the correct answer for each question. You may NOT use a calculator on this test.

Passage I

Schizophrenia is a mental illness that involves the dissociation of reason and emotion, resulting in symptoms that include hallucinations, hearing voices, intense withdrawal, delusions, and paranoia. The average age at which schizophrenia is diagnosed is 18 years for men and 23 years for women. It has been observed to run in families.

The cause remains a mystery, but there are several competing theories. These theories are based in part on findings from twin studies, which look at identical twins in which one or both have the disease. (Identical twins share 100 percent of their genetic material, while nonidentical twins share about 50 percent.) In 50 percent of the cases, the other will also suffer from schizophrenia. Identical twin pairs in which one individual is ill and the other is well are referred to as discordant twins.

Genetic Theory

One school of thought is that schizophrenia is a genetic disorder (one passed through the genes from parents to children). This theory gained support from the fact that schizophrenia runs in families. While it was originally believed that it was the family environment that caused this, a study has shown that children of schizophrenics adopted by families without the disease have the same risk of developing the illness as those raised by their birth parents. A final piece of evidence is the fact that the children of discordant identical twins all have the same chance of developing the illness: 17 percent. This indicates that even the healthy twin is somehow carrying the agent of the disease, presumably in the genes.

Infection Theory

Another school of thought is that schizophrenia arises because of a viral infection of the brain. Studies have shown that a class of viruses called “slow viruses” can linger in the brain for twenty years or longer before the infected person shows symptoms. Brain infections with viruses such as the common cold sore virus and herpes simplex type I can cause symptoms that resemble schizophrenia. Schizophrenia is also more common in children born in the winter, the season when viral infections are more common. Also, one study looking at families with a history of schizophrenia showed a 70 percent increase in the rate of schizophrenia among children whose mothers had the flu during the second trimester of pregnancy.
1. The schizophrenia theories are similar in that both
   (A) postulate that the foundation of the illness may be laid before birth.
   (B) postulate that the family environment plays some role.
   (C) predict that the children of schizophrenics are not at greater risk than other individuals.
   (D) show that identical twins are at greater risk for schizophrenia than other individuals.

2. Which of the following findings best supports the gene theory?
   (F) Parents of discordant twins report that the behavior of the twins begins to diverge at about 5 years of age, on average.
   (G) In discordant identical twin pairs, a brain structure called the basal ganglia is activated more often in the ill twin than in the healthy twin.
   (H) An identical twin of a schizophrenia sufferer is four times as likely to have the illness as a nonidentical twin of schizophrenia sufferer.
   (J) Studies have shown that viral infections sometimes infect one identical twin in the uterus and not the other.

3. The infection theory is most effective at explaining the fact that
   I. schizophrenic patients do poorly on some memory tests.
   II. among identical twins discordant for schizophrenia, the healthy twin may have some borderline schizophrenic traits.
   III. ill twins in discordant pairs have higher rates of finger abnormalities, which can be an indication of a viral infection that occurred in the womb.
   (A) I only
   (B) II only
   (C) III only
   (D) II and III

4. Which of the following hypotheses might supporters of both theories agree with?
   I. Individuals with schizophrenia have certain genes that predispose them to the disease but require some kind of trigger to turn the disease on.
   II. Individuals with schizophrenia have certain genes that predispose them to viral infections of the brain.
   III. Schizophrenia is not one disease but a collection of diseases.
   (F) I and II
   (G) I and III
   (H) II and III
   (J) I, II, and III
5. An identical pair of twins is found in which one was adopted at birth. Both received a diagnosis of schizophrenia as teenagers. An explanation that might be offered by supporters of the viral theory is

(A) children are most prone to viral infections when they are school age, long after the infant in this case was adopted.

(B) the stress of being an adopted child may have triggered schizophrenia in the predisposed twin.

(C) since 50 percent of identical twin pairs with schizophrenia are discordant for the disease, this case does not shed light on its origin.

(D) the brains of both twins may have been infected with a slow-acting virus when they were still in the womb.

6. Which of the following studies would be logical for supporters of the genetic theory to conduct next?

(F) One that looks for finger abnormalities in the parents and grandparents of schizophrenic children

(G) One that looks for differences in the chromosomes (which hold the genes) of schizophrenic individuals and healthy individuals

(H) One that looks for scarring in the brains of schizophrenic individuals, which might be a sign of an early injury or infection

(J) One that looks at the home environments of identical twins versus non-identical twins

Passage II

Seychelles warblers are insect-eating birds that usually lay one egg a year. Young warblers, particularly the females, often remain with their parents for several years helping them prepare and care for the next hatchlings (newly hatched birds), rather than mating themselves. A breeding pair (mating male and female) stays in the same territory from year to year.

Two experiments regarding the breeding behavior of the Seychelles warblers were performed:

Experiment 1

Biologists rated the territories of Seychelles warblers based on the density of insects available. They followed 100 breeding pairs in high- and low-quality territories over one breeding season, recording the breeding success (determined by the survival of a hatchling to leave the nest) for pairs with various numbers of helpers (previous offspring remaining with the mating pair). The results are seen in Table 11.4.

<table>
<thead>
<tr>
<th>Helper #</th>
<th>Reproductive Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-Quality Territory</strong></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>86%</td>
</tr>
<tr>
<td>1</td>
<td>94%</td>
</tr>
<tr>
<td>2</td>
<td>95%</td>
</tr>
<tr>
<td>3</td>
<td>79%</td>
</tr>
<tr>
<td><strong>Low-Quality Territory</strong></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>75%</td>
</tr>
<tr>
<td>1</td>
<td>65%</td>
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<tr>
<td>2</td>
<td>66%</td>
</tr>
<tr>
<td>3</td>
<td>64%</td>
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</tbody>
</table>

Experiment 2

The researchers hypothesized that Seychelles warblers might be able to adjust the sex ratio (number of males versus number of females) of their hatchlings depending on territory quality or number of helpers present. They again looked at 100 breeding pairs with various numbers of helpers in high- and low-quality territories and recorded the sex of their offspring for one breeding season. The results appear in Table 11.5.
### TABLE 11.5

<table>
<thead>
<tr>
<th>Helper #</th>
<th>Male Hatchlings (%)</th>
<th>Female Hatchlings (%)</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
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<tr>
<td>High-Quality Territory</td>
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<td>0</td>
<td>15%</td>
<td>85%</td>
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<tr>
<td>1</td>
<td>13%</td>
<td>87%</td>
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<td>2</td>
<td>78%</td>
<td>22%</td>
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<tr>
<td>3</td>
<td>76%</td>
<td>24%</td>
</tr>
<tr>
<td>Low-Quality Territory</td>
<td></td>
<td></td>
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<tr>
<td>0</td>
<td>75%</td>
<td>25%</td>
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<td>1</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>2</td>
<td>79%</td>
<td>21%</td>
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<tr>
<td>3</td>
<td>74%</td>
<td>26%</td>
</tr>
</tbody>
</table>

7. Which of the following statements about the design of Experiments 1 and 2 is most accurate?

(A) Experiment 1 investigated breeding success, while Experiment 2 investigated sex ratios for hatchlings.

(B) Experiment 1 followed warblers for several breeding seasons, while Experiment 2 followed them for only one season.

(C) Experiment 1 looked at the effect of varying helper number, while Experiment 2 was concerned only with responses to variations in territory quality.

(D) Experiment 1 followed breeding pairs, while Experiment 2 followed the helpers of breeding pairs.

8. Which of the following graphs best depicts the relationship between helper number and male hatchlings in a high-quality territory?

(F) Graph A  
(G) Graph B  
(H) Graph C  
(J) Graph D

9. Based on the information in the passage, which of the following statements about reproductive success in Seychelles warblers is most accurate?

(A) Reproductive success in low-quality territories goes up with helper number.

(B) Reproductive success in high-quality territories goes down with helper number.

(C) Reproductive success is dependent on helper number but not on territory quality.

(D) Reproductive success in high-quality territories goes up if there are one or two helpers and down if there are more than two.
10. Which of the following statements about helper number is correct?
   (F) Helper number has no effect on the sex ratios of hatchlings.
   (G) Helper number has no effect on the sex ratio of hatchlings in low-quality territories.
   (H) Warblers with zero or one helper have a greater proportion of female hatchlings.
   (J) Warblers with zero or one helper have a greater proportion of male hatchlings.

11. Which of the following theories fits the data collected in Experiments 1 and 2?
   (A) In high-quality areas, one or two helpers are useful, but more than two will put a drain on resources. Therefore, breeding pairs with several helpers will adjust the sex ratios of their hatchlings to favor males.
   (B) Breeding pairs in low-quality territories need the most help in raising their hatchlings and will adjust the sex ratios of their hatchlings in an attempt to gain more males.
   (C) All breeding pairs benefit from at least one helper and will adjust the sex ratios of their hatchlings to favor females if they have no helpers.
   (D) Male hatchlings require more resources than female hatchlings, so only birds in high-quality territories with several helpers will adjust the sex ratios of their hatchlings to favor males.

12. Assuming that the hypothesis of the researchers conducting Experiment 2 is correct, which of the following results would you expect from experiments in which breeding pairs and their helpers were moved to different territories?
   (F) Breeding pairs with several helpers moved from high-quality territories to low-quality territories switched to having more male hatchlings.
   (G) Breeding pairs with one helper moved from high-quality territories to low-quality territories attempted to increase their helper number.
   (H) Breeding pairs with one or two helpers moved from low-quality territories to high-quality territories switched to having mainly female hatchlings.
   (J) Breeding pairs with two or more helpers moved from low-quality territories to high-quality territories did not change the sex ratios of their hatchlings.
ANSWER KEY AND EXPLANATIONS

Exercise 1

1. The correct answer is (D). Since cigarettes and household sources produce the lion’s share of individuals’ benzene exposure (75 percent of the total), it seems clear that indoor rather than outdoor sources are responsible for the highest exposure levels.

2. The correct answer is (H). In Experiment 1, emission levels were compared to exposure levels; by contrast, in Experiment 2, only exposure levels were studied, while emission levels were ignored.

3. The correct answer is (A). The real anomaly in Table 11.3 is the high daytime “personal exposure” levels, which far exceed all the other numbers in the chart (which are all roughly comparable to one another, whether daytime or nighttime levels are considered). Of the four answer choices, choice (A) does the most to explain this result: If “moving about” stirs up a cloud of particles, this would explain why people have high personal exposure levels during the day, which subside at night (when they go to bed).

4. The correct answer is (J). Consider the second column of values in Table 11.3. The indoor exposure levels for the two experimental subjects shown there are quite close—98 and 95. If the third subject has an indoor exposure level of 75, that would be about 20 percent lower than either of the first two subjects. Now, if the personal exposure level varies by a similar amount, we’d expect the third subject to have a personal exposure level about 20 percent below 150—somewhere in the neighborhood of 120. Hence, choice (J) is the correct answer.

5. The correct answer is (B). We see in Table 11.2 that the actual indoor levels of breathable particles are about the personal exposure levels as recorded by monitoring devices. If the same relationship holds true for trichloroethane, then the level of 14 would be reduced by the same amount, to about 9.

6. The correct answer is (H). Experiment 2 measured only personal exposure levels, while Experiment 3 monitored the indoor and outdoor environments as well. To test whether the results of Experiment 3 would be duplicated with the compounds tested in Experiment 2, indoor environmental monitors would have to be added to the experiment.

7. The correct answer is (C). The crucial data for answering this question are the dots in the figure, which show actual communities in which fadeouts occurred. Since all of the dots appear to the left of the 400,000 population mark, we can see that that represents the level at which fadeouts of the virus are no longer likely to occur.
8. **The correct answer is (J).** All of the statements given in choices (F), (G), and (H) are true, as seen in the figure. The infectious period predicted in Model 1 is less concentrated than in Model 2 (see how long it takes for the “tail” of Model 1 to disappear at the right end of the graph). Model 1 predicts that more people will be infected after six days than does Model 2 (there’s a severe drop-off in infected individuals just prior to day 6, according to Model 2). And Model 2 shows a much higher infection rate in the early days than does Model 1 (its curve is at the very top of the scale).

9. **The correct answer is (B).** In the figure, notice how, at community sizes under 100,000 (the left end of the graph), the two curves of Model 1 and Model 2 track one another closely. (They are also both quite accurate as compared to the dots, which indicate actual experience of fadeouts.) Beyond the 100,000 population level, however, the curves gradually diverge more and more.

10. **The correct answer is (F).** Compare the height of the dots at the 300,000 population level with the vertical scale at the left-hand side of the graph. The dots are below the one-per-year level; hence, choice (F) is the correct answer.

11. **The correct answer is (A).** To answer this question, you need to consider data from both graphs. Only choice (A) fits the information in both figures: Model 2 does predict a larger number of infectious people early in the cycle, and it also predicts a smaller number of fadeouts than does Model 1.

12. **The correct answer is (H).** Since the new Model 3 predicts both a high number of infectious individuals in the early days (as does Model 2), while also extending their recovery period over a long period of time (as does Model 1), both factors would tend to reduce the number of predicted fadeouts. As a result, Model 3 would probably be less accurate than Model 2, erring on the side of predicting fewer fadeouts than would actually occur.

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**Exercise 2**

1. **The correct answer is (C).** As the key explains, the disease gene is represented by a capital D, while the normal gene is represented by a lowercase d. Thus, a healthy carrier would be a person with one disease gene and one normal gene, or a Dd combination. There are five such people depicted in the third generation of the figure.

2. **The correct answer is (G).** Only people who have two disease genes—DD—will suffer from a disease transmitted as a recessive trait. In the figure, we see just two such people: a female (circle) in Generation 2 and a female in Generation 3.

3. **The correct answer is (B).** Since the father (the square) in Generation 1 has one disease gene D, he must have had a parent from whom he inherited that gene.
4. The correct answer is (F). As with the father in Generation 1 in the figure, we see that the disease gene D is present in the father of this family. And since this is a dominant trait, whichever parent of that individual transmitted the disease gene to him must also have suffered from the disease.

5. The correct answer is (C). Anyone in the figure with even a single disease gene D will suffer from the disease. There are seven such individuals in the chart: one in Generation 1, three in Generation 2, and three more in Generation 3.

6. The correct answer is (H). Since the individual in question has genes labeled dd, she has two normal genes and does not need to worry about the possibility of transmitting a disease gene to her children.

7. The correct answer is (B). The disease cannot be a dominant trait. We can tell this because the male in Generation 2 who is affected by the disease (center of chart) has two healthy parents. If he had inherited a dominant disease trait from one of his parents, one or both of them would be affected by the disease as well.

8. The correct answer is (J). By gradually moving Mirror 2, the phase of the component of the light reflected by that mirror was gradually altered as well.

9. The correct answer is (C). Look at the first and last lines in the figure. In the last column, you can see that the phase relationship is 180 degrees out of synch on both lines. And in the first column, the light intensity is at its lowest—just one milli watt.

10. The correct answer is (G). In the graphs in the figure, wavelength is represented by the horizontal distance from peak to peak or from trough to trough of the wavy lines. Since this distance is greatest in the second graph, Light Source 2 must have the longest wavelength.

11. The correct answer is (C). As the figure suggests, maximum light intensity occurs when the two light components are perfectly in phase. The best way to ensure this happening would be for the distance traveled by the two light sources to be exactly equal, as is the case in the situation described in choice (C).

Exercise 3

<p>| | | | | |</p>
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<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>4</td>
<td>J</td>
<td>7</td>
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<td>H</td>
<td>5</td>
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<td>12</td>
<td>J</td>
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</table>

1. The correct answer is (A). Both the genetic theory and the infection theory attribute schizophrenia to prenatal events: in one theory, to a genetic disorder; in the other, to a prenatal infection that affects the brain of a developing infant.

2. The correct answer is (H). The fact that the shared incidence of schizophrenia is four times as great between identical twins as between nonidentical twins supports the idea that shared genetic material is a major factor in the development of the disorder.
3. The correct answer is (C). The phenomenon described in option III would be consistent with the idea that an infection occurred during prenatal development, thus supporting the infection theory.

4. The correct answer is (J). All three hypotheses could be consistent with both theories. In fact, all three could help to explain how both genetic and disease factors could be involved in producing schizophrenia.

5. The correct answer is (D). Those who favor the rival theory would be apt to explain the shared incidence of schizophrenia in this case as having resulted from the shared experience of a viral infection when both infants were in the womb together.

6. The correct answer is (G). It would be natural from supporters of the genetic theory to want to study the genes themselves in the hope of substantiating their theory by pinpointing the actual genetic differences that cause (or help to cause) the illness.

7. The correct answer is (A). As the descriptions of the experiments make clear, Experiment 1 measured breeding success in relation to the quality of the birds’ territory and the number of “helpers” the birds had, while Experiment 2 measured the ratio of male to female hatchlings against the same two variables.

8. The correct answer is (G). This graph accurately reflects the data found in the upper half of Table 11.5.

9. The correct answer is (D). As you can see in Table 11.4, the highest level of reproductive success in high-quality territories is found when one or two helpers are present (94 percent and 95 percent success); the rate falls off when a third helper appears (79 percent).

10. The correct answer is (G). Look at the lower half of Table 11.5. In low-quality territories, the percentage of male hatchlings varies in a narrow, seemingly random range (between 74 percent and 80 percent) as the number of helpers varies, suggesting that the number of helpers has no real effect on the sex ratio among hatchlings there.

11. The correct answer is (A). This is the only theory that even begins to explain the curious data in Table 11.5, in which all warbler pairs except low-helper pairs in high-quality territories produce more male offspring than female. If we assume that a shortage of resources favors male hatchlings (who perhaps have some different behavior from females; greater aggressiveness in pursuit of food, for example), then the pattern in Table 11.5 becomes at least understandable and consistent.

12. The correct answer is (J). Since all warbler pairs with two or more helpers have high male-to-female hatchling ratios—regardless of whether they are in high-quality or low-quality territories—one would expect no change in the ratio, even with a change from one territory to another.
ARE YOU READY TO MOVE ON?

How well do you understand the contents and format of the ACT Assessment Science Reasoning Test? How well have you incorporated your review knowledge into your test-taking behavior?

After you’ve corrected each exercise, find the number below. This will give you an idea of whether you need further help or whether you can move on to another subject area.

SCORE KEY FOR EACH PRACTICE EXERCISE

<table>
<thead>
<tr>
<th>Number Correct</th>
<th>Score</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>Poor</td>
<td>Study Chapters 7 and 11 again. See “Additional Sources for Review” below.</td>
</tr>
<tr>
<td>4–6</td>
<td>Below average</td>
<td>Study problem areas in Chapters 7 and 11. See “Additional Sources for Review” below if you have time.</td>
</tr>
<tr>
<td>7–10</td>
<td>Average</td>
<td>Skim problem areas in Chapters 7 and 11 if you have time.</td>
</tr>
<tr>
<td>11–15</td>
<td>Above average</td>
<td>You may move on to a new subject.</td>
</tr>
<tr>
<td>16–20</td>
<td>Excellent</td>
<td>You’re ready for the ACT Assessment Science Reasoning Test.</td>
</tr>
</tbody>
</table>

ADDITIONAL RESOURCES FOR REVIEW

If you want to review a specific science field—biology, chemistry, physics, or earth science—to feel more comfortable with the science passages on the ACT Assessment, refer to your high school textbook or favorite review book on the subject.
PART IV

THREE FULL-LENGTH PRACTICE ACT ASSESSMENT TESTS

Practice Test 1

Practice Test 2

Practice Test 3
521

PRACTICE TEST 1

Answer Sheet

TEAR HERE

SECTION 1: ENGLISH
1
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SECTION 2: MATH
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### SECTION 3: READING

1. A B C D  
2. E F G H  
3. A B C D  
4. E F G H  
5. A B C D  
6. E F G H  
7. A B C D  
8. E F G H  
9. A B C D  
10. E F G H  
11. A B C D  
12. E F G H  
13. A B C D  
14. E F G H  
15. A B C D  
16. E F G H  
17. A B C D  
18. E F G H  
19. A B C D  
20. E F G H  
21. A B C D  
22. E F G H  
23. A B C D  
24. E F G H  
25. A B C D  
26. E F G H  
27. A B C D  
28. E F G H  
29. A B C D  
30. E F G H  
31. A B C D  
32. E F G H  
33. A B C D  
34. E F G H  
35. A B C D  
36. E F G H  
37. A B C D  
38. E F G H  
39. A B C D  
40. E F G H  

### SECTION 4: SCIENCE REASONING

1. A B C D  
2. E F G H  
3. A B C D  
4. E F G H  
5. A B C D  
6. E F G H  
7. A B C D  
8. E F G H  
9. A B C D  
10. E F G H  
11. A B C D  
12. E F G H  
13. A B C D  
14. E F G H  
15. A B C D  
16. E F G H  
17. A B C D  
18. E F G H  
19. A B C D  
20. E F G H  
21. A B C D  
22. E F G H  
23. A B C D  
24. E F G H  
25. A B C D  
26. E F G H  
27. A B C D  
28. E F G H  
29. A B C D  
30. E F G H  
31. A B C D  
32. E F G H  
33. A B C D  
34. E F G H  
35. A B C D  
36. E F G H  
37. A B C D  
38. E F G H  
39. A B C D  
40. E F G H  

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SECTION 1: ENGLISH

75 Questions • Time—45 Minutes

Directions: This test consists of five passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box.

After you select the correct answer for each question, mark the oval representing the correct answer on your answer sheet.

Passage 1

On Coping in Another Culture

Language schools are booming, partially though in an era of global trade, busi-

1

nessmen realize that foreign lan-

guages can be a valuable asset. But a little

learning is a dangerous thing unless you

2

can really handle a language, it is best to

limit yourself to a few gracious phrases. Much more important is an awareness of

non-verbal behavior and the cultural nu-

ances of the country you were visiting.

3

The first thing you need to know, however, is whether you are dealing with

4

a “low-context” or a “high-context” culture. Low-context cultures, such as those

of the United States, England and Ger-

many, spell things out verbally and rely

1. (A) NO CHANGE
   (B) because
   (C) since
   (D) OMIT the underlined portion.

2. (F) thing, and
   (G) thing, unless
   (H) thing. Unless
   (J) thing; however

3. (A) NO CHANGE
   (B) have visited
   (C) will have visited
   (D) are visiting

4. (F) NO CHANGE
   (G) know, indeed
   (H) know
   (J) believe, therefore
on a more literal interpretation of the spoken word. There tends to be no gap between what is said and what is meant.

On the other hand, high-context cultures, which reside in Spain, France, Mexico, Japan, communicate more by gesture and situation, relying less on actual words than on gestures and situations.

What remains unsaid is often what is most important.

[9] The Japanese will listen and nod their heads and encourage you to go on, no matter what they think. This is a show of respect. The closest anyone will come to saying no is, “It is very difficult.”

5. (A) NO CHANGE
(B) their
(C) they’re
(D) it

6. (F) NO CHANGE
(G) cultures, such as reside in Spain, France, Mexico and Japan, communicate
(H) cultures: Spain, France, Mexico, Japan, communicate
(J) cultures—Spain, France, Mexico, Japan—communicate

7. (A) NO CHANGE
(B) and for that reason
(C) which is why they
(D) OMIT the underlined portion.

8. (F) NO CHANGE
(G) unsaid that is
(H) unsaid, which is
(J) unsaid is not

9. Which of the following sentences best continues to develop and support the theme of the essay while providing a smooth transition between the preceding paragraph and this one?
(A) In Japan, for example, people will never say no or openly disagree with you.
(B) One of the best examples of this would be the culture of Japan.
(C) Mexicans and Japanese are famous for being gracious hosts.
(D) High-context cultures often prize politeness and expressive mannerisms.
or, “We will give this positive study.”

[10] If someone is truly interested in what you are proposing, you will engage in a dialogue on the subject rather than simply encouraging you to speak.

Gestures too are potential sources of miscommunication. Even handshakes differ in subtle ways from country to country. The British handshake is firm and used infrequently. In Italy and France, a gentler grip will make a better impression. The Germans and Danes nod their heads when they shake hands as a gesture of respect, but someone not knowing this might misinterpret their attitude as being aggressive. Likewise, looking directly into someone’s eyes, which is a staple of Anglo-American

10. Given that all are true, which of the following sentences, if added here, would best enhance the illustration of that aspect of Japanese culture being discussed while at the same time maintaining the flow of the paragraph?
   (F) The Japanese have developed a complex set of rules aimed at saving face.
   (G) What this really means is “Let’s forget the whole business.”
   (H) It is, therefore, best not to state your own disagreement too boldly.
   (J) It is crucial for the Japanese to take into account the ranking order within any group.

11. (A) NO CHANGE
   (B) they could engage you in a dialogue on the subject
   (C) you will be engaged in a dialogue on the subject
   (D) he or she will engage you in a dialogue on the subject

12. (F) NO CHANGE
   (G) Because
   (H) And particularly
   (J) While even

13. (A) NO CHANGE
   (B) who does not know this
   (C) wary of this
   (D) whom is unaware of this
trust-building, is considered too aggressive in most countries of the Orient. [14] 14. Which of the following sentences, if added here, would best conclude the paragraph and tie it back to the main idea of the essay?

(F) Even a classic American O.K. sign is considered vulgar in countries such as Brazil and Greece.

(G) Thus, it is imperative to take care in making gestures while abroad and to follow the lead of your hosts.

(H) If, however, you find you are unsure how to read the codes of another culture, you can at least pay attention and strive to be polite on your own.

(J) Because of the variety of meanings that can be ascribed to a single gesture, it is important to study cultural habits before arriving in a foreign country.

Item 15 poses a question about the essay as a whole.

15. Suppose the writer had been assigned to write an essay exploring the distinction between low-context and high-context cultures. Would this essay successfully fulfill that assignment?

(A) Yes, because the essay focuses on patterns of difference between high-context and low-context cultures.

(B) Yes, because the essay describes in detail the contrast between Japanese and German customs.

(C) No, because the essay only makes the distinction within a more general treatment of cultural differences.

(D) No, because the essay fails to define the terms “low-context” and “high-context” and give clear examples.
Passage II

The Decline of Leisure

When I think of the decline of leisure, I picture a scene witnessed not too long ago on a river in Idaho. I went there to fly-fish on a warm September day. Beside the lazy rush of the current, there was a much more frenetic rush of canoes and rafts and rowboats full of fishermen, rowing furiously, staking out beachheads, and casting with the intensity of a competition.

In high season, fishing on the West’s great rivers is like entering gold rush days. The grand landscape is crowded with anglers who managed to carve time from their hectic schedules, and most are practicing a capital-intensive form of leisure.
Today’s fishermen don’t feel they are for real unless they’re sporting every one of the right clothes and equipment, the gear they’ve seen in magazines and catalogues. Fashionable rods and reels, polarized glasses, the right hat, rain jacket, boots, waders, and fly box are essential. And time, instead of melting into the river, is being reckoned with and watched, guides are hired because the hours are limited, the fish must be caught, and the great outdoors must be enjoyed at least enough to warrant the expense.

(1) Even free time now demands efficient productivity. (2) This type of scene is repeated at national parks, ski resorts, tennis clubs and shopping malls. (3) The Friday morning after Thanksgiving, people that have the day off line up in front of toy stores at six in the morning, buying this year’s hottest gift. (4) No wonder we don’t know how to relax.

21. (A) NO CHANGE
   (B) many of
   (C) a complete outfit of
   (D) OMIT the underlined portion.

22. (F) NO CHANGE
   (G) is
   (H) must be
   (J) has been

23. (A) NO CHANGE
   (B) watched, and guides
   (C) watched; and guides
   (D) watched: Guides

24. (F) NO CHANGE
   (G) with
   (H) who have
   (J) taking

25. (A) NO CHANGE
   (B) morning; buying
   (C) morning, to buy
   (D) morning to buy

26. Which of the following sequences of sentences will make paragraph 4 most logical?
   (F) 2, 1, 3, 4
   (G) 1, 3, 4, 2
   (H) 4, 1, 3, 2
   (J) 3, 2, 1, 4
Increasingly, we pay for consumer goods by racking up debt and bartering away our leisure time. Contrary to its promise, technology has made us work harder by blurring the boundaries between office and home, between work and play. And technology itself is an expensive, ever-changing product most of us can’t do without.

The desire to consume is rapidly replacing the desire for leisure, in fact, is being transformed into activities and products. What would you do if you had more free time? The very question is contrary to the definition of leisure. It used to mean spending a day doing almost nothing.

27. At this point, the author wishes to insert a concise supporting sentence. Which of the following would be most effective?
   (A) I remember setting out on a family vacation only to have my cell phone ring in the car.
   (B) Computers, e-mail, and cell phones have made it much more difficult to disconnect.
   (C) Many of us take home work and call the office on our days off.
   (D) The complex ramifications of technology are being slowly recognized.

28. (F) NO CHANGE
   (G) leisure, and in fact, it is
   (H) leisure. In fact, it is
   (J) leisure. In fact, leisure is

29. The writer wants to link the essay’s opening and its conclusion. Which of the alternatives most successfully achieves this effect?
   (A) NO CHANGE
   (B) Relaxation
   (C) Going fishing
   (D) Before its decline, leisure
Item 30 poses a question about the essay as a whole.

30. Suppose the writer were to eliminate paragraph 1. This omission would cause the essay as a whole to lose primarily
   (F) relevant details depicting the decline of leisure.
   (G) irrelevant details from a colorful anecdote.
   (H) background information that establishes the author’s expertise.
   (J) the connection between fishing and the transformation of leisure.

31. (A) NO CHANGE

32. (F) NO CHANGE

33. (A) NO CHANGE

34. (F) NO CHANGE
35. Which of the following sentences, if added here, would provide the most logical transition between paragraphs 2 and 3?

(A) Most photographers began photographing the day they arrived on location, but Smith couldn’t work like that.

(B) Smith was too independent a man to take orders from magazine editors who didn’t know as much about photography as he did.

(C) Smith considered himself to be an artist and only worked when he was inspired.

(D) Unlike other photographers, Smith cared more about the quality of his work than the pay he received.

36. (F) NO CHANGE

(G) country doctors, Spanish peasants, and African-American midwives

(H) country doctors; Spanish peasants; African-American midwives;

(J) country doctors or Spanish peasants and African-American midwives

37. (A) NO CHANGE

(B) be friendly enough

(C) become so familiar

(D) become familiar, so

38. (F) NO CHANGE

(G) portraits, poetic works that pay homage to the human spirit.

(H) portraits. Poetic works that pay homage to the human spirit.

(J) portraits, which are a poetic homage to the human spirit.

39. (A) NO CHANGE

(B) Smith, who was hired to take a series of photographs

(C) Smith, hired to take a series of photographs,

(D) Smith was hired to take a series of photographs
His ambition grew to encompass the many faces of Pittsburgh: its steel industry and workers; its forgotten neighborhoods; its backyards, bridges and parks. He set out to capture the very spirit of a time and a place.

His stay in Pittsburgh lasted nearly a year and he took over 11,000 photographs. For years, he sorted through the prints, a huge task of trying to put together his masterpiece. When a small portion of the work was finally published, he considered that a failure: the assignment was supposed to last three weeks. (4) He became entranced by his subject.

40. (F) NO CHANGE
   (G) streets and read histories
   (H) streets about which he read in histories
   (J) streets that were read about in histories

41. Which of the following sequences of sentences makes paragraph 4 most logical?
   (A) NO CHANGE
   (B) 1, 3, 2, 4
   (C) 1, 4, 3, 2
   (D) 3, 2, 1, 4

42. (F) NO CHANGE
   (G) the many faces of Pittsburgh: its steel industry and workers, its forgotten neighborhoods; its backyards, bridges and parks.
   (H) the many faces of Pittsburgh, its steel industry and workers, its forgotten neighborhoods, its backyards, bridges and parks.
   (J) the many faces of Pittsburgh—its steel industry and workers, its forgotten neighborhoods—its backyards, bridges and parks.

43. (A) NO CHANGE
   (B) prints in a huge attempt
   (C) prints, trying
   (D) prints, trying in a huge attempt

44. (F) NO CHANGE
   (G) considered it
   (H) considered what
   (J) considered that to be
images did not do justice to the spirit he had spent so long pursuing. [45]

Passage IV

A Wondrous Moment

[1]
For the past two weeks, I’ve been a guest on board The Regina IV, a fully-equipped research vessel hoping for a close-up view of sperm whales. From the scientists on board, I have gathered quite a bit of information for my article, but until now we have not been able to track a pod for observation.

[2]
We rush to the bridge and our binoculars are trained on the sea. A group of sperm whales is floating close together at the surface. Surprisingly, they don’t dive and barely seem to be in motion.

45. Which of the following, if added here, would most effectively conclude the essay and tie the conclusion to the beginning?

(A) The world, however, is lucky to possess such an eloquent and uncompromising failure.

(B) W. Eugene Smith was the harshest critic of his own work.

(C) The Pittsburgh project was never completed, yet it still provides a powerful document of the 1950s.

(D) W. Eugene Smith was an artist of the highest rank.

46. (F) NO CHANGE

(G) past, twice weeks

(H) past, two weeks

(J) past: two weeks

47. (A) NO CHANGE

(B) The Regina IV, a fully-equipped research vessel, hoping for a close-up view of sperm whales

(C) The Regina IV, a research vessel, hoping for a close-up view of sperm whales

(D) The Regina IV, hoping for a close-up view of sperm whales

48. (F) NO CHANGE

(G) up until now

(H) so far

(J) as of late

49. (A) NO CHANGE

(B) our binoculars train themselves on

(C) train our binoculars on

(D) through our binoculars we train on

50. (F) NO CHANGE

(G) jammed together

(H) squeezed against each other

(J) packed together like sardines
Then we spot the widening pool of blood, the oily slick created from their blubber.

The whales are gathered in a circle, heads at the center, tails facing out like the spokes in a wheel, it's a posture of defense.

[3]

A group of killer whales, their dorsal fins arched ominously above the waterline, race around just outside the circle of sperm whales. One of the killer whales cuts headlong between the thrashing tails and crunches into the flank of a sperm whale. Almost before the killer whale can be seen in its retreat, fresh-blood oozes to the surface of the sea. Then the posse of killer whales turns and moves away from their prey. The sperm whales, however, hold their defensive posture, as if they know it is a ruse.

51. (A) NO CHANGE
(B) the widening pool of blood: the oily slick created from their blubber.
(C) the widening pool of blood and the oily slick created from their blubber.
(D) the widening pool, blood, and the oily slick created from their blubber.

52. (F) NO CHANGE
(G) wheel. It is a posture of defense.
(H) wheel, in a posture of defense.
(J) OMIT the underlined portion.

53. Which of the following sentences, if added here, would enhance the narrative flow and provide a satisfactory transition between paragraphs 2 and 3?
(A) Never have I seen anything like it.
(B) Sperm whales have been known to do this when under attack.
(C) Soon the reason becomes apparent.
(D) None of us is prepared for what comes next.

54. (F) NO CHANGE
(G) race
(H) raced around
(J) races around

55. (A) NO CHANGE
(B) heading
(C) fast
(D) OMIT the underlined portion.

56. (F) NO CHANGE
(G) retreats
(H) is seen retreating
(J) is seen to be retreating
A few quiet minutes pass, holding me with a strange and awful suspense. On the one hand, I hope the killer whales will disappear; on the other hand, I am excited to witness an event that none of the researchers on this boat has ever seen before.

Suddenly several killer whales charge out of the distance. Their is a flurry of tails beating the water, followed by a heaving of the circle and a lone sperm whale is dragged away from the circle.

Nature is supposed to be savage, but what happens next is an act of heartwarming beauty. Despite opening themselves up to attack, a pair of sperm whales breaks from the circle and escorts their maimed companion back to the floundering formation.

57. (A) NO CHANGE
(B) holding I with
(C) holding me to
(D) holding me in

58. (F) NO CHANGE
(G) They are
(H) There are
(J) There is

59. Which of the following, if added here, would most effectively emphasize the emotion and meaning intended by the author in describing this event?
(A) with boundless courage in the face of disaster,
(B) with great speed and daring,
(C) like soldiers retrieving a fallen comrade from the line of fire,
(D) like the huge, unpredictable behemoths they are,
Item 60 poses a question about the essay as a whole.

60. Suppose the writer had been assigned to write an essay describing the method that killer whales employ to kill their prey. Would this essay successfully fulfill the assignment?

(F) Yes, because the essay focuses on the way in which killer whales attack a pod of sperm whales.

(G) Yes, because the essay describes the acts of the killer whales in great detail.

(H) No, because the essay focuses primarily on the behavior of the sperm whales.

(J) No, because the essay omits any mention of how the killer whales tracked their prey.

Passage V

A Fall Harvest

[1] Usually, it is wise to age a wine before you drink it. The Beaujolais Nouveau is an exception; it is best when young. In fact, time is of the essence with this unique wine. Weeks after the grapes having been harvested, following a process of rapid fermentation and bottling, the new wine is ready to drink. At one minute past midnight, on the third Thursday of each November, bottles of Beaujolais Nouveau are sent out to shops and restaurants all over the world. This annual event is heralded by colorful banners that reads, in many languages, “The Beaujolais Nouveau has arrived!”

61. (A) NO CHANGE
   (B) it, the
   (C) it. Because the
   (D) it, because the

62. (F) NO CHANGE
   (G) are
   (H) being quickly
   (J) are being

63. (A) NO CHANGE
   (B) passed
   (C) passing
   (D) past to

64. (F) NO CHANGE
   (G) reads’
   (H) read
   (J) reading
Whenever I see most of these banners, I am reminded of the month I spent harvesting grapes in the Beaujolais region of France. Every day at the crack of dawn, the grape pickers piled into a wagon and rode out to the fields. In order to complete the harvest in a hurry, the owner of the vineyard had drawn workers from many countries. In addition to Americans like myself, they’re Algerians, Moroccans, Poles and Bulgarians. Although everyone spoke some French, the conversation that traveled through the morning air was usually a jumble of languages.

65. (A) NO CHANGE  
(B) few of these banners  
(C) several of these banners  
(D) one of these banners

66. Which of the alternatives best provides new, specific details about the Beaujolais region of France?  
(F) NO CHANGE  
(G) The Beaujolais region is located south of Macon and north of Lyon.  
(H) The Beaujolais region is a specific region of France.  
(J) While the Beaujolais is famous for wine, many regions in France are known for specific food items, such as a special sandwich in Provence.

67. (A) NO CHANGE  
(B) hurry, the owner of the vineyard had drawn  
(C) hurry the owner of the vineyard, had drawn  
(D) hurry, the owner of the vineyard had drawn,

68. (F) NO CHANGE  
(G) their were  
(H) there were  
(J) there are

69. (A) NO CHANGE  
(B) grapes, for this harvest, is  
(C) grapes for this harvest is  
(D) grapes in a jumble of languages, is

70. (F) NO CHANGE  
(G) will allow  
(H) had allowed  
(J) allowed
One morning, while working alongside a young man from Poland, I thought I recognized the song he was singing. The song was a popular American hit of the year’s before, 71. The writer wants to add the following description of the work to paragraph 3: It involves much squatting and heavy lifting.

This sentence would most logically be placed

[F] before Sentence 1.

(G) after Sentence 1.

(H) before Sentence 3.

(J) before Sentence 4.

Michael Jacksons Billie Jean. We both knew all the words. Hearing me, he looked up and laughed. Soon we were singing together. I quickly found myself humming along.

STOP
END OF SECTION 1. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
SECTION 2: MATH

60 Questions • Time—60 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. If \( x \), \( y \), and \( z \) are all positive integers, what is the least possible value of \( x \)?
   (A) 21
   (B) 27
   (C) 36
   (D) 63
   (E) 189

2. In order to meet quality standards, a box of “Fruity Flakes” cereal must include at least 400 grams of cereal but no more than 405 grams of cereal. If \( c \) represents the weight of the cereal, in grams, this standard can be indicated by which of the following inequalities?
   (F) \( 400 < c < 405 \)
   (G) \( 400 \leq c < 405 \)
   (H) \( 400 \leq c \leq 405 \)
   (J) \( 400 > c > 405 \)
   (K) \( 400 \geq c \geq 405 \)

3. A certain town’s police department gave out 4,860 tickets for violations over a one-year period. If 70% of the issued tickets were for parking violations, how many of the tickets were issued for other violations?
   (A) 1,458
   (B) 2,430
   (C) 2,592
   (D) 3,402
   (E) 4,560

4. If \( 2x + 4 = -4(x - 1) \), then \( x = ? \)
   (F) \( -\frac{4}{3} \)
   (G) \( -\frac{1}{6} \)
   (H) 0
   (J) 1
   (K) \( \frac{4}{3} \)

5. If \((uv^2)(xy)z^4 = 10\), which of the following CANNOT be negative?
   (A) \( v \)
   (B) \( w \)
   (C) \( x \)
   (D) \( y \)
   (E) \( z \)

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6. A line can be expressed in the slope-intercept form \( y = mx + b \), where \( m \) and \( b \) are constants. What is the slope-intercept form of the equation \( 4x + 3y = 15 \)?

(F) \( y = -\frac{4}{3}x + 5 \)

(G) \( y = -\frac{4}{3}x + 1 \)

(H) \( y = -\frac{3}{4}x - 5 \)

(J) \( y = -\frac{3}{4}x + 5 \)

(K) \( x = -\frac{3}{4}y + \frac{15}{4} \)

7. The volume of a right cylinder can be expressed as \( \pi r^2h \), where \( r \) is the radius of the base of the cylinder and \( h \) is the height of the cylinder. What is the volume, in cubic inches, of a cylinder that has a base of radius 4 inches and a height of 8 inches?

(A) 16\( \pi \)

(B) 32\( \pi \)

(C) 64\( \pi \)

(D) 96\( \pi \)

(E) 128\( \pi \)

8. In the figure below, lines \( P \) and \( Q \) are parallel and line \( R \) is a transversal of lines \( P \) and \( Q \). If \( \angle x \) measures 80°, what is the measure of \( \angle y \)?

(F) 40°

(G) 80°

(H) 90°

(J) 100°

(K) 180°

9. In the figure below, where points \( A \), \( C \), and \( D \) all lie on the same line, what is the measure of \( \angle BCD \)?

(A) 130°

(B) 120°

(C) 115°

(D) 110°

(E) 100°
10. 10% of 10% = ?
   (F) 10
   (G) 1
   (H) .1
   (J) .01
   (K) .001

11. \( \sqrt{288} = ? \)
   (A) 8\( \sqrt{3} \)
   (B) 11\( \sqrt{3} \)
   (C) 7\( \sqrt{2} \)
   (D) 8\( \sqrt{2} \)
   (E) 12\( \sqrt{2} \)

12. For all real numbers \( p \) and \( q \), \((2p - 3q)^2 = ? \)
   (F) 36\( p^2q^2 \)
   (G) 4\( p^2 + 9q^2 \)
   (H) 4\( p^2 - 12pq + 9q^2 \)
   (J) 4\( p^2 + 12pq + 9q^2 \)
   (K) 4\( p^2 + 6pq - 9q^2 \)

13. The cost of 4 cookies, 6 doughnuts, and 3 boxes of doughnut holes is $8.15. The cost of 2 cookies, 3 doughnuts, and 4 boxes of doughnut holes is $7.20. What is the cost of a box of doughnut holes?
   (A) $.85
   (B) $.95
   (C) $1.05
   (D) $1.15
   (E) $1.25

14. Which of the following lines is parallel to the line \( 2x + y = 6 \)?
   (F) \( 2x + 2y = 6 \)
   (G) \( 3x + y = 9 \)
   (H) \( 4x + 2y = 10 \)
   (J) \( 5x + 10y = 6 \)
   (K) \( 6x + 4y = 12 \)

15. A father and his young son have a combined weight of 240 pounds. If the father weighs 3 times as much as his son, what is the son’s weight, in pounds?
   (A) 40
   (B) 60
   (C) 80
   (D) 160
   (E) 180

16. What is the product of \( \frac{3}{8} \) and .02 ?
   (F) .75
   (G) .075
   (H) .0075
   (J) .00075
   (K) .000075

17. In the figure below, parallel lines \( m \) and \( n \) are crossed by transversals \( s \) and \( t \). If the measures of \( \angle B \) and \( \angle C \) are 110° and 120°, respectively, what is the measure of \( \angle A \)?
   (A) 30°
   (B) 50°
   (C) 60°
   (D) 70°
   (E) 80°
18. In a student council executive board election, Aaron and Bonnie are running for president; Clarissa, Devon, and Edward are running for vice president; and Francine and Gary are running for treasurer. If these are the only candidates, the only offices, and there are no ties, how many different executive boards are possible?

(F) 6
(G) 7
(H) 12
(J) 14
(K) 21

19. Salesperson A has already called 45 of the 120 names on her list of prospects. If salesperson B picks a prospect at random from the same list, what is the probability that the prospect has not yet received a call from salesperson A?

(A) .375
(B) .45
(C) .55
(D) .625
(E) .75

20. If \( y - \sqrt{11} \) is negative, what is the greatest possible integer value for \( y \)?

(F) 1
(G) 2
(H) 3
(J) 4
(K) 5

21. The circumference of a circular garden is 20 meters. What is the radius, in meters, of the garden?

(A) \( 20\pi \)
(B) \( 40\pi \)
(C) \( \frac{2\sqrt{5}}{\pi} \)
(D) \( \frac{10}{\pi} \)
(E) \( \frac{20}{\pi} \)

22. For all positive \( a, b, \) and \( c \),

\[ \left( \frac{b+c}{c^2} \right) \left( \frac{a^2+b^2-c^2}{b^3} \right) = ? \]

(F) \( \frac{b}{ac} \)
(G) \( \frac{9bc}{a} \)
(H) \( \frac{9b}{a^3c^3} \)
(J) \( \frac{bc}{9a} \)
(K) \( \frac{b}{9a^2c^2} \)

23. A truck uses \( \frac{3}{7} \) of a gallon of diesel fuel for each mile it travels. How many miles can the truck go with a full 300 gallon fuel tank?

(A) 128 \( \frac{4}{7} \)
(B) 210
(C) 300
(D) 540
(E) 700
24. Which of the following states the complete solution for the quadratic equation \( x^2 - 4x = 5 \)?

(F) \( x = -5 \) or \( x = 1 \)
(G) \( x = -2 \) or \( x = 3 \)
(H) \( x = -1 \) or \( x = 5 \)
(J) \( x = 1 \) or \( x = 4 \)
(K) \( x = 1 \) or \( x = 5 \)

25. What is the area, in square centimeters, of the figure shown below?

![Figure with dimensions 5 cm x 5 cm, 6 cm x 6 cm, and 8 cm]

(A) 48
(B) 54
(C) 60
(D) 73
(E) 88

26. Which of the following is an equation of the circle that has its center at (4,2) in the standard \((x,y)\) coordinate plane and has a diameter of 8 units?

(F) \( (x - 4)^2 + (y - 2)^2 = 16 \)
(G) \( (x - 4)^2 + (y - 2)^2 = 64 \)
(H) \( (x - 2)^2 + (y - 4)^2 = 64 \)
(J) \( (x + 4)^2 + (y + 2)^2 = 8 \)
(K) \( (x + 4)^2 - (y + 2)^2 = -64 \)

27. Which of the following is the slope-intercept form of the equation of the line that passes through the point (4,0) in the standard \((x,y)\) coordinate plane and is perpendicular to the line \( y = 2x + 3 \)?

(A) \( y = -2x + 8 \)
(B) \( y = -\frac{1}{2}x + 2 \)
(C) \( y = -\frac{1}{2}x + 4 \)
(D) \( y = \frac{1}{2}x - 2 \)
(E) \( y = \frac{1}{2}x - \frac{1}{3} \)

28. For all \( a \) and \( b \) where

\[ (\sqrt{a^2 - b^2}) (\sqrt{a} - b) \]

is defined, the expression is equivalent to

(F) \( (a - b)(\sqrt{a} - b) \)
(G) \( (a - b)(\sqrt{a} + b) \)
(H) \( (a - b)^2 \)
(J) \( a^3 - b^3 \)
(K) \( \sqrt{a^3 - b^3} \)

29. A certain punch recipe calls for mixing cranberry juice and apple juice in a constant proportion. If 42 ounces of cranberry juice are needed to be mixed with 30 ounces of apple juice, how many ounces of cranberry juice would be needed to mix with 25 ounces of apple juice?

(A) 30
(B) 32.5
(C) 35
(D) 37.5
(E) 40
30. The diagonally opposite corners of a square have coordinates of (–1, 2) and (5, 2) in the standard \((x, y)\) plane. Which of the following represents the coordinates of one of the other corners of the square?

(F) \((5 - 3\sqrt{2}, 2 - 3\sqrt{2})\)

(G) \((5 - 3\sqrt{2}, 2 + 3\sqrt{2})\)

(H) \((-1, -2)\)

(J) \((1, 2)\)

(K) \((2, -1)\)

31. Which of the following represents a simplification of the inequality \(5 - x > 10 - 3(x - 2)\)?

(A) \(x < -\frac{1}{2}\)

(B) \(x > -\frac{1}{2}\)

(C) \(x < \frac{1}{4}\)

(D) \(x < \frac{11}{2}\)

(E) \(x > \frac{11}{2}\)

32. If the lengths of the sides of the triangle below are shown in centimeters, how many centimeters long is \(AC\)?

(F) 4

(G) 7

(H) 9

(J) \(\sqrt{91}\)

(K) \(\sqrt{109}\)

33. If \((2x + a)(2x + b) = 4x^2 - 4x + ab\), then \(a + b = ?\)

(A) –4

(B) –2

(C) –1

(D) 2

(E) 4

34. Two 45°-45°-90° triangles are shown below. The smaller triangle has legs each 2 inches long and a hypotenuse \(x\) inches long. If the hypotenuse of the larger triangle is \(2\sqrt{2}\) inches long, what is the perimeter of the larger triangle, in inches?

(F) \(4 + 2\sqrt{2}\)

(G) \(4 + 4\sqrt{2}\)

(H) \(8 + 4\sqrt{2}\)

(J) \(8 + 8\sqrt{2}\)

(K) \(16 + 8\sqrt{2}\)

35. If \(\log x = 5\), \(x = ?\)

(A) 10

(B) 16

(C) 25

(D) 32

(E) 64
36. In the figure below, the lengths of \( \overline{AB} \), \( \overline{AD} \), and \( \overline{BC} \) are 5 inches, 4 inches, and 13 inches, respectively. What is the area, in square inches, of triangle \( BCD \)?

(A) 12
(B) 20
(C) 26
(D) 30
(E) 40

37. In a certain talent contest, contestants are rated on a scale of 1 to 10 in each of the 3 rounds of competition. In order to determine the contestants’ final standing, a 1 to 10 point average score is determined by weighting the scores from the second round twice as heavily as those from the first round and weighting the scores from the third round twice as heavily as those from the second round. If \( S_1 \), \( S_2 \), and \( S_3 \) represent the scores from the first, second, and third rounds, respectively, which of the following expressions gives a contestant’s weighted average?

(A) \( \frac{S_1 + S_2 + S_3}{3} \)
(B) \( \frac{S_1 + 2S_2 + 2S_3}{3} \)
(C) \( \frac{S_1 + 2S_2 + 3S_3}{6} \)
(D) \( \frac{S_1 + 2S_2 + 4S_3}{3} \)
(E) \( \frac{S_1 + 2S_2 + 4S_3}{7} \)

38. In the figure below, \( \angle DCE \) measures 60° and \( ABCE \) is a rectangle. What is the area, in square inches, of quadrilateral \( ABCD \)?

(F) \( 48 + 18\sqrt{3} \)
(G) \( 40 + 15\sqrt{3} \)
(H) \( 24 + 36\sqrt{3} \)
(J) \( 66\sqrt{3} \)
(K) \( 72 \)

39. Which of the following is an equation of the circle shown below in the standard \((x,y)\) coordinate plane?

(A) \( (x - 4)^2 + (y - 2)^2 = 10 \)
(B) \( (x + 4)^2 + (y + 8)^2 = 16 \)
(C) \( x^2 + (y - 5)^2 = 16 \)
(D) \( x^2 + (y - 3)^2 = 25 \)
(E) \( x^2 + (y + 3)^2 = 25 \)
40. In the right triangle below, if \( \sin \angle X = \frac{1}{2} \), what is the value of \( \cos \angle Y \)?

\[
\begin{align*}
&\text{(F) } \frac{x}{3} \\
&\text{(G) } \frac{1}{2} \\
&\text{(H) } \frac{\sqrt{3}}{2} \\
&\text{(J) } \frac{2\sqrt{2}}{3} \\
&\text{(K) } \sqrt{3}
\end{align*}
\]

41. A line passes through the points (3,2) and (6,3) in the standard (x,y) coordinate plane. Which of the following points is also on this line?

\[
\begin{align*}
&\text{(A) } (4,6) \\
&\text{(B) } (9,5) \\
&\text{(C) } (10,5) \\
&\text{(D) } (12,6) \\
&\text{(E) } (15,6)
\end{align*}
\]

42. In the standard (x,y) coordinate plane, which of the following is the center of the ellipse \( 2(x + 3)^2 + 3(y - 4)^2 = 15 \)?

\[
\begin{align*}
&\text{(F) } (-3,4) \\
&\text{(G) } (-2,-3) \\
&\text{(H) } (3,-4) \\
&\text{(J) } (4,3) \\
&\text{(K) } (6,-12)
\end{align*}
\]

43. If \( \sin A = x \), which of the following expressions is equal to \( x \) at all points for which it is defined?

\[
\begin{align*}
&\text{(A) } (1 - \cos^2 A) \\
&\text{(B) } (\cot A)(\cos A) \\
&\text{(C) } (\tan A)(\cos A) \\
&\text{(D) } \csc A - 1 \\
&\text{(E) } \frac{\sec A}{\tan A}
\end{align*}
\]

44. The graph below of a line in the standard (x,y) coordinate plane corresponds to which of the following equations?

\[
\begin{align*}
&\text{(F) } y - 4x = 6 \\
&\text{(G) } 2y - 3x = 8 \\
&\text{(H) } 2y - 3x = 12 \\
&\text{(J) } 4y - 6x = 15 \\
&\text{(K) } 6y - 4x = 18
\end{align*}
\]
45. In the figure below, $\overline{AB}$ and $\overline{AD}$ each are 4 meters long. If triangle $BCD$ is equilateral, what is its area, in square meters?

46. A large cube is made up of 27 equal smaller cubes. If the edge of each smaller cube has a length of 3 inches, what is the volume of the larger cube, in cubic inches?

47. What positive value of $a$ “completes the square” in the equation $9x^2 + ax + 16$?

48. For what values of $x$ is $2x^2 + 5x - 3$ negative?

49. The 20th digit to the right of the decimal point when $\frac{1}{7}$ is written as a decimal is how much greater than the 20th digit to the right of the decimal point when $\frac{7}{15}$ is written as a decimal?

50. In the figure below, triangles $ABC$, $DBF$, and $EGF$ are all equilateral. If $\overline{AD}$ is twice as long as $\overline{BD}$, and $\overline{EG}$ is one half as long as $\overline{BD}$, then what is the ratio of the area of triangle $EGF$ to the area of triangle $ABC$?
51. The figure below is a regular octagon. What is the combined measure of all of the indicated angles?

(A) 720°
(B) 960°
(C) 1,080°
(D) 1,220°
(E) 1,440°

52. If the graph of \( \sin \theta \) is altered by having its amplitude multiplied by 6 and its period cut in half, then the new graph would be equivalent to the graph of which of the following expressions?

(F) \( 6\sin \frac{\theta}{2} \)
(G) \( 6\sin 2\theta \)
(H) \( 3\sin \frac{\theta}{2} \)
(J) \( 3\sin 2\theta \)
(K) \( \frac{1}{3}\sin \theta \)

53. If \( x^2 = ax + 12a^2 \), what are the 2 solutions for \( x \) in terms of \( a \)?

(A) \(-6a\) and \(-2a\)
(B) \(-4a\) and \(-3a\)
(C) \(-4a\) and \(3a\)
(D) \(-3a\) and \(4a\)
(E) \(-2a\) and \(6a\)

54. For values of \( A \) where \( \sin A, \cos A, \) and \( \tan A \) are all defined, \( \frac{\cos^2 A}{\sin^2 A} \cdot \tan A = ? \)

(F) 1
(G) \( \tan^3 A \)
(H) \( \cos^2 A \)
(J) \( \sin A \)
(K) \( \cot A \)

55. In the figure below, \( ABCD \) is a rhombus, a parallelogram with sides of equal length. If the diagonals \( AC \) and \( BD \) bisect each other and are 12 centimeters and 8 centimeters long, respectively, what is the perimeter of the rhombus, in centimeters?

(A) 20
(B) \( 8\sqrt{13} \)
(C) 40
(D) \( 16\sqrt{13} \)
(E) It cannot be determined.

56. For \( y \neq 3 \), what is the complete solution of the inequality \( \frac{1}{y-3} < 3 \)?

(F) \( y > 4 \)
(G) \( y > 12 \)
(H) \( y < -1 \)
(J) \( y < 3 \)
(K) \( y < 3 \) or \( y > 4 \)
57. A globe of radius 8" is to be placed into a square box for shipment. The globe’s stand will be in a separate container. What is the minimum inside volume that the box can be? (The formula for the volume of a sphere is $4\pi r^3$.)
   (A) 32\pi \text{ cu. in.}
   (B) 512\pi \text{ cu. in.}
   (C) 2,048\pi \text{ cu. in.}
   (D) 4,096\pi \text{ cu. in.}
   (E) 4,096 \text{ cu. in.}

58. At a carnival weight-guessing booth, Jason and his mother got on the scale and weighed a combined 285 pounds. When Jason and his father got on the scale the combined weight was 345 pounds. Finally, Jason’s mother and father got on the scale and weighed 310 pounds. If Jason, his mother, and his father had all gotten on the scale together, what would their weight have been, in pounds?
   (F) 420
   (G) 470
   (H) 510
   (J) 590
   (K) 940

59. For which of the following values of c will there be only 1 distinct real solution to the equation $3x^2 + 8x + c = 0$?
   (A) 0
   (B) $\frac{4\sqrt{3}}{3}$
   (C) $3\frac{1}{8}$
   (D) $4\frac{1}{2}$
   (E) $5\frac{1}{3}$

60. In the triangle below, $\overline{BC}$ has a length of a inches. If the slope of $\overline{AB}$ is b, which of the following expressions gives the length, in inches, of $\overline{AC}$?

   (F) $\frac{a}{b}$
   (G) $\frac{b}{a}$
   (H) $ab$
   (J) $a^2 + b^2$
   (K) $\frac{\sqrt{a^2 + b^2}}{b}$

STOP

END OF SECTION 2. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
James Cushat-Prinkly was a young man who had always had a settled conviction that one of these days he would marry; up to the age of thirty-four he had done nothing to justify that conviction. He liked and admired a great many women collectively and dispassionately without singling out one for special matrimonial consideration, just as one might admire the Alps without feeling that one wanted any particular peak as one's own private property. His lack of initiative in this matter aroused a certain amount of impatience among the sentimentally-minded women-folk of his home circle; his mother, his sisters, an aunt-in-residence, and two or three intimate matronly friends regarded his dilatory approach to the married state with a disapproval that was far from being inarticulate.

His most innocent flirtations were watched with the straining eagerness which a group of unexercised terriers concentrates on the slightest movements of a human being who may be reasonably considered likely to take them for a walk. No decent-souled mortal can long resist the pleading of several pairs of walk-beseeching dog-eyes; James Cushat-Prinkly was not sufficiently obstinate or indifferent to home influences to disregard the obviously expressed wish of his family that he should become enamoured of some nice marriageable girl, and when his Uncle Jules departed this life and bequeathed him a comfortable little legacy it really seemed the correct thing to do to set about discovering someone to share it with him.

The process of discovery was carried on more by the force of suggestion and the weight of public opinion than by any initiative of his own; a clear working majority of his female relatives and the aforesaid matronly friends had presented Joan Sebastable as the most suitable young woman in his range of acquaintance to whom he might propose marriage, and James became gradually accustomed to the idea that he and Joan would go together through the prescribed stages of congratulations, present-receiving, Norwegian or Mediterranean hotels, and eventual domesticity. It was necessary, however, to ask the lady what she thought about the matter; the family had so far conducted and directed the flirtation with ability and discretion, but the actual proposal would have to be an individual effort.

Cushat-Prinkly walked across the Park towards the Sebastable residence in a frame of mind that was moderately complacent. As the thing was going to be done he was glad to feel that he was going to get it settled and off his mind that afternoon. Proposing marriage, even to a nice girl like Joan, was a rather irksome business, but one could not have a honeymoon in Minorca and a subsequent life of married happiness without such preliminary. He wondered what Minorca was really like as a place to stop
in; in his mind's eye it was an island in perpetual half-mourning, with black or white Minorca hens running all over it. Probably it would not be a bit like that when one came to examine it. People who had been in Russia had told him that they did not remember having seen any Muscovy ducks there, so it was possible that there would be no Minorca fowls on the island.

His Mediterranean musings were interrupted by the sound of a clock striking the half-hour. Half-past four. A frown of dissatisfaction settled on his face. He would arrive at the Sebastable mansion just at the hour of afternoon tea. Joan would be seated at a low table, spread with an array of silver kettles and cream-jugs and delicate porcelain tea-cups, behind which her voice would tinkle pleasantly in a series of little friendly questions about weak or strong tea, how much, if any, sugar, milk, cream, and so forth. “Is it one lump? I forgot. You do take milk, don’t you? Would you like some more hot water, if it’s too strong?”

Cushat-Prinkly had read of such things in scores of novels, and hundreds of actual experiences had told him that they were true to life. Thousands of women, at this solemn afternoon hour, were sitting behind dainty porcelain and silver fittings, with their voices tinkling pleasantly in a cascade of solicitous little questions. Cushat-Prinkly detested the whole system of afternoon tea. According to his theory of life a woman should lie on a divan or couch, talking with incomparable charm or thinking unutterable thoughts, or merely silent as a thing to be looked on, and from behind a silken curtain a servant should silently bring in a tray with cups and dainties, to be accepted silently, as a matter of course, without drawn-out chatter about cream and sugar and hot water. If one’s soul was really enslaved at one’s mistress’s feet how could one talk coherently about weakened tea?

1. Which of the following places is mentioned as a potential location for a honey-moon?
   (A) Minorca
   (B) Russia
   (C) Africa
   (D) The Alps

2. The author compares James Cushat-Prinkly’s mother, sisters, aunt, and female friends to
   (F) a circle of energy.
   (G) a comfortable park.
   (H) an impressive mountain range.
   (J) a group of anxious dogs.

3. It is most reasonable to infer that James does not like afternoon tea time primarily because
   (A) he is slightly allergic to many types of tea.
   (B) it goes against his view of how women should act.
   (C) the woman he is courting cannot remember his tea preferences.
   (D) he does not like the woman he is going to meet.

4. Given the way he is presented in the passage, James Cushat-Prinkly can best be described as
   (F) young and belligerent.
   (G) ignorant of his relatives’ wishes.
   (H) passionate and enthused about marriage.
   (J) not eager to propose marriage.
5. The third paragraph suggests that up until this time, James’ courtship of Joan Sebastable has been
(A) disregarded by members of James’ family.
(B) found unsuitable by all of James’ female friends.
(C) the only way James can make Uncle Jules proud.
(D) organized primarily by people other than James.

6. Which of the following conclusions about James’ future plans with Joan is best supported by the details in the passage?
(F) After getting married, James plans on taking a honeymoon and then settling down.
(G) Joan and James plan on moving to the island of Minorca in the Mediterranean.
(H) James plans on marrying Joan as soon as he can be assured she is not after his money.
(J) James has no plans to propose to Joan.

7. What does the narrator suggest about James’ previous associations with women?
(A) Though he has liked many women, he never felt a strong enough attraction to be bound to one particular woman.
(B) Despite his attraction to various women, James did not wish to upset his delicate family with a marriage.
(C) James has asked numerous women for their hand in marriage, only to be denied because of his age.
(D) James’ demanding job has kept him from closely associating with women.

8. James imagines which of the following characterizations of Joan during afternoon tea?
(F) Her constant barrage of trivial questions is irritating.
(G) Her charming manner is incompatible with her common looks.
(H) Her lack of tact keeps her from being a good hostess.
(J) Her pleasant conversation is designed to avoid the topic of marriage.

9. One can reasonably infer from this passage that James is going to propose to Joan Sebastable because
(A) she is the one thing in the world he has loved.
(B) she is the only women who can stand his mood swings.
(C) James is trying to get over his first failed marriage.
(D) James feels family obligations to get married.

10. From what sources does James draw his impressions of what afternoon tea is like?
(F) Movies he has seen
(G) Books and personal experience
(H) Conversations with his family
(J) The opinions of his uncle

Passage II—SOCIAL SCIENCE

This passage is adapted from a collection of essays concerning pertinent social issues.

Why has affirmative action, once advocated as a relatively painless method of correcting social injustice in America, been almost universally abandoned? What happened to our collective desire to eliminate highly visible and agonizing hiring disparities among the races? Without a doubt it is because affirmative action programs have been vilified as bastions of “reverse discrimination.” Because affirmative action programs in the 1970s and 1980s used timetables
and hiring quotas to help balance the races in professions that had obvious disparities, members of the Caucasian majority felt they were being treated as less than human. This, some claimed, simply repeated the errors of discrimination, and even worse this new “reverse discrimination” was written into law.

There is no denying that most Americans would like to see equality in hiring practices. Opinion polls and common sense lead us to this transparent conclusion. But what scares Americans even more than racism is the loss of individuality. Being treated like a number and manipulated by an insensitive system: this drives Americans a little crazy, and likewise, drives them to the voting booths. As Bob Dole said during the 1994 campaign, “Why did 62 percent of white males vote Republican in 1994?” I think it’s because of things like [affirmative action], where sometimes the best-qualified person does not get the job because he or she may be of one color, and I’m beginning to believe that may not be the way it should be in America.”

Granted, Mr. Dole may be fishing for votes here, but his point is well taken. A vast majority of Americans, even minorities, do not think that affirmative action policies are effective ways of bettering society.

But the point that Dole and many conservative thinkers miss is that although affirmative action has, on the whole, failed to ingrain itself in our social order, the impetus for affirmative action—a belief that hiring practices should be equal and fair, and that currently they are not—is still strongly subscribed to by almost all Americans. Just because quota-based affirmative action policies have not been accepted does not mean that we should give up on the goal of improving equality in the workplace.

Democracy, we must remember, was an experiment in government. Conjured up by social philosophers such as Rene Descartes and John Locke, the experiment of Democracy was set into motion in the late 1700s in North America with the stipulation that the experiment should remain that: an experiment. In other words, the people conducting the experiment should be able to react to changes in their world and alter the rudimentary configuration of the experiment accordingly. To this end, the founders of this grand bit of research into human governance gave their sons and grandsons the right, indeed the obligation, to create laws, make amendments to the rules of the experiment, and even change the basic drafted rules of the experiment (the Constitution) if necessary. We should embrace this responsibility and recognize that in order to meet the end goal of the experiment—a society that equally promotes life, liberty, and the pursuit of happiness—we will have to constantly make adjustments to our laws. If a law or concept does not work out, or creates more problems than it solves, that does not mean we can abandon our responsibility. Like a son or daughter who must take over the family business, we must take over this business of America and make it profitable. Of course, the profit we seek is not monetary, but nevertheless it is just as tangible. Our profit is equality.

Our society is not a utopia; people of color still do not hold as many high-paying jobs as Caucasians do proportional to the size of their respective populations. Though we supposedly live in a meritocracy, the lack of regulations to promote minorities keeps many highly skilled people of color from finding gainful employment.

At one time in our nation, segregation was seen as a way to keep our society from fragmenting. Jim Crow laws kept blacks and whites supposedly “separate but equal” for decades. In 1896 the Supreme Court reaffirmed that Jim Crow laws were constitutionally valid in Plessy v. Ferguson. But in separate rulings in 1952 and 1954, the Court overturned its earlier decision and proclaimed that “separate is inherently
unequal.” However, it wasn’t until 1961, and President Kennedy’s Executive Order 10952, that federal contractors were ordered to “take affirmative action to ensure that applicants are employed, and employees are treated during their employment, without regard to race, creed, color or national origin.” It is our responsibility to continue this tradition of expanded equality. To achieve this equality, some action must be taken. Ask Kennedy, ask Rosa Parks, and ask yourself; what action must we take to affirm a better world.

11. The main point of the third paragraph is that although affirmative action has been rejected as a method of solving racial hiring disparities, it is still
(A) possible that future generations will implement affirmative action policies.
(B) difficult to understand why affirmative action policies were used in the first place.
(C) important that we attempt to increase equality in the workplace.
(D) troublesome that many conservatives still reject affirmative action.

12. The author of the passage finds Bob Dole’s statement (paragraph 2) pertinent but feels that it is also an example of
(F) affirmative action not working correctly.
(G) how politicians don’t deal with the actual issues.
(H) the way conservatives are out of touch with minorities.
(J) Bob Dole trying to sway voters.

13. The author implies that one of the reasons Americans have rejected affirmative action is because
(A) most Americans don’t care about equality in the workplace.
(B) it made Americans feel as if they were losing their individuality.
(C) affirmative action was helping only certain minorities.
(D) Caucasians were not aware of how affirmative action was positively affecting the workplace.

14. The author states that in 1952 and 1954, the Supreme Court overturned
(F) Kennedy’s Executive Order.
(G) affirmative action.
(H) Plessy v. Ferguson.
(J) concepts of liberty.

15. The author implies that segregation was originally designed to keep society from
(A) discriminating.
(B) regulating.
(C) fragmenting.
(D) being equal.

16. The author suggests that most Americans would like to see equality in the workplace and supports this statement by citing
(F) Bob Dole’s popularity.
(G) polls and common sense.
(H) examples of practical affirmative action programs.
(J) Jim Crow laws.

17. As it is used in line 93, the word profitable is used to indicate the idea of
(A) equality.
(B) money.
(C) happiness.
(D) politics.
18. According to the author, the experiment of Democracy was instituted in America with the assumption that
(F) the Constitution would never be altered.
(G) without reasoned debate, the experiment would fail.
(H) the rules of the experiment could be changed.
(J) skilled people would head the experiment.

19. Based on the passage, it may be reasonably inferred that affirmative action was not supported by
I. Robert Kennedy.
II. Bob Dole.
III. most Americans.
(A) I only
(B) II only
(C) I and II
(D) II and III

20. The author’s comment that “our society is not a utopia” refers to
(F) young people trying to take over a difficult business.
(G) continued racial discrimination in the workplace.
(H) the use of the term meritocracy.
(J) conflicting Supreme Court rulings.

Passage III—HUMANITIES

This passage is adapted from Guide to Life and Literature of the Southwest by Frank Dobie.

In using the word intellectual, one lays himself liable to the accusation of having forsaken democracy. For all that, “fundamental brainwork” is behind every respect-worthy piece of writing, whether it be a lightsome lyric that seems as careless as a redbird’s flit or a formal epic, an impressionistic essay or a great novel that measures the depth of human destiny. Nonintellectual literature is as nonexistent as education without mental discipline, or as “character building” in a school that is slovenly in scholarship. Billboards along the highways of Texas advertise certain towns and cities as “cultural centers.” Yet no chamber of commerce would consider advertising an intellectual center. The American populace has been taught to believe that the more intellectual a professor is, the less common sense he has; nevertheless, if American democracy is preserved it will be preserved by thought and not by physics. Editors of all but a few magazines of the country and publishers of most of the daily newspapers reinforce this attitude by crying out for brightness and vitality while at the same time shutting out critical ideas. They want intellect, but want it petrified. Happily, the publishers of books have not yet reached that form of delusion.

In 1834, Davy Crockett’s Autobiography was published. It is one of the primary social documents of America. It is as much Davy Crockett, whether going ahead after bears in a Tennessee canebrake or going ahead after General Andrew Jackson in Congress, as the equally plain but also urbane Autobiography of Franklin is Benjamin Franklin. It is undiluted regionalism. It is provincial not only in subject but in point of view.

No provincial mind of this day could possibly write an autobiography or any other kind of book equal in value to Crockett’s “classic in homespun.” In his time, Crockett could exercise intelligence and still retain his provincial point of view. Provincialism was in the air over his land. In these changed times, something in the ambient air prevents any active intelligence from being unconscious of lands, peoples, struggles far beyond any province.

Biographies of regional characters, stories turning on local customs, novels
based on an isolated society, books of history and fiction going back to provincial simplicity will go on being written and published. But I do not believe it possible that a good one will henceforth come from a mind that does not in outlook transcend the region on which it is focused. That is not to imply that the processes of evolution have brought all parts of the world into such interrelationships that a writer cannot depict the manners and morals of a community up Owl Hoot Creek without enmeshing them with the complexities of the Atlantic Pact. Awareness of other times and other wheres, not insistence on that awareness, is the requisite.

James M. Barrie said that he could not write a play until he got his people off on a kind of island, but had he not known about the mainland he could never have delighted us with the islanders—Islanders, after all, for the night only. Patriotism of the right kind is still a fine thing; but, despite all gulfs, canyons, and curtains that separate nations, those nations and their provinces are all increasingly interrelated.

Nothing is too trivial for art, but good art treats nothing in a trivial way. Nothing is too provincial for the regional writer, but he cannot be provincial-minded toward it. Being provincial-minded will prevent him from being a representative or skillful interpreter. Horace Greeley said that when the rules of the English language got in his way, they did not stand a chance. We may be sure that if by violating the rules of syntax Horace Greeley sometimes added forcefulness to his editorials, he violated them deliberately and not in ignorance. Luminosity is not stumbled into. The richly savored and deliciously unlettered speech of Thomas Hardy’s rustics was the creation of a master architect who had looked out over the ranges of fated mankind and looked also into hell. Thomas Hardy’s ashes were placed in Westminster Abbey, but his heart, in accordance with a provision of his will, was buried in the churchyard of his own village. A provincial writer must, above all, remain true to his foundations.

21. As it is used in line 42, the word undiluted most nearly means
(A) trapped.
(B) pure.
(C) forsaken.
(D) trivial.

22. The author’s assertions about Davy Crockett’s Autobiography are supported by all of the following statements EXCEPT that Autobiography
(F) was a work limited in its point of view.
(G) showed Crockett’s intelligence.
(H) is not considered an important work.
(J) was published in 1834.

23. One of the author’s main points is that it is currently impossible to write a good regional biography or story without
(A) having a sense of how real people talk and act.
(B) several years of sustained effort and rewriting.
(C) violating the trust that people place in an author as chronicler.
(D) some awareness of the interconnected world we live in.

24. The main emphasis of the first paragraph regarding the use of the word intellectual is on
(F) why schools no longer attempt to create intellectuals.
(G) changing the way people use the word intellectual.
(H) how to make magazines and newspapers more intellectual.
(J) how all good writing is in some sense intellectual.
25. As it is used in line 27, the phrase *crying out* most nearly means
   (A) ignoring.
   (B) advocating.
   (C) paying.
   (D) learning.

26. The example of Horace Greeley is presented in the sixth paragraph in order to reinforce the notion that
   (F) one must have general knowledge in order to effectively interpret specific things.
   (G) no matter how hard young writers try, they will always depict characters from a provincial viewpoint.
   (H) good art deals with issues that are not provincial in nature.
   (J) writers must follow accepted rules of grammar in order to communicate sensibly.

27. The author claims that true education cannot occur without
   (A) mental discipline.
   (B) strong morals.
   (C) an open-minded approach.
   (D) bowing to local customs.

28. The author contends that magazine and newspaper editors around the country do not wish to publish
   (F) autobiographies.
   (G) provincial views.
   (H) critical views.
   (J) regional stories.

29. The description of Thomas Hardy’s unique burial, in which his heart was buried in his village and his body was buried in Westminster Abbey, is intended to show
   (A) how Hardy never felt comfortable with his church.
   (B) that Hardy felt a strong connection with his provincial roots.
   (C) the lack of faith that Hardy had that his heirs would fulfil his requests.
   (D) how intelligence is in direct opposition with provincialism.

30. The author believes that James M. Barrie could not have written so well about characters on a hypothetical “island” if Barrie had not been aware of
   (F) Thomas Hardy.
   (G) the effects of patriotism.
   (H) what living on an island was like.
   (J) the “mainland.”

**Passage IV—NATURAL SCIENCE**

This passage is adapted from a magazine article about the evolution of birds.

For more than a century, paleontologists have been in heated debate about how birds evolved. This debate still fills the journals and classrooms of those who study the present for clues to the distant past.

While it has been popularly reported that birds descended from diminutive carnivorous dinosaurs like *Archaeopteryx*, there is a problem with this theory. About 65 million years ago, at the end of the Cretaceous Period, *Archaeopteryx*, along with thousands of other dinosaur species, abruptly became extinct.

So, what happened to birds during this great extinction? Did many species survive the extinction, or are all modern birds descended from a few species that were able to scratch out livings on the
coasts of ancient continents? The answer to this question would seem to lie in the fossil record. However, the fossil record seems to be in conflict with the genetic evidence extracted from modern birds.

The general consensus among evolutionary biologists is that modern bird species developed before the Cretaceous Period extinction occurred. Evidence for this conjecture comes from the distribution of bird groups in the modern world. Ostriches, rheas and emus all belong to an order of birds called the ratites, yet ostriches come from Africa, rheas come from South America, and emus are found in Australia. The ratites cannot fly, so the assumption has been that at some point in the distant past a common ancestor to modern ratites lived on the supercontinent Gondwanaland before it fragmented.

It is believed that about 80 million years ago all of the continents were pressed together to form a “supercontinent” called Gondwanaland. As this gigantic landmass fragmented over the next 80 million years, animals of the same species and order were trapped on different continents and each group evolved along different paths.

Alan Fediccia, an ornithologist at the University of North Carolina, believes that he has found evidence that disputes that view. He believes that only one small group of bird fossils from the Cretaceous looks like modern birds. These birds, which Fediccia believed lived in a narrow ecological niche along shorelines during the Cretaceous, look like modern stone curlews.

Along with this discovery, Fediccia points out that there are numerous examples of enantiornithine fossils from the Cretaceous Period. The name enantiornithine means “opposite bird” and refers to the fact that these “birds” had strange elongated foot bones, fleshy tails like lizards, and teeth. This hints that these “birds” were not the ancestors of modern birds. The enantiornithine are found in the fossil record right after Archaeopteryx originated, and like the Archaeopteryx they completely died out in the vast Cretaceous extinction.

This, says Fediccia, suggests the only birds that survived the Cretaceous extinction were shoreline birds that lived on hardy marine life. Fediccia assumes, as many scientists do, that the Cretaceous extinction was precipitated by a massive asteroid impact that darkened the sky and brought about a sudden global climatic change. Only these shore birds, Fediccia argues, were able to live through this massive cooling of the planet by feeding on marine animals like crabs that were able to adjust to the rapidly chilling environment.

After the asteroid hit, animals that were able to survive had to evolve swiftly, and birds, according to Fediccia and other researchers, did just that. Over the next 10 million years water and land-birds jump into the fossil record: penguins, flamingos, parrots, hawks, owls. Ancestors of these birds are not found in the Cretaceous fossil record, which means that in all probability these birds did not evolve until after the extinction.

One disclaimer should be made: any theory about the distant past can be upset by one discovery. Every fossilized bird that is discovered either slightly supports a theory or completely capsizes it.

In fact, other scientists believe that the only reason no fossils of Cretaceous birds have been found is because paleontologists just haven’t found them yet. These scientists believe that until thorough surveys of Cretaceous fossil gold mines like Antarctica and New Zealand are conducted, it is premature to advance theories that depend on the non-existence of most birds in the Cretaceous Period.

But what really calls Fediccia’s theory into doubt, some biologists contend, is genetic evidence. As a species evolves, its genes accumulate various mutations. Scientists have been able to measure how these mutations differ be-
33. According to the passage, a good place to look for fossils from the Cretaceous Period is
   I. New Zealand.
   II. South America.
   III. Gondwanaland.
   (A) I only
   (B) II only
   (C) I and II
   (D) I and III

34. According to Alan Fediccia, shoreline birds were able to survive in a radically altered environment (paragraph 8) because they could
   (F) fly faster and further than their land-based counterparts.
   (G) consume marine creatures that adjusted quickly to the changing environment.
   (H) easily attract mates using their simple vocal mechanisms.
   (J) avoid extinction by finding hovels in geologically immature regions.

35. Which of the following best describes the conclusion of the passage as to what more is needed to resolve the debate about how birds evolved?
   (A) More genetic and fossil data are needed before an agreeable theory can be advanced.
   (B) What is needed is a theory that explains the appearance of birds before the end of the Cretaceous Period.
   (C) Any more genetic or fossil data would further muddle the issue about the origin of modern birds.
   (D) Biologists would greatly benefit from a close study of the most well-preserved fossil specimens.
36. It can be inferred from the passage that all of the following statements about Gondwanaland are true EXCEPT that it began to fragment around 80 million years ago.
(F) began to fragment around 80 million years ago.
(G) was a gigantic landmass composed of other continents.
(H) is believed to have been the home to a common ancestor of modern ratites.
(J) began to fragment after the end of the Cretaceous Period.

37. The main reason many scientists doubt Fediccia's theory of bird evolution is because genetic evidence suggests that
(A) it is unlikely that one species could evolve so quickly without massive inbreeding and, as a result, reduced intelligence.
(B) when a species evolves, it must choose one direction, and birds have evolved into countless forms.
(C) Ostriches, emus, and rheas are in fact not descended from a common ancestor.
(D) it takes much longer than 10 million years to accumulate the genetic mutations currently found in the DNA of various bird species.

38. The passage suggests that the debate about how birds evolved is
(F) easily resolved.
(G) poorly understood.
(H) based on circumstantial evidence.
(J) at least 100 years old.

39. If a group of fossils was discovered that showed that before the Cretaceous Period Extinction, there were already distinct species of penguins, parrots, and owls, this would support the theory
I. advanced by Alan Fediccia in the passage.
II. that these birds evolved from enantiornithine.
III. that these birds did not evolve from ancient shorebirds.

(A) II only
(B) III only
(C) I and II
(D) I and III

40. It can reasonably be inferred from the passage that Alan Fediccia believes that enantiornithine are NOT the ancestors of modern birds because enantiornithine
(F) were extinct long before Archaeopteryx originated.
(G) are physically different from modern fowl.
(H) took more that 10 million years to evolve fully.
(J) are difficult to find in the fossil record of the Cretaceous.
 SECTION 4: SCIENCE REASONING

40 Questions • Time—35 Minutes

Directions: This test consists of seven passages, each followed by several questions. Read each passage, select the correct answer for each question, and mark the oval representing the correct answer on your answer sheet. You may NOT use a calculator on this test.

Passage I

Biochemical tests are used to identify the presence of organic molecules in solution. To perform a biochemical test, an agent is added to a solution, and, if a particular organic molecule is present, the agent will react with the organic molecule. The reaction can be seen because the agent changes color as a result of chemical bonds being broken and reformed. If no organic molecule is present, then no chemical bonds are broken upon the addition of the agent.

Three common biochemical tests are the Benedict’s test, Iodine test, and Biuret test. A positive result for a Benedict’s test is obtained only if the agent added changes from clear blue to a cloudy greenish, yellow, orange, red, or brown. A positive Iodine test is indicated only if the agent added changes from yellow to a deep blue-black color. A positive Biuret test is indicated only when the agent added changes from light blue to a purple or pink color. Each test is used to identify exactly one of the following types of organic molecules: monosaccharides, polysaccharides, or proteins.

Experiment 1

The three tests were performed on known organic molecules to determine which biochemical test identifies which organic molecule. Individual test tubes were filled with 3 ml of only one of the following four substances: monosaccharide, polysaccharide, protein, or water. The tests were done using water as a control. Each test was performed on a different set of four test tubes with the above-mentioned substances. Table 1 summarizes the results.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Benedict’s Test Before</th>
<th>Benedict’s Test After</th>
<th>Iodine Test Before</th>
<th>Iodine Test After</th>
<th>Biuret Test Before</th>
<th>Biuret Test After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monosaccharide</td>
<td>clear</td>
<td>blue</td>
<td>clear</td>
<td>dark</td>
<td>clear</td>
<td>light</td>
</tr>
<tr>
<td>Polysaccharide</td>
<td>clear</td>
<td>orange</td>
<td>clear</td>
<td>yellow</td>
<td>clear</td>
<td>light</td>
</tr>
<tr>
<td>Protein</td>
<td>cloudy</td>
<td>purple/ cloudy</td>
<td>yellow</td>
<td>cloudy</td>
<td>purple</td>
<td>blue</td>
</tr>
<tr>
<td>Water</td>
<td>clear</td>
<td>blue</td>
<td>clear</td>
<td>yellow</td>
<td>clear</td>
<td>light</td>
</tr>
</tbody>
</table>

Experiment 2

The three biochemical tests were then applied to unknown solutions to determine the composition of the unknown solutions. The data were recorded in Table 2 on the following page.
3. Which of the following lists accurately states which tests are used to identify monosaccharide, polysaccharide, and protein, respectively?
(A) Iodine, Biuret, Benedict’s
(B) Iodine, Benedict’s, Biuret
(C) Biuret, Benedict’s, Iodine
(D) Benedict’s, Iodine, Biuret

4. Based on the results of Experiment 2, which of the following substances tested positively for monosaccharide?
(F) Solution B
(G) Solution C
(H) Solution D
(J) Solution E

5. Which of the following pairs of substances tested positively for more than one organic molecule?
(A) A and C
(B) B and D
(C) C and D
(D) B and E

6. Some of the solutions showed a change in color that was not consistent with the change expected for a positive test result. Which statement best accounts for the color changes in the non-reactive solutions?
(F) Chemical bonds are broken to change the color of the added solution.
(G) The added substances have their own distinct color that diffuses through the non-reactive solutions.
(H) Benedict solution, Iodine solution, and Biuret solution are all colorless before being added to any solution.
(J) Benedict solution, Iodine solution, and Biuret solution become colorless when added to a non-reactive solution.
Passage II

Industrial melanism, the spread of darkly colored moths and butterflies near polluted, industrial centers, was observed in the late 1840s in England. Before the 1840s, tree trunks throughout Britain were a whitish color due to the growth of lichens on the trees. These lichens are sensitive to airborne pollutants and are unable to survive near major industrial centers. In the polluted areas, the lack of lichen on the trees results in the trees being darker than in the unpolluted areas.

The peppered moth (*Biston betularia*) began to appear more and more in its melanic form in the polluted areas. In certain areas, the darker moths constituted 98% of the population. Scientists hypothesized that the cause of the decline in the light-colored moths was due to predation by birds and not a result of the pollution itself.

Scientists performed an experiment to determine the selective force that caused the appearance of the darker moths. They distributed light and melanic moths in polluted and non-polluted areas and recorded the results shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Light</th>
<th>Melanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorset, England Woodland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Released</td>
<td>496</td>
<td>473</td>
</tr>
<tr>
<td>Recaptured</td>
<td>62</td>
<td>30</td>
</tr>
<tr>
<td>Percent Recaptured</td>
<td>12.5</td>
<td>6.3</td>
</tr>
<tr>
<td>Birmingham, England Woodland (dark background)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Released</td>
<td>137</td>
<td>447</td>
</tr>
<tr>
<td>Recaptured</td>
<td>18</td>
<td>123</td>
</tr>
<tr>
<td>Percent Recaptured</td>
<td>13.1</td>
<td>27.5</td>
</tr>
</tbody>
</table>

The scientists noted that they were also able to see birds capturing a higher proportion of moths that did not match their background. Scientists were also able to determine that the change in color is due to a genetic mutation. Once the mutation occurs, the new coloration is dominant and can therefore more successfully be passed to a greater percentage of offspring.

7. How many melanic moths were recaptured from the polluted region, according to the experimental data?
(A) 18
(B) 30
(C) 62
(D) 123

8. The fact that at least 100% more moths survived if they matched the background of the trees supports which of the following hypotheses?
(F) The presence of pollution negatively affects the survival of melanic moths.
(G) The existence of lichen on trees increases the survival of all moths.
(H) Birds eat more moths that differ in color from their background trees than those moths that do not.
(J) Birds are not selective as to the moths they eat.

9. If the scientist did not observe birds capturing a greater number of moths that did not match their backgrounds, all of the following could explain the data observed EXCEPT
(A) appearance of lichen increases the likelihood for moth survival.
(B) the pollution itself causes the light moth’s difficulty with survival.
(C) a selective force selects against the melanic moths in the unpolluted area and light moths in the polluted area.
(D) too few light moths were released in the polluted areas to make a valid comparison.
10. A critic of the experiment would point out that the scientists have not adequately accounted for which of the following?

(F) With a light background, a greater percentage of light moths survived compared to the percentage of melanic moths.

(G) Light moths were recovered in approximately the same percentage regardless of background color.

(H) With a dark background, an increased percentage of melanic moths survived compared to the percentage of light moths.

(J) Over both trials, the percentage of melanic moths recovered is close to the percentage of light moths recovered.

11. The increase in the percentage of melanic moths recaptured in polluted areas is consistent with which of the following?

(A) Selection can be strong enough to nearly complete a color change in a species in a short time frame.

(B) Moths depend on lichen for survival in polluted and non-polluted areas.

(C) Pollution is the cause of the demise of the moth as a species.

(D) The survival rate for the melanic moth is the same, regardless of pollution.

12. If it were determined that, as a result of decreased pollution, the lichens were increasing in many areas, the scientists would probably suggest that

(F) the number of melanic moths would increase and the number of light moths would decrease.

(G) the number of melanic moths would decrease and the number of light moths would increase.

(H) the number of both melanic moths and light moths would remain the same.

(J) the number of both melanic moths and light moths would decrease.

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**Passage III**

Public health experts realize that educating the public about hazardous activities can be just as important as identifying those risks. One method of educating the public is by simplifying complex scientific analysis into easy-to-understand guidelines. Teaching people how to follow these guidelines allows them to avoid undue health risks.

For example, both cold and sun pose a health risk to the skin. Frostbite can result due to exposure to extreme cold and wind, and sunburn and, ultimately, skin cancer may result from prolonged exposure to ultraviolet radiation from the sun. The wind chill factor and the UV Index are guidelines used by public health experts to inform people of these two risks.

Wind chill factor is the effect that wind velocity has on temperature. The actual temperature may be quite different than the effective temperature because wind velocity will lower the effective temperature. Wind chill increases the rate of heat loss and can change effective temperature significantly.

Table 1 below summarizes the effect of wind velocity on effective temperature. Temperatures in the range of –30°C to –55°C are moderately dangerous, and temperatures in the range of –60°C to –85°C are extremely dangerous. Exposed flesh can freeze in a minute at an effective temperature of –30°C. Effective temperatures below –60°C can cause freezing within seconds.
TABLE 1

<table>
<thead>
<tr>
<th>Wind Speed (km/hr)</th>
<th>Actual Temperature (°Celsius)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>−10 −15 −20 −25 −30 −35 −40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wind Speed (km/hr)</th>
<th>Effective Temperature (°Celsius)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>−15 −20 −25 −30 −35 −40 −45</td>
</tr>
<tr>
<td>20</td>
<td>−20 −25 −35 −40 −45 −50 −55</td>
</tr>
<tr>
<td>30</td>
<td>−25 −30 −40 −45 −50 −60 −65</td>
</tr>
<tr>
<td>40</td>
<td>−30 −35 −45 −50 −60 −65 −70</td>
</tr>
<tr>
<td>50</td>
<td>−35 −40 −50 −55 −65 −70 −75</td>
</tr>
</tbody>
</table>

13. What would the effective temperature be if the actual temperature was −25°C and the wind speed was 30 km/hr?
(A) −40°C
(B) −45°C
(C) −50°C
(D) −60°C

14. On a windless day, if a skier skis down a mountain at 30 km/h, the effective temperature would be classified as moderately dangerous if the actual temperature was which of the following?
I. −10°C
II. −15°C
III. −25°C
(F) I only
(G) II only
(H) I and II
(J) II and III

15. If the wind speed were 57 km/h, what would be the approximate effective temperature at actual temperature of −23°C?
(A) −40°C
(B) −45°C
(C) −50°C
(D) −55°C

16. A hiker plans to take an overnight camping trip in the mountains in the middle of winter. If the hiker is uncertain about the wind speed on the mountain but knows that it does not exceed 50 km/hr, what is the lowest that the temperature can be without the hiker risking exposure at the moderately or extremely dangerous effective temperatures?
(F) 0°C
(G) −10°C
(H) −20°C
(J) −30°C

The UV Index is an estimate of the amount of ultraviolet radiation that hits the earth’s surface at noon at a given location. Many factors go into the calculation of the index. Latitude, season, and elevation are all used to produce the single value. These factors are then combined with local weather forecasts, since it is the amount of sunshine that breaks through any clouds that plays the most significant role in the index. All other factors being equal, altitude can also have a large impact on the UV Index. A higher altitude means less atmosphere to absorb UV rays prior to their reaching the ground. Table 2 below summarizes the classification of different UV Index levels. Higher values indicate exposure to greater levels of ultraviolet radiation and a higher level of risk for sunburn.

TABLE 2

<table>
<thead>
<tr>
<th>UV Index</th>
<th>Exposure Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2</td>
<td>Minimal</td>
</tr>
<tr>
<td>3–4</td>
<td>Low</td>
</tr>
<tr>
<td>5–6</td>
<td>Moderate</td>
</tr>
<tr>
<td>7–9</td>
<td>High</td>
</tr>
<tr>
<td>10 and greater</td>
<td>Very High</td>
</tr>
</tbody>
</table>
17. The graph above shows the number of days in a certain 30-day period for which the UV Index was at a given level. A local weather forecaster issues a warning if the UV Index falls in the high range or above. On how many days would the forecaster have issued warnings over this period?
  
(A) 7  
(B) 11  
(C) 18  
(D) 26

18. Cities A and B are 75 miles apart. The UV Index for city A on a given day is 6, while the UV Index for city B is 9. Which of the following best explains this difference?
  
(F) City A is at an altitude 6,000 thousand feet above city B.  
(G) The weather forecast for city A is for scattered showers, whereas forecasters are predicting sun for city B.  
(H) City A’s annual average UV Index is lower than city B’s.  
(J) City A is windier than city B.

Passage IV

Respiration is the process that takes place within a cell to convert glucose to energy. Oxygen is required for this process, and carbon dioxide is a byproduct. An experiment was performed to determine the effect of temperature on the rate of respiration. Before the experiment was performed, a test tube was calibrated so that the amount of carbon dioxide produced during the experiment could be measured.

Calibration

A known volume of water was added to a small test tube, and the length of the test tube filled with water was measured. This was done for several volumes, and the results are presented in Table 1.

<table>
<thead>
<tr>
<th>Volume (ml)</th>
<th>Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2.1</td>
</tr>
<tr>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>8</td>
<td>5.6</td>
</tr>
<tr>
<td>10</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Experiment

The following experiment was performed to test the hypothesis that increasing the temperature will increase the rate of cellular respiration. Yeast was added to a sugar solution, and a small test tube filled with the solution was inverted into a larger test tube, also filled with the solution. No air bubbles were present in the inverted test tube at the beginning of the experiment. As cellular respiration takes place, the inverted test tube will collect carbon dioxide, which will rise to the top of the inverted test tube. At different times, the length of the bubble was measured, and, based on the calibration above, the volume of the bubble was determined. This procedure was repeated at two different temperatures.

<table>
<thead>
<tr>
<th>Elapsed Time (hr(s))</th>
<th>Test Tube 1 at 23° C</th>
<th>Test Tube 2 at 35° C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length (cm)</td>
<td>Volume (ml)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>3.5</td>
<td>5.0</td>
</tr>
<tr>
<td>6</td>
<td>8.1</td>
<td>11.6</td>
</tr>
<tr>
<td>8</td>
<td>11.2</td>
<td>16.0</td>
</tr>
<tr>
<td>24</td>
<td>12.7</td>
<td>18.1</td>
</tr>
</tbody>
</table>
19. If the calibration had been performed with 6 ml of water, to approximately what length would this have corresponded?
   (A) 2.4 cm
   (B) 4.2 cm
   (C) 6.0 cm
   (D) 8.4 cm

20. What was the volume of carbon dioxide in the test tube after 6 hours at 23°C?
   (F) 5.7 ml
   (G) 8.9 ml
   (H) 11.6 ml
   (J) 18.1 ml

21. If readings were taken at 0 hours and 24 hours only, which of the following hypotheses could be supported?
   (A) Temperature has no effect on the rate of respiration.
   (B) Increased temperature increases the rate of respiration.
   (C) Increased temperature decreases the rate of respiration.
   (D) Cellular respiration does not emit carbon dioxide as a byproduct.

22. Which statement best describes the effect of temperature in the experiment?
   (F) Increased temperature decreases the initial rate of carbon dioxide production.
   (G) Increased temperature increases the initial rate of carbon dioxide production.
   (H) Increased temperature decreases total carbon dioxide production.
   (J) Increased temperature increases total carbon dioxide production.

23. Comparing Test Tube 1 to Test Tube 2, approximately how many times greater is the measured length of carbon dioxide released after 2 hours?
   (A) 2
   (B) 3
   (C) 4
   (D) 6

24. Which of the following would explain why after 6 hours the volume of carbon dioxide in Test Tube 2 no longer increased?
   (F) Cellular respiration does not release carbon dioxide.
   (G) Yeast does not convert sugar through cellular respiration.
   (H) The yeast had converted all available sugar.
   (J) The yeast had not converted all available sugar.

**Passage V**

When two objects are placed near or next to one another and they are at different temperatures, energy is transferred to the cooler object. As a result of this energy transfer, the temperature of the cooler object rises. The ratio of the amount of energy transferred to the temperature change is called heat capacity. Table 1 summarizes the specific heat for various substances.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Specific Heat Capacity (kJ/kgK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>0.898</td>
</tr>
<tr>
<td>Steel</td>
<td>0.447</td>
</tr>
<tr>
<td>Lead</td>
<td>0.130</td>
</tr>
</tbody>
</table>

An experiment was done to illustrate the temperature changes that are observed when substances with different heat capacities are subjected to the same procedures. In this experiment, 1 kg of water at 27°C was...
placed in an insulated container. A 0.2 kg piece of metal was placed in the water after the metal was heated to a particular temperature. The final temperature of the water and piece of metal were then recorded and summarized in Table 2.

<table>
<thead>
<tr>
<th>Initial Temperature (^°Celsius)</th>
<th>Final Temperature (^°Celsius)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>Lead</td>
</tr>
<tr>
<td>50</td>
<td>27.95</td>
</tr>
<tr>
<td>75</td>
<td>28.98</td>
</tr>
<tr>
<td>100</td>
<td>30.01</td>
</tr>
<tr>
<td>150</td>
<td>32.08</td>
</tr>
<tr>
<td>200</td>
<td>34.14</td>
</tr>
</tbody>
</table>

25. Which metal underwent the greatest temperature change when the starting temperature was 50°C?
   (A) Aluminum
   (B) Unknown
   (C) Lead
   (D) Steel

26. If the test was repeated with aluminum heated to an initial temperature of 250°C, which of the following is most likely to have been the final temperature?
   (F) 28.47°C
   (G) 29.52°C
   (H) 31.74°C
   (J) 36.21°C

27. For each of the trials, as initial temperature of the metal increased, the final temperature of the metal and water
   (A) increased.
   (B) decreased.
   (C) remained constant.
   (D) varied depending on the metal.

28. Diamond has a specific heat capacity of 0.518 kJ/kgK. If the experiment had been performed using diamond, what would the expected temperature range be in °C if the starting temperatures ranged from 50°C to 200°C as in the other trials?
   (F) 26.95 to 27.82
   (G) 27.19 to 28.52
   (H) 27.55 to 31.20
   (J) 28.12 to 34.88

29. As the specific heat capacity for a substance increases, what observable effect is there on the range of final temperature readings?
   (A) There is no observable difference in the range of temperatures.
   (B) There is a greater range of final temperature readings.
   (C) There is a smaller range of final temperature readings.
   (D) The range of the final temperature readings is constant for all heat capacities.

30. Based on the temperature readings for the unknown metal, what would the estimated specific heat capacity of the unknown substance be?
   (F) 0.120 kJ/kgK
   (G) 0.234 kJ/kgK
   (H) 0.682 kJ/kgK
   (J) 0.953 kJ/kgK

Passage VI

Although astronomers have a general outline for the steps that lead up to the formation of the wide-ranging interplanetary bodies called comets, there remain as yet many questions of where and exactly how comets were formed. The major points of dispute involve the location of their formation and the processes by which the comets were drawn into the Oort cloud becoming permanent
members of our Solar System. Three astronomers describe their views on this process.

Astronomer 1

The flattened, rotating disk of the nebula* out of which our sun and its companion planets were formed is the ideal place for comets to have been born. The long, slow collapse of a nebula that evolved into a planetary system included the type of compression that would facilitate the accretion of the icy specks of matter into comet pellets. At a certain concentration level, these pellets began to clump into cometary nuclei and later aggregated into larger bodies. When our Solar System was formed, the bodies that formed in the outskirts became the population of comets known as the Oort cloud. Those comets that formed among the planets likely collided with the giant members of the sun’s family, coalescing into them. There is sufficient evidence of significant disturbance among the outer giant planets and their companion satellites in the early solar system to support this theory.

*A nebula is a vast cloud of interstellar gas and dust.

Astronomer 2

We may reasonably suspect that the nebula out of which our sun formed was at least twice the mass of the sun at its current stage. We believe that the processes that formed the inner Solar System worked rapidly and were completed within 100,000 years. The remaining, less thoroughly coalesced matter was blown into the outer regions of the infant Solar System. The larger masses eventually became the four outer gas giants—Jupiter, Saturn, Uranus, and Neptune. The smaller masses were thrown much farther, forming the Oort cloud. Here, so distant from the gravitational influence of their parent sun, they were much more subject to the random forces of other nearby stars. Some of them are pushed in toward us, making their periodic and sometimes spectacular visits; others are pushed out to wander unseen in the vast galaxy.

Astronomer 3

The interstellar clouds out of which stars are formed are more vast, cold, and formless than can easily be imagined. In the absence of evidence that all the members of the Solar System arose out of the same nebula, it is difficult to explain the birth of the wandering comets. The most likely scenario based on the actual evidence available is that icy grains of matter in these vast gas-molecular clouds slowly grew by aggregation as they wandered in cold, dark space. Eventually the masses would grow large enough to be deemed cometary. When the sun compressed and ignited, it possessed enough gravity to capture a large number of these cometary masses, forming a captive population of comets now orbiting far beyond the realm of the other Solar companions.

31. Which of the following statements about the formation of comets would be most consistent with the views of Astronomer 1 and not Astronomer 2?

(A) Gravity from other stars is a crucial factor in the birth of comets.
(B) Comets were not originally members of our Solar System.
(C) The sun, planets, and comets formed out of the same nebula.
(D) Comets previously existed in the same region as the planets.
32. Astronomer 2 would most likely criticize the theory of Astronomer 3 by saying that
(F) evidence shows that the formation of comets was outside our Solar System.
(G) the influence of forces from other stars is ignored.
(H) the formation of the sun was too slow and lengthy to account for the formation of comets.
(J) the role of the sun’s gravity is ignored.

33. What is Astronomer 3’s chief objection to the views of Astronomers 1 and 2?
(A) They do not account for the vast amount of gas and dust in interstellar space.
(B) There is no evidence that the formation of the sun and the planets was a very rapid process.
(C) They do not account for the formation of the Oort cloud.
(D) There is no evidence that comets formed out of the same nebula from which the sun and planets formed.

34. The theory of Astronomer 2 depends heavily on which of the following assumptions?
(F) The time needed to complete the formation of the outer regions of the Solar System was greater than for the inner Solar System.
(G) The outer planets and their companions experienced violent collisions during their formative stages.
(H) The comets were not originally members of our Solar System.
(J) The formation of the inner Solar System was a slow, lengthy process.

35. The theory of Astronomer 1 does not conflict with the theories of either Astronomer 2 or Astronomer 3 regarding
(A) the formation of comets outside our Solar System.
(B) the role of the sun or other stars influencing the orbit of comets.
(C) the quickness with which the nebula would have collapsed to form comets.
(D) the evidence of comets in the inner part of our Solar System.

Passage VII

A scientist wanted to determine the relationship, if any, between a mass placed on the end of a spring and the force exerted by the mass on the spring. Various weights were placed on the end of a spring and the force measured, in Newtons (N), that was exerted on the spring. The maximum displacement of the weight, called the amplitude, was measured by recording the extension of the spring. The time needed for one oscillation back and forth for the weight to return to its original position was also recorded. The results are shown in Table 1.

<table>
<thead>
<tr>
<th>Mass (kg)</th>
<th>Square Mass (root of Mass)</th>
<th>Force (N)</th>
<th>Extension (cm)</th>
<th>Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>9.8</td>
<td>5</td>
<td>1.20</td>
</tr>
<tr>
<td>2</td>
<td>1.4</td>
<td>19.6</td>
<td>15</td>
<td>1.68</td>
</tr>
<tr>
<td>3</td>
<td>1.7</td>
<td>29.4</td>
<td>25</td>
<td>2.04</td>
</tr>
<tr>
<td>4</td>
<td>2.0</td>
<td>39.2</td>
<td>35</td>
<td>2.40</td>
</tr>
</tbody>
</table>
36. Based on the data presented in the table, if a weight with mass 2.7 kg were placed on the end of the spring, the force exerted on the spring would be approximately
(F) 9 N
(G) 13 N
(H) 26 N
(J) 33 N

37. Which of the following best represents the relationship between the force exerted on the spring and the extension of the spring?

(A) 

(B) 

(C) 

(D) 

38. Approximately how long would a weight with mass 5 kg take for one oscillation?
(F) 0.8 sec
(G) 1.4 sec
(H) 1.9 sec
(J) 2.7 sec

39. Which of the following provides the best explanation as to why the scientist noted the square root of the mass?
(A) The mass is inversely proportional to the force exerted on the spring.
(B) The mass is directly proportional to the time of one oscillation.
(C) The square root of the mass is directly proportional to the time of one oscillation.
(D) The square root of the mass is directly proportional to the force exerted on the spring.

40. Which of the following suggests that the extension of the spring reaches a maximum value?
(F) When a force of 2 N is applied, there is no extension in the spring.
(G) When a force of 20 N is applied, the extension is 16 cm.
(H) When a force greater than 40 N is applied, the extension is greater than 35 cm.
(J) When a force greater than 40 N is applied, the extension is equal to 35 cm.

STOP
END OF SECTION 4. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
ANSWER KEY

Section 1: ENGLISH

<p>| | | | | | |</p>
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<td>42.</td>
<td>F</td>
</tr>
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<td>15.</td>
<td>C</td>
<td>30.</td>
<td>F</td>
<td>45.</td>
<td>A</td>
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</table>

Section 2: MATH

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### Section 3: READING

<table>
<thead>
<tr>
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<th>Answer</th>
<th></th>
<th>Answer</th>
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<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>9</td>
<td>D</td>
<td>17</td>
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<td>25</td>
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<td>33</td>
<td>A</td>
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<td>2</td>
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<td>10</td>
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<td>D</td>
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<td>8</td>
<td>F</td>
<td>16</td>
<td>G</td>
<td>24</td>
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### Section 4: SCIENCE REASONING

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<td>F</td>
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<td>28</td>
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<td>36</td>
<td>H</td>
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<td>5</td>
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<td>H</td>
<td>32</td>
<td>G</td>
<td>40</td>
<td>J</td>
<td></td>
</tr>
</tbody>
</table>
EXPLANATORY ANSWERS

Section 1: ENGLISH

Passage I

1. The correct answer is (B). Because is the subordinating conjunction that indicates the reason language schools are booming.

2. The correct answer is (H). The period is needed to separate the sentences. Unless logically belongs to the second sentence.

3. The correct answer is (D). The present continuous tense is necessary in this context.

4. The correct answer is (H). This option cuts out unnecessary words that make for awkward phrasing.

5. The correct answer is (A). There is the right word in this context.

6. The correct answer is (J). Dashes set off the countries, which serve as examples, from the rest of the sentence.

7. The correct answer is (D). This option is clearest because it cuts out unnecessary and awkward phrasing.

8. The correct answer is (F). What remains unsaid is the subject of the sentence. The verb is follows the subject as it should.

9. The correct answer is (A). This sentence effectively links the idea of what remains unsaid to a concrete example and thus provides a smooth transition between paragraphs while developing the theme of differences between high- and low-context cultures.

10. The correct answer is (G). This sentence explains the meaning of the example given in the previous sentence.

11. The correct answer is (D). He and she are the third-person singular pronouns and must be used in place of someone.

12. The correct answer is (F). Even modifies handshakes to indicate that they cannot be taken for granted while leaving the sentence structure intact.

13. The correct answer is (B). Who is the relative subject pronoun used for someone. Someone who does not know this is the subject of the sentence.

14. The correct answer is (H). This is the only option that refers to codes as opposed to the more restrictive gestures. The essay covers gestures and language.

15. The correct answer is (C). The essay makes the distinction between “high-context” and “low-context” cultures in order to show that language training is not as important as cultural training. The essay does not explore the differences cited above as its purpose.

Passage II

16. The correct answer is (H). A relative pronoun is required, and that is correct because a scene that I witnessed is a single identifying phrase—the object of picture.

17. The correct answer is (A). No punctuation is needed before the prepositional phrase that begins with on.

18. The correct answer is (F). The underlined portion is part of a single sentence, and the parallel structure of rowing, stalking, and casting is required because this series of modifiers refers to the same noun—fishermen.
19. The correct answer is (B). This is the most specific option. *Race* and *scowl* are vivid verbs, while *pools* is a noun that can be pictured. All the other answers use vague or abstract language.

20. The correct answer is (H). The present perfect tense, *have managed*, indicates that the anglers did something in the past that is relevant to the present moment. They have carved time out in order to fish.

21. The correct answer is (D). This option gets rid of unnecessary words and keeps the sentence clear all the way to its end. It also maintains the parallel between *the right clothes and the gear*.

22. The correct answer is (G). *To reckon* is the verb, and it is used in passive form.

23. The correct answer is (D). The colon is needed to indicate the series of examples that illustrates the reckoning of time.

24. The correct answer is (H). *Who* is the relative pronoun that indicates people.

25. The correct answer is (D). A verb form is required, not a modifier, and because there is already a conjugated verb—*people line up*—the second verb must be in the infinitive form (*to buy*), which cannot be separated by punctuation.

26. The correct answer is (F). Sentence 2 belongs first because “This type of scene . . .” refers to the description in the previous paragraph. It works as a transition from the scene to the idea that free time must be efficiently spent.

27. The correct answer is (B). This sentence gives specific examples of technology that blur the boundary between work and play and thus directly supports the previous sentence.

28. The correct answer is (J). The second sentence needs a subject, and both are clearer when separated by a period. By repeating the word *leisure*, choice (J) also avoids confusion over what it might refer to.

29. The correct answer is (C). *It* is ambiguous. A clear subject is needed. *Going fishing* is the best option because it maintains the link between the idea of leisure and the example of fishing that has been developed in the essay.

30. The correct answer is (F). The first paragraph is full of details that are relevant to the essay. It sets up the example that will be developed. It does not contain information establishing the author’s expertise, nor does it explore a social or historical connection between fishing and the transformation of leisure.

Passage III

31. The correct answer is (C). The preposition *from* is needed to indicate the distance in time between the early photographs and the later photographs.

32. The correct answer is (J). To make this sentence clear, *viewers and critical acclaim* must both relate clearly to the verb. *Have won* makes *praise from viewers* parallel to *critical acclaim*. Both become objects of the verb.

33. The correct answer is (D). The underlined information is unnecessary and redundant because of the phrase *all aspects of his work*.

34. The correct answer is (G). *Because* gets rid of the comma splice and shows that the second clause provides the reason for his missing deadlines.

35. The correct answer is (A). This is the only option that clearly links the missing of deadlines with Smith’s particular style of working.
36. **The correct answer is (F).** The commas between the adjective-noun combinations indicate that these are examples in series and that, in different instances, Smith took photographs of each of these groups. If *and were* added between the second and third groups in the series, the sentence would indicate that Smith spent time with these groups before every photo shoot.

37. **The correct answer is (C).** *Familiar* is better than *friendly* because it is associated with unobtrusive. Placing the modifier *so before familiar* increases the quality of familiarity and links it to *almost invisible*.

38. **The correct answer is (G).** This is the clearest construction. It maintains the integrity of the sentence and the plural from *portraits*.

39. **The correct answer is (D).** This answer links the subject *Smith* with the verb *was* to form a complete sentence.

40. **The correct answer is (G).** This is the clearest construction. It avoids awkward phrasing and keeps the subject *Smith* cleanly linked to the verbs *wandered* and *read*.

41. **The correct answer is (B).** Sentence 1 should come first because it introduces the year and the nature of the project. Sentence 3 states how long the assignment was to last, and this should be mentioned *before* the description of the deadline passing that occurs in Sentence 2.

42. **The correct answer is (F).** This is the only construction that properly separates *the many faces of Pittsburgh*. The colon indicates a list is coming. The semicolons separate the list into categories. Commas cannot be used for this separation because confusion would result in the final category where there is already a comma.

43. **The correct answer is (C).** This is the clearest, most succinct option. The others contain awkward phrasing such as *huge attempt* or redundancies such as *task of trying*.

44. **The correct answer is (G).** *It refers to* his work, which he thought a failure. *That refers to* the publication.

45. **The correct answer is (A).** This option concludes the story of the Pittsburgh project by addressing W. Eugene Smith’s high standards and the value of his work to the world, both of which are mentioned in the first paragraph.

**Passage IV**

46. **The correct answer is (F).** *Past two weeks* is the only construction that correctly describes the amount of time spent on board the *Regina IV*.

47. **The correct answer is (D).** This construction is the clearest because it places the modifier *hoping* closer to the subject it modifies and avoids making it sound as if the ship is the subject being modified. It also eliminates redundant information.

48. **The correct answer is (H).** *So far* is the prepositional phrase used to mean *from the beginning to the present moment*.

49. **The correct answer is (C).** Parallel structure requires the verb to be active: *We rush and train*.

50. **The correct answer is (F).** It maintains the tone of the essay and is straightforward and correct.
51. **The correct answer is (C).** The conjunction *and* separates the two different things that they see and keeps the sentence clear.

52. **The correct answer is (G).** This option gets rid of the comma splice and, by creating a new sentence, maintains the clarity of the description.

53. **The correct answer is (C).** Choice (C) is the only option that keeps the description of events flowing and also links the defensive posture of the whales with the sight of their attackers.

54. **The correct answer is (J).** Subject-verb agreement. A group of killer whales is a singular collective, so the correct form of the verb is *races*.

55. **The correct answer is (A).** *Headlong* is the only choice of an adverb to modify *cuts*. It adds a vivid quality to the description, and there is no reason to omit it.

56. **The correct answer is (G).** The active voice provides a clear, simple description of the action.

57. **The correct answer is (D).** The preposition *in* is used before the noun *suspense*.

58. **The correct answer is (J).** *There* is the right word, and the verb *is* agrees with *a flurry*.

59. **The correct answer is (C).** The author wants to emphasize the *heartwarming* quality of the event, the apparent sense of compassion from the whales, which he finds almost human.

60. **The correct answer is (H).** The essay is primarily about the sperm whales. It opens with the hope of seeing sperm whales and concludes with a feeling of admiration for their behavior.

### Passage V

61. **The correct answer is (A).** It provides punctuation (a period) that creates two complete sentences.

62. **The correct answer is (G).** Simple present tense is used to indicate the general reoccurring nature of the grape harvest.

63. **The correct answer is (A).** It uses the correct form of *past* in a descriptive phrase modifying *midnight*.

64. **The correct answer is (H).** Subject-verb agreement. *Banners* is a third-person plural noun.

65. **The correct answer is (D).** It is the most logical. The sight of only one banner is enough to remind the writer of her experience harvesting grapes.

66. **The correct answer is (G).** It provides new and specific information directly related to the region under discussion.

67. **The correct answer is (B).** It forms a complete sentence composed of a dependent clause and an independent clause separated by a comma.

68. **The correct answer is (H).** The verb form called for here is the past tense of the verb *to be*, and the word *there* is neither a contraction nor a possessive pronoun.

69. **The correct answer is (A).** It makes the writer’s point clearly and concisely without adding redundant and unnecessary words.

70. **The correct answer is (J).** The past tense of the verb is required because the writer is telling *what happened*, not what might have happened.

71. **The correct answer is (B).** *However* sets up the opposition to the previous sentence.
72. The correct answer is (G). The added sentence builds upon the idea that harvesting is difficult and should immediately follow the sentence in which that idea is introduced.

73. The correct answer is (D). It neither provides unnecessary punctuation nor involves the use of a phrase that is unfamiliar in common usage.

74. The correct answer is (G). It supplies the correct singular possessive punctuation.

75. The correct answer is (C). Sentence 1 introduces the setting and characters described in the anecdote. Sentence 6 describes a tentative response to the events in Sentence 1 and should be placed before the narrator takes more vigorous action (singing out loud, for example). Sentence 4 describes the young Pole’s response to her humming. Sentence 5, which describes the two workers singing together, cannot logically be placed before sentence 6, which describes the writer humming alone. Sentence 3, which introduces the fact that they both knew all the words to the song, logically follows the sentence in which they sing. Sentence 2 concludes the paragraph by revealing the name of the song.

Section 2: MATH

1. The correct answer is (D). 63 is the least common multiple of 3, 7, and 9.

2. The correct answer is (H). “At least” and “no more than” imply “greater than or equal to” and “less than or equal to,” respectively.

3. The correct answer is (A). The question asks how many tickets were issued for other violations, so the appropriate calculation is \((100\% - 70\%)(4,860) = (.3)(4,860) = 1,458\).

4. The correct answer is (H).

   \[
   2x + 4 = -4(x - 1) \\
   2x + 4 = -4x + 4 \\
   x = 0 \\
   x = 0
   \]

5. The correct answer is (A). A negative number raised to an even power gives a positive result. Only \(v\) is not raised to an even power. If \(v\) were negative, then the entire expression would be negative and could not equal 10.

6. The correct answer is (F).

   \[
   4x + 3y = 15 \\
   3y = -4x + 15 \\
   y = -\frac{4}{3}x + 5
   \]

7. The correct answer is (E).

   \[
   \pi r^2 h = \pi (4^2)(8) = 128\pi
   \]

8. The correct answer is (J). When parallel lines are cut by a transversal, the sum of a created acute angle and a created obtuse angle is always 180°. If \(x\) measures 80°, then \(y\) must measure \(180° - 80° = 100°\).

9. The correct answer is (B). \(\angle BAC = 180° - 115° = 65°\). An exterior angle of a triangle is equal to the sum of the opposite interior angles. \(\angle BCD = \angle CBA + \angle BAC = 55° + 65° = 120°\).

10. The correct answer is (J).

    10% of 10% = (.1)(.1) = .01.

11. The correct answer is (E).

    \[
    \sqrt{288} = \sqrt{144 \times 2} = 12\sqrt{2}
    \]

12. The correct answer is (H).

    \[
    (2p - 3q)(2p - 3q) = 4p^2 - 6pq - 6pq + 9q^2 \\
    = 4p^2 - 12pq + 9q^2
    \]

13. The correct answer is (E). Using the obvious notation, we have:

    \[
    4c + 6d + 3h = 815 \\
    2c + 3d + 4h = 720
    \]
Multiplying the second equation by $-2$ and adding the equations together yields $-5h = -625; h = 125$. Hence, the cost of a box of doughnut holes is $1.25.

14. The correct answer is (H). Parallel lines have the same slope. The easiest way to determine the slope is to put each of the equations into the slope-intercept form of $y = mx + b$, where $m$ is the slope. When converted to this form, you find that $2x + y = 6$ (or $y = -2x + 6$) and $4x + 2y = 10$ (or $y = -2x + 5$) both have a slope of $-2$.

15. The correct answer is (B). The question gives two equations for the father ($f$) and son's ($s$) weight:

$$f + s = 240$$

$$f = 3s$$

Through substitution, you solve for $s$:

$$3s + s = 240$$

$$4s = 240$$

$$s = 60$$

16. The correct answer is (H).

$$\frac{3}{4}(.02) = (.375)(.2) = .0075.$$ 

17. The correct answer is (B). By using angle rules for supplementary angles, triangles, and vertical angles, you can solve for $A$ as follows:

18. The correct answer is (H). To obtain the total number of different executive boards, you multiply the number of possibilities for each office: president (2) $\times$ vice president (3) $\times$ treasurer (2) = 12.

19. The correct answer is (D).

$$\frac{130 - 45}{720} = \frac{75}{720} = .625$$

20. The correct answer is (H). $\sqrt{11} = 3.3$, so 3 is the greatest integer that still gives a negative result.

21. The correct answer is (D).

$$2\pi r = 20$$

$$y = \frac{20}{2\pi} = \frac{10}{\pi}$$

22. The correct answer is (F).

$$\frac{3x^2 y^4}{x^2 y^2} = \frac{3x^2 y^2}{x^2 y^2} = \frac{3}{\pi}$$

23. The correct answer is (E).

$$\frac{300 \text{ gallons}}{\frac{2}{3} \text{ miles per gallon}} = 300 \times \frac{7}{2} = 700 \text{ miles}$$

24. The correct answer is (H).

$$x^2 - 4x - 5 = 0$$

$$(x + 1)(x - 5) = 0$$

$$x + 1 = 0 \text{ or } x - 5 = 0$$

$$x = -1 \text{ or } x = 5$$

25. The correct answer is (C). The area of the rectangular section of the diagram is $\frac{(6)(8)}{2} = 48$ square centimeters. Using the Pythagorean theorem, you can determine that the height of the triangular section is 3 cm and its area is $\frac{1}{2}(3)(8) = 12$ square centimeters. The area of the entire figure is $12 + 48 = 60$ square centimeters.

26. The correct answer is (F). The formula of a circle can be generalized as $(x-a)^2 + (y-b)^2 = r^2$, where $(a,b)$ is the center of the circle and $r$ is the radius. Notice that the problem gives a diameter of 8, so the radius is 4. The circle with a center at $(4,2)$ and a radius of 4 thus has an equation of $(x-4)^2 + (y-2)^2 = 16$.

27. The correct answer is (B). This problem can be solved through process of elimination. Perpendicular lines have negative reciprocal slopes, so the correct answer must have a slope of $-\frac{1}{2}$. Only $y = -\frac{1}{2}x + 2$ meets this condition and passes through the point $(4,0)$.

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28. The correct answer is (G).
\[
\frac{a^2 - b^2}{\sqrt{a} - b} = \frac{(a + b)(a - b)}{\sqrt{a} - b}
\]
\[
= (a + b)(\sqrt{a} - b)
\]

29. The correct answer is (C). You can solve this problem by setting up a proportion:
\[
\frac{42}{30} = \frac{x}{25}
\]
\[
x = 35
\]

30. The correct answer is (K). The diagonals of a square are perpendicular bisectors. The midpoint of one diagonal is thus the midpoint of the other diagonal. The midpoint of \((-1,2)\) and \((5,2)\) is \((2,2)\), and this diagonal is parallel to the \(-axis. The other diagonal must be parallel to the \(-axis and pass through \((2,2)\). Only \((2,-1)\) satisfies this condition.

31. The correct answer is (E).
\[
5 - x > 10 - 3(x - 2)
\]
\[
5 - x > 10 - 3x + 6
\]
\[
-x + 3x > 16 - 5
\]
\[
2x > 11
\]
\[
x > \frac{11}{2}
\]

32. The correct answer is (J). Use the Pythagorean theorem to solve for \(AC\):
\[
3^2 + b^2 = 10^2
\]
\[
9 + b^2 = 100
\]
\[
b^2 = 91
\]
\[
b = \sqrt{91}
\]

33. The correct answer is (B).
\[
(2x + a)(2x + b) = 4x^2 - 4x + ab
\]
\[
4x^2 + 2(a + b)x + ab = 4x^2 - 4x + ab
\]
\[
2(a + b) = -4
\]
\[
a + b = -2
\]

34. The correct answer is (J). This problem can be done fairly quickly if you remember that the relationship among the sides of a \(45^\circ-45^\circ-90^\circ\) triangle is \(s, s, s\sqrt{2}\), where \(s\sqrt{2}\) is the length of the hypotenuse. The smaller triangle has legs 2 inches long, so \(x\), the length of the hypotenuse, must be \(2\sqrt{2}\). The hypotenuse of the larger triangle is \(2x\sqrt{2}\) or \((2\sqrt{2})(2\sqrt{2}) = 8\) inches long. The legs of the larger triangle are each \(\frac{8}{\sqrt{2}} = 4\sqrt{2}\), so the perimeter is \(4\sqrt{2} + 4\sqrt{2} + 8 = 8 + 8\sqrt{2}\) inches.

35. The correct answer is (D).
\[
\log_2 x = 5
\]
\[
2^5 = x
\]
\[
x = 32
\]

36. The correct answer is (G). Using the Pythagorean theorem, you can obtain the length of \(AC\):
\[
5^2 + b^2 = 13^2 = 169
\]
\[
b^2 = 144
\]
\[
b = 12
\]
If \(AC\) is 12 inches long and \(AB\) is 4 inches, then \(CD\) is 8 inches. You now have both the height (5 inches) and base (8 inches) of triangle \(BCD\). The area of the triangle is \(\frac{1}{2}(5)(8) = 20\) square inches.

37. The correct answer is (E). In order to weight the second round scores twice as heavily as the first, you need to count them twice. In order to weight the third round scores twice as heavily as the second round score, you need to count them 4 times. The weighted average is thus \(\frac{5 + 25 + 45}{3 + 4 + 4} = \frac{5}{11}\) times. If \(AC\) is 12 inches long and \(CD\) is 8 inches, then you now have both the height (5 inches) and base (8 inches) of triangle \(BCD\). The area of the triangle is \(\frac{1}{2}(5)(8) = 20\) square inches.

38. The correct answer is (F). Since triangle \(CDE\) is a \(30^\circ-60^\circ-90^\circ\) triangle, you can solve for \(CE\) as \(\frac{\sqrt{3}}{2} = 6\) inches and \(DE\) as \(6\sqrt{3}\) inches. The rectangle \(ABCE\) thus has an area of \(6\) inches, and the triangle \(CED\) has an area of \(\frac{1}{2}(6)(6\sqrt{3}) = 18\sqrt{3}\) square inches. The
area of the entire quadrilateral is the sum of these two pieces.

39. The correct answer is (E). The trick to solving this problem quickly is to realize that the center of the circle must have an x-coordinate midway between −4 and 4 and a y-coordinate midway between −8 and 2. The circle thus has a center at (0,−3). Although it is possible to calculate the radius, you do not need to do so, since only the equation \( x^2 + (y + 3)^2 = 25 \) has the center in the correct spot.

40. The correct answer is (G). The sine of a given angle is equal to the cosine of its complement (angles that add up to 90° are complements). Since \( X \) and \( Y \) are complementary angles, \( \sin \angle X = \cos \angle Y \).

41. The correct answer is (E). The equation for a line passing through (3,2) and (6,3) is \( y = \frac{1}{3}x + 1 \). Only (15,6) also satisfies this equation.

42. The correct answer is (F). An ellipse in the form \( \frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1 \) has a center at \((h,k)\). The given ellipse would have a center at (−3,4): \( \frac{(x + 3)^2}{75} + \frac{(y – 4)^2}{25} = 1 \).

43. The correct answer is (C). An important trigonometric identity is that \( \tan A = \frac{\sin A}{\cos A} \). Thus, \( (\tan A)(\cos A) = \frac{\sin A}{\cos A} \cdot \cos A = \sin A \).

44. The correct answer is (H). In many cases, it is easier to answer this type of problem by seeing which equation is satisfied by both given points than by solving directly for the equation. Only \( 2y – 3x = 12 \) is satisfied by (−4,0) and (0,6).

45. The correct answer is (D). Using the relationships in a 45°-45°-90° triangle, it is easy enough to determine that the hypotenuse of triangle \( ABD \) is \( 4\sqrt{2} \) meters long. You can then use knowledge of the relationship of a 30°-60°-90° triangle to solve for the height of the equilateral triangle:

![Diagram of a 30°-60°-90° triangle](image)

The area of the triangle is \( \frac{1}{2}(4\sqrt{2})(2\sqrt{6}) = 4\sqrt{12} = 8\sqrt{3} \).

46. The correct answer is (G). The small cubes each have a volume of 3³ cubic inches. Since 27 (or 3³) small cubes make up the large cube, the volume of the large cube is \( 3^3(3^3) = 3^6 \) cubic inches.

47. The correct answer is (C). \( (3x + 4)^2 = 9x^2 + 24x + 16 \), so \( a \) equals 24.

48. The correct answer is (G). Factoring the expression gives \( (x + 3)(2x – 1) \). The expression can only be negative if one of the factors is positive and one is negative. Thus:

\[
\begin{align*}
x + 3 &> 0 \quad \text{and} \quad 2x – 1 < 0 \\
\end{align*}
\]

Thus:

\[
\begin{align*}
x > –3 \quad \text{and} \quad x < \frac{1}{2} \\
\end{align*}
\]

Note that the alternative \( (x + 3 < 0 \text{ and } 2x – 1 > 0) \) produces an empty set, so it does not affect the solution.

49. The correct answer is (B). \( \frac{3}{11} \) can be expressed as the repeating decimal .272727, so the 20th digit, like all even-numbered digits, will be 7. \( \frac{7}{11} \) can be expressed as .636363, so the 20th digit is 6. The difference is 1.

50. The correct answer is (F). If we call the length of a side of the smallest triangle \( x \), then we can determine that \( BD \) is \( 2x \) long and that \( AD \) is twice that, or \( 4x \). Thus, the large triangle has sides of length \( 2x + 4x = 6x \). Since all of the triangles are...
similar, the ratio between the height of the largest triangle and height of the smallest triangle is 6, and the ratio between the base of the largest triangle and the base of the smallest triangle is also 6. This means that the largest triangle has \(6(6) = 36\) times the area of the smallest triangle. Expressed another way, the ratio of triangle \(\triangle EGF\) to triangle \(\triangle ABC\) is 1:36.

51. The correct answer is (C). The sum of the interior angles of a polygon can be generalized by the formula \((N - 2)(180^\circ)\), where \(N\) is the number of sides of the polygon. Thus, the sum of the interior angles of the octagon is \((8 - 2)(180^\circ) = 1,080^\circ\).

52. The correct answer is (G). The graph of \(6 \sin 2\theta\) has 6 times the amplitude and half the period of the graph of \(\sin \theta\).

53. The correct answer is (D).
\[
x^2 = ax + 12a^2 \\
x^2 - ax - 12a^2 = 0 \\
(x + 3a)(x - 4a) = 0 \\
x = -3a \text{ or } x = 4a
\]

54. The correct answer is (K). Use two basic trigonometric identities to simplify this equation:
\[
\tan A = \frac{\sin A}{\cos A} \quad \text{and} \quad \cot A = \frac{\cos A}{\sin A}
\]
\[
\left(\frac{\tan A}{\sin A}\right) = \left(\frac{\sin A}{\cos A}\right) \left(\frac{\cos A}{\sin A}\right) = \cot A
\]

55. The correct answer is (B). The diagonals of a rhombus are perpendicular bisectors, so 4 equal right triangles are created. If the diagonals are 12 centimeters and 8 centimeters long, then the legs of each right triangle are 6 centimeters and 4 centimeters. The Pythagorean theorem gives the length of a side of the rhombus:
\[
c^2 = 4^2 + 6^2 \\
c^2 = 52 \\
c = 2\sqrt{13}
\]

The perimeter of the rhombus is thus \(4(2\sqrt{13}) = 8\sqrt{13}\).

56. The correct answer is (K). The difficulty in this problem is that you must be sure to account for \(y - 3\) being negative or positive, because it changes the direction of the inequality. First, assume that the quantity is positive:
\[
\frac{3}{y - 3} < 3 \\
3 < 3y - 9 \\
12 < 3y \\
y > 4
\]
On the other hand, if \(y - 3\) is negative, then the inequality sign changes direction and you end up with \(y < 4\). However, since values between 3 and 4, inclusive, do not make \(y - 3\) negative, the solution for this part of the inequality is actually \(y < 3\).

57. The correct answer is (E). The box must be a cube of inside dimensions 16" \(\times\) 16" \(\times\) 16" (16" is the diameter of the sphere), or 4,096 cubic inches.

58. The correct answer is (G). The question gives 3 equations for the weights of Jason (\(J\)), his mother (\(M\)), and his father (\(F\)):
\[
J + M = 285, \\
J + F = 345, \quad \text{and} \quad M + F = 310.
\]
The short-cut on this problem is to add up all three equations to obtain \(2J + 2F + 2M = 940\). Thus, the combined weight of Jason, his mother, and his father is \(\frac{940}{2} = 470\) pounds.

59. The correct answer is (E). The discriminant \((b^2 - 4ac)\) is the part of the quadratic formula underneath the radical that determines how many real roots a quadratic equation has. If the discriminant is equal to 0, then the two real roots are equal, so there is only 1 distinct real root.
Practice Test 1

\[ b^2 - 4ac = 0 \]
\[ 8^2 - 4(3)c = 0 \]
\[ 64 - 12c = 04 \]
\[ 12c = 64 \]
\[ c = \frac{64}{12} = \frac{16}{3} = 5 \frac{1}{3} \]

60. The correct answer is (F). Slope is equal to the “rise” divided by the “run.”

\[ \frac{\text{rise}}{\text{run}} = b \]
\[ \frac{a}{AC} = b \]
\[ \frac{a}{b} = AC \]

Section 3: READING

1. The correct answer is (A). Choice (A) is the best answer because in paragraph 4, James mentions “a honeymoon in Minorca.” Choice (B) is incorrect because although Russia is mentioned in paragraph 4, it is not mentioned as a place to honeymoon. Choice (C) is incorrect because Africa is not mentioned in the passage. Choice (D) is incorrect because although the Alps are mentioned in paragraph 1, they are never suggested as a honeymoon spot.

2. The correct answer is (J). Choice (F) is incorrect because a circle of energy is never mentioned. Choice (G) is incorrect because a park is never mentioned. Choice (H) is incorrect because although the Alps are mentioned in paragraph 1, they are not mentioned in comparison to James’ family members. Choice (J) is the best answer because in paragraph 1 and 2 state that the “women-folk of his home circle,” including his “mother, sisters, and aunt-in-residence,” watched with the “unrestrained eagerness” of “a group of unexercised terriers” (sentence 1, paragraph 2).

3. The correct answer is (B). Choice (A) is incorrect because James’ allergies are not mentioned. Choice (B) is the best answer because the final paragraph of the passage details how James’ theory of how women should act contrasts strongly with the “solicitous little questions” and conversation of afternoon tea. Choice (C) is incorrect because though Joan is shown to be forgetful of James’ preferences in the fifth paragraph, it is the chatter itself that makes him dislike afternoon tea, not the forgetfulness. Choice (D) is incorrect because we are never given any indication that James dislikes Joan.

4. The correct answer is (J). Choice (F) is incorrect because James is never presented as belligerent. Choice (G) is incorrect because in the second paragraph, we learn that James “was not sufficiently obstinate or indifferent to home influences.” Choice (H) is incorrect because in paragraph 1 and 4, we learn that James is not enthralled with the idea of marriage and finds proposing “irksome.” Choice (J) is the best answer because in paragraph 4, James reveals that “proposing marriage . . . was a rather irksome business.”

5. The correct answer is (D). Choice (A) is incorrect because the second paragraph mentions that James’ family paid close attention to his “most innocent flirtations.” Choice (B) is incorrect because James’ female friends support the choice of Joan (paragraph 3). Choice (C) is incorrect because paragraph 2 tells us that Uncle Jules is already dead and therefore cannot be made proud. Choice (D) is the best answer because the last sentence of paragraph 3 tells us that “the family had so far conducted and directed the flirtation.”

6. The correct answer is (F). Choice (F) is the best answer because in paragraph 3, we find that James has “became gradually accustomed to the idea that he and
Joan would go through the prescribed stages of congratulations, present-receiving, Norwegian or Mediterranean hotels, and eventual domesticity.” Paragraph 4 also says that James will “propose marriage” and then have a life of “married happiness.” Choice (G) is incorrect because James only wishes to honeymoon in Minorca (paragraph 3), not move there. Choice (H) is incorrect because nowhere in the passage do we find suggestion that Joan may be after James’ money. Choice (J) is incorrect because James does plan on proposing (paragraphs 3, 4, and 5).

7. **The correct answer is (A).** Choice (A) is the best answer because paragraph 1 states that James “liked and admired a great many women” but did not wish to claim one for his own. Choice (B) is incorrect because paragraphs 1, 2, and 3 suggest that James’ family wished that he would get married. Choice (C) is incorrect because the passage does not say that James has asked other women for their hand in marriage. Choice (D) is incorrect because the passage does not contain information about James’ job.

8. **The correct answer is (F).** Choice (F) is the best answer because paragraph 6 mentions that James “detests” afternoon tea, in part, because of the “drawn-out chatter” and the “solicitous little questions.” Choice (G) is incorrect because Joan’s looks are not mentioned in the passage. Choice (H) is incorrect because Joan is presented as someone with tact (paragraph 5). Choice (J) is incorrect because the passage does not state that Joan is avoiding the topic of marriage.

9. **The correct answer is (D).** Choice (A) is incorrect because nowhere in the passage does it state that James loves Joan. Choice (B) is incorrect because James is never presented as someone with mood swings. Choice (C) is incorrect because the passage never mentions a “first marriage” for James. Choice (D) is the best answer because, as paragraph 3 states, James was influenced more by the “weight of public opinion” than by any initiative of his own; a clear working majority of his female relatives and the aforesaid matronly friends had presented Joan Sebastable as the most suitable young woman in his range of acquaintance to whom he might propose marriage.”

10. **The correct answer is (G).** Choice (F) is incorrect because “movies” are not mentioned in the passage. Choice (G) is the best answer because the first sentence of the final paragraph of the passage states that James “had read of such things in scores of novels, and hundreds of actual experiences had told him they were true to life.” Choice (H) is incorrect because the passage does not mention conversations about afternoon tea James has had. Choice (J) is incorrect because the passage does not mention the opinions of James’ uncle.

11. **The correct answer is (C).** Choice (A) is incorrect because the passage does not say that affirmative action may be used in the future. Choice (B) is incorrect because the author makes it clear throughout the passage that affirmative action was intended to increase equality in the workplace. Choice (C) is the best answer because the final sentence in paragraph 3 states “Just because quota-based affirmative action policies have not been accepted does not mean that we should give up on the goal of improving equality in the workplace.” Choice (D) is incorrect because the author does not find it “troublesome” that conservatives rejected affirmative action.
12. **The correct answer is (J).** Choice (F) is incorrect because Dole’s statement is in no way an example of affirmative action. Choice (G) is incorrect because the author does not indicate that Dole is not dealing with the issue. Choice (H) is incorrect because at the end of paragraph 2, we learn that in fact conservatives are in agreement with minorities in dismissing affirmative action as ineffective. Choice (J) is the best answer because paragraph 2 states that “Mr. Dole may be fishing for votes here, but his point is well taken.”

13. **The correct answer is (B).** Choice (A) is incorrect because paragraphs 2 and 3 make it clear that most Americans do support the idea of equality in the workplace. Choice (B) is the best answer because paragraph 2 states that “what scares Americans even more than racism is the loss of individuality.” Choice (C) is incorrect because the fact that affirmative action helps only certain minority groups is never mentioned. Choice (D) is incorrect because a lack of knowledge is never cited as a reason affirmative action was rejected.

14. **The correct answer is (H).** Choice (F) is incorrect because Kennedy’s Executive Order was not given until 1961. Choice (G) is incorrect because the court’s rulings in 1952 and 1954 set the stage for affirmative action. Choice (H) is the best answer because the final paragraph states that “in separate rulings in 1952 and 1954, the Court overturned its earlier decision,” referring to *Plessy v. Ferguson*. Choice (J) is incorrect because the Court is not mentioned overturning concepts of liberty.

15. **The correct answer is (C).** Choice (A) is incorrect because limiting discrimination in society is not given as a reason for segregation. Choice (B) is incorrect because limiting regulation in society is not given as a reason for segregation. Choice (C) is the best answer because the final paragraph states that “segregation was seen as a way to keep our society from fragmenting.” Choice (D) is incorrect because keeping the society from being equal is not given as a reason for segregation.

16. **The correct answer is (G).** Choice (F) is incorrect because Bob Dole’s popularity is not cited as support for the author’s contention. Choice (G) is the best answer because paragraph 2 states that “Opinion polls and common sense lead us to this transparent conclusion.” Choice (H) is incorrect because examples of affirmative action programs are not cited as support for the author’s contention. Choice (J) is incorrect because Jim Crow laws are not cited as support for the author’s contention.

17. **The correct answer is (A).** Choice (A) is the best answer because paragraph 4 ends with “Of course, the profit we seek is not monetary, but nevertheless it is just as tangible. Our profit is equality.” Thus, *profitable* in this context refers to equality. Choice (B) is incorrect because paragraph 4 ends with “Of course, the profit we seek is not monetary, but nevertheless it is just as tangible. Our profit is equality.” Thus, *profitable* in this context refers to equality, not money. Choice (C) is incorrect because paragraph 4 ends with “Of course, the profit we seek is not monetary, but nevertheless it is just as tangible. Our profit is equality.” Thus, *profitable* in this context refers to equality, not happiness. Choice (D) is incorrect because paragraph 4 ends with “Of course, the profit we seek is not monetary, but nevertheless it is just as tangible. Our profit is equality.” Thus, *profitable* in this context refers to equality, not happiness.
as tangible. Our profit is equality.” Thus, *profitable* in this context refers to equality, not politics.

18. **The correct answer is (H).** Choice (F) is incorrect because paragraph 4 implies that the Constitution can and should be altered. See explanation for choice (H). Choice (G) is incorrect because the passage does not mention reasoned debate. Choice (H) is the best answer because paragraph 4 states that “the founders of this grand bit of research into human governance gave their sons and grandsons the right, indeed the obligation, to create laws, make amendments to the rules of the experiment, and even change the basic drafted rules of the experiment (the Constitution) if necessary.” Choice (J) is incorrect because the skill of the people heading the experiment is never mentioned.

19. **The correct answer is (D).** Choice (A) is incorrect because I is incorrect: Paragraph 6 states that Kennedy implemented the first affirmative action programs. Choice (B) is incorrect because although II is correct, III is also correct. See explanation for choice (D). Choice (C) is incorrect because although II is correct, I is not correct. See explanation for choice (A). Choice (D) is the best answer because I is incorrect. See explanation for choice (A). II is supported by Dole’s statement in paragraph 2 that “I’m beginning to believe that may not be the way it should be in America.” The statement in paragraph 2 that “A vast majority of Americans, even minorities, do not think that affirmative action policies are effective ways of bettering society” supports III.

20. **The correct answer is (G).** Choice (F) is incorrect because the statement that “our society is not a utopia” does not refer to the metaphor presented in the previous paragraph. Choice (G) is the best answer because the statement in question 20 is followed by “people of color still do not hold as many high-paying jobs as Caucasians do proportional to the size of their respective populations.” Choice (H) is incorrect because the statement that “our society is not a utopia” does not refer to the use of the word *meritocracy*. Choice (J) is incorrect because the statement that “our society is not a utopia” does not refer to Supreme Court rulings, which are not mentioned until the next paragraph.

21. **The correct answer is (B).** Choice (B) is the best answer because undiluted means “not watered down” or *pure*.

22. **The correct answer is (H).** Choice (F) is incorrect because in paragraph 2, the author calls the work “provincial,” which means limited in scope. Choice (G) is incorrect because in paragraph 2, the author states that “Crockett could exercise intelligence.” Choice (H) is the best answer because paragraph 2 states “It is one of the primary social documents of America.” Choice (J) is incorrect because in paragraph 2, the author says the work was published in 1834.

23. **The correct answer is (D).** Choice (A) is incorrect because the passage does not mention the speech patterns or actions of real people as being a prerequisite of a modern regional biography. Choice (B) is incorrect because the passage does not mention sustained effort as being a prerequisite of a modern regional biography. Choice (C) is incorrect because the passage does not mention violating trust as being a prerequisite of a modern regional biography. Choice (D) is the best answer because paragraph 3 states “I do not believe it possible that a good one will henceforth come from a mind that does not in outlook transcend the region on
which it is focused,” and the end of the paragraph continues: “Awareness of other times and other wheres, not insistence on that awareness, is the requisite.”

24. **The correct answer is (J).** Choice (F) is incorrect because the passage does not mention that schools no longer attempt to create intellectuals. Choice (G) is incorrect because the passage does not discuss changing the way people use the word “intellectual.” Choice (J) is the best answer because the first paragraph states that “fundamental brainwork” is behind every respect-worthy piece of writing.

25. **The correct answer is (B).** Choice (B) is the best answer because in this context, *crying out* most nearly means advocating.

26. **The correct answer is (F).** Choice (F) is the best answer because the final paragraph states: “Nothing is too provincial for the regional writer, but he cannot be provincial-minded toward it . . . We may be sure that if by violating the rules of syntax Horace Greeley sometimes added forcefulness to his editorials, he violated them deliberately and not in ignorance.” Thus, Greeley is presented as someone who could only provide a particular interpretation because he understood the greater context. Choice (G) is incorrect because “young writers” are never mentioned. Choice (H) is incorrect because the final paragraph says “nothing is too trivial for art.” Choice (J) is incorrect because Greeley is depicted breaking the rules of grammar and still communicating sensibly.

27. **The correct answer is (A).** Choice (A) is the best answer because paragraph 1 states that “Nonintellectual literature is as nonexistent as education without mental discipline.” Choice (B) is incorrect because strong morals are never mentioned in the passage. Choice (C) is incorrect because the author never related open-mindedness to education. Choice (D) is incorrect because the author never related local customs to education.

28. **The correct answer is (H).** Choice (F) is incorrect because the passage does not say that editors do not wish to publish autobiographies. Choice (G) is incorrect because the passage does not say that editors do not wish to publish provincial views (on the contrary, paragraph 1 suggests that they do). Choice (H) is the best answer because according to paragraph 1, “Editors of all but a few magazines of the country and publishers of most of the daily newspapers reinforce this attitude by crying out for brightness and vitality while at the same time shutting out critical ideas.” Choice (J) is incorrect because the passage does not say that editors do not wish to publish regional stories.

29. **The correct answer is (B).** Choice (A) is incorrect because how Hardy felt about his church is never discussed. Choice (B) is the best answer because the final paragraph ends with the statement “A provincial writer must, above all, remain true to his foundations.” Choice (C) is incorrect because the passage never suggests that Hardy had a lack of faith in his heirs. Choice (D) is incorrect because the main point of the passage, as presented in paragraphs 1 and 2, is that intelligence and provincialism are not mutually exclusive.

30. **The correct answer is (J).** Choice (F) is incorrect because Hardy is not mentioned in relation to Barrie. Choice (G) is incorrect because the author’s reference to patriotism in paragraph 4 is not related...
to the island analogy presented by Barrie. Choice (H) is incorrect because the point that the author makes is that Barrie had to have known what the mainland was like, not the island. See explanation for choice (J). Choice (J) is the best answer because paragraph 4 states “James M. Barrie said that he could not write a play until he got his people off on a kind of island, but had he not known about the mainland he could never have delighted us with the islanders.”

31. The correct answer is (D). Choice (A) is incorrect because the passage does not say that the shoreline birds were made extinct; in fact, paragraph 8 asserts that shoreline birds were the only birds to survive the impact. Choice (B) is incorrect because the evidence Fediccia finds is not about modern biologists. Choice (C) is incorrect because opposing bird populations are not mentioned in the passage. Choice (D) is the best answer because, as paragraph 6 reveals, the evidence Fediccia finds is that only one certain shoreline bird fossil resembles modern birds.

32. The correct answer is (F). Choice (F) is incorrect because their flight characteristics are never mentioned. Choice (G) is the best answer because paragraph 8 states “Only these shore birds, Fediccia argues, were able to live through this massive cooling of the planet by feeding on marine animals like crabs that were able to adjust to the rapidly chilling environment.” Choice (H) is incorrect because the vocal mechanisms of birds are not mentioned in the passage. Choice (J) is incorrect because bird hovels are not mentioned in the passage.

33. The correct answer is (A). Choice (A) is the best answer because only I is mentioned as a good place to look for fossils from the Cretaceous Period (paragraph 11: “Cretaceous fossil gold mines like Antarctica and New Zealand”). Choice (B) is incorrect because II (South America) is not mentioned as a good place to find fossils from the Cretaceous Period. Choice (C) is incorrect because II (South America) is not mentioned as a good place to find fossils from the Cretaceous Period. Choice (D) is incorrect because III (Gondwanaland) is not mentioned as a good place to find fossils from the Cretaceous Period. In fact, Gondwanaland broke up before the Cretaceous Period even began (see paragraphs 4 and 5).

34. The correct answer is (G). Choice (F) is incorrect because their flight characteristics are never mentioned. Choice (G) is the best answer because paragraph 8 states “Only these shore birds, Fediccia argues, were able to live through this massive cooling of the planet by feeding on marine animals like crabs that were able to adjust to the rapidly chilling environment.” Choice (H) is incorrect because the vocal mechanisms of birds are not mentioned in the passage. Choice (J) is incorrect because bird hovels are not mentioned in the passage.

35. The correct answer is (A). Choice (A) is the best answer because the passage ends with the sentence “Such an agreement is unlikely without more detailed information from the genetic and fossil records.” Choice (B) is incorrect because the passage does not suggest that a new theory is needed. See explanation for choice (A). Choice (C) is incorrect because the passage does not suggest that a new theory is needed. See explanation for choice (A). Choice (D) is incorrect because the
passage does not suggest that biologists need to closely study fossil specimens. See explanation for choice (A).

36. The correct answer is (J). Choice (F) is incorrect because paragraph 5 confirms the fact that Gondwanaland fragmented 80 million years ago. Choice (G) is incorrect because paragraph 4 confirms the statement that Gondwanaland was composed of other continents. Choice (H) is incorrect because paragraph 4 states that Gondwanaland was probably the home to an ancestor of ratites. Choice (J) is the best answer because according to paragraph 5, Gondwanaland began to fragment 80 million years ago and the Cretaceous Period ended 65 million years ago. Therefore, choice (J) is a false statement and the best answer for this EXCEPT question.

37. The correct answer is (D). Choice (A) is incorrect because inbreeding is never mentioned. Choice (B) is incorrect because the “direction” of evolution is never mentioned. Choice (C) is incorrect because according to paragraph 4, ostriches, rheas, and emus are in fact related species. Choice (D) is the best answer because paragraph 13 states genetic mutations build up in species, and paragraph 14 resolves that “Based on this genetic evidence, many scientists have concluded that it is impossible for so many bird species to have evolved from a common ancestor in so short a time (10 million years).”

38. The correct answer is (J). Choice (F) is incorrect because the passage ends with the conclusion that more data are needed, and any debate that lasts over a century must not be easy to resolve. Choice (G) is incorrect because the passage does not suggest that the debate about bird evolution is poorly understood. Choice (H) is incorrect because although some of the evidence for the bird debate may be considered circumstantial by some, the passage never mentions this. Choice (J) is the best answer because the passage opens with the sentence “For more than a century, Paleontologists have been in heated debate about how birds evolved.”

39. The correct answer is (B). Choice (A) is incorrect because II is incorrect. Paragraph 7 states that “the enantiornithine completely died out in the vast Cretaceous extinction,” so it could not be the ancestor of birds whose fossils were found in a period before the Cretaceous. Choice (B) is the best answer because if fossils of birds were found that proved their existence before the Cretaceous Extinction, then these birds would not have evolved from the shorebirds. In effect, the Fediccia theory would be negated by this discovery because it would show that ancient shorebirds are not the common ancestors of modern birds. Choice (C) is incorrect because I is incorrect (see explanation for B) and because II is incorrect. Paragraph 7 states that “the enantiornithine completely died out in the vast Cretaceous extinction,” so it could not be the ancestor of birds whose fossils were found in a period before the Cretaceous. Choice (D) is incorrect because I is incorrect. See explanation for choice (B).

40. The correct answer is (G). Choice (F) is incorrect because it contradicts the statement in paragraph 7 that “like the Archaeopteryx the enantiornithine completely died out in the vast Cretaceous extinction.” Choice (G) is the best answer because paragraph 7 states that “these ‘birds’ had strange elongated foot bones, fleshy tails like lizards, and teeth. This hints that these ‘birds’ were not the ancestors of modern birds.” Choice (H) is
incorrect because the length of enantiornithine’s evolution is never discussed. Choice (J) is incorrect because the difficulty of finding fossils of enantiornithine is not provided as a reason for thinking they are not the ancestors of modern birds.

Section 4: SCIENCE REASONING

1. The correct answer is (B). A positive Benedict’s test is indicated with a change of the solution to green, yellow, orange, red, or brown. The only solution to turn any of those colors was the polysaccharide solution.

2. The correct answer is (H). Protein showed a positive result to the Biuret test.

3. The correct answer is (B). Monosaccharide reacts positively to the Iodine test, polysaccharide reacts positively to the Benedict’s test, and protein reacts positively to the Biuret test.

4. The correct answer is (F). Monosaccharide is detected with the Iodine test, and Solution B turned purple when it underwent the Iodine test.

5. The correct answer is (A). Solution A reacted positively to the Iodine and Biuret tests, and Solution C reacted positively to the Benedict’s and Biuret tests.

6. The correct answer is (G). Choices (F), (H), and (J) contradict information provided in the passage and the data. Through process of elimination, choice (F) is the only one that could possibly be right.

7. The correct answer is (D). The Birmingham area is the polluted area, and in that region, 123 melanic moths were recovered.

8. The correct answer is (H). Pollution does not negatively affect the survival of the melanic moths; therefore, choice (F) is incorrect. Existence of lichen does not increase survival for all moths; therefore, choice (G) is incorrect. Birds show selectivity based on the color of the moths according to the scientists’ observations; therefore, choice (J) is incorrect. The data support that birds eat more moths that differ from their background. Therefore, the correct answer is (H).

9. The correct answer is (A). Appearance of lichen only increases the likelihood of survival for light moths but does not increase the likelihood of survival for melanic moths.

10. The correct answer is (G). In both cases, light moths were recovered in almost equal percentages so it could be concluded that the light moths survive at the same levels, regardless of pollution and presence of lichen.

11. The correct answer is (A). Choices (B), (C), and (D) contradict the data presented.

12. The correct answer is (G). The scientists concluded that the presence of lichen contributed to the success of the light moths. Therefore, if lichen reappeared, the light moths should be more successful than the melanic moths.

13. The correct answer is (B). The table indicates that at an actual temperature of –25 degrees, the effective temperature would be –45 degrees if the wind is 30 km/hour.

14. The correct answer is (J). To be moderately dangerous, the effective temperature would have to be between –30 and –55 degrees. When wind speed is 30 km/hour, actual temperatures of –15 and –25 degrees put the effective temperature within this range.
15. The correct answer is (D). The effective temperature declines as the actual temperature declines and as the wind speed increases. Since –23 degrees and winds of 57 km/hour is colder than –20 degrees and windier than 50 km/hour, the answer must be less than –50 degrees.

16. The correct answer is (F). Choices (G), (H), and (J) could all result in effective temperatures that are moderately dangerous and extremely dangerous. Choice (F) is the only possible answer.

17. The correct answer is (D). There are only 4 days over the 30-day period where the UV Index falls below the warning level.

18. The correct answer is (G). A higher altitude would normally produce a higher UV Index, not a lower one, so choice (F) can be eliminated. The average index has no bearing on the index for a given day, so choice (H) is wrong. No correlation between wind and the UV Index is discussed in the passage, so choice (J) is not correct. Only choice (G) provides a plausible explanation for the difference.

19. The correct answer is (B). Looking at Table 1, 6 ml would be between 4 ml and 8 ml, so the length would be between 3.5 cm and 5.6 cm.

20. The correct answer is (H). Looking at Table 2, test tube 1 is the one at 23 degrees. The volume after 6 hours would be 11.6 ml.

21. The correct answer is (A). At 0 hours, both test tubes had the same length and the same volume. At 24 hours, both test tubes again had the same length and same volume. It would appear based only on these two readings that temperature had no effect on the rate of respiration.

22. The correct answer is (G). The total carbon dioxide is equal for both trials. When the temperature is greater, the maximum level of carbon dioxide is reached more quickly.

23. The correct answer is (D). Comparing 0.7 cm to 4.1 cm, the latter is about six times greater.

24. The correct answer is (H). If the yeast had converted all of the available sugar, then there could be no further cellular respiration to occur, and therefore the volume of carbon dioxide would not increase beyond that point.

25. The correct answer is (A). Aluminum showed the greatest change in temperature when the starting temperature was 50 degrees.

26. The correct answer is (J). When the initial temperature was 200 degrees, the final temperature was 34.14 degrees. If the initial temperature is 250 degrees, then the final temperature would be greater than 34.14 degrees.

27. The correct answer is (A). The final temperature increases when the initial temperature increases for all of the metals.

28. The correct answer is (H). Diamond’s specific heat capacity is between that of aluminum and steel. The final temperatures for steel were lower than the final temperatures for aluminum for each different initial temperature. The range of temperatures for diamond should fall in between the range for aluminum and steel.

29. The correct answer is (B). Aluminum has a range of final temperature readings greater than steel, and steel has a range of temperature readings greater than lead.
30. The correct answer is (G). Based on the temperature readings, the specific heat capacity of the unknown metal would fall between that of lead and steel.

31. The correct answer is (D). Astronomer 1’s theory includes the existence of comets in the region occupied by planets, whereas Astronomer 2’s theory allows for comets beyond the region of the planets.

32. The correct answer is (G). Astronomer 2 believes that other stars influence the motion of the comets in the Oort cloud, whereas Astronomer 3 believes that the sun’s gravity is responsible for the orbits.

33. The correct answer is (D). Astronomer 3 points out that it cannot be known in certain terms whether all members of the Solar System arose from the same nebula.

34. The correct answer is (F). Astronomer 2 describes how the inner Solar System formed rapidly and the ignition of the sun blew lighter elements out to form the outer Solar System, so there was a difference in the time of formation for these two regions.

35. The correct answer is (B). Astronomer 1 does not comment on the effect that the sun or other stars have on the comets, so Astronomer 1 does not conflict with either Astronomer 2 or Astronomer 3.

36. The correct answer is (H). A mass of 2.7 kg would exert a force in between the reading for mass of 2 kg and 3 kg.

37. The correct answer is (B). As the force increases, the extension increases, and choice (B) is the only graph that represents this increase.

38. The correct answer is (J). A weight of 5 kg would take longer than a mass of 4 kg based on the trend shown in the table.

39. The correct answer is (C). There is a direct linear relationship between the square root of the mass and the force exerted on the spring.

40. The correct answer is (J). If the spring has a greater force applied and does not extend further than when a lesser force was applied, this is an indication that the spring extension has reached a maximum value.
PRACTICE TEST 2

Answer Sheet

SECTION 1: ENGLISH

1  A  B  C  D  20  A  B  C  D  39  A  B  C  D  58  A  B  C  D
2  F  G  H  I  21  A  B  C  D  40  F  G  H  I  59  A  B  C  D
3  A  B  C  D  22  A  B  C  D  41  A  B  C  D  60  A  B  C  D
4  F  G  H  I  23  A  B  C  D  42  F  G  H  I  61  A  B  C  D
5  A  B  C  D  24  A  B  C  D  43  A  B  C  D  62  A  B  C  D
6  F  G  H  I  25  A  B  C  D  44  F  G  H  I  63  A  B  C  D
7  A  B  C  D  26  A  B  C  D  45  A  B  C  D  64  A  B  C  D
8  F  G  H  I  27  A  B  C  D  46  F  G  H  I  65  A  B  C  D
9  A  B  C  D  28  A  B  C  D  47  A  B  C  D  66  A  B  C  D
10  F  G  H  I  29  A  B  C  D  48  F  G  H  I  67  A  B  C  D
11  A  B  C  D  30  A  B  C  D  49  A  B  C  D  68  F  G  H  I
12  F  G  H  I  31  A  B  C  D  50  F  G  H  I  69  A  B  C  D
13  A  B  C  D  32  A  B  C  D  51  A  B  C  D  70  F  G  H  I
14  F  G  H  I  33  A  B  C  D  52  A  B  C  D  71  A  B  C  D
15  A  B  C  D  34  A  B  C  D  53  A  B  C  D  72  A  B  C  D
16  F  G  H  I  35  A  B  C  D  54  F  G  H  I  73  A  B  C  D
17  A  B  C  D  36  A  B  C  D  55  A  B  C  D  74  F  G  H  I
18  F  G  H  I  37  A  B  C  D  56  A  B  C  D  75  A  B  C  D
19  A  B  C  D  38  A  B  C  D  57  A  B  C  D

SECTION 2: MATH

1  A  B  C  D  16  F  G  H  I  31  A  B  C  D  46  F  G  H  I
2  F  G  H  I  17  A  B  C  D  32  F  G  H  I  47  A  B  C  D
3  A  B  C  D  18  A  B  C  D  33  A  B  C  D  48  A  B  C  D
4  F  G  H  I  19  A  B  C  D  34  F  G  H  I  49  A  B  C  D
5  A  B  C  D  20  A  B  C  D  35  A  B  C  D  50  F  G  H  I
6  F  G  H  I  21  A  B  C  D  36  F  G  H  I  51  A  B  C  D
7  A  B  C  D  22  A  B  C  D  37  A  B  C  D  52  A  B  C  D
8  F  G  H  I  23  A  B  C  D  38  F  G  H  I  53  A  B  C  D
9  A  B  C  D  24  A  B  C  D  39  A  B  C  D  54  F  G  H  I
10  F  G  H  I  25  A  B  C  D  40  F  G  H  I  55  A  B  C  D
11  A  B  C  D  26  A  B  C  D  41  A  B  C  D  56  A  B  C  D
12  F  G  H  I  27  A  B  C  D  42  F  G  H  I  57  A  B  C  D
13  A  B  C  D  28  A  B  C  D  43  A  B  C  D  58  F  G  H  I
14  F  G  H  I  29  A  B  C  D  44  F  G  H  I  59  A  B  C  D
15  A  B  C  D  30  A  B  C  D  45  A  B  C  D  60  A  B  C  D
PART IV: Three Full-Length Practice ACT Assessment Tests

SECTION 3: READING

1  A  B  C  D  11  A  B  C  D  21  A  B  C  D  31  A  B  C  D
2  F  D  E  J  12  F  D  E  J  22  F  D  E  J  32  F  D  E  J
3  A  B  C  D  13  A  B  C  D  23  A  B  C  D  33  A  B  C  D
4  F  D  E  J  14  F  D  E  J  24  F  D  E  J  34  F  D  E  J
5  A  B  C  D  15  A  B  C  D  25  A  B  C  D  35  A  B  C  D
6  F  D  E  J  16  F  D  E  J  26  F  D  E  J  36  F  D  E  J
7  A  B  C  D  17  A  B  C  D  27  A  B  C  D  37  A  B  C  D
8  F  D  E  J  18  F  D  E  J  28  F  D  E  J  38  F  D  E  J
9  A  B  C  D  19  A  B  C  D  29  A  B  C  D  39  A  B  C  D
10  F  D  E  J  20  F  D  E  J  30  F  D  E  J  40  F  D  E  J

SECTION 4: SCIENCE REASONING

1  A  B  C  D  11  A  B  C  D  21  A  B  C  D  31  A  B  C  D
2  F  D  E  J  12  F  D  E  J  22  F  D  E  J  32  F  D  E  J
3  A  B  C  D  13  A  B  C  D  23  A  B  C  D  33  A  B  C  D
4  F  D  E  J  14  F  D  E  J  24  F  D  E  J  34  F  D  E  J
5  A  B  C  D  15  A  B  C  D  25  A  B  C  D  35  A  B  C  D
6  F  D  E  J  16  F  D  E  J  26  F  D  E  J  36  F  D  E  J
7  A  B  C  D  17  A  B  C  D  27  A  B  C  D  37  A  B  C  D
8  F  D  E  J  18  F  D  E  J  28  F  D  E  J  38  F  D  E  J
9  A  B  C  D  19  A  B  C  D  29  A  B  C  D  39  A  B  C  D
10  F  D  E  J  20  F  D  E  J  30  F  D  E  J  40  F  D  E  J

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Passage 1

Traveling Blues

I had been in Europe for three weeks, seeing twenty-five cities in six countries and sat on an infinite number of trains. The thought and idea of going to yet another crowded tourist site was not appealing, however, my traveling companions assured me that Florence, the most charming city in Europe, would cure my growing distaste for travel.

1. (A) NO CHANGE
   (B) was seeing
   (C) seen
   (D) saw

2. (F) NO CHANGE
   (G) thought
   (H) possibility
   (J) idea and thought

3. (A) NO CHANGE
   (B) appealing, and however,
   (C) appealing, however:
   (D) appealing. However,

4. (F) NO CHANGE
   (G) the charmingest
   (H) the most charmed
   (J) the by far most charming
The morning came all too soon; my ever-eager travel companions shaking me awake hours earlier than I thought reasonable. I stepped into twice-worn clothes while they babbled on about the Piazzale’s stunning charm. It was a bright sunny morning, and my friends wanted to walk. I would have been perfectly happy to snooze on a bench. Rather than this, I trudged to the nearest pensione for a room. My friends insisted that in the morning one look at the Piazzale Michelangelo would revitalize me.

All that night I slept on a lumpy bed, trying to ignore the rhythmic growling of my stomach.

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We arrived in the dead of night long after the last restaurant had closed, and trudged to the nearest pensione for a room. My friends insisted that in the morning one look at the Piazzale Michelangelo would revitalize me.

All that night I slept on a lumpy bed, trying to ignore the rhythmic growling of my stomach.

The sentence would most logically be inserted before sentence 3.

Instead of this, we arrived in the dead of night long after the last restaurant had closed, and trudged to the nearest pensione for a room. My friends insisted that in the morning one look at the Piazzale Michelangelo would revitalize me.

All that night I slept on a lumpy bed, trying to ignore the rhythmic growling of my stomach.

The morning came all too soon; my ever-eager travel companions shaking me awake hours earlier than I thought reasonable. I stepped into twice-worn clothes while they babbled on about the Piazzale’s stunning charm. It was a bright sunny morning, and my friends wanted to walk. I would have been perfectly happy to snooze on a bench. Rather than this, I trudged to the nearest pensione for a room. My friends insisted that in the morning one look at the Piazzale Michelangelo would revitalize me.

All that night I slept on a lumpy bed, trying to ignore the rhythmic growling of my stomach.
Finally, we reached the Piazzale. I gasped, but not with delight. Tourists teemed across the square like lemmings, jostling one another to take photos and videos of the spectacular domed Cathedral and its bell tower. “Isn’t this place amazing?” my friends cooed. They were already snapping pictures and seemed impervious to my glares.

I leaned against a wall to sulk and stare at the throngs in front of the Cathedral. Suddenly, a sweet, mysterious smell wafted up from behind the wall. My spirits lifted as I inhaled. I looked over to see thousands of roses basking in the glow of mid-morning. The garden was empty save for one lone, happy soul.

I climbed over the wall and slipped into the garden. I stretched out on an empty bench and gently touched the lump petals of a yellow rose. Solitude embraced me. For the first time in days, I gazed out at the beautiful skyline and smiled.
Item 15 poses a question about the essay as a whole.

15. The writer wishes to insert the following material into the essay:

I wondered why traveling was considered fun.

The sentence would most logically be inserted into Paragraph
(A) 1, after the last sentence.
(B) 3, after the last sentence.
(C) 4, before the first sentence.
(D) 6, before the first sentence.

Passage II

The Slow Birth of Agriculture

New digs and the development of techniques to glean more information from the scant evidence of ancient settlements are changing our view of the distant past. Anatolia, for instance, was thought to be the earliest known agricultural-based city. With a corresponding division of labor. Recent evidence, however, indicates that hunting and gathering continued to be key to survival way after the dense settlement was built.

This may have seemed like a debate limited to the archaeological community, but in fact, what is at stake is the theory of the rise of civilization that we were taught in school.

For several decades archaeologists have postulated that the birth of agriculture paved the...
The scenario states that agriculture was born in the Fertile Crescent at the end of the last ice age when humans learned to domesticate plants. A stable food supply led to dense cities. Food surpluses not only allowed more children to reach adulthood, but also resulted in a division of labor that evolved political and priestly classes, as well as soldiers and urban laborers. The benevolence of agriculture were obvious, and the techniques spread quickly, giving rise to civilization as we know it.

This story has begun to crumble from an onslaught of new data. Gene analysis of plants has enabled scientists to track changes over time.

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This story has begun to crumble from an onslaught of new data. Gene analysis of plants has enabled scientists to track changes in ancient grains, technological advances allowed for more accurate ways of dating the remains at different levels of ancient settlements. Rye fields were apparently cultivated in regions of the Near East four thousand years before the arrival of the classic agricultural economy. Squash in tropical forests of the Americas and rice in China seem to have been domesticated much earlier than the rise of the Neolithic Revolution.

Would it contribute to the understanding of the essay to define here the term “Neolithic Revolution”? (A) Yes, because it is unclear and essential to the theory being discussed.  (B) No, because the focus of the essay is on agriculture, not revolution.  (C) No, because the meaning of the term can be inferred from the rest of the paragraph.  (D) No, because the term is jargon and extraneous to the focus of the essay.

This theory was believed for several decades. (A) NO CHANGE  (B) This theory was believed for several decades.  (C) It was a very attractive hypothesis.  (D) This idea was recently disproved.

grains: technological advances allowed for more accurate ways of dating the remains at different levels of ancient settlements. Rye fields were apparently cultivated in regions of the Near East four thousand years before the arrival of the classic agricultural economy. Squash in tropical forests of the Americas and rice in China seem to have been domesticated much earlier than the rise of the Neolithic Revolution.

methods of dating measurements of dating dating of
of settlements in these regions. On the other hand, several dense settlements like Anatolia have been excavated to levels that show no evidence of domesticated food sources. Instead, remains point to a hunting and gathering economy.

Scientists now believe that agriculture was born slowly, in fits and starts, and that the first successes in plant domestication co-existed in hunter-gather economies. Instead of revolution, there was probably an evolution of food gathering techniques, and the first cities were probably built from an impulse other than agricultural surpluses.

27. (A) NO CHANGE
(B) In addition,
(C) However,
(D) As a consequence,

28. (F) NO CHANGE
(G) coexisted with
(H) coexisted, in
(J) coexisted before

Items 29 and 30 pose questions about the essay as a whole.

29. Suppose the writer wished to more closely examine evidence that supports the idea that agriculture was slowly incorporated into human economies. In order to expand on material already present there, this information would most logically be added to Paragraph
(A) 1
(B) 2
(C) 3
(D) 4

30. The essay consists of four paragraphs. Which of the following is the best description of their relationship?
(F) Introduction to subject; previous thinking on the subject; evidence contrary to the previous thinking; present thinking on the subject.
(G) Introduction to subject; discussion of one aspect of subject; discussion of second aspect; conclusion.
(H) Statement of purpose; elaboration of one reason for viewpoint; elaboration of a second reason; conclusion.
(J) Explanation of one viewpoint; explanation of opposing viewpoint; reconciliation of views; conclusion.
Passage III

Mount Vinson

At 16,076 feet, Mount Vinson is the highest peak in Antarctica. The views from its summit are spectacular. An unobstructed panorama of the numerous nearby mountains. Vinson is 1,200 miles from the northern tip of the Antarctic Peninsula and 600 miles away from the South Pole. The polar ice cap’s high-pressure system controls Vinson’s cold, relatively stable climate. However, because Vinson is in an arctic climate, snow and terrific winds are always feasible.

Summer runs from November through January, during this time, the sun shines 24 hours a day. The average midsummer temperature is –20°C. Despite this below-freezing temperature, the intensity of the sun often melts into a thin layer of snow, and you can walk around in a T-shirt if there is no wind. During the winter months, temperatures can dip to –100°C. Despite these adverse conditions, or maybe that is the reason why, there are still people eager to climb to

31. (A) NO CHANGE
(B) spectacular; an unobstructed panorama
(C) spectacular: an unobstructed panorama
(D) spectacular. Undoubtedly an obstructed panorama

32. (F) NO CHANGE
(G) away to
(H) from
(J) near

33. (A) NO CHANGE
(B) ice caps’
(C) ice caps
(D) ice-capped

34. (F) NO CHANGE
(G) Since
(H) Moreover,
(J) In addition,

35. (A) NO CHANGE
(B) January,
(C) January, but during
(D) January, and during

36. (F) NO CHANGE
(G) up
(H) around
(J) OMIT the underlined portion.

37. (A) NO CHANGE
(B) or maybe because of them,
(C) or perhaps with them in mind,
(D) OMIT the underlined portion.
the top of Mount Vinson because it is the highest of the Antarctic peaks and has had less than four hundred people at its summit.

Vinson’s stunning landscape of the wind-carved ice and snowdrifts also attracts thrill seekers.

To survive a trek up Vinson, you must have prior skiing and climbing experience and be prepared to withstand extreme weather conditions. During the height of winter, it can get cold enough for fillings to fall out of your teeth, for metal to stick to exposed flesh, and for kerosene to turn to jelly. However, the inevitable bouts with brutal winds can be more dangerous than the cold. When winds are fierce, one must pile on layer upon layer of clothing because any exposed skin, particularly on your extremities; ears, nose, cheeks, fingers, or toes—is susceptible to instantaneous frostbite.
Suffice it to say that if you want to climb Mount Vinson, you need more than a warm coat and a pair of mittens.

43. Suppose the writer were to substitute “to be prepared” for the underlined portion of this sentence. If made, this change would cause the sentence to be

(A) more dramatic.
(B) more informative.
(C) less effective.
(D) less straightforward.

44. Which of the following sentences, if added here, would provide the best conclusion to this essay?

(F) The effort, however, will reward you with one of the most stunning views on Earth.
(G) You must begin preparations and physical training months in advance of your departure.
(H) You should think carefully before undertaking such a formidable expedition.
(J) The magnificence of Mount Vinson and its panorama are hard to match anywhere in the world.

Item 45 poses a question about the essay as a whole.

45. The writer has been asked by a mountaineering magazine to write an essay that would prepare climbers who wish to ascend Mount Vinson. Would this essay fulfill that assignment?

(A) Yes, because the writer focuses on the specific obstacles and conditions that a climber is likely to face on Mount Vinson.
(B) Yes, because the writer focuses on the best viewpoints and ascent routes up the mountain.
(C) No, because the writer focuses on arctic conditions in general without particular regard to Mount Vinson.
(D) No, because the writer focuses on the appeal of Mount Vinson, offering a general description of its climate and setting.
Passage IV

I’d Rather Read the Book

Today, Hollywood is adapting more classic novels, like Victor Hugo’s Les Misérables, into films than ever before in the past. This is because more and more people think they can watch film adaptations which are the director’s interpretations, and still have the same experience. These people don’t get it that there is no replacing the classics. You must read them to appreciate them.

Because film is a visual medium, characters bore you with soliloquies and can only show you what they think and feel through dramatic action. Your experiences with the characters are limited because you can’t get

46. (F) NO CHANGE
   (G) has adapted
   (H) adapted
   (J) will adapt

47. (A) NO CHANGE
   (B) previously in the past.
   (C) ever before.
   (D) they have in the past.

48. (F) NO CHANGE
   (G) Despite this,
   (H) Fortunately,
   (J) However,

49. (A) NO CHANGE
   (B) of these time-proven classics
   (C) on the big screen
   (D) without reading the novels

50. (F) NO CHANGE
   (G) grasp the self-evident concept
   (H) sense
   (J) realize

51. (A) NO CHANGE
   (B) slow down the film by showing you what they think and feel through dramatic action.
   (C) can only show you what they think and feel through dramatic action or risk boring you with soliloquies that slow down the film.
   (D) in order not to risk boring you, slow down the film with soliloquies and show you what they think and feel through dramatic action.
When watching a film, you are visually spoonfed story and character development, a process that requires little complex thought on your part. Reading a novel requires an omnipresent narrator, a third character, or the characters themselves can go into great detail about inner emotions and thoughts, enabling us to not only get inside those characters but to become them.

In addition, when a novel is made into a film, many of the characters and much of the story are cut to fit the novel into a 2-hour format. Producing an oral presentation of an entire novel takes a lot longer than 2 hours. If you read the novel before you watch the film adaptation, you’ll probably find yourself wondering what happened to your favorite minor characters and most of the story. Chances are they just didn’t fit.

When watching a film, you are visually spoonfed story and character development, a process that requires little complex thought on your part. Reading a novel requires you to recreate and interpret that novel in your mind’s eye. You, not the film, are the active element here.

Finally, while the visuals of a good film are stimulating and exciting, there is no substitute for literature, which uses poetry, power...
59. The writer wishes to add a concluding sentence that will provide a link to the opening paragraph. Which of the alternatives most successfully achieves this effect?

(A) In conclusion, an educated person is one who has read the classics.

(B) Finally, the best films are those that are produced from original screenplays.

(C) The obvious conclusion to my argument is that reading is a better use of time than watching films.

(D) So the next time somebody tells you watching a film adaptation is the same as reading the novel, tell them, “I’d rather read the book.”

Item 60 poses a question about the essay as a whole.

60. Which of the following alternatives best summarizes the argument presented in this essay?

(F) Because they have been translated into films so often, classic books have lost their power to move us.

(G) Good books make for slow and boring films.

(H) Classic novels often lose a great deal of their power when adapted into films.

(J) Most directors haven’t read the books they adapt into films.

Passage V

Prince Rainier III of Monaco

When asked to imagine an existence of ease and luxury, many people immediately think of the life of a prince or princess. The benefits of such a life include servants waiting to attend to your every desire; a magnificent of words to evoke our imaginations and lead us into new worlds.  

61. (A) NO CHANGE

(B) desire:

(C) desire,

(D) desire
Perched on the Riviera and blessed with 300 sunny days a year, it truly seems that Monaco is a wonderful place in which to be royal. This wealthy indeed tiny country (Monaco is less than 500 acres) is currently ruled by Prince Rainier III. The prince’s family name is Grimaldi and one or another of his relatives has ruled Monaco for hundreds of years. In fact, the Grimaldi family is the oldest ruling family in Europe.

The Grimaldi’s are more than an ancient royal family, however. They are the...
reason Monaco exists at all. Many people know Monaco for its casinos; one was even featured in a James Bond movie. A treaty signed in 1918 states that, should the Grimaldis all die at the same time, Monaco will become a French state. But when I think about the fact that the Prince has three children and several grandchildren, the end of the Grimaldi family is not something that is likely to happen soon.

The prince’s wife and the mother of his three children was an American movie actress named Grace Kelly. Beautiful and poised, two fantasies were merged into one when she married Prince Rainier, becoming both a star and a princess. Sadly, Princess Grace died in an auto accident in 1982, when she was in the prime of her life. The tragic story of Princess Grace, and that of the husband whom mourns her still, reminds us all that even a prince’s life can be destroyed by sorrow.
Item 75 poses a question about the essay as a whole.

75. Suppose the writer had been assigned to write an essay comparing the lives of royalty to those of ordinary people. Would this essay successfully fulfill the assignment?

(A) Yes, because this essay discusses how tragedy can strike in the lives of both royalty and ordinary people alike.

(B) Yes, because this essay discusses the images that ordinary people think of when asked to imagine a royal life.

(C) No, because this essay restricts its focus to Prince Rainier III and his family.

(D) No, because this essay does not mention ordinary people at all, even indirectly.
SECTION 2: MATH

60 Questions • Time—60 Minutes

Directions: Solve each problem below and mark the oval representing the correct answer on your answer sheet.

Be careful not to spend too much time on any one question. Instead, solve as many questions as possible, and then use any remaining time to return to those questions you were unable to answer at first.

You may use a calculator on any problem in this test; however, not every problem requires the use of a calculator.

Diagrams that accompany problems may or may not be drawn to scale. Unless otherwise indicated, you may assume that all figures shown lie in a plane and that lines that appear straight are straight.

1. The regular price for a certain suit is $250. If a sale reduces the price by 25%, what is the sale price of the suit?
   (A) $187.50
   (B) $200
   (C) $222.50
   (D) $225
   (E) $312.50

2. A contractor is building a house with a rectangular foundation 60 feet long and 20 feet wide. What is the foundation’s perimeter, in feet?
   (F) 1,200 feet
   (G) 160 feet
   (H) 140 feet
   (J) 120 feet
   (K) 80 feet

3. If $a = -3$ and $b = -2a$, what is the value of the expression $ab - 3a$?
   (A) $-27$
   (B) $-12$
   (C) $-9$
   (D) $9$
   (E) $27$

4. In a rose garden, 18 of the 48 rose bushes are red roses. What percentage of the rose bushes are red roses?
   (F) 2%
   (G) 18%
   (H) 25%
   (J) 37.5%
   (K) 40%

5. If $n = 5$, then $3n^2 - 2n + 7 = ?$
   (A) 12
   (B) 22
   (C) 27
   (D) 72
   (E) 81
6. Five templates cut out of paper are shown below. Each template is made up of 6 equal squares, and they are only to be folded along the dotted lines. Which template could be folded, without tearing, to form a complete cube?

(F) 

(G) 

(H) 

(J) 

(K) 

7. If \((x + 2)(x - 5) = 8\), then which of the following must be true?

(A) \(x + 2 = 0\)
(B) \(x - 2 = 0\)
(C) \(x - 5 = 0\)
(D) \(x - 5 = 8\)
(E) \(x - 6 = 0\)

8. On a certain state’s drivers’ exam, an applicant must get at least 70% of the 400 possible points in order to pass. If an applicant raises his score on his second attempt by 25 points and passes with the minimum required score, what score did he receive on his first attempt?

(F) 255
(G) 260
(H) 265
(J) 280
(K) 305

9. A copy shop offers copies on 5 colors of paper, each of which comes in 4 finishes. If a company gets 2 newsletters copied on different paper, there are how many distinct possible combinations of newsletter, color, and finish?

(A) 40
(B) 20
(C) 11
(D) 10
(E) 5

10. The graphs below represent the solutions of two inequalities. Which of the following specifies the intersection of the two graphs in algebraic form?

(F) \(x \leq 2\) or \(x > -2\)
(G) \(x < 2\) or \(x \geq -2\)
(H) \(-2 < x < 2\)
(J) \(-2 < x \leq 2\)
(K) \(-2 \leq x < 2\)
11. How many inches long is the radius of a circle whose area is $24\pi$ square inches?
(A) 12 inches
(B) $4\sqrt{6}$ inches
(C) 6 inches
(D) $2\sqrt{6}$ inches
(E) 4 inches

12. Six points are drawn to scale below. Which four points could be connected in order to form a parallelogram?

(F) $ABCD$
(G) $ABDE$
(H) $BCDE$
(J) $BCDF$
(K) $CDEF$

13. For all real numbers $m$ and $n$, $3(m + n) - 2(m - 3n) = ?$
(A) $m + 9n$
(B) $m - 3n$
(C) $5m$
(D) $5m + 9n$
(E) $5m - 3n$

14. The hypotenuse of a right triangle is 5 inches long. What is the perimeter of the triangle in inches?
(F) 6 inches
(G) 10 inches
(H) 11 inches
(J) 15 inches
(K) It cannot be determined.

15. In the $(x,y)$ coordinate plane, at which $y$-value does the line $x + 3y = 6$ intersect the $y$-axis?
(A) 0
(B) 1
(C) 2
(D) 3
(E) 6

16. In a certain parking lot, 540 cars have in-state license plates, while the remaining 180 have out-of-state license plates. What percent of the cars in the parking lot have out-of-state license plates?
(F) 20%
(G) 25%
(H) 30%
(J) $33\frac{1}{3}$%
(K) $66\frac{2}{3}$%

17. $s = (2)(4)(6)(9)t$

If $t$ is a positive integer, then $s$ must be divisible, with no remainder, by all of the following EXCEPT
(A) 12
(B) 24
(C) 30
(D) 54
(E) 72
18. A rectangle has a length of \((3x + 2)\) centimeters and a width of \((5x - 3)\) centimeters. Which of the following expressions must represent the area, in square centimeters, of the rectangle?
   (F) \(8x - 1\)
   (G) \(15x^2 - 6\)
   (H) \(15x^2 - 9x - 6\)
   (J) \(15x^2 + x - 6\)
   (K) \(15x^2 + 19x - 6\)

19. The equation \(4x^2 = 6x + 4\) is equivalent to which of the following equations?
   (A) \((2x + 1)(x - 2) = 0\)
   (B) \((2x - 4)(2x - 1) = 0\)
   (C) \((4x - 1)(x + 4) = 0\)
   (D) \((4x - 2)(x - 2) = 0\)
   (E) \((4x + 2)(x + 2) = 0\)

20. The lengths of the sides of one triangle are 5 inches, 10 inches, and \(x\) inches, respectively. The length of the sides of a similar triangle are \(2.5x\) inches, \(5x\) inches, and \(4x\) inches, respectively. What is the value of \(x\)?
   (F) 2
   (G) 8
   (H) 12
   (J) 16
   (K) 32

21. If \(\sqrt{3} - 4.2 = .2x + 3.3\), then \(x = ?\)
   (A) \(-75\)
   (B) \(-45\)
   (C) 9
   (D) 45
   (E) 75

22. A plane left New York for San Francisco, a distance of about 3,000 miles, at 3 p.m. traveling at 350 mph. An hour later, a plane left San Francisco flying in the opposite direction at 450 mph. At what time will they pass each other?
   (F) 7:03 p.m.
   (G) 7:18 p.m.
   (H) 7:33 p.m.
   (J) 7:48 p.m.
   (K) 8:03 p.m.

23. If \((x - a)(x + b) = x^2 + 2x - 4b\), then \(b = ?\)
   (A) \(-2\)
   (B) 0
   (C) 2
   (D) 4
   (E) 6

24. \(\frac{3.2 - 1.557}{2(1 - .5 - .375)} = ?\)
   (F) 8.413
   (G) 6.572
   (H) 3.119
   (J) .9488
   (K) .41075

25. If \(12x^2 - ax - a = (3x + 1)(4x - 2)\), what is the value of \(a\)?
   (A) \(-2\)
   (B) 2
   (C) 3
   (D) 4
   (E) 6
26. The expression “rationalizing the denominator” refers to eliminating radicals from a denominator. Which of the following expressions represents \( \frac{x}{x - \sqrt{3}} \) with a rationalized denominator?

(F) \( x + \sqrt{3} \)

(G) \( x^2 \sqrt{3} + 3x \)

(H) \( \frac{3x}{x - 3} \)

(J) \( \frac{3x^2}{x^2 + 3} \)

(K) \( \frac{x^4 \sqrt{3} + 3x}{x^4 - 3} \)

27. If \( ABCD \), not shown, is a rectangle, then which of the following must be true?

I. \( ABCD \) is a quadrilateral.
II. \( ABCD \) is a rhombus.
III. \( ABCD \) is a parallelogram.

(A) I only
(B) II only
(C) I and II
(D) I and III
(E) I, II, and III

28. Work is defined in physics as force times distance and can be measured in joules. If it requires 150 joules to move an object 20 feet, how far would the object be moved with 180 joules?

(F) 24 feet
(G) 25 feet
(H) 26 feet
(J) 28 feet
(K) 30 feet

29. In the right triangle \( ABC \), illustrated below, the sine of \( \angle B \) is \( \frac{4}{5} \). What is the sine of \( \angle A \)?

(A) \( \frac{9}{4} \)

(B) \( \frac{\sqrt{65}}{4} \)

(C) \( \frac{\sqrt{65}}{9} \)

(D) \( \frac{\sqrt{65}}{9} \)

(E) \( \sqrt{65} \)

30. If \( n + 8 = 14 - 4(3 - n) \), then \( n = ? \)

(F) –3

(G) –1

(H) 0

(J) 1

(K) 2
31. What is the slope of a line that is parallel to the line with the equation $2x + 7y = 5$?

(A) $\frac{-7}{2}$

(B) $\frac{-2}{7}$

(C) $\frac{-2}{5}$

(D) $\frac{-5}{2}$

(E) $\frac{-7}{2}$

32. The diagram below shows the plan for a carpeted living room floor. What is the amount of carpet, in square feet, actually used to cover the floor?

(F) 120 sq. ft.

(G) 140 sq. ft.

(H) 160 sq. ft.

(J) 192 sq. ft.

(K) 208 sq. ft.

33. If $x + 10 = yz + 5$, where $xyz \neq 0$, which of the following expressions solves for $y$ in terms of $x$ and $z$?

(A) $y = \frac{x + 5}{z}$

(B) $y = \frac{x + 15}{z}$

(C) $y = \frac{5 - x}{z}$

(D) $y = \frac{5}{2} - x$

(E) $y = \frac{x}{z} + 5$

34. What is the slope of the line $6x - 5y = 10$?

(F) $-2$

(G) $\frac{-6}{5}$

(H) $\frac{-5}{6}$

(J) $\frac{5}{6}$

(K) $\frac{6}{5}$

35. If, in the diagram below, $AB$ is 20 centi-
35. If, in the diagram below, \( AB \) is 20 centimeters long, how many centimeters long is \( BC \)?

36. A circle with center at \( C(0,5) \) and passing through the point \( P(6,1) \) is in the standard \((x,y)\) plane below. What is the area of the circle, in square units?

37. The line \( y = \frac{5}{2}x + 1 \) passes through all of the following points in the standard \((x,y)\) plane EXCEPT

(A) \((-2, -4)\)
(B) \((0, 1)\)
(C) \((3, 8)\)
(D) \((5, 13.5)\)
(E) \((8, 21)\)

Use the following information to answer questions 38 and 39.

An advertisement for a men's clothing store reads, “Men’s shirts $22 each; 3 for $55. Receive a 10% discount on any sale of $100 or more.”

38. What is the total cost of eight shirts?

(F) $136.80
(G) $138.60
(H) $154
(J) $158.40
(K) $176

39. What is the greatest number of shirts you can buy if you have $100 to spend?

(A) 4 shirts
(B) 5 shirts
(C) 6 shirts
(D) 7 shirts
(E) 8 shirts
40. The lengths of the sides in the right triangle below are 10 inches, 24 inches, and 26 inches. What is the sine of \( \angle B \)?

\[ \frac{5}{13} \]  
\[ \frac{5}{12} \]  
\[ \frac{12}{13} \]  
\[ \frac{13}{12} \]  
\[ \frac{13}{5} \]

41. Polynomial \( P(x) \) is a third-degree polynomial with 3 distinct real roots. Polynomial \( Q(x) \) is a fourth-degree polynomial with 2 distinct real roots. If \( y = P(x) \times Q(x) \) is graphed on the standard \((x,y)\) coordinate plane, what is the maximum number of times the graph can intersect (touch or cross) the x-axis?

(A) 3  
(B) 5  
(C) 6  
(D) 7  
(E) 9

42. If \( y^2 - x^2 \neq 0 \), then \( \frac{2x^2 - 4xy + 2y^2}{y^2 - x^2} \) can be simplified to which of the following?

(F) 2  
(G) \( 2(x - y) \)  
(H) \( \frac{2(x + y)}{x - y} \)  
(J) \( \frac{2(x - y)}{x + y} \)  
(K) \( \frac{2(y - x)}{x + y} \)

43. What is the height of the equilateral triangle below?

(A) 3  
(B) \( 3\sqrt{2} \)  
(C) \( 3\sqrt{3} \)  
(D) 6  
(E) \( 6\sqrt{3} \)

44. How many different real numbers are solutions for the equation \((x + 2)(x - 6) = 2x - 21\)?

(F) 0  
(G) 1  
(H) 2  
(J) 3  
(K) 4
45. Six students in a history class of x students received A's on their term papers. If the professor never gives A's to fewer than 20% of the class nor never more than 40%, how many different values of x are possible?
   (A) 16  
   (B) 18  
   (C) 20  
   (D) 24  
   (E) 30

46. A polynomial that has zeros of 0, 1, and 2 could be which of the following?
   (F) $3x + 3 = 0$  
   (G) $x^2 + 2x - 3 = 0$  
   (H) $x^3 + 2x - 2 = 0$  
   (J) $x^3 - 3x^2 + 2x = 0$  
   (K) $x^3 + 3x^2 + 2x = 0$

47. If ABCDE is a square with sides 6 inches long, then what is the area, in square inches, of triangle CDE?

![Diagram of a square with triangle CDE]

   (A) 6 sq. inches  
   (B) 12 sq. inches  
   (C) 18 sq. inches  
   (D) 24 sq. inches  
   (E) It cannot be determined.

48. At what point in the standard (x,y) coordinate plane do the lines $y = 4x - 4$ and $3x + y = 10$ intersect?
   (F) (0,−4)  
   (G) (2,4)  
   (H) (8,−14)  
   (J) (14,52)  
   (K) The lines do not intersect.

49. If the perimeter of an isosceles right triangle is $16 + 16\sqrt{2}$ inches long, how long is one of the perpendicular sides?
   (A) $4\sqrt{2}$  
   (B) 4  
   (C) $8\sqrt{2}$  
   (D) 8  
   (E) $16\sqrt{2}$

50. If $x = \frac{2 - \sqrt{3}}{2 + \sqrt{3}}$ and $y = \frac{2 + \sqrt{3}}{2 - \sqrt{3}}$, what is the value of $x + y$?
   (F) 1  
   (G) 14  
   (H) $8\sqrt{3}$  
   (J) $\frac{4}{2 + \sqrt{3}}$  
   (K) $\frac{4 - 2\sqrt{3}}{4 + 2\sqrt{3}}$

51. If there are no real numbers that satisfy the inequality $3x - k(x + 2) \geq 10 - 3(1 + x)$, where $k$ is a constant, what is the value of $k$?
   (A) 0  
   (B) 1  
   (C) 2  
   (D) 4  
   (E) 6
52. During a week at a certain software company, the orders per day climbed at a constant rate from 40 on Monday to 60 on Friday. If the average order size decreased at a constant daily rate from a high of $250 on Monday to a low of $210 on Friday, on what day did the company first record at least $12,000 in orders?

(F) Monday
(G) Tuesday
(H) Wednesday
(J) Thursday
(K) Friday

53. In the figure below, K and J lie on triangle ABC, JK is parallel to AB, and the lengths of the sides of quadrilateral ABKJ are in inches as indicated. What is the perimeter of triangle ABC?

54. What is the maximum number of points of intersection between the graphs of a triangle and a circle?

(F) 1
(G) 2
(H) 3
(J) 4
(K) 6

55. For all real numbers a and b, which of the following must be true?

I. \(|a + b| = |a| + |b|

II. \(\frac{a}{b} = \frac{|a|}{|b|}

III. \(|ab| = |a| \times |b|

(A) II only
(B) III only
(C) I and II
(D) II and III
(E) I, II, and III

56. What are the real numbers x such that 

2x^2 - 2x = 2x(x^2 + 1)(x + 1)(x - 1)

(F) -1 only
(G) -1 and 1
(H) 0 only
(J) 0 and 1
(K) All real numbers

57. Compared to the graph of \(y = \cos \theta\), the graph of \(2y = \cos 2\theta\) has

(A) half the period and half the amplitude.
(B) half the period and twice the amplitude.
(C) twice the period and half the amplitude.
(D) twice the period and twice the amplitude.
(E) the same period and the same amplitude.

58. An ellipse with equation \(9(x + 2)^2 + 4(y - 2)^2 = 36\) is inscribed in a circle. Which of the following is the equation of the circle?

(F) \(x^2 + y^2 = 4\)
(G) \(x^2 + y^2 = 36\)
(H) \((x + 2)^2 + (y - 2)^2 = 6\)
(J) \((x + 2)^2 + (y - 2)^2 = 9\)
(K) \((x - 4)^2 + (y - 9)^2 = 6\)
59. The volume of a sphere with a radius of \( x \) inches is how many times the volume of a sphere with a radius of \( \frac{x}{2} \) inches?

(Note: The volume of a sphere is \( \frac{4}{3}\pi r^3 \), where \( r \) is the radius.)

(A) \( \frac{1}{4} \)

(B) 2

(C) 3

(D) 4

(E) 8

60. The angles of a triangle have measures of \( x^\circ \), \( 2x^\circ \), and \( 3x^\circ \). If the side opposite the smallest angle has a length of 4 units, how many units long is the perimeter of the triangle?

(F) \( 8\sqrt{3} \)

(G) \( 8 + 4\sqrt{3} \)

(H) \( 12 + 4\sqrt{3} \)

(J) \( 16 + 8\sqrt{3} \)

(K) 24

STOP

END OF SECTION 2. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
SECTION 3: READING

40 Questions • Time—35 Minutes

Directions: This test consists of four passages, each followed by several questions. Read each passage, select the correct answer for each question, and mark the oval representing the correct answer on your answer sheet.

Passage I—PROSE FICTION

This passage is adapted from Jack London’s *Burning Daylight*.

In all lands where life is a hazard lightly played with and lightly flung aside, men turn, almost automatically, to gambling for diversion and relaxation. In the Yukon men gambled their lives for gold, and those that won gold from the ground gambled for it with one another. Nor was Elam Harnish an exception. He was a man’s man primarily, and the instinct in him to play the game of life was strong. Environment had determined what form that game should take. He was born on an Iowa farm, and his father had emigrated to eastern Oregon, in which mining country Elam’s boyhood was lived. He had known nothing but hard knocks for big stakes. Pluck and endurance counted in the game, but the great god Chance dealt the cards. Honest work for sure but meager returns did not count. A man played big. He risked everything for everything, and anything less than everything meant that he was a loser. So for twelve Yukon years, Elam Harnish had been a loser. True, on Moosehide Creek the past summer he had taken out twenty thousand dollars, and what was left in the ground was twenty thousand more. But, as he himself proclaimed, that was no more than getting his ante back. He had anted his life for a dozen years, and forty thousand was a small pot for such a stake—the price of a drink and a dance at the Tivoli, of a winter’s flutter at Circle City, and a grubstake for the year to come.

The men of the Yukon reversed the old maxim till it read: hard come, easy go. At the end of the reel, Elam Harnish called the house up to drink again. Drinks were a dollar apiece, gold rated at sixteen dollars an ounce; there were thirty in the house that accepted his invitation, and between every dance the house was Elam’s guest. This was his night, the day of his birth, and nobody was to be allowed to pay for anything.

Not that Elam Harnish was a drinking man. Whiskey meant little to him. He was too vital and robust, too untroubled in mind and body, to incline to the slavery of alcohol. He spent months at a time on trail and river when he drank nothing stronger than coffee, while he had gone a year at a time without even coffee. But he was gregarious, and since the sole social expression of the Yukon was the saloon, he expressed himself that way. When he was a lad in the mining camps of the West, men had always done that. To him it was the proper way for a man to express himself socially. He knew no other way.

He was a striking figure of a man, despite his garb being similar to that of all the men in the Tivoli. Soft-tanned moccasins of moose-hide, beaded in Indian designs, covered his feet. His trousers were ordinary overalls, his coat was made from a blanket. Long-gauntleted leather mittens, lined with wool, hung by his side. They were connected in the
Yukon fashion, by a leather thong passed around the neck and across the shoulders. On his head was a fur cap, the ear-flaps raised and the tying-cords dangling. His face, lean and slightly long, with the suggestion of hollows under the cheekbones, seemed almost Indian. The burnt skin and keen dark eyes contributed to this effect, though the bronze of the skin and the eyes themselves were essentially those of a white man. He looked older than thirty, and yet, smooth-shaven and without wrinkles, he was almost boyish. This impression of age was based on no tangible evidence. It came from the abstracter facts of the man, from what he had endured and survived, and which was far beyond that of ordinary men. He had lived life naked and tensely, and something of all this smoldered in his eyes, vibrated in his voice, and seemed forever a whisper on his lips.

The lips themselves were thin, and prone to close tightly over the even, white teeth. But their harshness was retrieved by the upward curl at the corners of his mouth. This curl gave to him sweetness, as the minute puckers at the corners of the eyes gave him laughter. These necessary graces saved him from a nature that was essentially savage and that otherwise would have been cruel and bitter. The nose was lean, full-nostrilled, and delicate, and of a size to fit the face; while the high forehead, as if to atone for its narrowness, was splendidly domed and symmetrical. In line with the Indian effect was his hair, very straight and very black, with a gloss to it that only health could give.

1. It can be reasonably inferred from the passage that Elam Harnish did not drink because
(A) he did not like fraternizing with other men.
(B) he was too strong in mind and body.
(C) he had already spent too much of his life intoxicated.
(D) gambling was a better way to spend money.

2. According to the narrator, Elam's attraction to risky ventures was influenced most strongly by a
(F) wavering belief in God.
(G) lack of a mother to raise him.
(H) his difficult childhood.
(J) misunderstanding of the rules of chance.

3. Elam looked like an Indian for which of the following reasons?
I. His cheek bones were hollow.
II. He often moved about barefoot.
III. His hair was straight and black.
(A) I only
(B) III only
(C) I and III
(D) I, II, and III

4. The second paragraph suggests that Elam was buying alcohol for the people in the bar because
(F) he owed them a large amount of money.
(G) his mine had just struck a lode of gold.
(H) it was his best chance of winning at cards.
(J) he was throwing a birthday party for himself.
5. Elam seemed older than thirty because Elam’s
   I. face showed signs of aging.
   II. age showed in his eyes.
   III. voice carried a sense of experience.
   (A) I only
   (B) II only
   (C) II and III
   (D) I, II, and III

6. As it is described in the first paragraph, Elam’s Moosehide Creek mine was a venture that
   (F) did not yield as much as other nearby mines.
   (G) more than made up for the twelve years Elam had worked on it.
   (H) would potentially yield twenty thousand more dollars for Elam.
   (J) was not profitable until Elam joined up with other miners.

7. In the fourth paragraph, Elam is described as being dressed
   (A) much like everyone else in the region.
   (B) in the same way as a boy would dress.
   (C) similar to how visitors from the city would dress.
   (D) in a ridiculous manner.

8. Elam liked to relax in saloons because, despite his non-drinking nature, the saloon was
   (F) a great place to find gamblers to swindle.
   (G) the only place to hear local news.
   (H) something held in reverence from Elam’s childhood.
   (J) the only place for men to socialize.

9. According to the narrator, the men of the Yukon, after mining gold from the ground, would
   (A) hoard it in hope of raising its value.
   (B) then risk it in games of chance.
   (C) not reveal to each other where their mines were.
   (D) invest the gold in substantial business ventures.

10. What does the author suggest is a central characteristic of Elam Harnish?
    (F) Idiocy
    (G) Barbarity
    (H) Meekness
    (J) Loving kindness

**Passage II—SOCIAL SCIENCE**

This passage is adapted from Owen Wister’s *A Straight Deal*.

When you finished school, what idea did you have about the War of 1812? I will tell you what mine was. I thought we had gone to war because England was stopping American ships and taking American sailors out of them for her own service. I could refer to Perry’s victory on Lake Erie and Jackson’s smashing of the British at New Orleans; the name of the frigate Constitution sent thrills through me. And we had pounded old John Bull and sent him home a second time! Such was my glorious idea, and there it stopped.

Did you know much more than that about it when your schooling was done? Did you know that our reasons for declaring war against Great Britain in 1812 were not so strong as they had been three and four years earlier? That during those years England had moderated her arrogance, was ready to moderate further, and wanted peace; while we, who had been nearly unanimous for war, and with a fuller purse in 1808, were now, by our own congressional fuddling and messing, without any adequate army, and so divided in counsel.

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that only one northern state was wholly
in favor of war? Did you know that our
General Hull began by invading Canada
from Detroit and surrendered his whole
army without firing a shot? That the
British overrun Michigan and parts of
Ohio, and western New York, while we
retreated disgracefully? That though
we shone in victories of single combat on
the sea and showed the English that we
too knew how to sail and fight on the
waves as hardly as Britannia (we won
eleven out of thirteen of the frigate and
sloop actions), nevertheless she caught
us or blocked us up, and rioted unchecked along our coasts? You probably
did know that the British burned Wash-
ington, and you accordingly hated them
for this barbarous vandalism—but did
you know that we had burned Toronto a
year earlier?

I left school knowing none of this—it wasn’t in my school book, and I learned
it in my more mature years with amaze-
ment. I then learned also that England,
while she was fighting with us, had her
hands full fighting Bonaparte, that her
war with us was a sideshow, and that
this was uncommonly lucky for us—as
lucky as those ships from France under
Admiral de Grasse, without whose help
Washington could never have caught
Cornwallis and compelled his surrender
at Yorktown on October 19, 1781. Did
you know that there were more French
soldiers and sailors than Americans at
Yorktown? Is it well to keep these things
from the young?

My next question is what did you
know about the Mexican War of 1846—
1847 when you came out of school? The
names of our victories, I presume, and
perhaps of the heroes Zachary Taylor
and Winfield Scott; and possibly the
treaty of Guadalupe Hidalgo, whereby
Mexico ceded to us the whole of Texas,
New Mexico, and Upper California, and
we paid her fifteen million. No doubt you
know that Santa Anna, the Mexican
General, had a wooden leg. Well, there is
more to know than that, and I found it
out much later.

I found out that General Grant,
who had fought with credit as a lieuten-
ant in the Mexican War, briefly summar-
ized it as “iniquitous.” I gradually,
through my reading as a grown man,
learned the truth about the Mexican
War that had not been taught me as a
boy; that in that war we bullied a weaker
power, that we made her our victim,
that the whole discreditable business
had the extension of slavery at the bot-
tom of it. More Americans were against
it than had been against the War of
1812. But how many Americans ever
learn these things? Do not most of them,
only leaving school, leave history also
behind them, and become farmers, or
merchants, or plumbers, or firemen, or
carpenters, or whatever, and read little
but the morning paper for the rest of
their lives?

The blackest pages in our history
would take a long while to read. Not a
word of them did I ever see in my school
textbooks. Those books were written on
the premise that America could do no
wrong. Only recently have our educa-
tors and textbook writers begun to real-
ize that teaching the truth instills a
greater sense of love for our great na-
tion. Just as we love our friends in spite
of their faults, and all the more intelli-
gently because we know these faults, so
our love of our country would be just as
strong, and far more intelligent, were
we honestly and wisely taught in our
early years those acts and policies of
hers wherein she fell below her lofty and
humane ideals. Her character and her
record on the whole from the beginning
are fine enough to allow the shadows to
throw the sunlight into relief. To have
produced at three different stages of our
growth three such men as Washington,
Lincoln, and Roosevelt, is quite suffi-
cient justification for our existence.
11. According to the passage, two fairly well-known heroes of the Mexican War of 1846–1847 are
(A) Abraham Lincoln and Thomas Jefferson.
(B) George Washington and Admiral de Grasse.
(C) Zachary Taylor and Winfield Scott.
(D) Sam Bowie and Davy Crockett.

12. The author of the passage would most likely agree with which of the following statements?
(F) Students should learn about both the positive and negative aspects of American history.
(G) The best way to deal with horrific aspects of history in an educational setting is to avoid mentioning them or mention them only in passing.
(H) The Mexican War was prompted by aggressive Mexican military action along the Texan border.
(J) Students who learn about the War of 1812 seldom learn about the torching of Washington, D.C., by British troops.

13. It can be inferred from the first paragraph of the passage that when the author of the passage attended school, he was taught that the War of 1812 was instigated by the
(A) Americans, who openly attacked British frigates.
(B) Americans, who were in collusion with Napoleon Bonaparte.
(C) English, who were taking sailors from American ships.
(D) English, who had invaded Michigan and Ohio.

14. According to the second paragraph, the War of 1812 was fought by America in 1812 instead of 1808 despite
I. more support for the war in 1808.
II. England’s desire for peace in 1812.
III. inadequate military resources in 1812.
(F) I only
(G) III only
(H) I and II
(J) I, II, and III

15. The passage asserts that there were more French soldiers than American soldiers in which of the following battles?
(A) New Orleans
(B) Guadalupe Hidalgo
(C) Toronto
(D) Yorktown

16. The passage argues that, at the time of the Mexican War, a great many Americans felt that the war
(F) was necessary.
(G) should not be fought.
(H) was started by Santa Anna.
(J) kept the economy going.

17. One of the main ideas of the passage is that
(A) learning about America’s faults makes people love America in a more intelligent manner.
(B) what the author learned in school about America is essentially the correct view.
(C) education is only practical if it clearly has a nationalistic bias.
(D) the U.S. government benefits from the disingenuous education of its citizens.
18. According to the passage, the Mexican War was fought by the United States primarily in order to
I. strengthen alliances.
II. expand slavery.
III. gain land.
(F) II only  
(G) I and II  
(H) I and III  
(J) II and III

19. It may reasonably be inferred from the passage that General Grant fought in
(A) the War of 1812.  
(B) the Revolutionary War.  
(C) the Mexican War.  
(D) World War II.

20. It may be inferred that the author believes that British troops burned Washington, D.C., in response to which of the following events?
(F) The looting of London  
(G) The Battle of New Orleans  
(H) The victory in New York  
(J) The burning of Toronto

**Passage III—HUMANITIES**

*This passage is adapted from the article “The Education of the Child” by Edward Key.*

The art of natural education consists of ignoring the faults of children nine times out of ten, avoiding immediate interference, which is usually a mistake, and devoting one’s whole vigilance to the control of the environment in which the child is growing up. The art also includes watching the education of the child, which is allowed to go on by itself. But educators who, day in and day out, are consciously transforming the environment and themselves are still a rare product. Most people live on the capital and interest of an education, which perhaps once made them model children, but has deprived them of the desire for educating themselves. Only by keeping oneself in constant process of growth, under the constant influence of the best things in one’s own age, does one become a companion half-way good enough for one’s children. To bring up a child means carrying one’s soul in one’s hand, setting one’s feet on a narrow path. It means the humble realization of the truth that the ways of injuring the child are infinite, while the ways of being useful to him are few.

How seldom does the educator remember that the child is making experiments with adults, with marvelous shrewdness making his own valuations and reacting sensitively to each impression. The slightest mistrust, the smallest unkindness, the least act of injustice or contemptuous ridicule, leave wounds that last for life in the finely strung soul of the child. While on the other side unexpected friendliness, kind advances, just indignation, make quite as deep an impression on those senses that people term as soft as wax but treat as if they were made of cowhide.

Relatively excellent was the old education that consisted solely in keeping oneself whole, pure, and honorable. For it did not in the least depreciate personality, although it did not form it either. By leading, not interfering, acting as an invisible providence through which the child obtains experience, that child may draw his own conclusions. The present practice is to impress one’s own discoveries, opinions, and principles on the child by constantly directing his actions. The last thing to be realized by the educator is that he really has before him an entirely new soul, a real self whose first and chief right is to think over the things with which he comes in contact. By a new soul he understands only a new generation of an old humanity to be treated with a fresh dose of the old remedy. We teach the new souls not to steal, not to lie, to economize their
money, to obey commands, say their prayers. But who teaches the new souls to choose for themselves the path they must tread? Who thinks that the desire for this path of their own can be so profound that a hard or even mild pressure toward uniformity can make the whole of childhood a torment?

The new educator will, by regularly ordered experience, teach the child by degrees his place in the great orderly system of existence. But in other respects, none of the individual characteristics of the child will be suppressed, so long as they do not injure the child himself, or others. Therefore, the educator should do anything but advise the child to do what everybody does. He should rather rejoice when he sees in the child tendencies to deviation. Using other people's opinion as a standard results in subordinating one's self to their will. So we become a part of the great mass, led by the Superman through the strength of his will, a will that could not have mastered strong personalities. For the progress of the whole of the species, as well as of society, it is essential that education shall awake the feeling of independence; it should invigorate and favor the disposition to deviate from the type in those cases where the rights of others are not affected, or where deviation is not simply the result of the desire to draw attention to oneself.

Finally, the new educator must remember that the sensitive feelings of children are constantly injured by lack of consideration on the part of grown people. Their easily stimulated aversions are constantly being brought out. Just as there are few better methods of teaching than to ask children, when they have behaved unjustly to others, to consider whether it would be pleasant for them to be treated in that way, so there is no better corrective for the trainer of children than the habit of asking oneself: Would I consent to be treated as I have just treated my child? If it were only remembered that the child generally suffers twice as much as the adult, parents would perhaps learn physical and psychological tenderness without which a child's life is a constant torment.

21. In line 32, the word *shrewdness* most nearly means
(A) perceptiveness.
(B) cunning.
(C) stupidity.
(D) depravity.

22. According to the first paragraph of the passage, a good educator is
I. open to change and growth.
II. intent on educating himself or herself.
III. aware that it is easier to harm children than help them.
(F) I only
(G) III only
(H) II and III
(J) I, II, and III

23. In the third paragraph, it is possible to infer from the sentence “For it did not in the least depreciate personality, although it did not form it either” that
(A) current education is better in every way than old education.
(B) the main flaw in old education is the fact that it suppressed personality.
(C) although the old education is superior in some ways to current education, it is still flawed.
(D) new education is not intent on forming personality.
24. Which of the following does the author assume is a fact of human nature rather than a precept of a sound educational philosophy?

(F) It is important to allow a child to express his or her individual characteristics.

(G) Children are exposed to both positive and negative adult influences.

(H) In order to be an effective educator, one must not interfere with children’s natural faults.

(J) It is more important to teach children to go their own way than it is to teach them to conform to society.

25. In the fourth paragraph, the lines “So we become part of the great mass, led by the Superman through the strength of his will, a will that could not have mastered strong personalities” imply that

(A) strong personalities are easy to develop in children, since educators encourage them.

(B) without individualism, instead of progressing and developing, society will become easy prey to strong personalities that don’t have society’s best interests at heart.

(C) education should help nurture the Superman personalities that are meant to run society.

(D) people need to conform their behavior to other people’s opinions.

26. Which of the following statements best reflects the meaning of the phrase “those senses that people term as soft as wax but treat as if they were made of cowhide” from Paragraph 2?

(F) Children are able to ignore insensitive treatment.

(G) Adults are incapable of inflicting pain on children.

(H) Although many adults give lip service to children’s sensitive natures, those same adults tend to treat children insensitively.

(J) Children are able to internalize good treatment more quickly than bad.

27. According to the author, a natural education

(A) is determined by a parent’s ability to reprimand a child fairly.

(B) means a child is allowed to do exactly as he or she pleases all the time, with no interference.

(C) enables a child to conform to societal expectations.

(D) is dependent on the educator’s ability to recognize that encouragement of a child’s individuality is more important than correcting a child’s flaws.

28. In Paragraph 1, the phrase, “carry one’s soul in one’s hand, setting one’s feet on a narrow path” refers to the author’s belief that

(F) in order to raise children successfully, you must be willing to recognize your flaws.

(G) child-rearing is a divine function few can master.

(H) child-rearing severely restricts one’s life.

(J) raising children is unfulfilling.
29. According to the last paragraph of the passage, adults will treat children with greater care if they
   I. remember that children are highly sensitive to inconsiderate behavior.
   II. treat children as insubordinate creatures in need of guidance.
   III. asked themselves if they would want to be treated the way they treat children.
   (A) II only
   (B) III only
   (C) I and III
   (D) I, II, and III

30. In line 50, *providence* most nearly means
   (F) manipulator.
   (G) worrier.
   (H) observer.
   (J) influence.

Passage IV—NATURAL SCIENCE

This passage is adapted from an article about quantum mechanics.

Pick a random point in the universe and chances are you will find nothing. That is because the universe is mostly made up of empty space. Between the vastly spread out solar systems and galaxies are regions of interstellar space where there may be less than one atom per square mile. But even if you were to randomly pick a point near a sun or in an interstellar dust cloud, chances are that you would still come up with nothing. Think for a moment of how small our planets are in comparison to the total area of the solar system. Then recall that most of the nine planets are rotating on a thin disk around the sun. Running into matter in all this empty space is as unlikely as winning the lottery several dozen times in a row!

It is no surprise that many physicists have spent a great deal of time trying to deduce the nature of the vacuum, since it makes up the vast bulk of the universe. For more than 2,500 years philosophers and scientists have attempted to comprehend what the vacuum is and if it even exists. In the early twentieth century, quantum mechanics experimentally determined that the vacuum isn’t exactly empty. In fact, the vacuum is highly dynamic.

In 1925, quantum mechanics replaced classical Newtonian physics as the best way to describe the actions of subatomic particles. One of the crucial concepts of quantum mechanics is what is known as the uncertainty principle. Named after its discoverer Werner Heisenberg, the uncertainty principle basically states that you cannot know with certainty the speed and position of a subatomic particle at the same time. The more accurately you measure the speed of an electron, for example, the less accurately you are able to determine its position at any given time. This is due to the peculiar nature of subatomic particles.

The uncertainty principle makes more sense when you think of particles as constantly vibrating waves. No matter how much you try to slow them down, they always shake to some degree.

This constant oscillation, which seems to be an inherent feature of the universe, also affects the vacuum. Even though a section of the universe may be empty of matter, it is nevertheless permeated with electromagnetic fields that constantly fluctuate on all wavelengths. Since there is a potentially infinite amount of vacuum, the sum total of all of the energy fluctuations in the universe must be infinite.

“But if there is infinite energy in empty space, then we must be able to tap it and have unlimited energy resources!” you may shout. The problem, most physicists will tell you, is that to tap the energy in the fluctuations of empty space you would have to break several basic laws of physics.
Even more incredible is the quantum mechanical finding that occasionally the electromagnetic fluctuations of the vacuum lead to the materialization of new particles. You heard it right: sometimes, you can get something from nothing. Every once in a random while, for a split second, a negative electron and a paired particle made of antimatter pop into existence and then annihilate each other a millisecond later.

One metaphor that has been proposed is that the dynamic vacuum is like the surface of a lake. Its surface is rippled with energy vacillations, with negative electrons with their antimatter twins popping out of the surface of the lake like paired fish every few moments, only to disappear moments later.

These revelations severely alter the classical conception of the vacuum. Scientists from Aristotle to Newton viewed the vacuum as being a stable medium filled with the “ether.” Even after the existence of the ether was called into question in the 1887 by the work of Albert Michelson and Edward Morley, physicists felt that the ether was necessary for the movement of waves of light. They used as their justification the premise that waves must have a medium to travel in. But in 1905, Einstein dispensed with the ether in his paper on the Special Theory of Relativity. Dismissing the concept as superfluous, Einstein showed that light waves (and all electromagnetic waves) were unlike waves in water or air because of their unique subatomic nature. With one fell swoop, Einstein slay the great ether beast that had been loosed upon science by Aristotle.

31. The main idea of the passage is that
   (A) when electromagnetic particles collide, there is sometimes a subatomic explosion.
   (B) the vacuum of space is dynamic and fluctuating.
   (C) the Special Theory of Relativity changed the way scientists thought about the universe.
   (D) it may be possible to extract great amounts of energy from empty space.

32. The passage compares the vacuum to a
   (F) surface of a lake.
   (G) thin disk of matter.
   (H) dozen lotteries.
   (J) room full of oxygen.

33. The passage states that the uncertainty principle was formulated by
   (A) Einstein.
   (B) Albert Michelson and Edward Morley.
   (C) Heisenberg.
   (D) Aristotle.

34. As it is used in line 54, the word oscillation most nearly means
   (F) rotation.
   (G) speed.
   (H) change.
   (J) vibration.

35. According to the passage, which of the following is NOT a concept supported by quantum mechanics?
   (A) It is impossible to be certain about both the speed and position of a subatomic particle.
   (B) The vacuum is suffused with fluctuations in electromagnetic fields.
   (C) The universe is pervaded by an electromagnetic medium called the ether.
   (D) Sometimes new particles materialize in the vacuum of space.
36. With which of the following statements would the author of the passage most likely agree?

(F) Subatomic particles behave in much the same way as motes of dust behave.

(G) The vacuum is basically a static, unchanging electromagnetic medium.

(H) Waves of light behave like waves of sound under certain circumstances.

(J) The amount of vacuum in the universe far exceeds the amount of matter.

37. What, according to the passage, is the reason that it would be impossible to extract energy from the fluctuations of the vacuum?

(A) Einstein determined in 1905 that any attempt to extract energy from the vacuum would call the existence of the ether into question.

(B) Extracting energy from the vacuum is impossible because it is too difficult to find the place in the universe where random fluctuations are occurring.

(C) The laws of physics dictate that such an extraction of energy from empty space is impossible.

(D) Without the ability to channel the tapped energy, any attempt to harness this unlimited source of energy would result in a massive explosion.

38. The passage suggests that although interstellar space does indeed contain atoms of matter, these atoms are

(F) grouped together.

(G) composed mainly of hydrogen.

(H) widely spaced.

(J) unlike atoms found on planets.

39. It may be reasonably inferred from the passage that the idea of the ether was popularized in a scientific context by

(A) Aristotle.

(B) Einstein.

(C) Albert Michelson and Edward Morley.

(D) Werner Heisenberg.

40. What is the main idea of the fourth paragraph?

(F) Quantum mechanics has changed the way we think about reality.

(G) Subatomic particles are in constant motion.

(H) The speed of a subatomic particle is directly related to its position.

(J) In a vacuum, particles move much slower.

STOP

END OF SECTION 3. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
SECTION 4: SCIENCE REASONING

40 Questions • Time—35 Minutes

Directions: This test consists of seven passages, each followed by several questions. Read each passage, select the correct answer for each question, and mark the oval representing the correct answer on your answer sheet. You may NOT use a calculator on this test.

Passage I

Osmosis is the diffusion of water across a semi-permeable membrane. Water will move across a semi-permeable membrane if the concentration of solutes is different on the two sides of the membrane. Solutes are those particles present in solution. Water will always move from a region of lower concentration to a region of higher concentration of solutes. Equilibrium is the point at which the concentration of solutes is the same for the two regions divided by the semi-permeable membrane. Osmosis will continue until equilibrium is reached. When this equilibrium state is reached, the environment is said to be isotonic.

A scientist hypothesized that potato contained NaCl (table salt). When potato is submersed in an NaCl solution, it would either release water to the solution or absorb water from the solution, depending on the NaCl concentration in the solution. A series of experiments was performed to observe the effect that different NaCl concentrations would have on raw potato. Water with a particular NaCl concentration was prepared, and a potato core was submersed in the water and NaCl solution. The potato cores were weighed before and after submersion. Also, the volume of the potato cores was determined before and after submersion. Table 1 shows the results of the experiment as well as the percent change observed for weight and volume.

<table>
<thead>
<tr>
<th>% NaCl Initial conc. wt. of sol. (g.)</th>
<th>Final wt. (g.)</th>
<th>% chg. in wt.</th>
<th>Initial vol. (ml.)</th>
<th>Final vol. (ml.)</th>
<th>% chg. in vol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>2.80</td>
<td>3.25</td>
<td>16</td>
<td>2.62</td>
<td>3.28</td>
</tr>
<tr>
<td>0.5</td>
<td>2.75</td>
<td>2.80</td>
<td>2</td>
<td>2.57</td>
<td>2.67</td>
</tr>
<tr>
<td>1.0</td>
<td>2.74</td>
<td>2.47</td>
<td>−10</td>
<td>2.56</td>
<td>2.15</td>
</tr>
<tr>
<td>1.5</td>
<td>2.81</td>
<td>2.30</td>
<td>−18</td>
<td>2.61</td>
<td>2.09</td>
</tr>
<tr>
<td>2.0</td>
<td>2.82</td>
<td>2.20</td>
<td>−22</td>
<td>2.60</td>
<td>1.98</td>
</tr>
<tr>
<td>3.0</td>
<td>2.77</td>
<td>2.08</td>
<td>−25</td>
<td>2.58</td>
<td>1.88</td>
</tr>
<tr>
<td>5.0</td>
<td>2.78</td>
<td>2.00</td>
<td>−28</td>
<td>2.59</td>
<td>1.81</td>
</tr>
</tbody>
</table>

1. According to data presented, what was the final weight and volume, respectively, of the potato core when it was submersed in an NaCl concentration of 1.5%?
   (A) 2.30 g and 2.09 ml
   (B) 2.47 g and 2.15 ml
   (C) 2.81 g and 2.61 ml
   (D) 2.82 g and 2.60 ml

2. Dividing the final weight of the sample by the final volume gives a measure of the density of the sample in g/ml. At which of the following salt concentrations did the final sample have a density less than 1 g/ml?
   (F) 0%
   (G) 0.5%
   (H) 2%
   (J) 5%
3. Which of the following graphs best represents the percentage change in weight with increasing NaCl concentration?

(A) ![Graph A]

(B) ![Graph B]

(C) ![Graph C]

(D) ![Graph D]

4. From the data in Table 1, at approximately what NaCl concentration do the cores reach an isotonic state?

(F) 0.0%

(G) 0.3%

(H) 0.6%

(J) 1.9%

5. What could you expect to happen if the cores were submerged in water with an NaCl concentration of 10%?

(A) The weight would increase, and volume would increase.

(B) The weight would increase, and volume would decrease.

(C) The weight would decrease, and volume would increase.

(D) The weight would decrease, and volume would decrease.

6. Which of the following observations supports the hypothesis that the cores contained some NaCl prior to the experimental procedure?

(F) The cores absorbed water when placed in a solution with 0% NaCl concentration.

(G) The cores released more water into the solution as NaCl concentration increased.

(H) The cores released less water into the solution as NaCl concentration increased.

(J) The cores released water into the solution when the solution was 5% NaCl concentration.
7. Another variety of potato was tested and its weight decreased from 2.72g to 2.34g in an NaCl concentration of 3.0%. In another trial, the initial weight increased from 2.73g to 3.19g in an NaCl concentration of 1.5%. How would the original NaCl concentration compare to the variety of potato used in the original experiment?

(A) The original NaCl concentration would be lower in the second variety tested.

(B) The original NaCl concentration would be higher in the second variety tested.

(C) The original NaCl concentration would be comparable in the two potatoes.

(D) The original NaCl concentration could be either greater or less than the original variety tested.

Passage II

Geologists have continued to engage in debate over the cause of major periods of glaciation, or Ice Ages, during the history of Earth. Although the mechanics of glacier formation are well understood in a general sense, the causes of the alternating periods of global-scale glaciation and intervening periods of glacial retreat have been the subject of some controversy. Below two geologists present two different geological theories:

Geologist 1

The dramatic long-term cooling trends leading to widespread terrestrial glaciation depend upon the physics of the earth’s motion around the sun and around its own axis of rotation. The generally elliptical orbit of the earth varies in shape, tending sometimes to a form that appears more circular, other times to a shape that has a more pronounced elliptical quality. This cycle of varying between a circular and elliptical trend is repeated on an average of about once every 100,000 years. When the earth’s orbit is more elliptical, the earth receives significantly less heat energy from the sun. Also, the axis of the earth’s rotation fluctuates from a tilt of 21.5 degrees to 24.5 degrees, which influences the amount of heat the planet receives from the sun.

Furthermore, there is a precession, or a kind of “wobbling” of the axis itself, which further contributes to fluctuations that must affect the global temperature on a scale that would lead to growth and retreat of the terrestrial ice caps. The precession of the earth’s axis operates on a 41,000-year cycle. Research to this date has provided ample evidence of glaciation and warming matching the cycles with cooling trends evident on both the 100,000-year and 41,000-year scales.

Geologist 2

It is now generally accepted that one of the larger mass extinctions to occur on Earth, the K-T boundary event of 65 million years ago, was the result of a massive asteroid or comet impact that caused a kind of “nuclear winter.” It makes much sense then, if we keep in mind how common space junk is in our solar system, to infer that Earth’s contact with dust and debris of a smaller and more plentiful nature would contribute to other cycles of cooling and warming. It is likely that these dustloadings may be random in nature but not as random and rare as killer impacts on the scale of the K-T boundary event. These dustloadings are simply fluctuations in gross amounts of interplanetary dust in our region that may be affected by gravitational forces and other cosmic interactions that ebb and flow around us.

Furthermore, the planets orbit the sun in a plane—imagine a plate with the nine orbits drawn concentrically upon its surface. This angle changes ever so slightly, subtly altering the regions of space through which our Earth travels. So it is the change in position relative to clouds of cosmic dust, gas,
and meteoroids that limit the amount of solar energy reaching our planet. The scale on which this occurs is a better match to our evidence of 100,000-year cycles of glaciational and warming.

8. If the 41,000-year cooling trends were substantiated with available evidence, whose theory would be supported?
   (F) Geologist 1’s theory
   (G) Geologist 2’s theory
   (H) Both geologists’ theories
   (J) Neither geologist’s theory

9. With which of the following statements would Geologist 1 and Geologist 2 agree?
   (A) Cosmic dust and meteors play a major role in patterns of terrestrial glaciation.
   (B) Cosmic dust and meteors do not play a major role in patterns of terrestrial glaciation.
   (C) Orbital motion variations play a major role in patterns of terrestrial glaciation.
   (D) Orbital motion variations play no real role in patterns of terrestrial glaciation.

10. Geologist 2 might argue that Geologist 1 does NOT account for which of the following?
    (F) The effect that the precession of the earth has on the amount of heat received by Earth
    (G) The change of energy Earth receives from the sun based on Earth’s distance from the sun
    (H) All cycles of terrestrial glaciation
    (J) The impact that extraterrestrial debris has on the temperature of the earth

11. If it was found that 70,000 years ago there was a major global cooling trend, Geologist 1 would most likely suggest that
    (A) the earth’s orbital tilt was a major influence on this episode of terrestrial cooling.
    (B) the earth passed through a cloud of cosmic dust and gas during that period.
    (C) the earth’s orbit was less elliptical at that time.
    (D) a large meteor could have struck the earth at that time.

12. Which of the following assumptions about the earth’s motions was made by Geologist 2?
    (F) Changes in orbital angle and position have a negligible effect on terrestrial glaciation patterns.
    (G) Changes to the size and shape of the earth’s orbit do not influence patterns of cooling and warming.
    (H) Fluctuations of extraterrestrial debris are not a contributing factor to cooling trends.
    (J) The tilt of the earth’s axis impacts the amount of energy received from the sun.

Passage III

Acids are substances that increase the hydrogen ion concentration in aqueous solution. A convenient way to quantify the concentration of hydrogen ion in aqueous solution is with the pH scale. The pH range for most substances is between 0 and 14. The closer to 0 a substance is on the pH scale, the more acidic the solution is considered. The closer the solution is to 14 on the pH scale, the more basic it is considered. Table 1 shows the hydrogen ion concentration and pH for some common substances.
Indicators are substances that change color at different pH levels. The pH range of an indicator shows at what pH level the indicator will change color. When the pH level is lower than the range indicated, the indicator will be in its acidic form. When pH level is higher than the range indicated, the indicator will be in its basic form. The interval represents when the indicator is in the process of changing color. Table 2 summarizes the sensitivity of different indicators to different pH levels.

### TABLE 1

<table>
<thead>
<tr>
<th>Substance</th>
<th>Hydrogen ion conc. (mol/l)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium hydroxide</td>
<td>$1.0 \times 10^{-13}$</td>
<td>13.0</td>
</tr>
<tr>
<td>Household ammonia</td>
<td>$1.0 \times 10^{-12}$</td>
<td>12.0</td>
</tr>
<tr>
<td>Borax</td>
<td>$4.0 \times 10^{-10}$</td>
<td>9.4</td>
</tr>
<tr>
<td>Seawater</td>
<td>$3.0 \times 10^{-9}$</td>
<td>8.4</td>
</tr>
<tr>
<td>Blood</td>
<td>$3.1 \times 10^{-8}$</td>
<td>7.5</td>
</tr>
<tr>
<td>Milk</td>
<td>$1.0 \times 10^{-7}$</td>
<td>7.0</td>
</tr>
<tr>
<td>Coffee</td>
<td>$1.0 \times 10^{-5}$</td>
<td>5.0</td>
</tr>
<tr>
<td>Wine</td>
<td>$3.2 \times 10^{-4}$</td>
<td>3.5</td>
</tr>
<tr>
<td>Gastric juice</td>
<td>$1.0 \times 10^{-2}$</td>
<td>2.0</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>$1.0 \times 10^{-1}$</td>
<td>1.0</td>
</tr>
</tbody>
</table>

13. For what substance is the concentration of hydrogen ion $1 \times 10^{-5}$ moles/liter?
   (A) Sodium hydroxide  
   (B) Coffee  
   (C) Gastric juice  
   (D) Hydrochloric acid

14. Thymol blue will turn completely blue when added to which of the following solutions?
   (F) Blood  
   (G) Seawater  
   (H) Borax  
   (J) Household ammonia

15. According to Table 1, which of the following is the most basic?
   (A) Gastric juice  
   (B) Coffee  
   (C) Milk  
   (D) Borax

16. Which of the following indicators requires the greatest change in pH to complete its conversion from acid to base form?
   (F) Methyl violet  
   (G) Alizarin yellow G  
   (H) Methyl red  
   (J) Phenolphthalein

17. If bromthymol blue were blue, which of the following solutions could be added to convert it to its acidic form?
   (A) Sodium hydroxide  
   (B) Milk  
   (C) Coffee  
   (D) Seawater

### TABLE 2

<table>
<thead>
<tr>
<th>Indicator</th>
<th>pH interval for color change</th>
<th>Acid color</th>
<th>Base color</th>
</tr>
</thead>
<tbody>
<tr>
<td>methyl violet</td>
<td>0.0–2.0</td>
<td>yellow</td>
<td>violet</td>
</tr>
<tr>
<td>methyl yellow</td>
<td>1.2–2.3</td>
<td>red</td>
<td>yellow</td>
</tr>
<tr>
<td>methyl orange</td>
<td>2.9–4.0</td>
<td>red</td>
<td>yellow</td>
</tr>
<tr>
<td>methyl red</td>
<td>4.2–6.3</td>
<td>red</td>
<td>yellow</td>
</tr>
<tr>
<td>bromthymol blue</td>
<td>6.0–7.6</td>
<td>yellow</td>
<td>blue</td>
</tr>
<tr>
<td>thymol blue</td>
<td>8.0–9.6</td>
<td>yellow</td>
<td>blue</td>
</tr>
<tr>
<td>Phenolphthalein</td>
<td>8.3–10</td>
<td>colorless</td>
<td>pink</td>
</tr>
<tr>
<td>alizarin yellow G</td>
<td>10.1–12.0</td>
<td>yellow</td>
<td>red</td>
</tr>
</tbody>
</table>
Passage IV

Substances can generally exist in 3 phases: solid, liquid, and gas. A phase change is the transition of a substance from one phase to another. If pressure remains constant and temperature is increased, the substance will increase in temperature until it reaches the point where the phase change occurs. The temperature will not increase further until the substance completely changes from one phase to another.

The energy absorbed or liberated in a phase change is called the latent heat. The latent heat of fusion (L_f) refers to the heat needed to convert a substance from solid to liquid phase. The melting point is the temperature at which this phase change takes place at atmospheric pressure. The latent heat of vaporization (L_v) refers to the heat needed to convert a substance from liquid to gaseous phase. The boiling point is the point at which this phase change takes place at atmospheric pressure.

The table below lists the latent heats of fusion and vaporization, melting points, and boiling points for several substances at atmospheric pressure. The latent heats of fusion and vaporization indicate the heat needed to change 1 kg from one phase to another.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Melting Point (°C)</th>
<th>Heat of Fus. (kJ/kg)</th>
<th>Boiling Point (°C)</th>
<th>Heat of Vap. (kJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helium</td>
<td>–269</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>–210</td>
<td>25.5</td>
<td>–196</td>
<td>201</td>
</tr>
<tr>
<td>Ethyl alcohol</td>
<td>–114</td>
<td>104</td>
<td>78</td>
<td>854</td>
</tr>
<tr>
<td>Water</td>
<td>0</td>
<td>333</td>
<td>100</td>
<td>2,255</td>
</tr>
<tr>
<td>Lead</td>
<td>327</td>
<td>24.5</td>
<td>1,620</td>
<td>912</td>
</tr>
<tr>
<td>Silver</td>
<td>960</td>
<td>88.3</td>
<td>2,193</td>
<td>2,335</td>
</tr>
<tr>
<td>Gold</td>
<td>1,063</td>
<td>64.4</td>
<td>2,660</td>
<td>1,580</td>
</tr>
</tbody>
</table>

18. Once 1 kg lead is at a temperature of 327°C, how much energy is required to convert it from solid to liquid phase?
   (F) 24.5 kJ
   (G) 912 kJ
   (H) 1,620 kJ
   (J) 2,335 kJ

19. Which of the following substances can exist in a liquid phase over the widest range of temperatures?
   (A) Nitrogen
   (B) Ethyl Alcohol
   (C) Water
   (D) Gold

20. Which of the following 2 substances have the smallest difference between their latent heats of vaporization?
   (F) Nitrogen and helium
   (G) Lead and ethyl alcohol
   (H) Silver and lead
   (J) Water and gold

21. The values for the latent heat of vaporization of water and silver contradict which of the following hypotheses?
   (A) The substance with the highest boiling point has the greatest latent heat of vaporization.
   (B) The substance with the lowest melting point has the smallest latent heat of fusion.
   (C) Of the seven substances, helium has the lowest heat of vaporization.
   (D) Latent heat of vaporization is independent of melting point.

22. If placed in an oven at 1,000°C, which of the following would remain in liquid form?
   (F) Nitrogen and water
   (G) Helium and lead
   (H) Ethyl alcohol and water
   (J) Lead and silver

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23. Which of the following hypotheses is supported by the data?

(A) As melting point increases, latent heat of fusion increases.
(B) As boiling point increases, latent heat of fusion increases.
(C) As melting point decreases, boiling point decreases.
(D) As boiling point decreases, latent heat of vaporization decreases.

Passage V

An antigen is a substance that can elicit a specific immune response when introduced into an animal with a functioning immune system. Proteins, polysaccharides, and nucleic acids can serve as antigens if they are injected into an animal that normally does not have those substances as normal constituents. Antibodies are specific molecules that the body produces as an immune response to the introduction of an antigen.

An antigen can also be mixed with pure antibody that is directed against that antigen to form a precipitate containing antigen-antibody complexes. Because it is possible to directly measure precipitate formed, it is also possible to determine the amount of antibody present when a known amount of antigen is added.

An experiment was performed to determine the amount of antibody produced as part of an immune response. The scientist followed a procedure that allowed the harvest of antibody in serum from two rabbits. A different antibody was harvested from each rabbit. A series of test tubes were prepared with samples of the antibody in serum, and different levels of antigen were added. Polysaccharide antigen was used to precipitate one antibody, and protein antigen was used to precipitate the other.

The graphs below show the results of the relationship between the amount of antigen added and the amount of antibody precipitated. Figure 1 shows when polysaccharide was used and Figure 2 when protein was used.

24. When 0.4 mg of polysaccharide were added, how much antibody precipitate formed?

(F) 1 mg
(G) 5 mg
(H) 8 mg
(J) 12 mg

25. Approximately what 2 amounts of protein antigen could be added to yield 8 mg of antibody precipitate?

(A) 0.1 mg and 2 mg
(B) 0.4 mg and 1.6 mg
(C) 0.8 mg and 2 mg
(D) 1.2 mg and 1.5 mg
26. The zone of equivalence is the point at which there is maximal precipitation and there is no excess antigen and no excess antibody. This zone in Figure 2 was reached when antigen added equaled which of the following?
   (F) 0.4
   (G) 1.0
   (H) 1.5
   (J) 2

27. If the trial using polysaccharide antigen was repeated and the antigen was added only in increments of 1 mg, how would the equivalence zone appear compared to the actual equivalence zone?
   (A) It would shift to the left and up.
   (B) It would shift to the right and down.
   (C) It would shift right and up.
   (D) It would remain the same.

28. When only 0.2 mg of either polysaccharide and protein antigen are added, which of the following statements could be supported by the data?
   (F) There was an excess of antibody compared to antigen in both cases.
   (G) There was an excess of antigen compared to antibody in both cases.
   (H) There was an excess of antigen in Figure 1 and an excess of antibody in Figure 2.
   (J) There was an excess of antibody in Figure 1 and an excess of antigen in Figure 2.

29. Which of the following best explains the drop in antibody precipitate when the level of polysaccharide was greater than 0.5 mg?
   (A) There was more antibody present in the test tubes in which 0.5 mg of polysaccharide was used.
   (B) The amount of antibody was constant in all the test tubes that were tested with polysaccharide antigen.
   (C) The presence of less than 0.5 mg of antigen caused the excess to interfere with the formation of the antigen-antibody complexes and therefore inhibited the formation of a precipitate.
   (D) The presence of more than 0.5 mg of antigen caused the excess to interfere with the formation of the antigen-antibody complexes and therefore inhibited the formation of a precipitate.

Passage VI
Atoms are composed of protons, neutrons, and electrons. Protons and neutrons reside in the nucleus or inner core of the atom, and the electrons reside outside the nucleus. Electrons are negatively charged particles that occupy orbital shells around the nucleus. In a neutral atom, the number of electrons is equal to the number of protons, the positively charged particles. The atomic number for an element indicates how many protons are in the nucleus of a given element.

If an electron is removed from an atom, the atom will become positively charged. The energy required to remove an electron is referred to as the ionization energy. The table below summarizes the ionization energies for several elements with respect to the removal of the first three electrons. Successive ionization energies are designated with a subscript consistent with which electron is being removed.
30. What is the ionization energy, in kJ/mol, to remove the first electron in silicon?
   (F) 580
   (G) 780
   (H) 1,575
   (J) 3,220

31. Which element has the greatest difference in ionization energies for the removal of the first two electrons?
   (A) Sodium
   (B) Aluminum
   (C) Phosphorus
   (D) Chlorine

32. It was hypothesized that energy required to remove the first electron from a neutral atom increases as atomic radius decreases. Which pair of elements from the table would contradict this hypothesis?
   (F) Sodium and Chlorine
   (G) Magnesium and Silicon
   (H) Aluminum and Sulfur
   (J) Phosphorus and Chlorine

33. Which of the following statements is supported by the data?
   (A) Ionization energy remains constant as electrons are removed from an atom.
   (B) Ionization energy decreases as electrons are removed from a neutral atom.
   (C) Atomic radii increase as atomic numbers decrease.
   (D) Atomic radii decrease as atomic numbers decrease.

34. After removal of electrons from the outer shell, ionization energies more than triple relative to when the elements contained electrons in the outer shell. The data from which of the elements supports this statement?
   I. Sodium
   II. Magnesium
   III. Aluminum
   (F) I only
   (G) II only
   (H) I and II
   (J) I, II, and III

Passage VII
A chemist, a biologist, and a doctor spent several years studying and measuring their respective populations in an Alaskan fishing community. Some of their observations are recorded below.

### CHEMIST: SEAWATER SALINITY*/TEMPERATURE (°C) (SEASONAL AVERAGE)

<table>
<thead>
<tr>
<th></th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>0/–1°</td>
<td>25/1°</td>
<td>32/12°</td>
<td>15/2°</td>
</tr>
<tr>
<td>5 meters</td>
<td>0/–1°</td>
<td>29/5°</td>
<td>32/7°</td>
<td>26/7°</td>
</tr>
<tr>
<td>20 meters</td>
<td>39/4°</td>
<td>32/5°</td>
<td>32/6°</td>
<td>34/5°</td>
</tr>
<tr>
<td>(ocean floor)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Seawater salinity is measured in parts thousand.
**BIOLOGIST: POPULATION COUNTS (SEASONAL AVERAGE)**

<table>
<thead>
<tr>
<th>Bay (free-swimming)</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fur seals</td>
<td>6.3</td>
<td>3.0</td>
<td>5.4</td>
<td>2.2</td>
</tr>
<tr>
<td>(number successfully hunted)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmon</td>
<td>0</td>
<td>122.5</td>
<td>1,152.6</td>
<td>4,259.5</td>
</tr>
<tr>
<td>(tonnage caught)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray whales</td>
<td>0</td>
<td>29.8</td>
<td>32.4</td>
<td>1.4</td>
</tr>
<tr>
<td>(number observed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bay (bottom-dwelling amphipods)

<table>
<thead>
<tr>
<th>Gammarus duebeni (sample count in one gallon of seawater)</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>25</td>
<td>15</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gammarus locusta (sample count in one gallon of seawater)</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>340</td>
<td>5</td>
<td>5</td>
<td>260</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land species</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kodiak Bears (number observed)</td>
<td>0</td>
<td>4</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Humans (number counted)</td>
<td>63</td>
<td>66</td>
<td>85</td>
<td>117</td>
</tr>
</tbody>
</table>

**DOCTOR: NUMBER OF MEDICAL COMPLAINTS (SEASONAL AVERAGE)**

<table>
<thead>
<tr>
<th></th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehydration-related illnesses</td>
<td>0.0</td>
<td>0.0</td>
<td>3.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Bear attacks</td>
<td>0.0</td>
<td>0.2</td>
<td>1.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Protein deficiency-related illnesses</td>
<td>10.4</td>
<td>4.1</td>
<td>1.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

35. Between which seasons was the greatest change in salinity at a depth of 5 meters observed?
(A) Winter to Spring
(B) Spring to Summer
(C) Summer to Fall
(D) Fall to Winter

36. The temperature and salinity readings at the ocean floor support which of the following conclusions?
(F) *Gammarus duebeni* is sensitive to temperature changes.
(G) *Gammarus locusta* is sensitive to temperature changes.
(H) *Gammarus locusta* is sensitive to salinity changes.
(J) Both species of *gammarus* are equally sensitive to salinity changes.
37. Which graph best expresses the relationship between the seasonal salmon catch and the incidence of protein-deficiency-related illnesses in the doctor’s data?

(A) 

(B) 

(C) 

(D) 

38. Which of the following supports the trend observed with respect to dehydration-related illnesses?

(F) In the Fall, there is ample freshwater due to frequent rainy periods.

(G) In the Winter, all freshwater reserves are frozen and cannot be accessed as drinking water.

(H) In the Spring, not enough ice has melted to provide enough freshwater.

(J) In the Summer, all of the ice that stores fresh water reserves melts and the freshwater is lost to the ocean.

39. Which of the following statements is NOT supported by the evidence?

(A) Whales are most commonly seen in the area in the Spring and Summer.

(B) Summer and Fall are the primary salmon fishing seasons.

(C) Spring and Summer are the primary fur seal hunting seasons.

(D) Bear attacks are uncommon in the winter.
40. A biologist wants to isolate the effect on bear population due to salmon levels from the effect due to human influence, in particular, the availability of an alternative food source in the village. What could the biologist do to help obtain the most accurate measure of the bear population when they have access only to their natural salmon food supply?

(F) Feed the bears salmon to replace their intake of village garbage and food.

(G) Ensure that the village’s garbage containers and food storage containers are kept locked.

(H) Remove the salmon from the area and measure the effect on the bears.

(J) Increase the frequency of the bear population survey from weekly to daily.
ANSWER KEY

Section 1: ENGLISH


Section 2: MATH

EXPLANATORY ANSWERS

Section 1: ENGLISH

Passage I

1. The correct answer is (C). *I had* is understood to be the first part of the verb, and this structure requires the second part of the verb to be in the past participle. The series should read: *I had been, . . . seen . . . and sat.*

2. The correct answer is (G). This option gets rid of redundancy without changing the meaning.

3. The correct answer is (D). A period is needed to separate the two sentences.

4. The correct answer is (F). This is the superlative form of *charming.*

5. The correct answer is (C). The phrase *long after the last restaurant had closed* modifies the *dead of night* and therefore is placed directly after *night* with commas separating the modifier from the rest of the sentence.

6. The correct answer is (J). *All* is unnecessary, and no new words need to be added to make the sentence clear.

7. The correct answer is (B). First, they arrive in Florence. Then, after learning that the restaurants are closed, we can be told that they haven’t eaten dinner. This detail describes one of the reasons the narrator is unhappy and should come before sentence 2 where the narrator’s friends try to console her.

8. The correct answer is (G). The portion beginning *my ever-eager travel companions . . .* is not a sentence and so should only be separated by a comma. *All too soon* should not be omitted because it shows the narrator’s irritation.

9. The correct answer is (B). *Instead* is the right word to indicate the opposition between the narrator’s desires and that of her companions while providing a smooth transition between the sentences.

10. The correct answer is (F). This paragraph illustrates the narrator’s basic unhappiness with the choices her companions continue to make on their trip.

11. The correct answer is (A). The possessive pronoun for an object is *its.*

12. The correct answer is (J). The verbs are in the infinitive—*to sulk and stare*—and the object of the verb (*throng*) should not be separated from the verb by a comma.

13. The correct answer is (B). This should be a new paragraph because it describes a new and pivotal action in the story. In the previous paragraph, the narrator stands outside the wall to the garden. In this paragraph, the narrator finally follows his or her impulse and climbs into the garden.

14. The correct answer is (F). *Embraced* is the best verb because the connotation is one of warmth and happiness. The active sentence is clean and direct.

15. The correct answer is (B). The material emphasizes the narrator’s discomfort and should therefore be placed after the description of something that helps to create this discomfort. By placing the material at the end of Paragraph 3, it becomes a summary statement of how the narrator feels as she walks uphill in the hot sun after too little sleep.
Passage II

16. The correct answer is (G). There should not be a comma separating the subjects from the verb, which is in the present continuous tense.

17. The correct answer is (D). The prepositional phrase (*with . . . *) belongs to the previous sentence and should not be separated.

18. The correct answer is (H). *Long after* is the accepted idiom. *Way after* is too colloquial. The other options are wrong.

19. The correct answer is (D). The sentence is in the present tense and requires that form of the verb *to seem*.

20. The correct answer is (F). *That* is the right choice of relative pronoun. It identifies the theory and adds no unnecessary words.

21. The correct answer is (C). While the term is not defined, the context makes it clear that the revolution involved a sudden transformation to an agricultural economy and the rise of cities.

22. The correct answer is (G). While *benefit* is the right noun for this context, the verb *were* demands the plural form.

23. The correct answer is (A). This is the only sentence that links the old thinking with the evidence against it—gene analysis, etc.—without going too far and claiming that the old theory was definitively disproved at a certain moment in the past.

24. The correct answer is (H). The two sentences should be separated. The second does not define the first, which would justify a colon, nor is there an opposition to justify the conjunction *but*.

25. The correct answer is (D). The preposition *of* after the underlined portion excludes all other possibilities. *Dating of the remains* is the only phrase that makes sense.

26. The correct answer is (G). Subject-verb agreement. There are two subjects, *Squash* and *rice*, and therefore the verb is conjugated in third-person plural.

27. The correct answer is (A). There are two sides to the evidence: that which shows plant domestication before the rise of settlements and that which shows settlements before the rise of plant domestication. *On the other hand* indicates this distinction between the evidence in the previous sentence and the evidence that follows.

28. The correct answer is (G). Two things coexist *with* each other, one alongside the other.

29. The correct answer is (C). Paragraph 3 already includes several pieces of evidence against the swift rise of agriculture. Therefore, it is the best place to more fully examine why this evidence points to the slow development of large-scale agriculture.

30. The correct answer is (F). This is the only option that describes the basic tension of the essay between the previous and present day thinking on the subject. The specific pattern of the essay is exactly described. The other options are either too vague, choice (G), or simply wrong, choices (H) and (J).

Passage III

31. The correct answer is (C). The fragment beginning *an unobstructed panorama* explains the spectacular views from the previous sentence and should therefore be linked by a colon.

32. The correct answer is (H). This option gets rid of an unnecessary word and maintains the sense of distant isolation.
33. The correct answer is (A). The construction calls for the possessive. The polar ice cap is singular, and therefore the apostrophe comes before the s.

34. The correct answer is (F). However is the only option that indicates a contrast to the relatively stable climate mentioned in the preceding sentence.

35. The correct answer is (D). There are two separate sentences that need to be linked. This can be done with a comma and a conjunction. But does not work because it indicates a contrast where there is none.

36. The correct answer is (J). There is no need for a preposition between the verb and its object.

37. The correct answer is (B). This option clarifies the sentence by maintaining a straightforward conceptual and grammatical link with the opening phrase. Despite indicates that people are not put off by the adverse conditions; or because of them offers the possibility that people may even be attracted by these conditions. The other options are either awkward or alter the meaning of the sentence.

38. The correct answer is (F). The subordinating conjunction because creates a causal link between the two clauses. The subject (it) of the subordinate clause follows the conjunction to maximize clarity and avoid awkwardness.

39. The correct answer is (C). This option is the clearest because it avoids redundancy and leaves out the definite article (the), which incorrectly indicates that the snowdrifts have been mentioned before.

40. The correct answer is (F). This option makes it clear that the discussion is about what must be done in order to survive a trek up Vinson.

41. The correct answer is (C). Throughout the paragraph, the writer employs the informal you to address the reader about what must be done to climb Vinson.

42. The correct answer is (G). Dashes are used to set off an explanation in the middle of a sentence, in this case, examples of extremities.

43. The correct answer is (C). The underlined portion makes the point, in a humorous way, by citing specific examples that are clearly insufficient for arctic mountain climbing.

44. The correct answer is (F). This is the only sentence that relates the effort involved in making a climb to the reward. The essay has spent a great deal of time describing both.

45. The correct answer is (D). This essay provides an interesting and informative description that is directed toward a general audience.

Passage IV

46. The correct answer is (F). The sentence describes something that is currently taking place.

47. The correct answer is (C). This option gets rid of redundant phrasing.

48. The correct answer is (F). According to the passage, the adaptation of books into movies is caused by the belief that stories can be told just as well on film.

49. The correct answer is (D). This answer avoids redundancy and makes the writer’s point that the audience has not read the book in advance of seeing the film.

50. The correct answer is (J). This option avoids unnecessary words and overly colloquial language.
51. The correct answer is (C). This is the only option that clearly conveys the author's point that there is no effective way to explore the mind of a character on film.

52. The correct answer is (G). The reference is to the heads of the characters, and therefore the possessive pronoun is required.

53. The correct answer is (B). The word *omniscient* means all-knowing.

54. The correct answer is (H). Reading is the only option that translates the actual length of a novel into time.

55. The correct answer is (B). A comma separates the clauses for the sake of clarity.

56. The correct answer is (H). Paragraph 4 introduces the idea that films spoon-feed character development to the audience. That idea is elaborated on in Paragraph 2.

57. The correct answer is (A). This option is the most logical given the writer's emphasis on the reader's imagination.

58. The correct answer is (J). This option conveys the idea that words are both poetic and powerful without making the sentence awkward.

59. The correct answer is (D). This option restates the main idea of the essay, which is the writer's desire to persuade the reader to read classic novels rather than watch film adaptations of them.

60. The correct answer is (H). The writer's argument centers on the problems inherent in adapting classic novels for the screen and not on the comparative value of books and films.

**Passage V**

61. The correct answer is (C). The word *desire* is part of a series, and the series should be separated by commas.

62. The correct answer is (G). This choice avoids unnecessary words and is neither overly technical nor overly vague.

63. The correct answer is (A). This sentence links the idea of fantasy, from Paragraph 1, with Monaco.

64. The correct answer is (J). The conjunction *but* indicates that the combination *wealthy* and *tiny* might go against expectation.

65. The correct answer is (A). The present perfect implies correctly that the family ruled in the past and continues to do so.

66. The correct answer is (G). No possessive punctuation is required here. *Grimaldis* is a plural noun.

67. The correct answer is (D). Any addition here of extraneous information would interrupt the logic of the paragraph, which focuses on the Grimaldis.

68. The correct answer is (J). This option avoids unnecessary words and inappropriate changes in tone.

69. The correct answer is (B). This choice maintains the third-person style of the essay and the logic of the sentence.

70. The correct answer is (G). Nationalities are capitalized. *An* is necessary to avoid consecutive vowels.

71. The correct answer is (C). Beautiful and poised refer to Princess Grace; she is the subject of the verbs.

72. The correct answer is (F). The past tense is appropriate here. The sentence describes something that did in fact happen.

73. The correct answer is (B). The pronoun *who* correctly implies that Prince Rainier is the subject of the verb *to mourn*.
A comma is required following the word still in order to separate this clause from the next.

74. **The correct answer is (J).** It implies a negative impact of the tragedy without exaggerating it.

75. **The correct answer is (C).** This essay does not fulfill the assignment since it only refers to ordinary people indirectly.

**Section 2: MATH**

1. **The correct answer is (A).** The sale price of the suit is $250 – (.25)(250) = $187.50.

2. **The correct answer is (G).** The perimeter of the foundation is equal to twice the length plus twice the width or $2(60) + 2(20) = 160$ feet.

3. **The correct answer is (C).** If $a = -3$, then $b = (-2)(-3) = 6$. The expression $ab - 3a$ equals $(-3)(6) - 3(-3) = -18 + 9 = -9$.

4. **The correct answer is (J).** $\frac{15}{50} = .375 = 37.5\%$ of the bushes are red roses.

5. **The correct answer is (D).** $3(5^2) - 2(5) + 7 = 75 - 10 + 7 = 72$.

6. **The correct answer is (K).** None of the other templates can be folded into a cube without violating the rules of the question.

7. **The correct answer is (E).**
   
   $(x + 2)(x - 5) = 8$
   $x^2 - 3x - 10 = 8$
   $x^2 - 3x - 18 = 0$
   $(x - 6)(x + 3) = 0$
   $x - 6 = 0$ or $x + 3 = 0$

8. **The correct answer is (F).** The minimum passing score is $(400)(.7) = 280$ points. If the applicant raised his score by 25 points and received 280, then his first score was $280 - 25 = 255$.

9. **The correct answer is (A).** The number of different combinations can be obtained by multiplying the number of variations on each variable—color, finish, and newsletter. The number of distinct combinations is $(5)(4)(2) = 40$.

10. **The correct answer is (H).** The first graph illustrates $x > -2$, and the second graph illustrates $x < 2$. The intersection of these inequalities is $-2 < x < 2$.

11. **The correct answer is (D).**

   $\pi r^2 = 24\pi$
   $r^2 = 24$
   $r = \sqrt{24} = 2\sqrt{6}$

12. **The correct answer is (G).** A parallelogram is a quadrilateral with two sets of parallel sides. $ABDE$ satisfies these conditions.

13. **The correct answer is (A).** $3(m + n) - 2(m - 3n) = 3m + 3n - 2m + 6n = m + 9n$

14. **The correct answer is (K).** Knowing only the hypotenuse of a right triangle is not enough information to determine the lengths of the legs.

15. **The correct answer is (C).** A line intersects the $y$-axis where $x = 0$, so substitute $x = 0$ into the equation and solve for $y$:
   
   $0 + 3y = 6$
   $3y = 6$
   $y = 2$

16. **The correct answer is (G).** There are $180 + 540 = 720$ cars in the parking lot, so $\frac{180}{720} = .25 = 25\%$ have out-of-state plates.

17. **The correct answer is (C).** If $t = 1$, the product $(2)(4)(6)(9)t$ is divisible by all of the answers except 30.

18. **The correct answer is (J).** The area of a rectangle is length times width:

   $area = (3x + 2)(5x - 3)$
   $= 15x^2 - 9x + 10x - 6$
   $= 15x^2 + x - 6$

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19. The correct answer is (A).

\[4x^2 = 6x + 4 \quad 4x^2 - 6x - 4 = 0 \quad 2x^2 - 3x - 2 = 0 \text{ (divide both sides by 2)} \quad (2x + 1)(x - 2) = 0\]

20. The correct answer is (G). You can determine that the sides of the second triangle are all 4 times as long as the sides of the first triangle, because you are given that two of the similar sides are \(x\) and 4\(x\). You can then use this fact to solve for \(x\). The side that is 5\(x\) is 4 times the side of length 10, so 5\(x\) = 40 or \(x = 8\).

21. The correct answer is (A). Multiplying both sides of the equation by 10 gets rid of the fractions and decimal points:

\[x - 42 = 2x + 33 \quad -x = 75 \quad x = -75\]

22. The correct answer is (G). First plane left at \(t + 1\). Second plane \((t)\) left at 4 p.m.; therefore,\[350(t + 1) + 450t = 3,000 \quad 350t + 350 + 450t = 3,000 \quad 800t = 3,000 - 350 = 2,650 \quad t = 3.3\]
That’s 3.3 hours after 4 p.m. or 7:18 p.m.

23. The correct answer is (E).

\[(x - a)(x + b) = x^2 + 2x - 4b \quad x^2 + (b - a)x - ab = x^2 + 2x - 4b\]

From the above equation, you know that \(ab = 4b\), or \(a = 4\). Given that \(a = 4\), you can solve for \(b\):

\[b - a = 2 \quad b - 4 = 2 \quad b = 6\]

24. The correct answer is (G).

\[\frac{\sqrt{12} \cdot \sqrt{157}}{2\sqrt{5}} = \frac{143}{2} = 6.572\]

25. The correct answer is (B).

\[12x^2 - ax - a = (3x + 1)(4x - 2) \quad 12x^2 - ax - a = 12x^2 - 2x - 2 \quad a = 2\]

26. The correct answer is (K).

\[\frac{x \sqrt{3}}{z - \sqrt{3}} \times \frac{z + \sqrt{3}}{z + \sqrt{3}} = \frac{x^2 + 3x}{z^2 - 3}\]

27. The correct answer is (D). A rectangle is a four-sided polygon, so it is a quadrilateral. It has two sets of parallel sides, so it is a parallelogram. However, a rhombus has 4 equal sides, and a rectangle does not (unless it is a square).

28. The correct answer is (F). Solve for the distance by setting up a proportion:

\[\frac{20}{150} = \frac{x}{180} \quad 150x = 3,600 \quad x = 24\]

29. The correct answer is (C). Since sine is defined as \(\frac{\text{opposite}}{\text{hypotenuse}}\), you can assume that \(AC\) is 4 and \(AB\) is 9. Solving for \(BC\) using the Pythagorean theorem gives 65. The sine of \(\angle A\) is thus \(\frac{65}{9}\).

30. The correct answer is (K).

\[n + 8 = 14 - 4(3 - n) \quad n + 8 = 14 - 12 + 4n \quad -3n = -6 \quad n = 2\]

31. The correct answer is (B). Parallel lines have equal slope. Put the original equation into the form \(y = mx + b\), where \(m\) is the slope:

\[2x + 7y = 5 \quad 7y = -2x + 5 \quad y = -\frac{2}{7}x + \frac{5}{7}\]

32. The correct answer is (G). You can divide the room into a rectangular section with an area of (10)(12) = 120 square
feet and a triangular section with an area of \( \frac{1}{2} \times 4 \times 10 = 20 \) square feet. The amount of carpet used is \( 120 + 20 = 140 \) square feet.

33. The correct answer is (A).
\[
x + 10 = yz + 5 \\
x + 5 = yz \\
x + \frac{5}{y} = y
\]

34. The correct answer is (K). Determine the slope by putting the equation into the form \( y = mx + b \), where \( m \) is the slope:
\[
6x - 5y = 10 \\
-5y = -6x + 10 \\
y = \frac{6}{5} x - 2
\]

35. The correct answer is (D). The relationship among the sides of a \( 30^\circ-60^\circ-90^\circ \) triangle is \( x, x\sqrt{3}, \) and \( 2x \), respectively. You can use these relationships to determine the lengths of the sides of the triangles.

\[\begin{align*}
A & \quad \text{30}^\circ \\
D & \quad \text{10 cm}
\end{align*}\]

36. The correct answer is (J). Use the distance formula to determine the radius of the circle:
\[
r = \sqrt{(0 - 6)^2 + (5 - 1)^2} \\
= \sqrt{36 + 16} \\
= \sqrt{52}
\]
The area of the circle is
\[
\pi r^2 = \pi (\sqrt{52})^2 = 52\pi.
\]

37. The correct answer is (C). Substitute the \( x \) and \( y \) values into the equation and you find that only \((3,8)\) does not satisfy the equation of the line.

38. The correct answer is (G). Eight shirts are two sets of three, plus two singles, which will cost $110 plus $44, or $154. Then you get a $15.40 discount (10%), bringing the final cost to $138.60.

39. The correct answer is (C). If you buy five shirts, you get three for $55 plus two more for $22 each, for a total of $99. But if you buy six shirts (two sets of three), you pay $110 less a 10% discount of $11, bringing your cost down to $99. The extra shirt is free!

40. The correct answer is (H). Sine is equal to \( \frac{\text{opposite}}{\text{hypotenuse}} \), so \( \sin \angle B = \frac{24}{26} = \frac{12}{13} \).

41. The correct answer is (B). A graph of a polynomial intersects the \( x \)-axis at each real root. If the 3 real roots of \( P(x) \) are different from the 2 real roots of \( Q(x) \), then the graph would intersect the \( x \)-axis at 5 points.

42. The correct answer is (K).
\[
\frac{2x^2 - 4xy + 2y^2}{y^2 - x^2} = \frac{2(x - y)(x - y)}{(y - x)(y + x)} \\
= \frac{2(x - y)}{y + x} \\
= \frac{2(x - y)}{x + y}
\]

43. The correct answer is (C). You can use the relationships of a \( 30^\circ-60^\circ-90^\circ \) triangle to solve for the height, or you can apply the Pythagorean theorem:
\[
3^2 + b^2 = 6^2 \\
9 + b^2 = 36 \\
b^2 = 27 \\
b = \sqrt{27} = 3\sqrt{3}
\]

44. The correct answer is (G).
\[
(x + 2)(x - 6) = 2x - 21 \\
x^2 - 4x - 12 = 2x - 21 \\
x^2 - 6x + 9 = 0 \\
(x - 3)^2 = 0 \\
x = 3
\]

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There is only one real number that solves the equation.

45. The correct answer is (A). If the 6 students represent exactly 20% of the class, then there are $\frac{6}{0.2} = 30$ students in the class. If the 6 students represent exactly 40% of the class, then there are $\frac{6}{0.4} = 15$ students in the class. Since any number of students between 15 and 30 is also possible, there are a total of 16 different values of $x$.

46. The correct answer is (J). A zero is a real root—a point at which the function has a $y$-value of 0. If a polynomial has zeros of 0, 1, and 2, then the polynomial could be as follows:
\[
(x - 0)(x - 1)(x - 2) = 0
\]
\[
x(x^2 - 3x + 2) = 0
\]
\[
x^3 - 3x^2 + 2x = 0
\]

47. The correct answer is (B). To determine the area of a triangle, you need to know its base and its height. You can call the side shared with the square the base, and you know that it is 6 inches long. Although the height is not given directly, you are given that the entire horizontal distance from $A$ to $D$ is 10 inches. Thus, the height of the triangle is $10 - 6 = 4$ inches. The area is $\frac{1}{2}(6)(4) = 12$.

48. The correct answer is (G). You can substitute each of the points into the equations, or you can solve the simultaneous equations:
\[
y - 4x = -4
\]
\[
-y + 3x = 10
\]
\[
-7x = -14
\]
\[
x = 2
\]

49. The correct answer is (C). In an isosceles right triangle, if a leg has a length of $x$, then the hypotenuse has a length of $x\sqrt{2}$. Given the perimeter, you can solve for the length of $x$:
\[
x + x + x\sqrt{2} = 16 + 16\sqrt{2}
\]
\[
(2 + \sqrt{2})x = 16 + 16\sqrt{2}
\]
\[
(2 + \sqrt{2})x = (2 + \sqrt{2})8\sqrt{2}
\]
\[
x = 8\sqrt{2}
\]

50. The correct answer is (G). $x + y$ can be found by getting a common denominator for the two fractions:
\[
\frac{2 - \sqrt{3}}{2 + \sqrt{3}} + \frac{2 + \sqrt{3}}{2 - \sqrt{3}} = \frac{(2 - \sqrt{3})(2 - \sqrt{3}) + (2 + \sqrt{3})(2 + \sqrt{3})}{(2 + \sqrt{3})(2 - \sqrt{3})}
\]
\[
= \frac{4 - 2\sqrt{3} + 1}{4 - 3} + \frac{4 + 2\sqrt{3} + 3}{4 - 3}
\]
\[
= 14
\]

51. The correct answer is (E).
\[
3x - k(x + 2) \geq 10 - 3(1 + x)
\]
\[
3x - kx - 2k \geq 10 - 3 - 3x
\]
\[
6x - kx \geq 7 + 2k
\]
\[
(6 - k)x \geq 7 + 2k
\]

If $k$ equals 6, then the inequality is $0 \geq 19$, which cannot be true.

52. The correct answer is (J). The orders per day on Monday through Friday are 40, 45, 50, 55, and 60. The average order sizes are $250, 240, 230, 220,$ and $210$. The first day that the company has sales of at least $12,000 is Thursday: $(55)(220) = 12,100$.

53. The correct answer is (C). Triangles $ABC$ and $JKC$ are similar. If $CJ$ is $x$, then you can solve as follows:
\[
\frac{x}{x + 48} = \frac{50}{100}
\]
\[
100x = 60x + 2,880
\]
\[
40x = 2,880
\]
\[
x = 72
\]

You can then solve for $CK$ as $y$:
\[
\frac{y}{72} = \frac{48}{248}
\]
\[
48y = 3,600
\]
\[
y = 75
\]

The perimeter of the triangle is $100 + 72 + 48 + 75 + 50 = 345$ inches.
54. The correct answer is (K). If the triangle extends just beyond the circle at the three vertices, then there are 6 points of intersection.

55. The correct answer is (D). I is not always true. For example, if $a$ is negative and $b$ is positive, II is always true. The expressions will always be positive and will always be equal. III is always true, as well.

56. The correct answer is (K).
\[
2x^3 - 2x = 2x(x^2 + 1)(x + 1)(x - 1) \\
2x(x^4 - 1) = 2x(x^2 + 1)(x + 1)(x - 1) \\
x^4 - 1 = (x^2 + 1)(x^2 - 1) \\
x^4 - 1 = x^4 - 1
\]
The equation is true for all values of $x$.

57. The correct answer is (A). $2y = \cos 2\theta$ can be rewritten as $y = \cos \theta$. The amplitude of this expression is half that of $y = \cos \theta$ and so is its period.

58. The correct answer is (J). First, you may want to rewrite the ellipse in the standard form:
\[
\frac{(x+2)^2}{4} + \frac{(y-3)^2}{9} = 1
\]
One way of thinking about this problem is to realize that a circle is simply an ellipse with equal denominators. Thus, the equation of the circle that inscribes the ellipse is
\[
\frac{(x+2)^2}{4} + \frac{(y-3)^2}{9} = 1 \text{ or } (x+2)^2 + (y-3)^2 = 9.
\]

59. The correct answer is (E).
\[
\frac{2\pi r}{2\pi(2r)} = \frac{r}{2} = 8.
\]

60. The correct answer is (H). First, solve for $x$:
\[
x + 2x + 3x = 180 \\
6x = 180 \\
x = 30
\]
What you have, then, is a $30^\circ$-$60^\circ$-$90^\circ$ triangle. If the side opposite the $30^\circ$ angle has a length of 4, then the side opposite the $60^\circ$ angle has a length of $4\sqrt{3}$. The side opposite the $90^\circ$ angle has a length of 8. The perimeter of the triangle is $12 + 4\sqrt{3}$.

Section 3: READING

1. The correct answer is (B). Choice (A) is incorrect because we learn in the third paragraph that Elam was “gregarious.” Choice (B) is the best answer because the second sentence in the third paragraph tells us “he was too vital and robust” to be inclined toward drinking. Choice (C) is incorrect because the passage does not mention Elam drinking. Choice (D) is incorrect because although Elam did gamble, nowhere in the passage does it say he preferred it to drinking.

2. The correct answer is (H). Choice (F) is incorrect because Elam’s religious conviction is never mentioned. Choice (G) is incorrect because Elam’s mother is never mentioned. Choice (H) is the best answer because the first paragraph states “he had known nothing but hard knocks for big stakes” and “Environment had determined what form that game should take” in reference to Elam’s gambling nature. Choice (J) is incorrect because nowhere does it state that Elam misunderstood games of chance.

3. The correct answer is (C). Choice (A) is incorrect because although I is mentioned in Paragraph 4, III is mentioned
in Paragraph 5. Choice (B) is incorrect because although III is mentioned in Paragraph 5, I is mentioned in Paragraph 4. Choice (C) is the best answer because I is mentioned in the middle of Paragraph 4 and III is mentioned at the end of in Paragraph 5. Choice (D) is incorrect because II is never mentioned.

4. **The correct answer is (J).** Choice (F) is incorrect because owing money is never mentioned. Choice (G) is incorrect because though Elam’s mine is mentioned in Paragraph 1, he had struck gold “the past summer.” Choice (H) is incorrect because playing cards is not mentioned. Choice (J) is the best answer because at the end of the second paragraph, it mentions it was “the day of his birth.”

5. **The correct answer is (C).** Choice (A) is incorrect because Paragraph 4 states that Elam was “without wrinkles.” Choice (B) is incorrect because III is also mentioned in Paragraph 4. Choice (C) is the best answer because II and III are both mentioned in Paragraph 4. Choice (D) is incorrect because Paragraph 4 states that Elam was “without wrinkles,” so I is incorrect.

6. **The correct answer is (H).** Choice (F) is incorrect because the yield from Elam’s mine is not compared to other mines. Choice (G) is incorrect because Paragraph 1 states that the Moosehide Creek mine allowed Elam to “no more than get his ante back.” Choice (H) is the best answer: Paragraph 1 states that “what was left in the ground was twenty thousand more.” Choice (J) is incorrect because other miners are not mentioned.

7. **The correct answer is (A).** Choice (A) is the best answer because the first sentence of Paragraph 4 tells us that “despite his garb being similar,” Elam was striking. Choice (B) is incorrect because though the paragraph says Elam looks boyish, it does not say he dresses that way. Choice (C) is incorrect because visitors from the city are not mentioned in the passage. Choice (D) is incorrect because Elam dressing in a “ridiculous manner” is not mentioned.

8. **The correct answer is (J).** Choice (F) is incorrect because swindling gamblers is never mentioned. Choice (G) is incorrect because local news is not mentioned in the passage. Choice (H) is incorrect because though the “mining camps” of Elam’s youth are mentioned, there is no suggestion that Elam held them in “reverence.” Choice (J) is the best answer because Paragraph 3 tells us “it was the proper way for a man to express himself socially” and that Elam “knew no other way.”

9. **The correct answer is (B).** Choice (A) is incorrect because raising the value of gold is not mentioned. Choice (B) is the best answer because Paragraph 1 states “those that won gold from the ground gambled for it with one another.” Choice (C) is incorrect because “revealing mines” is never mentioned. Choice (D) is incorrect because “investment” is never mentioned.

10. **The correct answer is (G).** Choice (F) is incorrect because nothing said about Elam suggests he was an idiot. Choice (G) is the best answer because the final paragraph of the passage says Elam’s nature was “essentially savage.” Choice (H) is incorrect because nowhere does it say Elam was meek. Choice (J) is incorrect because the final paragraph of the passage says Elam’s nature was “essentially savage,” which is incongruous with the suggestion that he is full of “loving kindness.”
11. The correct answer is (C). Choice (A) is incorrect because Jefferson is not mentioned in the passage, and Lincoln is not mentioned as being a war hero. Choice (B) is incorrect because although Washington and de Grasse are mentioned in the passage, neither is mentioned in connection with the Mexican War. Choice (C) is the best answer because Paragraph 4 mentions the heroes “Zachary Taylor and Winfield Scott.” Choice (D) is incorrect because Sam Bowie and Davy Crockett are not mentioned in the passage.

12. The correct answer is (F). Choice (F) is the best answer because the last paragraph of the passage states that students should be taught “those acts and policies of [America] wherein she fell below her lofty and humane ideals.” Choice (G) is incorrect because it contradicts the statement mentioned above. Choice (H) is incorrect because Paragraph 5 makes clear that the Mexican War was started by the United States with the purpose of “the extension of slavery.” Choice (J) is incorrect because in the last sentence of Paragraph 2 the author states “you probably know that the British burned Washington,” referring to students who know something about the War of 1812.

13. The correct answer is (C). Choice (A) is incorrect because Paragraph 1 clearly states that the author was taught the British started the War of 1812. Choice (B) is incorrect because Paragraph 1 clearly states that the author was taught the British started the War of 1812. Choice (C) is the best answer because the passage does not say that Santa Anna started the war. Choice (J) is incorrect because the passage does not mention the economy.

14. The correct answer is (J). Choice (J) is the best answer because I, II, and III are all supported by the sentence “That during those years [between 1808 and 1812] England had moderated her arrogance, was ready to moderate further and wanted peace; while we, who had been nearly unanimous for war, and with a fuller purse in 1808, were now, by our own congressional fuddling and messing, without any adequate army, and so divided in counsel that only one northern state was wholly in favor of war?”

15. The correct answer is (D). Choice (D) is the best answer because the second to the last sentence in Paragraph 3 mentions that there were more French soldiers than American soldiers at the Battle of Yorktown.

16. The correct answer is (G). Choice (F) is incorrect because Paragraph 5 states “More Americans were against it than had been against the War of 1812.” Choice (G) is the best answer because Paragraph 5 states “More Americans were against it than had been against the War of 1812.” Choice (H) is incorrect because the passage does not say that Santa Anna started the war. Choice (J) is incorrect because the passage does not mention the economy.

17. The correct answer is (A). Choice (A) is the best answer because it is a paraphrase of the statement from the final paragraph that “our love of our country would be just as strong, and far more intelligent, were we honestly and wisely taught in our early years those acts and policies of hers wherein she fell below her lofty and humane ideals.” Choice (B) is
incorrect because throughout the passage, the author asserts that he did not learn the whole story of American history in school. Choice (C) is incorrect because the author never makes statements that support the concept of “nationalistic bias.” Choice (D) is incorrect because in the last paragraph, the author argues that the country would be better off if people were taught the whole truth about American history.

18. **The correct answer is (F).** Choice (F) is the best answer because only II is correct, supported by the contention presented in Paragraph 5 that “the whole discreditable business had the extension of slavery at the bottom of it.” Choice (J) is incorrect because although, in reality, statement III may have been true, this fact is not mentioned or supported anywhere in the passage.

19. **The correct answer is (C).** Choice (A) is incorrect because Paragraph 5 begins with the phrase “General Grant, who had fought with credit as a lieutenant in the Mexican War.” Choice (B) is incorrect because Paragraph 5 begins with the phrase “General Grant, who had fought with credit as a lieutenant in the Mexican War.” Choice (C) is the best answer because Paragraph 5 begins with the phrase “General Grant, who had fought with credit as a lieutenant in the Mexican War.” Choice (D) is incorrect because Paragraph 5 begins with the phrase “General Grant, who had fought with credit as a lieutenant in the Mexican War.”

20. **The correct answer is (J).** Choice (F) is incorrect because London is not mentioned in the passage. Choice (G) is incorrect because the Battle of New Orleans is not mentioned in connection with the burning of Washington. Choice (H) is incorrect because the victory in New York is not mentioned in connection with the burning of Washington. Choice (J) is the best answer because Paragraph 2 ends with the sentence “You probably did know that the British burned Washington, and you accordingly hated them for this barbarous vandalism—but did you know that we had burned Toronto a year earlier,” that infers a connection between the attack on Toronto and the burning of Washington.

21. **The correct answer is (A).** Choice (A) is the best answer because the context of “shrewdness” supports a child’s ability to evaluate adult behavior. Choice (B) is incorrect because “cunning” implies a sneakiness the author never attributes to children. Choice (C) is incorrect because a child’s intelligence and/or stupidity is not mentioned in this passage. Choice (D) is incorrect because “depravity” implies unnatural behavior on a child’s part that is not discussed in the passage.

22. **The correct answer is (J).** Choice (J) is the best answer because I, II, and III are all correct. I is supported by the phrase in Paragraph 1 “educators who, day in and day out, are consciously transforming the environment and themselves.” II is supported by the sentence in Paragraph 1 “Most people live on the capital and interest of an education, which perhaps once made them model children but has deprived them of the desire for educating themselves.” The implication here is that, unless one maintains this desire for education, one can’t be a good educator. III is supported by the sentence in Paragraph 1 “It means the humble realization of the truth that the ways of injuring the child
are infinite, while the ways of being useful to him are few.”

23. The correct answer is (C). Choice (A) is incorrect because this sentence is used as an example of an attribute of old education that current education does not have. Choice (B) is incorrect because while the context of the sentence implies the old education did not necessarily develop personalities, it does not imply anywhere that old education meant to suppress such development. Choice (C) is the best answer because, although the sentence prior to this one implies that the old education did have excellent qualities, the fact that it “did not form” personality is depicted as a negative quality in the rest of the passage, which stresses the importance of developing children’s individual personalities. Choice (D) is incorrect because it is contradicted by the sentence in Paragraph 4 “it is essential that education shall awake the feeling of independence; it should invigorate and favor the disposition to deviate from the type.” This sentence stresses that new education does try to form personality.

24. The correct answer is (G). Choice (F) is incorrect because it is explicitly mentioned in the passage as a precept of the author’s philosophy of education. Choice (G) is the best answer because it is an assumed fact of human nature and the only answer that is not a directive explicitly mentioned within the author’s philosophy of education. Choice (H) is incorrect because it is explicitly mentioned in the passage as a precept of the author’s philosophy of education. Choice (J) is incorrect because it is explicitly mentioned in the passage as a precept of the author’s philosophy of education.

25. The correct answer is (B). Choice (A) is incorrect because the context of Paragraph 4 does not discuss how easy or difficult it is to develop any type of personality in children, much less strong ones. Choice (B) is the best answer because the statement in Paragraph 4 “for the progress of the whole of the species, as well as of society, it is essential that education shall awake the feeling of independence” supports the idea that without individualism, society will weaken. The sentence in Paragraph 4 “Using other people’s opinion as a standard results in subordinating one’s self to their will” implies that if one tries to conform, the danger is that one will be under the power of other, stronger personalities. Choice (C) is incorrect because although the context of the phrase encourages the development of personality in children, the Superman personalities are presented as a negative influence that people end up subordinating themselves to, as the phrase “Using other people’s opinion as a standard results in subordinating one’s self to their will” in Paragraph 4 implies. Choice (D) is incorrect because the whole point of Paragraph 4 is that people do not conform their behavior to others, but rather they develop their individuality.

26. The correct answer is (H). Choice (F) is incorrect because in Paragraph 2, insensitive behavior is stated to “leave wounds that last for life in the finely strung soul of the child,” indicating that insensitive treatment affects children regardless of their outward reaction to it. Choice (G) is incorrect because the phrase from Paragraph 5 “the sensitive feelings of children are constantly injured by lack of consideration on the part of grown people” directly contradicts it. Choice (H)
is the best answer because it is supported by the phrase from Paragraph 5 “the sensitive feelings of children are constantly injured by lack of consideration on the part of grown people.” Choice (J) is incorrect because in the second paragraph, kind treatment of children is said to “make quite as deep an impression” as negative treatment does, indicating that children internalize good and bad treatment equally.

27. The correct answer is (D). Choice (A) is incorrect because how fairly a parent reprimands a child is not mentioned in this passage. Choice (B) is incorrect because the first paragraph states natural education should ignore “the faults of children nine times out of ten,” implying that children should not be allowed to do what they want all the time. Choice (C) is incorrect because the fourth paragraph specifically states that a new educator “rejoice when he sees in the child tendencies to deviation” from society, indicating that natural education enables a child to deviate from, not conform to, society. Choice (D) is the best answer because the first phrase in Paragraph 1 “the art of natural education consists in ignoring the faults of children nine times out of ten” supports the idea that fault control is not important to natural education, while the entire fourth paragraph is devoted to the importance of developing a child’s individuality.

28. The correct answer is (F). Choice (F) is incorrect because the phrase that directly follows it “the humble realization of the truth that the ways of injuring the child are infinite, while the ways of being useful to him are few” implies adult flaws injure children. Choice (G) is incorrect because, while the first paragraph states “educators who . . . are consciously transforming the environment and themselves are a rare product,” indicating that there are few people truly good at child-rearing, nowhere in the passage is child-rearing referred to as divine. Choice (H) is incorrect because although “setting one’s feet on a narrow path” in Paragraph 1 may seem to indicate a limitation, the line that follows it, “the humble realization of the truth that the ways of injuring the child are infinite, while the ways of being useful to him are few,” indicates that the narrow path is actually the educator’s navigation of the treatment of children. Choice (J) is incorrect because in Paragraph 4, the phrase referring to child rearing and education as being “for the progress of the whole of the species, as well as of society” implies that such an outcome is indeed fulfilling.

29. The correct answer is (C). Choice (C) is the best answer because I and III are correct and II is incorrect. I is supported by the statement in the fifth paragraph that “the new educator must remember that the sensitive nature of children are constantly injured by lack of consideration on the part of grown people.” III is supported by the statement in Paragraph 5 “Would I consent to be treated as I have just treated my child.” II is incorrect because although the passage does imply that children are in need of guidance, it does not portray children as disobedient creatures but rather as sensitive, fallible beings. Choice (D) is incorrect because, although I and III are correct, II is not correct.

30. The correct answer is (J). Choice (F) is incorrect because “manipulator” implies an underhanded, conscious desire on the part of a good educator to control the child, which directly contradicts one of
the main points of the passage—that an educator must sensitively guide a child toward individuality. Choice (G) is incorrect because nowhere does the passage stress the educator as a “worrier.” Choice (H) is incorrect because the context of “providence” implies that the educator will be invisibly guiding the child through his example, not merely observing the child’s behavior. Choice (J) is the best answer because the context of “providence” supports the image of the educator as an influential figure from whose example the child learns.

31. The correct answer is (B). Choice (A) is incorrect because although the passage mentions matter and antimatter annihilating each other in Paragraph 7, it is only a small portion of the passage. Choice (B) is the best answer because Paragraph 2 ends with the statement that the vacuum is dynamic, and Paragraphs 3–8 deal with the different ways the vacuum fluctuates. Choice (C) is incorrect because although the Special Theory of Relativity is mentioned in Paragraph 9, it is not the main idea of the passage. Choice (D) is incorrect because although the ether was disproved by Einstein in 1905, so it could not be part of the theory of quantum mechanics, which was developed in the 1920s. Choice (J) is incorrect because a room full of oxygen is never mentioned in the passage.

32. The correct answer is (C). Choice (F) is incorrect because Paragraph 8 states “One metaphor that has been proposed is that the dynamic vacuum is like the surface of a lake.” Choice (G) is incorrect because although a thin disk of matter is mentioned in Paragraph 1, it is used to describe the planets. Choice (H) is incorrect because “a dozen lotteries” is used in Paragraph 1 of the passage to describe the chances of finding matter, not to describe the actual vacuum. Choice (J) is incorrect because according to the third paragraph, subatomic particles have a “peculiar nature” that makes them unlike visible objects like motes of dust. Choice (F) is incorrect because rotation means spin, and the particles are vibrating. Choice (G) is incorrect because speed means to quick movement, and the particles are vibrating. Choice (H) is incorrect because the particles are vibrating, not changing. Choice (J) is the best answer because Paragraph 3 states that we should “think of particles as constantly vibrating waves.”

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35. The correct answer is (C). Choice (A) is incorrect because the statement is supported by Paragraph 3 (the uncertainty principle). Choice (B) is incorrect because the statement is supported by the information in Paragraph 5. Choice (C) is the best answer because the ether was disproved by Einstein in 1905, so it could not be part of the theory of quantum mechanics, which was developed in the 1920s. Choice (D) is incorrect because the statement is supported by the information in Paragraph 7.

36. The correct answer is (J). Choice (F) is incorrect because according to the third paragraph, subatomic particles have a “peculiar nature” that makes them unlike visible objects like motes of dust. Choice (G) is incorrect because the entire passage makes reference to the vacuum as a dynamic, fluctuating entity. Choice (H) is incorrect because according to the
final paragraph of the passage, waves of light behave unlike other waves. Choice (J) is the best answer because Paragraph 1 states that “the universe is mostly made up of empty space.” This idea is repeated in Paragraph 2.

37. The correct answer is (C). Choice (A) is incorrect because no connection is made in the passage between Einstein and tapping the fluctuation of energy in the vacuum. Choice (B) is incorrect because finding where the fluctuations take place is not mentioned in Paragraph 6 as a reason tapping the energy cannot be accomplished. Choice (C) is the best answer because according to Paragraph 6, in order to “tap the energy,” you would need to “break several basic laws of physics.” Choice (D) is incorrect because a “massive explosion” resulting from the tapped energy is not discussed.

38. The correct answer is (H). Choice (F) is incorrect because the passage does not say that atoms are grouped together. Choice (G) is incorrect because the passage does not say that most atoms in interstellar space are hydrogen. Although this may be truthful, it is not suggested by the passage and is therefore an incorrect answer choice. Choice (H) is the best answer because according to Paragraph 1, “Between the vastly spread out solar systems and galaxies are regions of interstellar space where there may be less than one atom per square mile.” Choice (J) is incorrect because the passage does not say that atoms in interstellar space are different than other atoms.

39. The correct answer is (A). Choice (A) is the best answer because the passage ends with a reference to “the great ether beast that had been loosed upon science by Aristotle.” Choice (B) is incorrect because Einstein refuted the idea of the ether (final paragraph). Choice (C) is incorrect because Michelson and Morley attacked the idea of the ether (final paragraph). Choice (D) is incorrect because Heisenberg is not mentioned in reference to the ether.

40. The correct answer is (G). Choice (F) is incorrect because the fourth paragraph does not mention the way people perceive reality. Choice (G) is the best answer because the fourth paragraph mentions “constantly vibrating waves” and that particles “always shake to some degree.” Choice (H) is incorrect because though the statement in choice (H) is supported by the information in Paragraph 3, it is not the main idea of Paragraph 4. Choice (J) is incorrect because nowhere in the passage does it state that a vacuum slows down the movement of particles.

Section 4: SCIENCE REASONING

1. The correct answer is (A). Looking at the table, at 1.5% salt concentration, the final weight was 2.30 g and the final volume was 2.09 ml.

2. The correct answer is (F). In the 0.0% NaCl solution, the final weight is 3.25 g and the final volume is 3.28 ml. This is the only sample that gives a density less than 1 g/ml.

3. The correct answer is (A). The percentage weight change at lower concentrations is positive, and the percentage weight change at higher concentrations is negative.

4. The correct answer is (H). The isotonic state is the point at which there is no net movement of water between the semipermeable membrane. This would have occurred in between 0.5% and 1.0% salt concentration according to the data in the table.

5. The correct answer is (D). According to the table, if the NaCl concentration were increased above 5%, the volume and weight of the potato core should decrease.

www.petersons.com/arco
6. The correct answer is (F). When the core was submerged in water with no NaCl concentration, the weight and volume of the core increased. Water will move toward the area of greater solute concentration. The core had to have some NaCl concentration, otherwise the water would not have been absorbed.

7. The correct answer is (B). The isotonic state for the second variety would be reached at a higher NaCl than the other variety; therefore, the initial NaCl concentration in the second variety would be higher than in the first.

8. The correct answer is (F). Only Geologist 1 accounts for the 40,000-year cycles.

9. The correct answer is (C). Both geologists believe that orbital motion has an effect on cooling trends. The two geologists only differ as to the mechanism for cooling.

10. The correct answer is (J). Geologist 1 does not address the impact of extraterrestrial debris on Earth’s temperature.

11. The correct answer is (A). Geologist 1 proposes that orbital tilt can affect the amount of heat the earth receives from the sun.

12. The correct answer is (G). Geologist 2 assumes that the orbit of the earth does not contribute to cooling trends.

13. The correct answer is (B). Looking at Table 1, coffee has the indicated hydrogen ion concentration.

14. The correct answer is (J). Thymol blue will turn in the presence of pH greater than 9.6. Household ammonia is the only substance listed with a pH this high.

15. The correct answer is (D). The most basic substance will have the highest pH. Of the four substances, Borax has the highest pH.

16. The correct answer is (H). Methyl violet needs a pH change of 2, alizarin yellow G needs a pH change of 1.9, methyl red needs a pH change of 2.1, and phenolphthalein needs a pH change of 1.7.

17. The correct answer is (C). To be converted to its acidic form, the pH level would need to be 6.0 or lower. Coffee is the only substance among the answers with a pH low enough.

18. The correct answer is (F). Looking at the table, lead requires 24.5 kJ/kg to change from the solid to liquid phase. Since 1 kg is being changed, 24.5 kJ is required.

19. The correct answer is (D). Liquid phase exists between melting point and boiling point. Gold is liquid over the widest range of temperatures.

20. The correct answer is (G). Look at the table and compare the substances. Nitrogen and helium have a difference of 180 kJ/kg, lead and ethyl alcohol have a difference of 58 kJ/kg, silver and lead have a difference of 1,423 kJ/kg, and water and gold have a difference of 675 kJ/kg.

21. The correct answer is (A). If silver and water were not considered, the greater the boiling point, the greater the heat of vaporization would be.

22. The correct answer is (J). Lead and silver are both liquid at 1,000 degrees.

23. The correct answer is (C). The only hypothesis that is supported by the data is that as melting point decreases, boiling point decreases.

24. The correct answer is (J). Look at Figure 1 at the point at which 0.4 mg of antigen was added. The graph shows that the amount of precipitate would be close to 12 mg.
25. **The correct answer is (C).** Look at Figure 2 and see at what levels the antigen must be to yield 8 mg of precipitate.

26. **The correct answer is (H).** The zone of equivalence was reached when 1.5 mg of antigen was added. The graph is at its maximum at this point.

27. **The correct answer is (B).** The equivalence zone would shift to the right and down because the point at 1 mg antigen would yield the most precipitate. It would appear that all of the available antibody and antigen were used at an antigen level of 1 mg.

28. **The correct answer is (F).** When 0.2 mg of either antigen was added, there was antibody present that did not precipitate because there was not enough antigen added relative to the amount of antibody present.

29. **The correct answer is (D).** As antigen levels were increased above 0.5 mg, the antigen took up too much space relative to the antibody; the antibody could not sufficiently bind to the antigen to form the precipitate.

30. **The correct answer is (G).** From the chart, the first ionization energy for silicon is 780 kJ/mol.

31. **The correct answer is (A).** Look at the table at each element and look at the difference between I_1 and I_2. The difference for sodium is 4,070 and is greater than any of the other elements.

32. **The correct answer is (H).** If aluminum and sulfur were not considered, the ionization energies would increase as atomic radius decreases.

33. **The correct answer is (C).** The table shows that as atomic radius decreases, atomic number increases and vice versa.

34. **The correct answer is (J).** All three elements have ionization energies that increase by at least a factor of three after the electrons in the outer shell are removed.

35. **The correct answer is (A).** From Winter to Spring, the salinity changed from 0 to 29.

36. **The correct answer is (H).** As salinity changes at the ocean floor, the number of *gammarus locusta* changes the most drastically.

37. **The correct answer is (B).** When the salmon catch is high, the number of protein deficiency–related illnesses is low, and when the salmon catch is low, the number of protein deficiency–related illnesses is high.

38. **The correct answer is (J).** This is the only answer that is consistent with the number of illnesses recorded.

39. **The correct answer is (C).** There is no primary season for fur seal hunting, since they seem to be caught at fluctuating levels throughout the year.

40. **The correct answer is (G).** This would force the bears to depend upon their natural food supply and not rely on the food taken from the village.
SECTION 1: ENGLISH

SECTION 2: MATH
SECTION 1: ENGLISH

75 Questions • Time—45 Minutes

Directions: This test consists of five passages in which particular words or phrases are underlined and numbered. Alongside the passage, you will see alternative words and phrases that could be substituted for the underlined part. You must select the alternative that expresses the idea most clearly and correctly or that best fits the style and tone of the entire passage. If the original version is best, select “NO CHANGE.”

The test also includes questions about entire paragraphs and the passage as a whole. These questions are identified by a number in a box.

After you select the correct answer for each question, mark the oval representing the correct answer on your answer sheet.

Passage I

The Names of Flowers

I look and stare at the first green shoots sprouting up through the dead leaves. The sight sets me trembling with anticipation, and I kneel down toward the earth to make sure I’ve seen right. Yes, the daffodils are already pushing toward the sun. As if in a

1. (A) NO CHANGE
   (B) look, staring
   (C) looking and staring
   (D) stare

2. (F) NO CHANGE
   (G) to anticipate
   (H) and anticipating
   (J) OMIT the underlined portion.

3. (A) NO CHANGE
   (B) forward
   (C) downward
   (D) OMIT the underlined portion.

4. (F) NO CHANGE
   (G) have already pushed
   (H) could already be pushing
   (J) push
fever I forget my work and wander about the garden inspecting the mulched beds. Winter is almost over, and I can taste the coming delirium of flowers.

[2] Gardening is something new to me, a delight this city boy never imagined. Raised in an apartment in New York, it seems enough to know that there were flowers and trees.

Culture marked even more than the seasons were by nature. In autumn, we played football in the street, or when I was older, tried to pick the peak foliage weekend to go camping. We were familiar with the highlights that marked each season, whereas the subtle particulars, the gradual way one transformed into another.

That intimacy was reserved for buildings, crowds, and subway trains.

[3] Now the twilight of summer is marked for me by budding chrysanthemums that spill over the retaining wall on the side of the house. In two seasons, they’ve grown huge and sprawling. At the height of autumn they

5. (A) NO CHANGE
   (B) fever, I forget my work and wander
   (C) fever, I forget my work, and wander
   (D) fever I forget my work, and wander

6. (F) NO CHANGE
   (G) does seem
   (H) did seem
   (J) seemed

7. (A) NO CHANGE
   (B) Even culture was marked more than the seasons were by nature.
   (C) Even the seasons were marked more by culture than by nature.
   (D) Seasons were marked more even by culture than by nature.

8. (F) NO CHANGE
   (G) though not
   (H) even though not
   (J) while not

9. The purpose of Paragraph 2 as it relates to the remainder of the essay is primarily to
   (A) provide background that helps to explain the significance of the garden to the writer.
   (B) provide background that explains why the writer feels lucky to have escaped the city.
   (C) portray the writer’s childhood as vividly as the writer’s garden.
   (D) establish the writer’s sensitive personality and ability to appreciate flowers.

10. (F) NO CHANGE
    (G) over
    (H) for
    (J) at
are as bright yellow and red and purple as any foliage and the season ends when they turn brown, when the last rose buds on the climbers leaning up the porch fail to open.

Daffodils along the front walk mark the beginning of a long Missouri spring that unfolds with crocuses and tulips, irises and peonies under my study window, and forsythia and spirea around the edges of the lawn. Summer means daisies swaying on the hill, and later, black-eyed susans jostling along the fence.

At thirty-five, I’m beginning to learn the names of flowers, and more than just the names. Names are our entry into the world, and I feel a fresh side of myself come alive as I become familiar with the words standing for all those vivid scents and colors springing from the ground. It’s nice to know that one can keep on growing, finding enough space inside for gardens and for subway trains.

Items 14 and 15 pose questions about the essay as a whole.

14. Is the writer’s use of contractions appropriate in the essay?
   (F) No, it creates confusion when the writer switches from the present to the past.
   (G) No, it creates an informal tone that is inappropriate for the subject.
   (H) Yes, it creates an informal tone that is appropriate for the intimate nature of the subject.
   (J) Yes, it helps to focus the essay on the specific flowers in the garden.

11. (A) NO CHANGE
   (B) bright, yellow, and red and purple
   (C) bright, yellow, and red, and purple
   (D) bright yellow, and red, and purple

12. (F) NO CHANGE
   (G) have marked
   (H) marks
   (J) marked

13. (A) NO CHANGE
   (B) that stand
   (C) who stand
   (D) whose stand
15. The writer wishes to insert the following detail into the essay:
   I could tell you there were pines but not
distinguish them from cedar.
The sentence would most logically be in-
serted into Paragraph
   (A) 1
   (B) 2
   (C) 3
   (D) 4

16. (F) NO CHANGE
   (G) So therefore,
   (H) also
   (J) so

17. (A) NO CHANGE
   (B) not taken for granted
   (C) not well understood
   (D) hard to fathom

18. (F) NO CHANGE
   (G) is
   (H) had been
   (J) could be

19. Which of the following sentences, if in-
serted at this point, would provide the
most effective transition to the second
paragraph?
   (A) Throughout history, agriculture has
always played a major role in the
development of civilizations.
   (B) Throughout history, the movement of
people and goods has been a major
factor in changing human societies.
   (C) Many examples can be found in the
history of trade during the past fifty
years.
   (D) However, this phenomenon was never
as important as it is in the modern
world.

Passage II

Pasta and Tomatoes

As trade goes, so also goes the world. In
these days of global markets where people
and goods crisscross the world, the idea that
a development in Asia can have a major effect
on America is taken for granted. Less com-
monly understood was the fact that exchange
has always been a motor force in world af-
fairs.

Agricultural techniques developed in
the Near East spread deeper into Asia, as well
as Europe and Africa, evolving form as they
That is why Herodotus could marvel at the different practices he found upon his tour of the ancient Mediterranean, and why too his impressions had been passed on to generations born two millennium later. In fact, the ancient Greeks, whom were well aware of the influences of Egypt on their civilization, did not pass their wealth of knowledge directly on to Modern Europe, which claims Greece as its root. Greek thought was kept alive by Arab scholars at the height of Islam's power. Greek texts had to be translated from Arabic into Latin before the likes of Thomas Aquinas could open the intellectual door to the European Renaissance.

But perhaps the clearest examples of this exchange and transformation lay in a realm less heady and much closer to the stomach. How would modern Italy be without pasta and tomatoes? Imagine Switzerland...
Marco Polo brought pasta back to Europe from China. Tomatoes, potatoes and cacao, they were all brought back from the Americas and transformed into something else. Therefore while neither pasta nor tomatoes is originally Italian, one cannot think of pasta and tomato sauce in all its glorious forms without thinking of Italy.

 Passage III

The Uncharted Waters of Alternative Medicine

Enter any large Natural foods store, head to the homeopathic section, and you are liable to find yourself bewildered by a sea of herbal remedies, each claiming a variety of medicinal properties. It is very difficult to know which works and what doesn’t. Often, the choice comes down to trial and error mixed with a good dose of faith.

27. Which of the alternatives provides the most logical conclusion for Paragraph 4?
   (A) Yet none of these familiar staples were known in the Europe of the Middle Ages.
   (B) These staples have become part of the very identity of these nations.
   (C) They would not be the same countries that they are today.
   (D) Cuisine is an important element of every culture.

28. (F) NO CHANGE
   (G) cacao,
   (H) cacao
   (J) cacao, which

29. (A) NO CHANGE
   (B) Because
   (C) Since
   (D) For

30. Which of the alternatives would conclude this sentence so that it supports the writer’s point about culture?
   (F) NO CHANGE
   (G) they have been adapted by Italians.
   (H) they are now important in Italian cooking.
   (J) one cannot forget that they were once unknown in Italy.

31. (A) NO CHANGE
   (B) remedies; each
   (C) remedies, and each
   (D) remedies each

32. (F) NO CHANGE
   (G) who
   (H) which
   (J) why it
The same can be said of techniques like the one called acupuncture. No one has ever been able to prove the existence of energy paths in the body, the theory upon which acupuncture is based. Yet a video clip of a Chinese woman giving birth while eating a bowl of rice is very convincing as to acupuncture’s effectiveness against pain.

Yet perhaps one of the reasons that alternative medicine is booming today has precisely because in an era in which invasive medical procedures and antibiotics are prescribed at the drop of hat, people have become less trusting of medical science. The medical profession has traditionally scoffed at the claims of alternative medicine. When anecdotal evidence of its successes is trotted out, doctors have routinely put it down to the placebo effect. Clearly drugs and technology, as valuable as they are, all the answers to health do not hold.

The antagonism between medical science and alternative medicine is older than most people know. In fact, the American Medical Association was founded in 1846 mostly in response to the nation’s first medical association, the American Institute of Homeopathy. The A.M.A. set the standard for medical practice...
40. (F) NO CHANGE
(G) licenses. And
(H) licenses and
(J) licenses; and

41. Which of the following sentences, if inserted at this point, would provide the most effective transition to Paragraph 5?
(A) Homeopathy is still not fully accepted by the medical establishment.
(B) The rules of the A.M.A. are not as strict as they once were.
(C) However, alternative medicine is making a comeback.
(D) Only now are there signs that this deep schism in the field of health is beginning to heal.

42. (F) NO CHANGE
(G) is some possibility to
(H) might or might not
(J) might

43. Which of the choices is most consistent with the style established in the essay?
(A) NO CHANGE
(B) one approaches
(C) you are approached by
(D) approach is intended to
Items 44 and 45 pose questions about the essay as a whole.

44. If this essay were revised to include a paragraph on the philosophy of homeopathic remedies, the new paragraph would most logically follow paragraph ____________________________.
   (F) 2
   (G) 3
   (H) 4
   (J) 5

45. Suppose the writer had been assigned to write an essay exploring the reasons for the present popularity of alternative medicine. Would this essay successfully fulfill the assignment?
   (A) Yes, because the essay focuses on people’s dissatisfaction with the medical establishment.
   (B) Yes, because the essay touches on the reasons for alternative medicine’s popularity in Paragraph 3.
   (C) No, because the essay focuses on the question of the value of alternative medicine.
   (D) No, because the essay restricts its focus to the antagonism of doctors toward alternative medicine.

46. (F) NO CHANGE
   (G) there are few women in the field who is taken seriously.
   (H) there were few women in the field who are taken seriously.
   (J) there were few women in the field who were taken seriously.

47. (A) NO CHANGE
   (B) no illusions: I
   (C) no illusion in which I
   (D) no illusion that I

Passage IV
A Professional Lesson
[1] When I first began working as a journalist in the 1970s, there are few women in the field who are taken seriously. I had no illusions, I would have to prove myself again and again.

[2] Editors were surprised when my work turned out to be first rate. It took me a long time to understand that the reason had to do
with the way I carried myself, not to mention the fact that I was making no attempt with which to conceal my anxieties. I had not yet learned to put on a professional face.

Editors who would try to hand me the softer stories, or the stories with a “woman angle.”

“Maybe you could do a piece on the charity work of the First Lady.” I was un-daunted by these incidents, and by the inevitable tasteless jokes and innuendoes. After all, I had chosen a career that meant not breaking ground in a traditional male bast-ion. Determination and a thick skin were required.

There was, however; an aspect of profes-sional life for which many of us were not prepared. I remember that when I was working on a difficult assignment and I checked in with the editor, I would tell him about my worries, describe the obstacles I had yet to surmount, or sometimes even complaining about the minor frustrations that had made for a bad day. I thought of it as communication, being honest in my work. I never doubted that I would get past these problems. They merely represented the moment to moment process of doing my job. After all, life was like
that too—full of difficulties that I discussed with friends as a way of getting through them.

54. Would it add to the effectiveness of the essay if the writer inserted a paragraph at this point describing the way in which she discussed problems with a close friend?

(F) No, it would be superfluous because the writer’s description of how she interacted with her editor is already clear.

(G) No, because such a description belongs just before this paragraph.

(H) Yes, because the writer needs to more fully illustrate how she interacts with other people.

(J) Yes, because the writer needs to show why she wanted the “softer stories” she was assigned.

55. (A) NO CHANGE
(B) somewhat
(C) in support of my ideas
(D) though

56. (F) NO CHANGE
(G) my behavior and
(H) my behaving in that way and
(J) OMIT the underlined portion.

57. (A) NO CHANGE
(B) who
(C) whom
(D) what
Items 58–60 ask questions about the essay as a whole.

58. For the sake of unity and coherence, Paragraph 2 should be placed
   (F) where it is now.
   (G) before Paragraph 1.
   (H) after Paragraph 4.
   (J) after Paragraph 5.

59. Suppose the writer were to eliminate Paragraph 4. This omission would cause the essay as a whole to lose primarily
   (A) relevant details about the mistakes the writer made that led to her ultimate realization.
   (B) historical information regarding women in the workplace.
   (C) relevant details regarding the writer’s male colleagues’ behavior.
   (D) an irrelevant anecdote about the writer’s experience with her friends.

60. Which of the following assignments would this essay most clearly fulfill?
   (F) Write a persuasive essay about the benefits of holding a job.
   (G) Write an essay comparing current versus past business environments for women.
   (H) Write an essay about a lesson you learned from a professional experience.
   (J) Write an essay about an experience in which your personal integrity was challenged.
Passage V

Edwidge Danticat, a Born Writer

Those who live in countries where a large proportion of the population is illegible, share their stories orally. In Haiti, it being a small country, when someone has a tale to tell he or she will call out Krik? Neighbors: friends and relatives will then gather around with an answering call of Krak!, signaling there willingness to listen.

The Haitian-born writer, Edwidge Danticat, would have been only twenty-six when she took these two words and made them the title for her collection of stories. The nine stories in Krik?Krak! focus on the hardships of living alongside a dictatorship and the struggles encountered by families who flee Haiti and seek new lives, in the United States. The book received much critical acclaim and even became a finalist for the National Book Award.

Born in Port-au-Prince in 1969, Danticat moved to New York City when she was twelve.
She spoke little as a new immigrant, because when she did speak, you may find this hard to believe, other children made fun of her heavily-accented English. Her thesis in graduate school later became the novel *Breath, Eyes, Memory*. That novel, which was subsequently chosen by Oprah Winfrey for her book club, featured a heroine who, like the author, moved from Haiti to New York City at the age of twelve. Danticat’s third book, *The Farming of Bones*, is also set in a small Caribbean country called Haiti.

This young author’s chosen subject matter, as well as the Creole-accented language she uses to tell her stories, show that while she has left Haiti for her adopted country of America, she has forgotten both the land of her birth and its brave people.

69. (A) NO CHANGE
(B) you may find this hard to believe
(C) as hard to believe as you may find this
(D) OMIT the underlined portion.

70. Which of the following sentences, if added here, would best provide a transition from the description of Danticat as a young girl to that of Danticat as an author?

(F) Danticat refrained from criticizing them in return, however, and was successful in the end.
(G) Most Haitians speak Creole, and the language is quite different from American English.
(H) Many writers have had difficult childhoods.
(J) Although she was silent much of the time, Danticat watched and remembered, as if already thinking like a writer.

71. (A) NO CHANGE
(B) in the country of the author’s birth, which is called Haiti.
(C) in Haiti, which shares a border with the Dominican Republic.
(D) in Haiti.

72. (F) NO CHANGE
(G) authors’
(H) author’s
(J) author

73. (A) NO CHANGE
(B) the land of her birth, its people
(C) neither the land of her birth nor its
(D) neither the land of her birth and its
Items 74 and 75 ask questions about the essay as a whole.

74. The writer wishes to open the essay with a sentence that will set the theme and tone of the essay. Which of the following would most effectively accomplish this?
   (F) Whether or not they can read, people all over the world love stories.
   (G) One of my favorite books is a collection of stories set in Haiti.
   (H) The problem of illiteracy results in a variety of consequences for people all over the world.
   (J) Have you ever wondered what it feels like not to be able to read?

75. The writer wishes to give this essay a different title. Which of the following alternatives would be most appropriate?
   (A) “How Edwidge Danticat Overcame Struggles as an Immigrant”
   (B) “Life in Haiti”
   (C) “A New Voice in Literature”
   (D) “The Haiti I Will Never Forget”

STOP

END OF SECTION 1. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
1. Thirty-two of the 80 children at a daycare center missed at least one day because of illness in January. What percent of the children at the center missed at least one day due to illness in January?
   (A) 4%
   (B) 16%
   (C) 24%
   (D) 32%
   (E) 40%

2. Three lines intersect to form the triangle below. What is the measure of \( \angle X \)?
   (F) 65°
   (G) 75°
   (H) 85°
   (J) 95°
   (K) 105°

3. A businessperson calculates that it costs her \( P \) dollars per hour in parts costs and \( L \) dollars per hour in labor costs to operate a certain piece of machinery. Which of the following expressions would provide her with the total cost of operating this machine for \( x \) hours?
   (A) \( PLx \)
   (B) \( (Px)(Lx) \)
   (C) \( (P + L)x \)
   (D) \( PL \)
   (E) \( P + L \)

4. In the standard \((x,y)\) coordinate plane, a straight line segment is drawn to connect \((0,0)\) and \((4,4)\). Which of the following sets of points, when connected by a straight line segment, will intersect the original segment?
   (F) \((-3,3)\) and \((3,4)\)
   (G) \((0,-1)\) and \((4,3)\)
   (H) \((0,1)\) and \((4,5)\)
   (J) \((1,0)\) and \((8,4)\)
   (K) \((2,1)\) and \((2,5)\)
5. A phone company charges $1 per calling card call plus 25 cents per minute for the length of the call. If Jacob makes 10 calling card calls, half of which last exactly 1 minute and half of which last exactly 3 minutes, what is his cost for the 10 calls?
   (A) $5
   (B) $10
   (C) $15
   (D) $20
   (E) $25

6. Which of the following is one of the factors of $x^2 + x - 30$?
   (F) $x + 10$
   (G) $x + 6$
   (H) $x + 5$
   (J) $x + 3$
   (K) $x + 2$

7. Which of the following is equal to the sum of $\frac{2}{3}$, $\frac{1}{5}$, and .177?
   (A) .656
   (B) .677
   (C) .689
   (D) .692
   (E) .702

8. In the figure below, $\overline{BC}$ is 2 inches long, $\overline{CD}$ is 8 inches long, and $B$, $C$, and $D$ are collinear. If the area of triangle $ABC$ is 5 square inches, what is the area of triangle $ACD$, in square inches?
   (F) 10 sq. in.
   (G) 15 sq. in.
   (H) 20 sq. in.
   (J) 25 sq. in.
   (K) 30 sq. in.

9. What is the value of $m^2 - 4mn + n$ when $m = -1$ and $n = -3$?
   (A) $-15$
   (B) $-14$
   (C) $-11$
   (D) 8
   (E) 10

10. $(3 + \sqrt{2})(4 - \sqrt{2}) = ?$
    (F) 10
    (G) 14
    (H) $8 - \sqrt{2}$
    (J) $10 + \sqrt{2}$
    (K) $14 + 7\sqrt{2}$

11. What is the measure of one of the interior angles of a regular hexagon?
    (A) $60^\circ$
    (B) $90^\circ$
    (C) $100^\circ$
    (D) $110^\circ$
    (E) $120^\circ$
12. What is the least possible integer that is separately divisible by each of 2, 4, 6, and 10 (with no remainder)?
   (F) 12
   (G) 30
   (H) 60
   (J) 120
   (K) 480

13. A store charges $20 for a box of 40 computer diskettes, $13 for a box of 25 diskettes, and $8 for a box of 10 diskettes. What is the least amount of money, excluding tax, for which a customer can buy at least 100 diskettes from this store?
   (A) $60
   (B) $58
   (C) $56
   (D) $54
   (E) $53

14. \((.01)^4 = ?\)
   (F) \(10^{-8}\)
   (G) \(10^{-4}\)
   (H) \(10^{-2}\)
   (J) \(10^4\)
   (K) \(10^8\)

15. In the figure below, \(\overline{AD}\) and \(\overline{BC}\) intersect at \(E\) and \(\overline{AB}\) is parallel to \(\overline{CD}\). The measure of \(\angle ABE\) is 60°, and the measure of \(\angle CDE\) is 40°. What is the measure of \(\angle CED\)?
   (A) 30°
   (B) 40°
   (C) 60°
   (D) 80°
   (E) It cannot be determined.

16. For all \(a\), \((2a - 3)^2 = ?\)
   (F) \(4a - 6\)
   (G) \(4a^2 - 9\)
   (H) \(4a^2 - 6a + 9\)
   (J) \(4a^2 - 12a + 9\)
   (K) \(4a^2 + 9a - 6\)

17. What is the slope-intercept form of the line \(3x + y - 2 = 0\)?
   (A) \(y = 3x - 2\)
   (B) \(y = 3x + 2\)
   (C) \(y = \frac{1}{3}x + \frac{1}{2}\)
   (D) \(y = -3x + 2\)
   (E) \(y = -3x - 2\)
18. A painter calculates that one side of a house requires exactly 4 large cans of paint OR exactly 6 small cans of paint. If all 4 sides of the house require identical amounts of paint, which collection of paint cans will cover all 4 sides with no waste?
   (F) 2 large and 24 small
   (G) 4 large and 18 small
   (H) 6 large and 16 small
   (J) 8 large and 8 small
   (K) 12 large and 12 small

19. At what value of $x$ does the expression $|x - 5| + 2$ reach its minimum?
   (A) −5
   (B) −2
   (C) 0
   (D) 2
   (E) 5

20. What is the smallest positive integer for which $x - \sqrt{5} > 5$ is true?
   (F) 9
   (G) 8
   (H) 7
   (J) 6
   (K) 5

21. If $x + 6$ is a factor of $x^2 + bx - 6$, then $b = ?$
   (A) 1
   (B) 2
   (C) 3
   (D) 5
   (E) 6

22. In the figure below, triangle $ABC$ and triangle $FDE$ are similar. If the lengths of the sides are indicated in units, how many units long is $DE$?

23. What is the area of the right triangle below, in square centimeters?
24. It took Rene exactly 9 minutes and 20 seconds to download a 1,400-kilobyte file from the Internet onto her computer. At that same rate, how long would it take Rene to download a 2,000-kilobyte file?
(F) 11 minutes
(G) 12 minutes and 10 seconds
(H) 12 minutes and 40 seconds
(J) 13 minutes
(K) 13 minutes and 20 seconds

25. A college campus’s central green is a square lawn bordered by footpaths 100 feet long on each side. The college is debating creating a diagonal footpath that would connect the southwest corner of the green to the northeast corner of the green. Approximately how many feet shorter would the new path be than taking the shortest possible route on the existing paths?
(A) 20
(B) 40
(C) 60
(D) 80
(E) 140

26. If \( x < 0 \) and \( 3x^2 - 7x = 6 \), then \( x = ? \)
(F) \(-6\)
(G) \(-3\)
(H) \(-2\)
(J) \(-\frac{3}{2}\)
(K) \(-\frac{2}{3}\)

27. For all \( a \) and \( b \), \( \sqrt[4]{a^2 b^3} = ? \)
(A) \(9a^7b^1\)
(B) \(9a^2b^1\)
(C) \(9a^{-2}b^0\)
(D) \(27a^0b^2\)
(E) \(27a^6b^4\)

28. Lines \( p \), \( q \), and \( r \) intersect to form a triangle in the figure below. What is the measure of \( \angle A \)?
(F) \(70^\circ\)
(G) \(75^\circ\)
(H) \(80^\circ\)
(J) \(85^\circ\)
(K) It cannot be determined.
29. \( \frac{0.18}{12} \) is equal to how many thousandths?
(A) 1.5
(B) 15
(C) 60
(D) 150
(E) 667

30. Which of the following inequalities gives the complete solution set for \( |x - 1| \leq 2 \)?
(F) \(-3 \leq x \leq 3\)
(G) \(-1 \leq x \leq 3\)
(H) \(0 \leq x \leq 2\)
(J) \(0 \leq x \leq 3\)
(K) \(x \leq 3\)

31. In the figure below, \( \overline{BE} \) and \( \overline{CD} \) are parallel. The length of \( \overline{BC} \) is 4 units, and the length of \( \overline{DE} \) is 3 units. If \( \overline{AB} \) is 10 units long, how many units long is \( \overline{AE} \)?

![Triangle Diagram]

(A) 7.5
(B) 9.0
(C) 10.5
(D) 12.0
(E) 12.5

32. For \( 0^\circ < \theta < 90^\circ \), if \( \cos \theta = \frac{5}{7} \), then \( \tan \theta = \)?
(F) \( \frac{2}{7} \)
(G) \( \frac{7}{5} \)
(H) \( \frac{2\sqrt{6}}{7} \)
(J) \( \frac{2\sqrt{6}}{5} \)
(K) \( \frac{24}{7} \)

33. The average of \( x \) numbers is 15. If two of the numbers are each increased by \( y \), the new average will be increased by how much?
(A) \( 2y \)
(B) \( y \)
(C) \( \frac{x}{2y} \)
(D) \( \frac{y}{x} \)
(E) \( \frac{2y}{x} \)

34. What is the slope of the line passing through the points \((-1,4)\) and \((2,-5)\) in the standard \((x,y)\) plane?
(F) \(-3\)
(G) \(-\frac{1}{3}\)
(H) 0
(J) \( \frac{1}{9} \)
(K) 9
35. A 12-foot ladder is propped against a 10-foot house as outlined below. What is the best approximation for how many feet the base of the ladder is from the wall of the house?

(A) 2.0  
(B) 4.0  
(C) 5.5  
(D) 6.6  
(E) 7.1

36. A circle with a radius of 3 feet has a circumference how many feet long?

(F) \( \frac{3}{2} \pi \)  
(G) 3\( \pi \)  
(H) 6\( \pi \)  
(J) 9\( \pi \)  
(K) 12\( \pi \)

37. If \( \frac{1}{3} n + \frac{2}{7} = \frac{3}{7} n - \frac{2}{3} \), then \( n = ? \)

(A) -4  
(B) -3  
(C) 0  
(D) 2  
(E) 3

38. A line in the standard (x,y) coordinate plane is parallel to the y-axis and passes through the point (2,3). Which of the following is an equation of this line?

(F) \( x = 2 \)  
(G) \( y = 3 \)  
(H) \( y = 2x \)  
(J) \( y = 2x - 3 \)  
(K) \( y = x + 1 \)

39. If the lengths of the sides are shown in units in the triangle below, \( \sin x^\circ = ? \)

(A) \( \frac{5}{13} \)  
(B) \( \frac{5}{12} \)  
(C) \( \frac{12}{13} \)  
(D) \( \frac{13}{12} \)  
(E) \( \frac{13}{5} \)
40. If the quadrants in the standard \((x,y)\) plane are numbered as below, the graph of the circle defined by \((x - 4)^2 + (y + 6)^2 = 25\) lies entirely in which quadrants?

\[\text{(F) I and II} \]
\[\text{(G) I and IV} \]
\[\text{(H) II and III} \]
\[\text{(J) II and IV} \]
\[\text{(K) III and IV} \]

41. If the circle below has center at \(C\) and a radius of 9 feet, what is the length, in feet, of arc \(XYZ\)?

\[\text{(A) } \frac{3\pi}{2} \]
\[\text{(B) } 3\pi \]
\[\text{(C) } 6\pi \]
\[\text{(D) } 18\pi \]
\[\text{(E) } 27\pi \]

42. What is the least possible value for the product \(xy\) if \(x + y = 24\) and \(x\) and \(y\) are both prime numbers?

\[\text{(F) } 23 \]
\[\text{(G) } 44 \]
\[\text{(H) } 95 \]
\[\text{(J) } 119 \]
\[\text{(K) } 143 \]

43. The area of a circle is 64 square inches. What is the diameter, in inches, of the circle?

\[\text{(A) } 8 \]
\[\text{(B) } 16 \]
\[\text{(C) } \frac{8}{\pi} \]
\[\text{(D) } \frac{8}{\sqrt{\pi}} \]
\[\text{(E) } \frac{16}{\sqrt{\pi}} \]

44. If \(2x = 4x + 1\), then \(6x - 2 = ?\)

\[\text{(F) } -5 \]
\[\text{(G) } -3 \]
\[\text{(H) } -1 \]
\[\text{(J) } 2 \]
\[\text{(K) } 4 \]
45. In the isosceles right triangle below, what is the value of \( \tan x^\circ \)?

![Isosceles right triangle diagram]

(A) \( \frac{\sqrt{2}}{2} \)

(B) 1

(C) \( \sqrt{2} \)

(D) \( \frac{\sqrt{3}}{2} \)

(E) \( \sqrt{3} \)

46. What is the area of the rectangle shown below in the standard \((x, y)\) coordinate plane?

![Rectangle diagram]

(F) \( 32\sqrt{2} \)

(G) 64

(H) 88

(J) 128

(K) 144

47. If \( \frac{x^y}{z^x} \) is positive, then which of the following may be true?

I. \( x \) and \( z \) are both negative.

II. \( x \) is negative, and \( z \) is positive.

III. \( x \) is zero.

(A) I only

(B) II only

(C) I and II

(D) II and III

(E) I, II, and III

48. The average of 6 test scores is 80. When 2 more tests are included, the average for all 8 tests is 85. What is the average score on the 2 added tests?

(F) 70

(G) 85

(H) 90

(J) 95

(K) 100

49. If \( x \) is inversely related to \( y \) and \( y \) is directly related to \( z \), which of the following expressions gives one possibility for \( y \) in terms of \( x \) and \( z \)?

(A) \( y = \frac{x}{z} \)

(B) \( y = \frac{z}{x} \)

(C) \( y = zx \)

(D) \( y = xz \)

(E) \( y = z^x \)

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50. A circle exists such that its center is at C(1,–1) and it passes through P(5,2) in the standard (x,y) coordinate plane below. Which equation determines the circle described?

\[ (F) (x - 5)^2 + (y - 2)^2 = 25 \]
\[ (G) (x + 5)^2 + (y + 2)^2 = 25 \]
\[ (H) (x - 1)^2 + (y + 1)^2 = 25 \]
\[ (J) (x + 1)^2 + (y - 1)^2 = 25 \]
\[ (K) (x + 1)^2 + (y + 1)^2 = 25 \]

51. If \(-[(x - 4) - (3 - 2x)] = 3 - (5x + 6)\), what is the value of x?

\[ (A) -6 \]
\[ (B) -5 \]
\[ (C) -4 \]
\[ (D) -3 \]
\[ (E) -2 \]

52. What is the period of the graph of \(y = 3 \sin \frac{x}{2}\)?

\[ (F) \frac{\pi}{2} \]
\[ (G) \pi \]
\[ (H) \frac{3\pi}{2} \]
\[ (J) 2\pi \]
\[ (K) 4\pi \]

53. If exactly one real value of x satisfies the equation \(x^2 + \alpha x + 16 = 0\), which of the following is a possible value of \(\alpha\)?

\[ (A) -8 \]
\[ (B) -4 \]
\[ (C) 4 \]
\[ (D) 6 \]
\[ (E) 10 \]

54. A positive number x is increased by 20 percent and then the result is decreased by 30 percent. The final result is equal to which of the following?

\[ (F) x \text{ decreased by 50 percent} \]
\[ (G) x \text{ decreased by 16 percent} \]
\[ (H) x \text{ decreased by 10 percent} \]
\[ (J) x \text{ increased by 10 percent} \]
\[ (K) x \text{ increased by 25 percent} \]

55. A 50-foot wire is attached to the top of an electric pole and is anchored on the ground. If the wire rises in a straight line at a 70° angle from the ground, how many feet tall is the pole?

\[ (A) 50 \sin 70° \]
\[ (B) 50 \cos 70° \]
\[ (C) 50 \tan 70° \]
\[ (D) \frac{\cos 70°}{50} \]
\[ (E) \frac{50}{\cos 70°} \]

56. What is the complete solution set for the equation \(|1 - x| = x - 1| ?

\[ (F) \text{All real numbers} \]
\[ (G) \text{All } x \leq -1 \]
\[ (H) \text{All } x \leq 1 \]
\[ (J) \text{All } x \geq 1 \]
\[ (K) \text{Only } x = 1 \]
57. At which point in the standard \((x, y)\) coordinate plane do the 2 lines below intersect?

\[
\frac{x}{2} + y = 2 \\
2x + y = 2
\]

(A) \((2, 1)\)
(B) \((1, -2)\)
(C) \((0, 2)\)
(D) \((-1, -1)\)
(E) \((-2, 0)\)

58. Lines \(m\) and \(n\) are perpendicular in the standard \((x, y)\) coordinate plane below. Which of the following is the equation for line \(n\)?

\[
\begin{align*}
&\text{(F)} \quad y = -x + 5 \\
&\text{(G)} \quad y = -2x + 3 \\
&\text{(H)} \quad 2y = -x - 4 \\
&\text{(J)} \quad 3y = -x + 14 \\
&\text{(K)} \quad 3y = x + 16
\end{align*}
\]

59. Five cards lettered A through E are placed in a hat. If two cards are drawn at random from the hat, what is the probability that the B and C cards will both be drawn?

(A) .05
(B) .1
(C) .125
(D) .2
(E) .4

60. While shopping at a clothing store, Ben finds that a shirt and two ties cost $105, while two shirts and one tie cost $135. If the store charges the same price for all of its shirts and the same price for all of its ties, what is Ben’s cost if he wants to buy just one tie?

(F) $20
(G) $25
(H) $30
(J) $35
(K) $40

STOP

END OF SECTION 2. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.
Passage I—PROSE FICTION

This passage is adapted from Theodore Dreiser’s *Sister Carrie*.

Once across the river and into the wholesale district, Carrie glanced about her for some likely door at which to apply. As she contemplated the wide windows and imposing signs, she became conscious of being gazed upon and understood for what she was—a wage-seeker. She had never done this thing before, and lacked courage. To avoid a certain indefinable shame she felt at being caught spying about for a position, she quickened her steps and assumed an air of indifference just as if she were upon an errand. In this way she passed many manufacturing and wholesale houses without once glancing in. At last, after several blocks of walking, she felt that this would not do, and began to look about again, though without relaxing her pace. A little way on she saw a great door which, for some reason, attracted her attention. It was ornamented by a small brass sign, and seemed to be the entrance to a vast hive of six or seven floors.

“Perhaps,” she thought, “they may want someone,” and crossed over to enter. When she came within a score of feet of the desired goal, she saw through the window a young man in a gray checked suit. That he had anything to do with the concern, she could not tell, but because he happened to be looking in her direction her weakening heart depaerated her and she hurried by, too overcome with shame to enter. Over the way stood a great six-story structure, labeled Storm and King, which she viewed with rising hope. It was a wholesale dry goods concern and employed women. She could see them moving about now and then upon the upper floors. This place she decided to enter, no matter what. She crossed over and walked directly toward the entrance. As she did so, two men came out and paused in the door, looking in her direction. A messenger in blue dashed past her and up the few steps that led to the entrance and disappeared. Several pedestrians out of the hurrying throng which filled the sidewalks passed about her as she paused, hesitating. She looked helplessly around, and then, seeing herself observed, retreated. It was too difficult a task. She could not go past them.

So severe a defeat told sadly upon her nerves. Her feet carried her mechanically forward, every foot of her progress being a satisfactory portion of a flight which she gladly made. Block after block passed by. Upon streetlamps at the various corners she read names such as Madison, Monroe, La Salle, Clark, Dearborn, State, and still she went, her feet beginning to tire upon the broad stone flagging. She was pleased in part that the streets were bright and clean. The morning sun, shining down with steadily increasing warmth, made the shady side of the streets pleasantly cool. She looked at the blue sky overhead with more realization of its charm than had ever come to her before.
Her cowardice began to trouble her in a way. She turned back, resolving to hunt up Storm and King and enter. On the way, she encountered a great wholesale shoe company, through the broad plate windows of which she saw an enclosed executive department, hidden by frosted glass. Without this enclosure, but just within the street entrance, sat a gray-haired gentleman at a small table, with a large open ledger before him. She walked by this institution several times hesitating, but, finding herself unobserved, faltered past the screen door and stood humbly waiting. “Well, young lady,” observed the old gentleman, looking at her somewhat kindly, “what is it you wish?”

“I am, that is, do you—I mean, do you need any help?” she stammered.

“Not just at present,” he answered smiling. “Not just at present. Come in some time next week. Occasionally we need someone.”

She received the answer in silence and backed awkwardly out. The pleasant nature of her reception rather astonished her. She had expected that it would be more difficult, that something cold and harsh would be said—she knew not what. That she had not been put to shame and made to feel her unfortunate position, seemed remarkable.

With the wane of the afternoon went her hopes, her courage, and her strength. She had been astonishingly persistent. So earnest an effort was well deserving of a better reward. On every hand, to her fatigued senses, the great business portion grew larger, harder, more stolid in its indifference. It seemed as if it was all closed to her, that the struggle was too fierce for her to hope to do anything at all. Men and women hurried by in long, shifting lines. She felt the flow of the tide of effort and interest—felt her own helplessness without quite realizing the wisp on the tide that she was. She cast about vainly for some possible place to apply, but found no door which she had the courage to enter. It would be the same thing all over. The old humiliation of her plea, rewarded by curt denial. Sick at heart and in body, she turned to the west, the direction of Minnie’s flat, which she had now fixed in mind, and began that weari, baffled retreat which the seeker for employment at nightfall too often makes.

1. The firm of Storm and King is described in the passage as a
(A) department store.
(B) wholesale shoe company.
(C) sweat shop.
(D) wholesale dry goods store.

2. When Carrie attempts to get a job at the shoe company, she is met with what could best be described as
(F) apathetic dismissal.
(G) angry rebuttal.
(H) congenial rejection.
(J) exasperated disdain.

3. As she walks along the street in the late afternoon, Carrie feels as if she
(A) has made a mistake in moving to the city.
(B) deserves a better reward for her hard work.
(C) is ready to look all night for a job if necessary.
(D) knows that employment is a waste of time.

4. In order to overcome her embarrassment while looking for work, Carrie pretends that she is
(F) a spy carrying out a secret mission.
(G) performing an appointed task.
(H) the boss of a large company.
(J) rich and doesn’t really need a job.
5. In the third paragraph, all of the following street names are mentioned EXCEPT  
(A) Monroe.  
(B) Block.  
(C) Madison.  
(D) State.

6. As it is used in line 22, the word ornamented most nearly means  
(F) complicated.  
(G) lacking.  
(H) withdrawn.  
(J) adorned.

7. Given the way she is presented in the passage, Carrie’s mental state can best be described as  
(A) irate.  
(B) compassionate.  
(C) despondent.  
(D) mechanical.

8. In the final paragraph of the passage, the narrator suggests that Carrie’s failure to find work has  
(F) affected her physical well-being.  
(G) filled her with vanity.  
(H) made her feel wholesome.  
(J) given her a renewed sense of purpose.

9. After Carrie asks him for work, the old gentleman at the shoe company tells Carrie that she  
(A) will not be able to find work in the city.  
(B) should seek out an employment agency.  
(C) has no marketable skills.  
(D) should come back next week.

10. What keeps Carrie from entering the wholesale dry goods store mentioned in the second paragraph?  
(F) The messengers are entering and leaving the building.  
(G) The pedestrians are rushing down the street.  
(H) The men are standing in the doorway watching her.  
(J) She cannot find the entrance to the store.

**Passage II—SOCIAL SCIENCE**

This passage is adapted from a sociological study of traditional Fiji culture conducted by Dr. Alfred Goldsborough Mayer.

Land tenure in traditional Fijian culture is a subject so complex that heavy volumes could be written about it. In general it may be said that the chief could sell no land without the consent of his tribe. In traditional Fijian society, cultivated land belonged to the man who originally farmed it, and was passed undivided to all his heirs. Waste land was held in common. Native settlers who were taken into the tribes from time to time were permitted to farm some of the waste land, and for this privilege they and their heirs paid a yearly tribute to the chief either in produce or in service. In essence, this amounted to paying rent to the chief.

Fijians appear never to have been wholly without a medium of exchange, for sperm-whale's teeth always had a recognized purchasing power. They also were especially regarded as a means of expressing good will and honesty of purpose. A whale's tooth was as effective to secure compliance with the terms of a bargain in ancient Fiji as a signed contract is with modern Americans. Given Americans' penchant for wiggling their way out of contracts, a whale’s tooth from a Fijian probably generated much more trust that the agreement would be fulfilled.
As in all communities, including our own world of finance, a man's wealth consisted not only of what he possessed but even more so of the number of people from whom he could beg or borrow. Wilkes records an interesting example of this, for he found that the rifle and other costly presents he had presented to King Tanoa were being seized by Tanoa’s nephew who, as his vasu, had a right to take whatever he might select from the king’s possessions. Indeed, in order to keep his property in sight, Tanoa was forced to give it to his own sons, thus escaping the rapacity of his nephew.

In a traditional Fiji tribe, an individual as such can hardly be said to own property, for nearly all things belong to his family or clan, and are shared among cousins. This condition is partially responsible for the absence of personal ambition which once struck Westerners as so illogical, but which was nevertheless the dominant feature of the social fabric of traditional Polynesians, and which prevented the introduction of “ideals of modern progress” until well into the twentieth century. The Fijians, for much of the last few centuries, were relatively happy; why should they work when every reasonable want was already supplied? None were rich in material things, but none were beggars except in the sense that all were such. No one could be a miser, a capitalist, a banker, or a promoter in such a community, and thieves were almost unknown.

Indeed, the honesty of the traditional Fijians was one of those virtues that promoted the comment of travelers in previous centuries.

During Professor Alexander Agassiz’s cruises in the late 1800s, in which he visited nearly every island of the Fijis, the natives came on board by the hundreds and not a single object was stolen, although things almost priceless in native estimation lay loosely upon the deck. Once, indeed, when the deck was deserted by both officers and crew and fully a hundred natives were on board, the Professor found a man who had been gazing wistfully for half an hour at a bottle which lay upon the laboratory table. Somehow he had managed to acquire a shilling, a large coin in Fiji at the time, and this he offered in exchange for the coveted bottle. As Agassiz tells us: “One can never forget his shout of joy and the radiance of his honest face as he leaped into his canoe after having received it as a gift.”

As these Fijians said to Professor Agassiz, “The white man possesses more than we, but his life is full of toil and sorrow, while our days are happy as they pass.” But this was the Fiji of the past, when life was an evanescent thing, and only as real as the murmur of the surf when the sea breeze comes in the morning. This was Fiji before capitalism took hold, before the forests were slashed and burned to make more land available for farming, and before the young people began to leave their ancient islands to look for “a better life.” This life usually entails hoarding wealth and becoming enmeshed in the rat race of modern civilization. Sadly, this race rarely has a happy ending.

Hoarded wealth inspired no respect in the Fiji of previous centuries, and indeed, were it discovered, its possession would have justified immediate confiscation. Yet man must raise idols to satisfy his instinct to worship things above his acquisition, and thus rank was more revered because respect for property was low. Among traditional Fijian tribes chiefs were greatly revered, and names themselves had more power than worldly goods.

One aspect to note is that names in traditional Fijian culture could change throughout one’s life, depending on any important events that occurred. For instance, Chief Thakombau began life as “Seru,” then after the civil war in which he overcame his father’s enemies and reestablished Tanoa’s rule in Mbau he was called “Thakombau” (evil to Mbau).

At the time he also received another name, “Thikinovu” (centipede) in allu-
sion to his stealth in approaching to bite his enemy, but this designation, together with his given Christian name “Ebenezer,” (he was converted by British missionaries) did not survive the test of usage.

11. The passage specifies that in traditional Fijian society, individual property was, for the most part
(A) taken by Western explorers.
(B) collectively owned by the family or clan.
(C) owned solely by the chief of the tribe.
(D) thought to be possessed of evil phantoms.

12. Based on information in the passage, a contract from a traditional Fijian would most likely take the form of which of the following?
(F) A burnt offering to the gods
(G) A semiprecious stone
(H) The granting of a Fijian name
(J) A whale’s tooth

13. The anecdote about King Tanao’s nephew described in the third paragraph is presented in order to illustrate the principle that
(A) Western civilization has decimated traditional Fijian values.
(B) the right to take or borrow from another was a notable indication of wealth in Fijian culture.
(C) all communities that value personal property levy heavy sanctions against theft.
(D) trust was not easily gained among Fijian tribes.

14. The author of the passage appears to feel that the answer to the question “what does modern civilization mean for the people of Fiji?” is best answered by the assertion that
(F) Fiji, like most island civilizations, must give up its insular culture in order to compete in world markets.
(G) capitalism will help the people of Fiji profit from their traditional values of honesty and egalitarianism.
(H) modern civilization will not make the people of Fiji any happier than they previously were.
(J) there is little chance that modern civilization will ever have an impact on the way of life enjoyed by most Fijians.

15. The author states in paragraph 4 that “the introduction of ‘ideals of modern progress’ was prevented “until well into the twentieth century” in Fiji because of a lack of
(A) a sense of personal ownership.
(B) established religious customs.
(C) codified land laws.
(D) Western cultural indoctrination.

16. As it is used in line 25, the word compliance most nearly means
(F) agreement.
(G) introduction.
(H) withdrawal.
(J) inconsistency.

17. According to the passage, Chief Thakombau was granted his name after he
(A) was born to distinguished parents.
(B) hoarded a large amount of wealth.
(C) was converted by British missionaries.
(D) restored Tanoa’s rule in Mbau.
18. The author’s analysis of traditional Fiji culture includes details concerning
   I. ownership of land.
   II. how capitalism has changed Fijian culture.
   III. the shortage of natural resources in Fiji.
   (F) I only
   (G) I and II only
   (H) II and III only
   (J) I, II, and III

19. It can reasonably be inferred from the information in the first paragraph that a Fijian chief did not have the right to
   (A) declare war.
   (B) start a new community on the same island.
   (C) cultivate land.
   (D) sell tribal land without the tribe’s permission.

20. One of the main points made in the fourth paragraph (lines 48–73) is that although traditional Fijians did not have strong ambitions to acquire personal wealth, one benefit of this was the
   (F) lack of good jobs.
   (G) promotion of industrialization.
   (H) scarcity of theft in Fijian society.
   (J) growth of friendship between Fijian chiefs.

Passage III—HUMANITIES

This passage is adapted from The Physical Michelangelo by James Frederick Rogers.

Had Michelangelo been less poetic and more explicit in his language, he might have said there is nothing so conducive to mental and physical wholeness as saturation of body and mind with work. The great artist was so prone to over-anxiety and met (whether needlessly or not) with so many rebuffs and disappointments that only constant absorption in manual labor prevented spirit from fretting itself free from flesh. He toiled “furiously” in all his mighty undertakings that body and mind remained one and in abundant health for nearly four score and ten years. Michelangelo’s life was devoted with passion to art. Art became his religion and required of him the sacrifice of all that might keep him below his highest level of power for work. His father early warned him to have a care for his health. Said he, “In your profession, if once you were to fall ill you would be a ruined man.” To one so intent on perfection and so keenly alive to imperfection such advice must have been superfluous, for the artist could not but observe the effect upon his work of any depression of his bodily well-being. He was, besides, too thrifty in all respects to think of lapsing into bodily neglect or abuse. He was severely temperate, save in those times when devotion to work caused him to sleep with his clothes on, so that he might not lose time in seizing the chisel when he awoke. He ate to live and to labor. When intent on some work he usually confined his diet to a piece of bread which he ate in the middle of his labors. Few hours were devoted to sleep. He ate comparatively little and slept less than many men because he worked better. He dressed for comfort and not to mortify the flesh, sometimes leaving his high dog-skin boots on for so long that when he removed them the scarf skin came away like the skin of a molting serpent.

His intensity of purpose and fiery energy expressed themselves in his features and form. His face was round, his brow square, ample, and deeply furrowed; the temples projected much beyond the ears; his eyes were small rather than large, of a dark color and peered, piercingly, from under heavy brows. The flattened nose was the result of a blow from a rival apprentice. He evidently looked the part, though for such mental
powers one of his colossal statues would seem a more fitting mold.

It was not until the age of seventy that an illness which seemed to mark any weakening of his bodily powers came upon Michelangelo. At seventy-five, symptoms of calculus (a disease common in that day at fifty) appeared, but, though naturally pessimistic, he writes, “In all other respects I am pretty much as I was at thirty years.” He wielded the brush and the chisel with consummate skill in his seventy-fifth year. With the later loss of his energy, he found vent more in the planning and supervising of architectural works, culminating in the building of St. Peter’s. But even in these later years he took up the chisel as an outlet for superfluous energy and to induce sleep. Though the product of his hand was not good, his health was the better for this mutual exercise of mind and body.

In his eighty-sixth year he is said to have sat drawing for three consecutive hours until pains and cramps in his limbs warned him that he had not the endurance of youth. For exercise, when manual labor proved a disappointment, he often took horseback rides. There was no invalidism about this great spirit, and it was not until the day before his death that he would consent to go to bed.

His temperance, manual industry, and his extraordinary blamelessness in life and in every action had been his source of preservation. He was miserly, suspicious, quarrelsome and pessimistic, but the effects of these faults were balanced by his better habits of thought and action. That he, like most great men, felt keenly the value of health, is evidenced not only by his own practice, but by his oft repeated warnings to his nephew when choosing a wife to see that whatever other qualities she might have she be healthy. One of those who looks beneath unusual human phenomena for signs of the pathologic finds Michelangelo “affected by a degree of neuropathy bordering closely upon hysterical disease.” What a pity that more of us do not suffer from such degrees of neuropathy and how much better for most of us if we had such enthusiasm for perfection, and such mania for work, at least of that health-bringing sort in which there is absorbing unity of brain and hand. True it is that “there is no better way of keeping sane and free from anxiety than by being mad.”

21. According to the passage, Michelangelo had to maintain his physical health because
   (A) poor health ran in his family.
   (B) his father demanded that he did.
   (C) if he got sick, he wouldn’t be able to work.
   (D) he could get seriously injured.

22. The author of the passage would most likely agree with which of the following statements?
   (F) Michelangelo used the physicality of his work to help relieve his many anxieties and frustrations.
   (G) Michelangelo was an easygoing, carefree man who possessed a unique genius for art.
   (H) In order to be successful, all artists have to have the same passion Michelangelo had.
   (J) Michelangelo’s artistic skills remained completely intact until he died.

23. The passage says that Michelangelo began planning and supervising more architectural works when he was
   (A) under thirty.
   (B) eighty-six.
   (C) under seventy.
   (D) over seventy-five.
24. According to the third paragraph, Michelangelo’s physical appearance reflected
   I. a coarse sense of humor.
   II. fierce devotion to his work.
   III. enormous mental capacity.
   (F) I only
   (G) III only
   (H) II and III
   (J) I, II and III

25. It can be inferred from the second paragraph that by limiting his food and sleep, Michelangelo was
   (A) able to fully realize his potential as an artist.
   (B) driven to madness.
   (C) unable to be as prolific as he might otherwise have been.
   (D) able to control his health.

26. In line 44, mortify most nearly means
   (F) bruise.
   (G) darken.
   (H) beautify.
   (J) warm.

27. The main idea of the passage is that
   (A) to live a long, healthy life, one must make the same sacrifices Michelangelo did.
   (B) Michelangelo’s supreme devotion to his work enabled him to live to a ripe old age with a unique merging of mind and spirit.
   (C) through sheer force of will, Michelangelo was able to stay healthy.
   (D) Michelangelo was insane.

28. According to paragraph 6, Michelangelo’s “source of preservation” was due in part to his
   I. ascetic living style.
   II. miserly nature.
   III. pessimistic outlook.
   (F) I only
   (G) I and II
   (H) I and III
   (J) II and III

29. Based on the information in the passage, which of the following is a fact rather than an opinion?
   (A) Michelangelo’s last sculptures were not of the same artistic caliber as his earlier works.
   (B) Michelangelo’s bad qualities were balanced by his good ones.
   (C) We would all be better off if we had the same keen desire for perfection that Michelangelo did.
   (D) Michelangelo did not rest until the day before his death.

30. The phrase “one of his colossal statues would seem a more fitting mold” in Paragraph 3 implies
   (F) many of Michelangelo’s sculptures were self-portraits.
   (G) Michelangelo’s actual appearance was not as impressive as his work.
   (H) his intellectual skills were not as great as his sculptural ability.
   (J) Michelangelo didn’t create small-scale sculptures.
Passage IV—NATURAL SCIENCE:

This passage is adapted from an excerpt of a biology text.

Imagine for a moment that you are a plant living in a bog. You strain to extract the nitrogen you need from the soil, but it’s simply too acidic for the bacteria that break down dead plant matter to grow in.

So where do you get the nitrogen you need? If you’re a pitcher plant, you get it from insects that you catch. Like the Venus flytrap, the sundew and the bladderwort, the pitcher plant is able to trap and consume insects. But unlike these other carnivorous plants, the pitcher plant does not produce enzymes to digest the captured insects itself. Instead, the pitcher plant absorbs nutrients that are the result of a complex interaction between insect larvae that grow in the pitcher plant’s deadly interior.

A pitcher plant has a sweet-smelling flower and purple-veined leaves that form “pitchers” by curving in on themselves. These leaves have tiny downward-pointing hairs on them to prevent any insects that happen to wander into the pitcher’s clutches from wandering out again. Below the downward-pointing hairs is a highly slippery part of the leaf. When insects reach this slippery section, they fall into the heart of the pitcher plant: a highly acidic mixture of water and the plant’s own secretions.

First, an insect is attracted to the pitcher plant by the sugary smell of its flower. Once the insect has drowned in the deadly water, the pitcher plant has its own unique system of extracting needed nutrients from the deceased insect. Inside the pitcher plant, living in the deadly acid reservoir, are the larva of three distinct insect species. The larvae of a fly, a mosquito, and a midge species all live in the noisome fluid of the pitcher plant. These larvae, which are astoundingly found nowhere else in nature, work together to break down the victim insects into base components that can be absorbed by the plant, and along the way the larvae also receive needed sustenance. Within the pitcher plant is a tiny ecosystem of plants and animals working together.

Each larva has a life span of about a year, which is also the life span of each pitcher plant leaf. In July, adult insects deposit their young in the pitcher plant where for four months the larva consume insects unlucky enough to fall into the watery pit. Then the larvae spend the cold winter months frozen inside of the pitcher plant. With the spring thaw, the larvae resume their feast until early July. At that point they are fully mature insects, ready to fly off from their botanic home, find a mate and lay their eggs in a new pitcher plant receptacle.

The three different insect species do not actually compete for the insects that fall into the clutches of the pitcher plant. The fly larvae are much larger than the midge and mosquito larvae. Floating at the top of the pitcher pool, the fly maggot chews on insects when they first enter the pool and drown. Underneath the fly maggot the mosquito and midge larvae lurk, waiting for carcasses or parts of carcasses that escape the greedy jaws of the maggot.

Then the midge gets to work, gnawing on insects that sink below the fly. The mosquito has to wait for the midge to finish eating, since the mosquito can only consume very small particles of insect that the midge chews up first. The mosquito larvae also consume the bacteria that grow on the surface of these insect particles.

Field biologists were able to examine the interaction of these species by taking clear plastic tubes, filling them with water from actual pitcher plants, and then sticking these tubes into bogs. These tubes were then used in a variety of experiments to determine just how the insect larvae in pitcher plants process their food.
In one experiment, a fixed number of midges and mosquitoes were placed in various plastic pitchers. After a week, the plastic tubes were taken to a lab and analyzed. Measurements were made of the amount of food particles in each tube, how much bacteria was in each pool, and the number of midges and mosquitoes that survived. Each midge and mosquito larva was also weighed to determine how healthy it was.

Biologists found that the more midges there were in a pitcher plant, the better off the mosquitoes were. This is because instead of competing for resources with the mosquitoes, the midges were actually preparing food for mosquitoes to consume. This is a unique interaction in the animal kingdom. Usually when animals are in a symbiotic relationship they both benefit in some way, but in this case the mosquito population did not positively effect the midges in the experiments conducted. But since the mosquitoes brought no harm to the midges, this could not be considered a parasitic relationship. This relationship, where one species produces food for another species, has been termed a “processing chain” by some biologists.

The passage mentions that biologists have conducted experiments demonstrating that mosquito larvae in the pitcher plant benefit from

(A) an absence of midge larvae in the plant’s basin.
(B) a dearth of fly larvae in the plant’s basin.
(C) an increase in the number of midge larvae in the plant’s basin.
(D) any change in the amount of bacteria in the plant’s basin.

According to the passage, the pitcher plant has

I. long, penetrating roots.
II. a sweet-smelling flower.
III. leaves with tiny hairs on them.

(F) I only
(G) II only
(H) I and II
(J) II and III

The passage suggests that a pitcher plant leaf lives for approximately

(A) one month.
(B) four months.
(C) one year.
(D) ten years.

It can reasonably be inferred from the passage that the water found in the basin of a pitcher plant is all of the following EXCEPT

(F) full of enzymes produced by the pitcher plant.
(G) the home for several species of insect larvae.
(H) highly acidic in nature.
(J) the fluid from which the pitcher plant absorbs needed nutrients.

According to the passage, fly larvae differ from mosquito and midge larvae because fly larvae

(A) do not present a danger to field biologists.
(B) always live on the bottom of the pitcher plant’s basin.
(C) directly affect the number of midge larvae in the pitcher plant.
(D) are larger than mosquito and midge larvae.
36. The reason that the pitcher plant cannot extract nitrogen from the soil of a bog is due to
   (F) the pitcher plant’s immature root system.
   (G) the surplus of water found in boggy locations.
   (H) the lack of a certain type of bacteria in the soil.
   (J) the insect larvae living in the plant’s interior.

37. According to the passage, mosquito larvae cannot eat insect parts until the insects have first been
   (A) broken down by the midge larva in the pitcher plant.
   (B) completely absorbed by the pitcher plant.
   (C) frozen for several months in the interior of the pitcher plant.
   (D) completely consumed by the fly larva in the pitcher plant.

38. The passage states that biologists used plastic tubes in order to
   (F) trap mosquito larvae for testing.
   (G) test the acidity of the soil found in the bog.
   (H) simulate the form of the pitcher plant.
   (J) give fly larvae a chance to compete with the midges and mosquitoes.

39. Based on information from the passage, the leaves of the pitcher plant have all of the following characteristics EXCEPT that pitcher plant leaves do not have
   (A) downward-pointing hairs.
   (B) a way to produce digestive enzymes.
   (C) purple veins on them.
   (D) a section that is highly slippery.

40. Which of the following would be the best example of a “processing chain” that mirrors the midge and mosquito relationship found in the interior of the pitcher plant?
   (F) A human farmer grows grains to be consumed by both humans and farm animals.
   (G) A vulture can eat a moose only after it has been killed and partially consumed by a wolf.
   (H) A certain fish survives by eating the bacteria found on a shark’s skin, and the shark benefits from this relationship with healthier skin.
   (J) A bird feeds her young by taking food from other smaller birds.
Passage I

As power is supplied to a circuit, current flows through the circuit. An ammeter is the device used to measure the current, and many ammeters measure current in milliamps (mA). The voltage responsible for the current can be measured by a voltmeter and is measured in volts. When a resistor is placed in a circuit, it dampens the current flowing through a circuit at a given voltage.

If there is a linear relationship between current and voltage when a resistor is placed in the circuit, the resistor is considered an ohmic device. If the temperature of the resistor changes, then it is not considered an ohmic device. Some resistors are sensitive to small external temperature changes and will show a change in resistance as a result of these temperature changes. These resistors are called thermistors. The change in resistance exhibited by a thermistor can be detected by a change in the observed current at a given voltage.

The following procedure was performed to investigate whether different resistors acted as ohmic devices in a circuit. The circuit was constructed as shown in Figure 1.

Figure 1

After each resistor was connected to the circuit, the resistor was submerged in water to detect any changes in temperature as well as its sensitivity to different beginning temperatures. The power source was turned on, and the voltage of the power source and the resulting current were recorded. The voltage was changed several times, and the corresponding current was noted.

Table 1 summarizes the results when 3 different resistors were tested at 2 different temperatures. In all cases, no change in water temperature was observed.
TABLE 1

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Resistor A</th>
<th>Resistor B</th>
<th>Resistor C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>25</td>
<td>150</td>
<td>5</td>
</tr>
<tr>
<td>0.50</td>
<td>50</td>
<td>195</td>
<td>10</td>
</tr>
<tr>
<td>1.00</td>
<td>100</td>
<td>230</td>
<td>20</td>
</tr>
<tr>
<td>2.00</td>
<td>200</td>
<td>295</td>
<td>40</td>
</tr>
<tr>
<td>3.00</td>
<td>300</td>
<td>345</td>
<td>60</td>
</tr>
<tr>
<td>4.00</td>
<td>400</td>
<td>405</td>
<td>80</td>
</tr>
<tr>
<td>4.50</td>
<td>450</td>
<td>420</td>
<td>90</td>
</tr>
<tr>
<td>5.00</td>
<td>500</td>
<td>445</td>
<td>100</td>
</tr>
</tbody>
</table>

1. When the voltage is 3 volts and the temperature 23°C, what is the current of the circuit when Resistor B is used?
   - (A) 54 milliamps
   - (B) 60 milliamps
   - (C) 300 milliamps
   - (D) 345 milliamps

2. If 6.0 volts were used in the circuit with Resistor C at 25°C, approximately what would the current have read?
   - (F) 108 milliamps
   - (G) 140 milliamps
   - (H) 485 milliamps
   - (J) 600 milliamps

3. According to the data, which of the following resistors is NOT sensitive to temperature?
   - I. Resistor A
   - II. Resistor B
   - III. Resistor C
   - (A) I only
   - (B) III only
   - (C) I and II
   - (D) II and III

4. Which of the following observations supports that one of the resistors is a thermistor?
   - (F) Resistor A showed a change in resistance when introduced to two different temperatures.
   - (G) Resistor B had a greater measured current than Resistor A.
   - (H) Resistor C had a change in resistance when introduced to two different temperatures.
   - (J) Resistor C had a lower observed current than Resistor A.

5. Based on the data in Table 1, Resistor B does not appear to be an ohmic device because
   - (A) at a constant voltage, the current varies with temperature.
   - (B) the current is unaffected by temperature.
   - (C) the voltage and current have a linear relationship.
   - (D) the voltage and current do not have a linear relationship.

6. Which of the following hypotheses would be disproved if there had been a noted temperature change in the water for all six trials?
   - (F) Resistor A is an ohmic device because of its linear relationship between voltage and current.
   - (G) Resistor B is affected by different starting temperatures.
   - (H) Resistor C is not an ohmic device because it does not have a linear relationship between voltage and current.
   - (J) Resistor C is not affected by different starting temperatures.
Passage II
A state forestry commission engaged a
group of ecologists to study the nutrient
flow in a forest on federal lands that was
being considered for lease to a logging
company. They were also asked to study
the effects of clear-cutting in selected
areas to predict what the long-term ef-
fects on the nutrient budget might be.
The scientists selected several small sec-
tions of the forest for observation and
experiment.

The first task was to estimate the
average nutrient flow within the entire
forest area. Table 1 shows their esti-
mate based on 6 experimental areas
chosen within the forest. Nutrients en-
ter the forest ecosystem via pre-
cipitation, so rain gauges were set up in
various locations in the study areas.
Nutrients exit the ecosystem through
runoff from streams and rivers, so the
ecologists measured stream flows in the
designated areas.

After estimating the overall nutri-
ent flow in this forest, the ecologists had
one 15-hectare* area cleared of trees in
order to determine the amount of in-
crease that would occur in runoff. The
trees were removed from the area, but
nothing else was disturbed. For the first
two years after the logging, an herbicide
was applied so that no vegetation would
grow back. The ecologists then com-
pared this cleared watershed with one of
the intact watersheds under study. They
measured the stream flow for the first
two years after the logging took place.
Table 2 summarizes the amounts of or-
ganic and inorganic matter found at
the watershed. A net and filter system
was utilized to catch finer matter as the
runoff exited the watershed area.

* A hectare is a metric unit of measure equal to
2.471 acres.

### TABLE 1
<table>
<thead>
<tr>
<th>Substance</th>
<th>Precipitation</th>
<th>Stream Water</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>0.21</td>
<td>1.51</td>
<td>-619%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.05</td>
<td>0.37</td>
<td>-640%</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.10</td>
<td>0.23</td>
<td>-130%</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.12</td>
<td>0.94</td>
<td>-683%</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.01</td>
<td>0.24</td>
<td>-2,300%</td>
</tr>
<tr>
<td>Ammonium</td>
<td>0.22</td>
<td>0.05</td>
<td>-340%</td>
</tr>
<tr>
<td>Sulfate</td>
<td>3.10</td>
<td>6.20</td>
<td>-100%</td>
</tr>
<tr>
<td>Nitrate</td>
<td>1.30</td>
<td>1.14</td>
<td>12%</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.42</td>
<td>0.64</td>
<td>-52%</td>
</tr>
<tr>
<td>Dissolved</td>
<td>0.03</td>
<td>4.59</td>
<td>-15,300%</td>
</tr>
</tbody>
</table>

Note: Data is given in kilograms per dry weight of
materials per hectare of the watershed. Basin-caught
materials are coarse, net-caught materials are fine,
and filter-caught materials are superfine.

### TABLE 2
ANNUAL LOSSES OF PARTICULATE MATTER

<table>
<thead>
<tr>
<th>Source of Output</th>
<th>Year</th>
<th>Organic</th>
<th>Inorganic</th>
<th>Organic</th>
<th>Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponding</td>
<td>1</td>
<td>4.62</td>
<td>8.30</td>
<td>35.41</td>
<td>158.32</td>
</tr>
<tr>
<td>Basin</td>
<td>2</td>
<td>11.39</td>
<td>31.00</td>
<td>45.13</td>
<td>321.88</td>
</tr>
<tr>
<td>Net</td>
<td>2</td>
<td>0.43</td>
<td>0.25</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Filter</td>
<td>2</td>
<td>3.32</td>
<td>6.24</td>
<td>7.10</td>
<td>5.10</td>
</tr>
<tr>
<td>Ponding</td>
<td>3</td>
<td>3.83</td>
<td>5.78</td>
<td>53.72</td>
<td>540.32</td>
</tr>
<tr>
<td>Basin</td>
<td>3</td>
<td>0.42</td>
<td>0.27</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Net</td>
<td>3</td>
<td>2.61</td>
<td>8.73</td>
<td>12.98</td>
<td>12.98</td>
</tr>
</tbody>
</table>

Note: Data is given in kilograms per dry weight of
materials per hectare of the watershed. Basin-caught
materials are coarse, net-caught materials are fine,
and filter-caught materials are superfine.
7. Based on the figures reported in Table 1, which is apparently true of the nutrient budget as estimated using the 6 experimental areas?
   (A) There is a net loss for all measured nutrients entering the ecosystem.
   (B) There is a net gain for all measured nutrients entering the ecosystem.
   (C) There is a net loss for all measured nutrients, except for ammonium and nitrate.
   (D) There is a net gain for all measured nutrients, except for ammonium and nitrate.

8. According to the data obtained, which substances are most dramatically depleted in this ecosystem?
   (F) Sodium and Calcium
   (G) Silica and Aluminum
   (H) Magnesium and Potassium
   (J) Chloride and Nitrate

9. Which of the following best explains why the scientists chose to use three different collection methods?
   (A) It enabled them to collect particulate matter at different water sheds.
   (B) It enabled them to collect particulate matter of different sizes.
   (C) All of the collected particulate matter was quite coarse.
   (D) The collected particulate matter was dissolved in water.

10. Which of the following hypotheses concerning the effects of logging on the forest ecosystem is supported by the data?
    (F) Logging decreases the loss of organic and inorganic matter from the forest ecosystem.
    (G) Logging increases the loss of organic matter but has no effect on inorganic matter in the forest ecosystem.
    (H) Logging increases the loss of inorganic matter but has no effect on organic matter in the forest ecosystem.
    (J) Logging increases the loss of organic and inorganic matter from the forest ecosystem.

11. Based on the trend in the numbers over the first 3 years of observing the undisturbed and logged watershed areas reported in Table 2, it would be reasonable to predict that the runoff
    (A) would vary from year to year within narrow limits in the undisturbed area but steadily increase in the logged area.
    (B) in both experimental areas would steadily increase over the years.
    (C) in both experimental areas would vary from year to year.
    (D) in the undisturbed area would remain constant, but the runoff in the logged area would vary from year to year.
12. The ecologists inform the state officials that the bark in trees contains a significant proportion of nutrients. If the state officials are committed to leasing a set amount of this federal land to a logging company, they might reduce the nutrient loss in that region by
   (F) removing all remains from the trees after they are cut down so that the area is clear for new growth.
   (G) applying herbicide immediately after any logging operation.
   (H) allowing the logging companies to use the cleared areas for roads.
   (J) stripping the bark from all logged trees and leaving it behind in the cleared area.

Passage III

Elements are categorized to help understand the similarities and differences between them. One way is to consider their similarities based on the number of negatively charged particles in a particular orbit. Alkali metals are reactive elements that contain one electron in what is considered an s orbital. Scientists have been able to observe different characteristics in alkali metals. Atomic number is the number of positively charged particles (protons) in an element. These positively charged particles are balanced with the same number of electrons in a neutrally charged atom.

Table 1 contains data for the alkali metals, including the atomic number, atomic weight, melting point, and density.

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic Number</th>
<th>Atomic Weight (amu)</th>
<th>Melting Point (°C)</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>3</td>
<td>6.9</td>
<td>181</td>
<td>0.53</td>
</tr>
<tr>
<td>Sodium</td>
<td>11</td>
<td>23.0</td>
<td>98</td>
<td>0.97</td>
</tr>
<tr>
<td>Potassium</td>
<td>19</td>
<td>39.1</td>
<td>63</td>
<td>0.86</td>
</tr>
<tr>
<td>Rubidium</td>
<td>37</td>
<td>85.5</td>
<td>39</td>
<td>1.53</td>
</tr>
<tr>
<td>Cesium</td>
<td>55</td>
<td>132.9</td>
<td>29</td>
<td>1.87</td>
</tr>
</tbody>
</table>

13. The element with atomic weight of 85.5 amu has a melting point of
   (A) 29°C  
   (B) 37°C  
   (C) 39°C  
   (D) 63°C

14. According to the table, which of the following elements has a density of approximately twice that of sodium?
   (F) Lithium  
   (G) Potassium  
   (H) Rubidium  
   (J) Cesium

15. The data seems to indicate that as atomic number increases, melting point
   (A) increases.  
   (B) decreases.  
   (C) remains constant.  
   (D) decreases, then increases.

16. It was hypothesized that the density will increase as atomic weight increases. Based on the data in the table, which of the following pairs of substances supports this hypothesis?
   I. Sodium and Potassium
   II. Rubidium and Cesium
   III. Lithium and Potassium
   (F) I only  
   (G) III only  
   (H) I and II  
   (J) II and III
17. If an alkali metal existed with an atomic number greater than that of cesium, which of the following would be the best predicted measurements for its melting point and density?

(A) Melting point would be greater than \(29^\circ\)C, and density would be greater than \(1.87\) g/cm\(^3\).

(B) Melting point would be less than \(29^\circ\)C, and density would be less than \(1.87\) g/cm\(^3\).

(C) Melting point would be greater than \(29^\circ\)C, and density would be less than \(1.87\) g/cm\(^3\).

(D) Melting point would be less than \(29^\circ\)C, and density would be uncertain.

Passage IV

By studying rock samples, geologists can reconstruct much of an area’s geologic history. Table 1 lists rock samplings taken along a line proceeding east and inland from a shoreline, in 20-mile intervals. The sampled rock found at each altitude and distance is shown, and the crystallization temperature and ages typical of each type of rock are listed. Figure 1 shows the cross-sectional area of measurement.

**TABLE 1**

<table>
<thead>
<tr>
<th>Distance East (miles)</th>
<th>Altitude (ft)</th>
<th>Type of Rock in Sample</th>
<th>Crystallization Temp* (°C)</th>
<th>Estimated Age (millions of years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (shoreline)</td>
<td>0</td>
<td>Rhyolite</td>
<td>750°</td>
<td>10.0</td>
</tr>
<tr>
<td>20</td>
<td>6,000</td>
<td>Diorite</td>
<td>850°</td>
<td>250.0</td>
</tr>
<tr>
<td>40</td>
<td>5,000</td>
<td>Peridotite</td>
<td>1,200°</td>
<td>200.0</td>
</tr>
<tr>
<td>60</td>
<td>90</td>
<td>Shale</td>
<td>750°</td>
<td>0.1</td>
</tr>
<tr>
<td>80</td>
<td>–10</td>
<td>Limestone</td>
<td>800°</td>
<td>6.0</td>
</tr>
<tr>
<td>100</td>
<td>25</td>
<td>Brecchia</td>
<td>750°</td>
<td>0.5</td>
</tr>
<tr>
<td>120</td>
<td>75</td>
<td>Andesite</td>
<td>950°</td>
<td>3.6</td>
</tr>
<tr>
<td>140</td>
<td>2,000</td>
<td>Andesite</td>
<td>900°</td>
<td>4.0</td>
</tr>
<tr>
<td>160</td>
<td>3,300</td>
<td>Gabbro</td>
<td>1,100°</td>
<td>300.0</td>
</tr>
<tr>
<td>180</td>
<td>13,900</td>
<td>Granite</td>
<td>700°</td>
<td>400.0</td>
</tr>
</tbody>
</table>

*Crystallization temperature is based on the mineral composition of the rock.

18. What is the relationship between the ages of rocks and altitude?

(F) The oldest rocks are generally found at lower altitudes.

(G) The oldest rocks are generally found at higher altitudes.

(H) There is no relationship between altitude and rock ages.

(J) Rocks less than 100 million years old are only found in areas less than 1,000 feet in altitude.

19. If higher crystallization temperatures generally produce darker-colored rocks, which of the following rocks is most likely to be dark-colored?

(A) Limestone

(B) Shale

(C) Gabbro

(D) Granite

20. Which of the following measurements is shown on the vertical axis in Figure 1?

(F) Altitude

(G) Distance inland from shoreline

(H) Temperature

(J) Age of rocks

21. Iron ore is usually found in rocks that crystallize at higher temperatures. From the data shown, how far east of the shoreline would a miner try to find large concentrations of iron?

(A) 40 miles

(B) 100 miles

(C) 120 miles

(D) 180 miles
22. Based on the data provided, what is the relationship between distance from shoreline and the ages of the rock samples?
(F) Rocks closer to the shoreline are always younger.
(G) Rocks closer to the shoreline are always older.
(H) The age of rocks gradually increases farther inland.
(J) There is no consistent relationship between the distance from shore and the ages of the rock samples.

23. Limestone is sedimentary rock that develops from the accumulated deposits of sea organisms with shells. Andesite is igneous rock deposited by lava flows from volcanoes. Which of the following is the best hypothesis about the geologic record of the shaded area?
(A) Part of this area was once a sea while volcanoes erupted to the east.
(B) Part of this area was once a sea; later, volcanoes erupted to the east.
(C) A volcano arose west of an inland sea in this area.
(D) A sea existed in part of this area after nearby volcanoes became extinct.

Passage V
The apparent bird-dinosaur evolutionary connection has been a source of considerable debate among paleontologists during the second half of the twentieth century. This association was proposed on the basis of numerous anatomical similarities and has been supported by the discovery of fossils of a small number of seeming transitional forms uncovered in Europe and Asia. Yet scientists differ in their interpretation of the significance of these similarities and the nature of the fossil evidence as well.

Paleontologist A
The discovery of fossil reptiles equipped with feathers, wings, and beak-like snouts may be significant but more likely provides only limited support for the dinosaurs-into-birds hypothesis. Convergent evolution often provides animals of very distant lineages with similar appendages—witness, for example, the similarities in the body shape and presence of fins in fish and cetaceans such as whales and dolphins. We would never put forth the idea that orcas evolved from sharks based on the morphological similarities of these creatures; it would be immediately deemed absurd.

It is more likely the case that birds and dinosaurs share a very distant common ancestor, perhaps from among the thecodonts. These prototypical reptiles of the late Permian survived the largest mass extinction recorded in the planet’s history to bring forth many more recent lines; crocodiles, dinosaurs, pterosaurs, and birds are the most notable among these.

Paleontologist B
In our studies of numerous dinosaur fossils, it has become obvious that the lifestyles of dinosaurs were amazingly varied. No longer is it acceptable to view dinosaurs only as lumbering, cold-blooded monsters; indeed, the most frightening dinosaurs did not lumber at all. They were agile, swift, and deadly predators, who could run, leap, kick, and shred to pieces an animal they were intent upon consuming. Lightweight muscular body structure would be crucial to the success of this type of predator.

Based upon this observation, along with a number of obvious physical similarities and evidence from the fossil record, we are convinced that birds evolved from small, carnivorous dinosaurs called theropods. A mere examination of the forelimb, hindlimb, and feet of a theropod fossil, and a comparison to one of the five available speci-
mens of Archaeopteryx*, will bear this out. In addition, more recent discoveries of fossil dinosaurs with bird-like traits and habits, particularly the finds uncovered in the Liaoning province of China, lend further credible support for our position that birds are for all intents and purposes actual members of the lineage Dinosauria living and thriving in our midst.

*Archaeopteryx was a feathered reptile of the late Jurassic Era thought to represent an intermediate form between dinosaurs and birds.

24. According to Paleontologist A, similarities in the body forms of dinosaurs and birds
   (F) represent a failed experiment of evolution.
   (G) are the products of convergent evolution.
   (H) are completely without significance.
   (J) helped both types of organism survive a large mass extinction.

25. Which of the following types of evidence, if found, would lend strong support to the position of Paleontologist A?
   (A) Discovery of thecodont fossils with characteristics of modern birds and existing dinosaur fossils
   (B) Discovery of another possible intermediate form between dinosaurs and birds from the Jurassic Era
   (C) Discovery of an avian prototype dating back to before the beginning of the era of dinosaur dominance
   (D) A careful examination of several sets of theropod fossil remains

26. Which of the following is a criticism that Paleontologist A would make of the avian evolutionary hypothesis of Paleontologist B?
   (F) It ignores the possibility of the existence of transitional forms.
   (G) It ignores the impact of a very large mass extinction.
   (H) It assumes that morphological similarities are a result of a direct lineage.
   (J) It proposes that dinosaurs and birds arose from distant lineages.

27. Which of the following perspectives would be consistent with the views of Paleontologist B?
   (A) Convergent evolution produces similar forms in diverse lineages.
   (B) Dinosaurs and birds may be related via a common ancestor.
   (C) Birds and dinosaurs arose out of completely separate lineages.
   (D) Birds arose out of a lineage of dinosaurs.

28. If genetic evidence was established to date the avian lineage 85 million years prior to the rise of Archaeopteryx, this finding would tend to
   (F) support the theory of Paleontologist A.
   (G) support the theory of Paleontologist B.
   (H) support the theories of both paleontologists.
   (J) refute the theories of both paleontologists.
29. If Paleontologist B could confirm that birds appeared much later in evolutionary history than any dinosaurs, which of the following statements would reconcile this fact with the theory of Paleontologist A?

(A) The ancestors of birds and the ancestors of dinosaurs were exposed to specific environmental conditions at the same time, and this caused the development of similar characteristics.

(B) The ancestors of birds and the ancestors of dinosaurs were exposed to specific environmental conditions that caused the development of similar characteristics, but the dinosaur ancestors were exposed to these environmental conditions later than the bird ancestors were.

(C) The rate of evolutionary change from the thecodont ancestor was much slower for the lineage that resulted in birds than for the lineage that resulted in dinosaurs.

(D) The rate of evolutionary change from the thecodont ancestor was much faster for the lineage that resulted in birds than for the lineage that resulted in dinosaurs.

Passage VI

Ecology graduate students wished to experiment with levels of diversity in a simple community to observe the relationship between increasing complexity and stability of populations. In particular, they were interested in the impact of changing certain conditions in a community on populations of two species of Paramecium, a common ciliated protozoan.

A trophic level is the number of steps a species is away from the producer species in a community. Producers are organisms that synthesize energy out of chemical products into nutrients. Table 1 shows the trophic level occupied by each type of organism involved in the experiments and the number of species that would be used on each level.

<table>
<thead>
<tr>
<th>Trophic Level</th>
<th>Organism</th>
<th>Number of Species Studied</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Bacteria</td>
<td>3</td>
</tr>
<tr>
<td>Second</td>
<td>Paramecia</td>
<td>2</td>
</tr>
<tr>
<td>Third</td>
<td>Amoebae</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(predator of protozoa)</td>
<td></td>
</tr>
</tbody>
</table>

**Experiment 1**

The graduate students wished to study the relationship between one species of Paramecium and the number of species of bacteria available for consumption in the community. They created 300 “microcosms”—100 cultures each populated with communities of one, two, or three species of bacteria and one of the Paramecium species. After 20 days, they examined the cultures individually. The results are displayed in Table 2.

<table>
<thead>
<tr>
<th>Number of Bacterium Species</th>
<th>Number of Cultures in Which Paramecia Survived</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32/100</td>
</tr>
<tr>
<td>2</td>
<td>61/100</td>
</tr>
<tr>
<td>3</td>
<td>70/100</td>
</tr>
</tbody>
</table>

**Experiment 2**

The students then decided to study how two species of Paramecium would be affected when different combinations of Paramecium and bacteria were mixed in the cultures. They created 100 dishes each of six separate types of communities—600 cultures with different combinations of the Paramecium and the three bacteria species. After 20 days, they examined the cultures and recorded their results. These results are reproduced in Table 3.
Practice Test 3

TABLE 3

<table>
<thead>
<tr>
<th>Number of Bacterium/Paramecium Species</th>
<th>Number of Cultures in which Paramecia Survived</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>35/100</td>
</tr>
<tr>
<td>2/1</td>
<td>58/100</td>
</tr>
<tr>
<td>3/1</td>
<td>65/100</td>
</tr>
<tr>
<td>1/2</td>
<td>20/100</td>
</tr>
<tr>
<td>2/2</td>
<td>26/100</td>
</tr>
<tr>
<td>3/2</td>
<td>31/100</td>
</tr>
</tbody>
</table>

Experimt 3

The last condition that the graduate students studied was the addition of a third trophic level to their microcosms. They introduced two different species of *Amoebae* that feed on *Paramecium*. They decided to use five different versions in 100 culture dishes each, creating 500 communities for this last experiment. They allowed them to grow undisturbed for 20 days, and then examined the cultures and recorded their results in Table 4 displayed below.

TABLE 4

<table>
<thead>
<tr>
<th>Number of Bacterium/Paramecium/Amoeba Species</th>
<th>Number of Cultures in Which Paramecia Survived</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/1</td>
<td>22/100</td>
</tr>
<tr>
<td>2/1/1</td>
<td>15/100</td>
</tr>
<tr>
<td>2/2/1</td>
<td>8/100</td>
</tr>
<tr>
<td>2/2/2</td>
<td>6/100</td>
</tr>
<tr>
<td>3/2/2</td>
<td>2/100</td>
</tr>
</tbody>
</table>

30. Which of the following factors was varied in Experiment 1?
   (F) The species of *Paramecium* in the community
   (G) The number of species of bacteria present in the community
   (H) The medium used to culture the microbes
   (J) The number of trophic levels in the community

31. According to the results of Experiments 1 and 2, increasing the number of bacteria species present in the community
   (A) decreased the survival rates of the *Paramecium* in the community.
   (B) increased the survival rates of the *Paramecium* in the community.
   (C) had no effect on any species in the community.
   (D) decreased the survival rates of one type of bacteria in the community.

32. According to the results of Experiment 2, increasing the number of *Paramecium* species in the community was related to
   (F) decreased survival rates for the *Paramecium*, depending on the number of bacteria species present in the community.
   (G) decreased survival rates for all species present in the community.
   (H) decreased survival rates for the *Paramecium* independent of the number of bacteria species present in the community.
   (J) increased survival rates for the *Paramecium*, depending on the number of bacteria species present in the community.
33. What new factor was introduced in Experiment 3?
   (A) An additional species of bacteria
   (B) A longer time for incubation of the experimental cultures
   (C) A new method for culturing the experimental microbes
   (D) An additional trophic level

34. After examining the results of Experiment 3, it would be reasonable to conclude that increased diversity in the experimental communities
   (F) was beneficial to all species present in the communities.
   (G) had no effect on any species in the communities.
   (H) had a detrimental effect on the survival rate of one species of Amoebae only.
   (J) had a detrimental effect on the survival rates of both species of Paramecium under study.

Passage VII
The nine planets of our solar systems were categorized as planets as each was discovered. Scientists have observed some differences among the planets that have caused them to reconsider whether all of the planets should retain their current categorization.

There has been the discovery and classification of objects called Trans-Neptunian Objects that do not fit into the existing categories of planets, satellites (moons), comets, or asteroids. Some of the characteristics that make these objects distinct include size, orbital inclination, and orbital eccentricity. Orbital inclination is the amount the orbit is tilted with respect to the plane of the solar system. Orbital eccentricity refers to the amount that the orbit deviates from a circular orbit. The difficulty that scientists face is that the wide variation among the planets and among the Trans-Neptunian Objects on these characteristics makes it difficult to create numerical classifications upon which everyone can agree.

The table below summarizes many of the qualities of the nine planets, as well as those of the earth’s moon for comparison.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Mass (kg)</th>
<th>Density (kg/m³)</th>
<th>Black-body Temp. (°K)</th>
<th>Orbital Inclination (°)</th>
<th>Orbital Eccentricity</th>
<th>Rotation Period (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>3.3 × 10²⁴</td>
<td>5,427</td>
<td>442.5</td>
<td>7.000</td>
<td>0.2056</td>
<td>1,407.60</td>
</tr>
<tr>
<td>Venus</td>
<td>4.9 × 10²⁴</td>
<td>5,204</td>
<td>238.1</td>
<td>3.390</td>
<td>0.0068</td>
<td>5,832.50</td>
</tr>
<tr>
<td>Earth</td>
<td>6.0 × 10²³</td>
<td>5,520</td>
<td>247.3</td>
<td>0.000</td>
<td>0.0167</td>
<td>23.93</td>
</tr>
<tr>
<td>Mars</td>
<td>6.4 × 10²³</td>
<td>3,933</td>
<td>216.6</td>
<td>1.850</td>
<td>0.0934</td>
<td>24.62</td>
</tr>
<tr>
<td>Jupiter</td>
<td>1.9 × 10²⁷</td>
<td>1.326</td>
<td>90.6</td>
<td>1.305</td>
<td>0.0484</td>
<td>9.93</td>
</tr>
<tr>
<td>Saturn</td>
<td>5.7 × 10²⁶</td>
<td>687</td>
<td>63.9</td>
<td>2.484</td>
<td>0.0542</td>
<td>10.50</td>
</tr>
<tr>
<td>Uranus</td>
<td>8.7 × 10²⁶</td>
<td>1,318</td>
<td>35.9</td>
<td>0.770</td>
<td>0.0472</td>
<td>17.24</td>
</tr>
<tr>
<td>Neptune</td>
<td>1.0 × 10²⁶</td>
<td>1,638</td>
<td>33.2</td>
<td>1.769</td>
<td>0.0086</td>
<td>16.11</td>
</tr>
<tr>
<td>Pluto</td>
<td>1.3 × 10²²</td>
<td>2,050</td>
<td>42.7</td>
<td>17.140</td>
<td>0.2488</td>
<td>153.29</td>
</tr>
<tr>
<td>Satellite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth's Moon</td>
<td>7.3 × 10²³</td>
<td>3,340</td>
<td>274.5</td>
<td>5.145</td>
<td>0.0549</td>
<td>655.73</td>
</tr>
</tbody>
</table>

35. Neptune has a density greater than which of the following planets?
   (A) Mars, Venus, and Mercury
   (B) Saturn, Uranus, and Jupiter
   (C) Earth, Jupiter, and Pluto
   (D) Venus, Saturn, and Earth
36. Black-body temperature is the temperature that would result from the planet absorbing all received electromagnetic radiation without reflection. If black-body temperatures are higher for objects closer to the sun, which of the following would be considered furthest from the sun based on the data presented?
   (F) Mercury
   (G) Uranus
   (H) Pluto
   (J) Neptune

37. If an astronomer proposed that Trans-Neptunian Objects would be defined solely on having an orbital inclination greater than 5 degrees and orbital eccentricity of 0.2, how many of the current planets would be recategorized as Trans-Neptunian Objects?
   (A) 4
   (B) 3
   (C) 2
   (D) 1

38. If scientists were to define planets based only on a minimum mass requirement and the mass designated would be greater than that of Earth’s Moon, which of the current planets would lose its designation as a planet?
   (F) Mercury
   (G) Mars
   (H) Pluto
   (J) Jupiter

39. It was hypothesized that Jupiter, Saturn, Neptune, and Uranus were gaseous planets, whereas the others were composed of solid material. Which of the following statements best supports this hypothesis?
   (A) Jupiter, Saturn, Neptune, and Uranus have lower temperatures than most of the other planets.
   (B) Jupiter, Saturn, Neptune, and Uranus have densities much smaller than the densities of the other planets.
   (C) Jupiter, Saturn, Neptune, and Uranus have greater masses than the other planets.
   (D) Jupiter, Saturn, Neptune, and Uranus have rotation periods that are much shorter than the other planets.

40. Which of the following statements is NOT supported by the data?
   (F) Mercury and Venus exhibit the longest rotation periods of all the planets.
   (G) Rotation period decreases as black-body temperature decreases.
   (H) The two planets with the greatest mass have the shortest rotation periods.
   (J) Mars and Earth have rotation periods within one hour of length of each other.

STOP
END OF SECTION 4. IF YOU HAVE ANY TIME LEFT, GO OVER YOUR WORK IN THIS SECTION ONLY. DO NOT WORK IN ANY OTHER SECTION OF THE TEST.

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## ANSWER KEY

### Section 1: ENGLISH

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
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<td>D</td>
<td>16</td>
<td>J</td>
<td>31</td>
<td>A</td>
</tr>
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<td>2</td>
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### Section 2: MATH

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Section 3: READING


Section 4: SCIENCE REASONING

EXPLANATORY ANSWERS

Section 1: ENGLISH

Passage I

1. **The correct answer is (D).** This option gets rid of the redundant phrasing caused by two similar verbs.

2. **The correct answer is (F).** *With* is the appropriate preposition in this common phrase. The phrase should not be omitted because it explains the writer’s trembling.

3. **The correct answer is (D).** *Kneel* indicates a downward motion, and therefore no other word is necessary.

4. **The correct answer is (F).** The action is in the process of happening; therefore, the present continuous tense is appropriate.

5. **The correct answer is (B).** A comma is needed after *fever* to separate the introductory phrase from the main clause of the sentence. No comma is needed before *and* because both verbs belong to the same subject.

6. **The correct answer is (J).** The past tense is appropriate because the writer is describing his childhood.

7. **The correct answer is (C).** This option clearly states the writer’s point that in New York, culture was the dominating element even when it came to marking the passage of the seasons.

8. **The correct answer is (G).** *Though* is the appropriate conjunction to indicate the contrast between knowing the highlights and knowing the particulars of the seasons.

9. **The correct answer is (A).** Paragraph 2 tells us that the writer grew up knowing little about nature. This fact is essential to understanding the garden’s effect on the writer.

10. **The correct answer is (J).** The retaining wall is located *at* the side of the house. It is not attached to the house, nor is it dangling in air, as *over* would suggest.

11. **The correct answer is (A).** No commas should be used because *bright* modifies yellow and all the other colors. No commas are needed to separate the colors because the writer has chosen to link them with the conjunction *and*.

12. **The correct answer is (F).** The present tense is appropriate for a general situation that is repeated year after year. The plural, *Daffodils*, demands the third-person plural form of the verb.

13. **The correct answer is (B).** A relative pronoun is needed to link the words with what they stand for. *That* is appropriate for objects.

14. **The correct answer is (H).** The tone of the essay is personal and informal.

15. **The correct answer is (B).** This detail is an example of how little the writer knew about nature and therefore belongs in the paragraph that discusses growing up in New York.

Passage II

16. **The correct answer is (J).** The idiomatic expression is: *as x goes, so goes y*. The other options either add unnecessary words or are simply awkward.

17. **The correct answer is (A).** From the following sentence, it is clear that the writer means that this phenomenon is *well understood* when applied to the present but not when applied to the past.
18. The correct answer is (G). The writer is speaking about our present understanding of trade in the past. It is an assertion without any sense of the conditional.

19. The correct answer is (B). This is the only sentence that stresses the historical importance of exchange and thereby links the previous paragraph to the examples of this phenomenon presented in paragraph 2.

20. The correct answer is (J). The clearest construction lists the subjects and proceeds directly to the verb without punctuation or unnecessary words.

21. The correct answer is (D). No punctuation should separate the noun from the prepositional phrase that identifies it.

22. The correct answer is (G). The present perfect tense indicates the connection between the past and the present, between antiquity and today.

23. The correct answer is (C). Greeks is the subject of the relative clause, and therefore the relative pronoun who is appropriate.

24. The correct answer is (G). A coordinating conjunction is needed to link the two independent clauses. And is the best choice because it indicates the consequential relationship between the clauses. Therefore also expresses this relationship but cannot be used to link two independent clauses.

25. The correct answer is (B). This phrasing properly indicates that the question is about the character of modern Italy. The other options ask different questions.

26. The correct answer is (F). The imperative form avoids unnecessary words and maintains the authoritative tone of the essay.

27. The correct answer is (A). This sentence makes the point that these foods are not indigenous to the nations that rely on them, and this point is crucial to the main idea of the essay.

28. The correct answer is (H). As in question 20, the sentence begins with a series of subjects and should then proceed to the verb without punctuation or unnecessary words.

29. The correct answer is (D). For creates a smooth transition from the previous sentence without changing the meaning. Therefore would wrongly indicate that the way we think of Italy is a direct consequence of the transformation of exchanged goods.

30. The correct answer is (F). This option emphasizes the creative transformation of tomatoes and pasta by Italian cooking.

Passage III

31. The correct answer is (A). A comma is necessary to separate the modifying phrase from remedies, the noun it modifies. The other options that separate would only work if the final phrase were an independent clause.

32. The correct answer is (H). Which is used to ask a question involving a choice of many. In this case, it is also required by parallel structure.

33. The correct answer is (C). This option avoids unnecessary words and is the clearest.

34. The correct answer is (F). There is no need for a conjugated verb (which would have to be in the continuous tense). The gerund phrase describes what the woman is doing and keeps the sentence flowing.
35. The correct answer is (B). The present tense is needed because the sentence speaks about today. One of the reasons is singular, so the third-person singular is required.

36. The correct answer is (H). This option supplies the possessive pronoun for alternative medicine.

37. The correct answer is (D). This option is the most straightforward and avoids awkward phrasing.

38. The correct answer is (G). Yet indicates the contrasting nature of sentence 1. By placing it after sentence 3, it counters the position of the medical establishment and serves as a bridge to the conclusion that medical science does not hold all the answers.

39. The correct answer is (C). Than is part of a comparison and should come directly after the comparative form of the adjective.

40. The correct answer is (H). The sentence has only one subject, and the verb should not be separated from it by punctuation.

41. The correct answer is (D). This sentence declares that the antagonism of the previous paragraph is lessening and paves the way for the examples that follow.

42. The correct answer is (J). This option expresses the intended possibility while avoiding unnecessary words.

43. The correct answer is (A). The reader was addressed directly as you in the opening sentence, which is referred to here.

44. The correct answer is (F). Paragraph 2 mentions the theory behind acupuncture and provides an example of its use. In addition, Paragraph 2 is the only option that discusses homeopathy without also mentioning medical science. Therefore, an exploration of homeopathy’s philosophy should follow here.

45. The correct answer is (C). The essay discusses alternative medicine in terms of its possible but unproven value in the field of health.

46. The correct answer is (J). The phrase refers to the past, and so the verbs must be in the past tense. The plural subject demands the third-person plural form of the verb.

47. The correct answer is (B). The first sentence of the paragraph tells us that the writer must prove herself in reality. This answer is the only one that maintains such a meaning and is correctly punctuated with a colon to separate the two related independent clauses.

48. The correct answer is (H). This option maintains the parallel structure set up by the preposition with and thus indicates that the two factors mentioned are sides of the same problem.

49. The correct answer is (B). This option turns the fragment into a complete sentence.

50. The correct answer is (F). This option makes it clear that the writer is being asked to write a piece about the First Lady’s charity work.

51. The correct answer is (B). The gerund phrase acts as a noun, in this case the object of the verb meant, creating a correct sentence. The form should be positive because the essay makes it clear that the author did break ground.

52. The correct answer is (H). Commas are required to set “however” apart from the rest of the sentence.
53. The correct answer is (D). The verb *would tell* in the previous part of the sentence sets up a parallel structure that requires *describe and complain*.

54. The correct answer is (F). The suggested paragraph would add details that are unnecessary in making the writer’s point and would therefore constitute a digression.

55. The correct answer is (D). This is the only answer choice that indicates that the writer is contrasting her behavior in the previous paragraph with the behavior of her male colleagues.

56. The correct answer is (J). This option avoids unnecessary wording and correctly conveys the writer’s feeling that her complete honesty was inappropriate for her workplace.

57. The correct answer is (B). The relative subject pronoun is needed because *women* is the subject of the relative clause.

58. The correct answer is (J). The opening sentence of the paragraph indicates that the writer has set some kind of expectation up that her work will not be first rate. Therefore, in order for this paragraph to be most effective, it should come at the end of the passage, after the writer has shown us what she has done to set up such an expectation. In addition, the last line of the paragraph serves to point out the lesson that has been learned, concluding the essay.

59. The correct answer is (A). The writer sets up important, relevant information regarding her behavior that ultimately helped her to understand why she needed to put on a professional face.

60. The correct answer is (H). The writer is conveying an experience she had in her professional life that led to a personal revelation.

Passage V

61. The correct answer is (C). Illiterate means unable to read, and population is a singular noun.

62. The correct answer is (J). The size of the country is irrelevant here.

63. The correct answer is (D). The word *neighbors* is part of a list and should be separated from the next item by a comma.

64. The correct answer is (H). The *willingness* refers to that of the neighbors, friends, and relatives, and so the possessive pronoun is called for here.

65. The correct answer is (D). The sentence describes the age of the author at the time referred to, requiring the simple past tense of the verb *to be*.

66. The correct answer is (G). *To live under* a dictatorship is the idiomatic phrase.

67. The correct answer is (C). No punctuation is needed before the prepositional phrase that begins with *in*.

68. The correct answer is (F). The modifier indicates a quantity of critical acclaim, and *acclaim* is a singular noun. *Too much* would give the sentence an unwanted negative connotation.

69. The correct answer is (D). The underlined portion is irrelevant and deviates from the tone of the essay.

70. The correct answer is (J). This option links Danticat’s childhood behavior with her development as a writer.

71. The correct answer is (D). This option avoids unnecessary words and irrelevant facts.

72. The correct answer is (H). Only one author is being referred to, and the possessive form is used to indicate that the subject matter belongs to the author.

73. The correct answer is (C). This option is the most logical because of the author’s
subject matter. The negative construction requires the conjunctions neither, nor.

74. The correct answer is (F). This option introduces the informative, impersonal tone of the essay and provides an introduction to the theme of storytelling.

75. The correct answer is (C). The essay is primarily about an emerging writer.

Section 2: MATH

1. The correct answer is (E). \[ \frac{32}{80} = .4 = 40\% \text{ of the children missed at least one day in January.} \]

2. The correct answer is (J). An exterior angle of a triangle is equal to the sum of the two opposite interior angles. The measure of \( \angle X \) is \( 40° + 55° = 95° \).

3. The correct answer is (C). The machine costs \( P + L \) to operate each hour, so if it operates for \( x \) hours, the expression would be \( (P + L)x \).

4. The correct answer is (K). If you sketch each of the segments on a coordinate plane, you’ll find that only the segment connecting (2,1) and (2,5) intersects with the original segment.

5. The correct answer is (C). Jacob’s cost is \( 5(1 + .25(1)) + 5(1 + .25(3)) = 6.25 + 8.75 = $15 \).

6. The correct answer is (G). \[ x^2 + x – 30 = (x + 6)(x – 5) \]

7. The correct answer is (E). \[ \frac{2}{3} + \frac{1}{6} + .177 = .4 + .125 + .177 = .702 \]

8. The correct answer is (H). If the area of triangle \( ABC \) is 5 square inches, then you can solve for its height: \[ \frac{1}{2}(2)h = 5 \]
\[ h = 5 \]
Triangle \( ACD \) has the same height, so its area is \( \frac{1}{2}(8)(5) = 20 \text{ square inches.} \)

9. The correct answer is (B). \[ (-1)^2 – 4(-1)(-3) + (-3) = 1 – 12 – 3 \]
\[ = -14 \]

10. The correct answer is (J). \[ (3 + \sqrt{2})(4 – \sqrt{2}) = 12 – 3\sqrt{2} + 4\sqrt{2} – \sqrt{2} \]
\[ = 10 + \sqrt{2} \]

11. The correct answer is (E). The sum of the interior angles of a polygon can be generalized by the formula \( (N-2)(180°) \), where \( N \) is the number of sides of the polygon. The sum of the interior angles of a hexagon is \( (6 – 2)(180°) = 720° \). In a regular hexagon, the six interior angles are all equal, so each angle is \( \frac{720°}{6} = 120° \).

12. The correct answer is (H). The least common multiple of 2, 4, 6, and 10 is 60.

13. The correct answer is (D). It is cheapest not to buy exactly 100 diskettes, but rather to buy 105 diskettes by purchasing two boxes of 40 and one box of 25. The total cost is \( 2($20) + $14 = $54 \).

14. The correct answer is (F). \[ (.01)^4 = (10^{-2})^4 = 10^{-8} \]

15. The correct answer is (D). When parallel lines are cut by a transversal, the alternate interior angles are equal. Thus, \( \angle DCE \) measures 60°. Since the measures of the angles in a triangle add up to 180°, \( \angle CED \) measures 180° – 40° – 60° = 80°.

16. The correct answer is (J). \[ (2a – 3)(2a – 3) = 4a^2 – 6a – 6a + 9 = 4a^2 – 12a + 9 \]

17. The correct answer is (D). The slope-intercept form of a line is \( y = mx + b \).
\[ 3x + y – 2 = 0 \]
\[ y = –3x + 2 \]

18. The correct answer is (G). If painting one side of the house requires 6 small cans, then all 4 sides require 24 small cans. Given the relationship of 4 large
cans = 6 small cans, you can convert large cans to small by multiplying by \( \frac{6}{4} = 1.5 \). Thus, 4 large cans and 18 small cans is equivalent to the 24 small cans required.

19. **The correct answer is (E).** Since an absolute value can never be negative, its minimum is at 0. \( x - 5 \) equals 0 if \( x = 5 \).

20. **The correct answer is (G).**

\[
8 - \sqrt{8} = 5.17
\]

21. **The correct answer is (D).**

\[
(x + 6)(x - 1) = x^2 + 5x - 6, \text{ so } b = 5.
\]

22. **The correct answer is (J).** Set up a proportion between similar sides:

\[
\frac{24}{30} = \frac{x}{40}
\]

\[
30x = 960
\]

\[
x = 32
\]

23. **The correct answer is (A).** The area of a triangle is \( \frac{1}{2}bh \). The legs of a right triangle can always be considered the base and height, so the area of the triangle is \( \frac{1}{2} \times 5x = \frac{5}{2}x \).

24. **The correct answer is (K).** Convert the time to seconds and set up a proportion:

\[
\frac{560}{1,400} = \frac{x}{2,000}
\]

\[
1,400x = 1,120,000
\]

\[
x = 800 \text{ seconds}
\]

\[
= 13 \text{ minutes and } 20 \text{ seconds}
\]

25. **The correct answer is (C).** The current paths require a trip of 200 feet. A diagonal path would form an isosceles right triangle with the existing paths. By the rules of 45°-45°-90° triangles, the length of the path would be 100\( \sqrt{2} \) feet or approximately 140 feet. The new path would shorten the route by about 200 - 140 = 60 feet.

26. **The correct answer is (K).**

\[
3x^2 - 7x - 6 = 0
\]

\[
(3x + 2)(x - 3) = 0
\]

\[
x + 2 = 0 \text{ or } x - 3 = 0
\]

\[
x = -\frac{2}{3} \text{ or } x = 3
\]

Since \( x < 0 \), \( x = -\frac{2}{3} \).

27. **The correct answer is (B).**

\[
\sqrt[3]{3^4} a^3 b^2 = (3^2 a^2 b^2)^{\frac{1}{3}} = 3^2 a^\frac{2}{3} b^\frac{2}{3} = 9a^\frac{2}{3} b^\frac{2}{3}
\]

28. **The correct answer is (H).** Given that there are 180° in a line and in a triangle, you can solve for the angles in the triangle:

29. **The correct answer is (D).** \( \frac{0.18}{12} = 0.150 \) or 150 thousandths.

30. **The correct answer is (G).** When solving for an absolute value, you need to account for the possibility that the expression is positive (in which case, it will be unchanged by the absolute value) or negative (in which case, its sign will be changed by the absolute value). First, assume that \( x - 1 \) is positive:

\[
x - 1 \leq 2
\]

\[
x \leq 3
\]

If \( x - 1 \) is negative, then the absolute value changes the signs:

\[
-(x - 1) \leq 2
\]

\[
-x + 1 \leq 2
\]

\[
x \leq 1
\]

\[
x \geq -1
\]

The complete solution is thus \(-1 \leq x \leq 3\).
31. The correct answer is (A). You are dealing with similar triangles, so you can set up a proportion between the segments:
\[
\frac{10}{4} = \frac{x}{3}
\]
\[4x = 30\]
\[x = 7.5\]

32. The correct answer is (J). If \(\cos \theta = \frac{5}{7}\), then you can create a right triangle with an adjacent side of 5 and a hypotenuse of 7. Solving for the opposite leg gives:
\[5^2 + b^2 = 7^2\]
\[25 + b^2 = 49 - 25\]
\[b^2 = 24\]
\[b = 2\sqrt{6}\]
Tangent is equal to opposite divided by adjacent or \(\frac{2\sqrt{6}}{5}\).

33. The correct answer is (E). Average is equal to \(\frac{\text{total number}}{\text{number}}\). The new average is \(\frac{15x + 2y}{x + 2}\), or \(\frac{2y}{x}\) more than the old average.

34. The correct answer is (F). Slope is equal to the change in \(y\) divided by the change in \(x\):
\[
\frac{4 - (-5)}{-1 - 2} = \frac{9}{-3} = -3
\]

35. The correct answer is (D). The ladder forms a right triangle with the house and the ground, so you can use the Pythagorean theorem to solve for the distance:
\[10^2 + b^2 = 12^2\]
\[b^2 = 144 - 100\]
\[b = \sqrt{44} = 6.6\]

36. The correct answer is (H). Circumference = \(2\pi r\). The radius is 3 feet, so the circumference is \(2\pi(3) = 6\pi\) feet.

37. The correct answer is (A). Multiplying both sides of the equation by 35 eliminates the fractions:
\[
\left(\frac{3}{2}n + \frac{2}{3}\right)35 = \left(\frac{3}{2}n - \frac{2}{3}\right)35
\]
\[21n + 10 = 15n - 14\]
\[6n = -24\]
\[n = -4\]

38. The correct answer is (F). In order for a line to be parallel to the \(y\)-axis, it must have the same \(x\)-coordinate at all points. Since the line passes through (2,3), its equation must be \(x = 2\).

39. The correct answer is (A). Sine is equal to opposite divided by hypotenuse, so \(\sin x = \frac{5}{13}\) in the given triangle.

40. The correct answer is (K). The given circle has a center at (4,–6) and a radius of 5. The circle is centered in quadrant IV and part of the circle would also go into quadrant III, but it would not reach quadrants I or II.

41. The correct answer is (C). If \(\angle Z\) measures 30°, then \(\angle X\) also measures 30°, and \(\angle C\) must measure 180° – 30° – 30° = 120°. Arc XYZ is thus \(\frac{120}{360} = \frac{1}{3}\) of the entire circumference of the circle. The circumference is \(2\pi(9) = 18\pi\) feet, so arc XYZ has a length of \(6\pi\) feet.

42. The correct answer is (H). Three pairs of prime numbers add to 24: (5,19), (7,17), (11,13). (5)(19) = 95 is the least possible value of \(xy\). Note that 1 is NOT a prime number.

43. The correct answer is (E).
\[
\text{Area} = \pi r^2
\]
\[\pi r^2 = 64\]
\[r^2 = \frac{64}{\pi}\]
\[r = \frac{8}{\sqrt{\pi}}\]
The diameter is twice the radius or \( \frac{16}{\sqrt{\pi}} \) inches.

44. The correct answer is (F). First, solve for \( x \):

\[
2x = 4x + 1 \\
-2x = 1 \\
x = -\frac{1}{2}
\]

Substituting this value into the second equation gives \( 6(-\frac{1}{2}) - 2 = -5 \).

45. The correct answer is (B). Tangent equals opposite divided by adjacent. In an isosceles right triangle, the opposite and adjacent sides are equal, so \( \tan \theta = 1 \).

46. The correct answer is (G). You can solve for the width and length of the rectangle using the distance formula:

\[
w = \sqrt{(-5 - (-1))^2 + (-2 - (-6))^2} \\
= \sqrt{16 + 16} \\
= \sqrt{32} = 4\sqrt{2}
\]

\[
l = \sqrt{(-1 - 7)^2 + (-6 - 2)^2} \\
= \sqrt{64 + 64} \\
= \sqrt{128} = 8\sqrt{2}
\]

The area of the rectangle is \( (4\sqrt{2})(8\sqrt{2}) = 64 \).

47. The correct answer is (A). In order for the expression to be positive, \( x \) and \( z \) must either both be negative or both be positive.

48. The correct answer is (K). Average \( = \frac{\text{Total}}{\text{Number}} \) or, alternatively, Total = (Average)(Number). The total of the 6 original scores is \( (6)(80) = 480 \) points. The total of all 8 tests is \( (8)(85) = 680 \) points. The average of the 2 added tests is \( \frac{680 - 480}{2} = 100 \).

49. The correct answer is (B). \( y = \frac{1}{x} \) describes a direct relationship between \( y \) and \( z \) but an inverse relationship between \( x \) and \( y \).

50. The correct answer is (H). The generalized formula for a circle is \( (x - h)^2 + (y - k)^2 = r^2 \), where \( (h, k) \) is the center of the circle and \( r \) is the radius. Of the equations given, only \((x - 1)^2 + (y + 1)^2 = 25\) has a center at \((1, -1)\).

51. The correct answer is (B).

\[
-[(x - 4) - (3 - 2x)] = 3 - 5x + 6 \\
-(x - 4 - 3 + 2x) = 3 - 5x - 6 \\
-3x + 7 = -5x - 3 \\
2x = -10 \\
x = -5
\]

52. The correct answer is (K). The graph of sine has a period of \( 2\pi \). However, if you graph \( \sin \frac{x}{2} \), the period doubles in length to \( 4\pi \).

53. The correct answer is (A). In order for the equation to have only one real root, it must be a double root. Given the values in the equation, the only possibilities are \((x + 4)^2\) and \((x - 4)^2\). Only \((x - 4)^2\) gives a value for \( a \) that is one of the answer choices:

\[
(x - 4)^2 = x^2 - 8x + 16 \\
a = -8
\]

54. The correct answer is (G).

\[
x + .2x = 1.2x \\
1.2x - (.3)(1.2x) = .84x
\]

This is equivalent to decreasing \( x \) by 16%:

\[
x - .16x = .84x
\]

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55. **The correct answer is (A).** As shown in the diagram below, the height of the pole, $x$, is opposite $70^\circ$ and the hypotenuse is 50. Since sine equals opposite divided by hypotenuse:

$$\frac{x}{50} = \sin 70^\circ$$

$$x = 50 \sin 70^\circ$$

![Diagram of a pole with height $x$ opposite $70^\circ$ and hypotenuse 50.]

57. **The correct answer is (C).** The easiest way of solving this problem is to test each point and see which one satisfies both equations. Otherwise, you can solve the question using simultaneous equations:

$$2x + y = 2$$

$$-(\frac{1}{2}x + y = 2)$$

$$\frac{3}{2}x = 0$$

$$x = 0$$

$$y = 2$$

58. **The correct answer is (J).** The equation for line $m$ is $y = 3x + 8$. Since line $n$ is perpendicular to $m$, it must have a slope of $-\frac{1}{3}$. You can see that $3y = -x + 14$ has a slope of $-\frac{1}{3}$ when you put it into the slope-intercept form: $y = -\frac{1}{3}x + \frac{14}{3}$.

59. **The correct answer is (B).** The probability that you will draw either B or C out of the hat on the first draw is $\frac{2}{5}$. Your odds of drawing the remaining card on the second draw is $\frac{1}{4}$. The probability of both of these events happening is $\frac{2}{5} \times \frac{1}{4} = \frac{2}{20} = \frac{1}{10}$, which equals .1.

60. **The correct answer is (G).** The problem provides you with 2 equations for the prices of a shirt ($s$) and a tie ($t$): $s + 2t = 105$ and $2s + t = 135$. You can solve for $t$ using simultaneous equations. If you multiply both sides of the first equation by 2, then you get the following:

$$2s + 4t = 210$$

$$-(2s + t = 135)$$

$$3t = 75$$

$$t = 25$$
Section 3: READING

1. The correct answer is (D). Choices (A), (B), and (C) are incorrect because in the middle of the second paragraph, we learn that Storm and King is a “whole-sale dry goods concern.”

2. The correct answer is (H). Choice (H) is the best answer because in Paragraphs 4 through 7, the old gentleman treats her “kindly” and Carrie is surprised at her “pleasant reception,” even though she is told there is no work. For the same reason, choice (F) is incorrect. Choice (J) is incorrect because the old gentleman in Paragraph 4 shows Carrie no disdain. The old gentleman is not angry either, which makes choice (G) incorrect.

3. The correct answer is (B). Choice (A) is incorrect because the passage makes no reference to Carrie believing her move into the city was a “mistake.” Choice (B) is the best answer because the second sentence of the final paragraph states “so earnest an effort was well deserving of a better reward.” Choice (C) is incorrect because the passage ends with Carrie going homeward, making a “baffled retreat.” Choice (D) is incorrect because nowhere in the passage does Carrie express an opinion that looking for work is a “waste of time.”

4. The correct answer is (G). Choice (F) is incorrect because the passage does not mention Carrie pretending she is a spy. Choice (G) is the best answer because in the first paragraph, we learn that Carrie “assumed an air of indifference just as if she were upon an errand.” Choice (H) is incorrect because the passage does not mention Carrie pretending she is a boss. Choice (J) is incorrect because the passage does not mention Carrie pretending she is rich.

5. The correct answer is (B). Choice (A) is incorrect because “Monroe” is mentioned in Paragraph 3. Choice (B) is the best answer because “Block” is not mentioned as a street name in Paragraph 3. Choice (C) is incorrect because “Madison” is mentioned in Paragraph 3. Choice (D) is incorrect because “State” is mentioned in Paragraph 3.

6. The correct answer is (J). Choice (J) is the best answer because *ornamented*, in this context, means “adorned.”

7. The correct answer is (C). Choice (A) is incorrect because Carrie is never described as being irate. Choice (B) is incorrect because the passage never mentions Carrie’s feelings for other workers. Choice (C) is the best answer because in the final paragraph, we learn that Carrie has lost “her hopes, her courage, and her strength” and that she “felt her own helplessness.” Choice (D) is incorrect because Carrie’s despondent feelings, as mentioned in the final paragraph, show that she is not being mechanical about her job search.

8. The correct answer is (F). Choice (F) is the best answer because the last sentence of the passage tells the reader that Carrie was “sick at heart and in body.” Choice (G) is incorrect because though Carrie looked “vainly” for work (final paragraph), that does not equate to “van- ity” or self-love. Choice (H) is incorrect because the last sentence of the passage tells the reader that Carrie was “sick at heart and in body,” consequently not “wholesome.” Choice (J) is incorrect because the last sentence of the passage tells the reader that Carrie was “sick at heart and in body,” so she would not have a “renewed sense of purpose.”
9. The correct answer is (D). Choice (A) is incorrect because the old gentleman never mentions Carrie not finding work. Choice (B) is incorrect because the old gentleman never mentions an employment agency. Choice (C) is incorrect because the old gentleman never mentions Carrie’s skills. Choice (D) is the best answer because the old gentleman says “Come in some time next week” in Paragraph 6.

10. The correct answer is (H). Paragraph 2 tells us “two men came out and paused in the door . . . She looked helplessly around, and then, seeing herself observed, retreated. It was too difficult a task. She could not go past them.” “Them” in the final sentence refers to the men in the doorway, not the messenger. Choices (F) and (G) are incorrect because “Them” does not refer to the messenger or the pedestrians on the street. Choice (H) is the best answer because Paragraph 2 tells us “two men came out and paused in the door . . . She looked helplessly around, and then, seeing herself observed, retreated. It was too difficult a task. She could not go past them.” “Them” in the final sentence refers to the men in the doorway. Choice (J) is incorrect because Paragraph 2 does not mention Carrie’s inability to find the entrance to the store.

11. The correct answer is (B). Choice (A) is incorrect because the passage does not say that Westerners had taken Fijian property. Choice (B) is the best answer because Paragraph 4 begins by stating that “In a traditional Fiji tribe an individual as such can hardly be said to own property, for nearly all things belong to his family or clan.” Choice (C) is incorrect because, according to the first paragraph, the chief cannot sell land without “the consent of his tribe.” Furthermore, Paragraph 4 states that property belongs to the “family or tribe.” Choice (D) is incorrect because the passage does not mention evil phantoms or spirits.

12. The correct answer is (J). Choice (F) is incorrect because burnt offerings to the gods are not mentioned in the passage. Choice (G) is incorrect because semiprecious stones are never mentioned in the passage. Choice (H) is incorrect because the granting of a Fijian name is not mentioned as a way to represent a contract. Choice (J) is the best answer because Paragraph 2 states that a whale’s tooth expressed “good will” and was comparable with “a signed contract.”

13. The correct answer is (B). Choice (A) is incorrect because Western destruction of Fijian values is not mentioned in the passage. Choice (B) is the best answer because Paragraph 3 begins with the statement: “As in all communities, including our own world of finance, a man’s wealth consisted not only in what he possessed but even more so in the number of people from whom he could beg or borrow,” then presents the Tanao story as an example of this principle. Choice (C) is incorrect because theft is not mentioned until Paragraph 4. Choice (D) is incorrect because the anecdote is not presented to show the difficulty of obtaining Fijian trust.

14. The correct answer is (H). Choice (F) is incorrect because competition in world markets is not mentioned in the passage.
Choice (G) is incorrect because Paragraph 7 tells us that instead of profiting from capitalism, Fijians instead are “becoming enmeshed in the rat race of modern civilization. Sadly, this race rarely has a happy ending.” Choice (H) is the best answer because Paragraph 7 shows that the author believes that modern civilization (capitalism) “entails the hoarding of wealth and becoming enmeshed in the rat race of modern civilization. Sadly, this race rarely has a happy ending.” Choice (J) is incorrect because Paragraph 7 clearly shows that modern civilization has had an impact on the lives of Fijians.

15. The correct answer is (A). Choice (A) is the best answer because Paragraph 4 clearly links the lack of personal property to the difficulty in introducing “ideals of modern progress” in Fiji. Choice (B) is incorrect because religious customs are never discussed. Choice (C) is incorrect because land laws are never mentioned in relation to the introduction of “ideals of modern progress.” Choice (D) is incorrect because Western cultural indoctrination is never mentioned in relation to the introduction of “ideals of modern progress.”

16. The correct answer is (F). Choice (F) is the best answer because the paragraph discusses contracts and uses the word compliance to signify agreement. Choice (G) is incorrect because compliance would never mean “introduction.” Choice (H) is incorrect because compliance would never mean “withdrawal.” Choice (J) is incorrect because compliance would never mean “inconsistency.”

17. The correct answer is (D). Choice (A) is incorrect because the final paragraph in the passage does not mention Chief Thakombau’s parents. Choice (B) is incorrect because the final paragraph in the passage does not mention Chief Thakombau’s hoarded wealth, and the eighth paragraph tells us the hoarded wealth was not respected in Fiji. Choice (C) is incorrect because the final paragraph in the passage says that Chief Thakombau’s Christian name was “Ebenezer.” Choice (D) is the best answer because the final paragraph says “Chief Thakombau began life as “Seru,” then after the civil war in which he overcame his father’s enemies and reestablished Tanoa’s rule in Mbau, he was called “Thakombau” (evil to Mbau).

18. The correct answer is (G). Choice (F) is incorrect because although I is discussed in Paragraph 1, II is also discussed. Choice (G) is the best answer because I is mentioned in Paragraph 1 (“land tenure”), II is mentioned in Paragraph 7 (“Fiji before capitalism took hold”), and III is not mentioned. Choice (H) is incorrect because although II is discussed in Paragraph 7, III is never discussed. Choice (J) is incorrect because although I is mentioned in Paragraph 1 (“land tenure”), and II is mentioned in Paragraph 7 (“Fiji before capitalism took hold”), III is never mentioned in the passage.

19. The correct answer is (D). Choice (A) is incorrect because the passage does not say that chiefs may not declare war. Choice (B) is incorrect because the passage does not mention starting communities on the same island. Choice (C) is incorrect because the passage makes no reference to chiefs cultivating land. Choice (D) is the best answer because the second sentence of the passage states, “In general it may be said that the chief could sell no land without the consent of his tribe.”
20. The correct answer is (H). Choice (F) is incorrect because the lack of jobs in Fiji is never presented as a benefit of the lack of ambition to acquire personal property. Choice (G) is incorrect because the lack of ambition would not promote industrialization, but rather would have the opposite effect. Choice (H) is the best answer because Paragraph 4 ends with the statement that “No one could be a miser, a capitalist, a banker, or a promoter in such a community, and thieves were almost unknown.” Choice (J) is incorrect because the passage does not mention friendship between Fijian chiefs.

21. The correct answer is (C). Choice (A) is incorrect because there is no indication in the passage that anyone in Michelangelo’s family was in poor health. Choice (B) is incorrect because although Michelangelo’s father advised his son to take care of his health, there is nothing in the passage that implies Michelangelo’s father meant this advice as a demand. Choice (C) is the best answer because in Paragraph 2, Michelangelo’s father states, “In your profession, if once you were to fall ill you would be a ruined man.” Choice (D) is incorrect because although Michelangelo’s work was extremely physical and the possibility of injury existed, this possibility is never mentioned, nor does it have any bearing on whether or not he maintained his long-term health.

22. The correct answer is (F). Choice (F) is the best answer because it paraphrases the statement in Paragraph 1: “The great artist was so prone to over-anxiety and met (whether needlessly or not) with so many rebuffs and disappointments that only constant absorption in manual labor prevented spirit from fretting itself free from flesh.” Choice (G) is incorrect because it contradicts the above statement and because, in Paragraph 6, the author describes him as “miserly, suspicious, quarrelsome and pessimistic.” Choice (H) is incorrect because nowhere does the passage make reference to other artists or how they might aspire to Michelangelo’s greatness. Choice (J) is incorrect because in Paragraph 4, the lines “though the production of his hand was not good” imply that Michelangelo was not able to produce work as skillfully and artistically impressive as he once had.

23. The correct answer is (D). Choice (D) is the best answer because Paragraph 4 states that, while the artist still painted and sculpted with the skill of a genius at age 75, he later lost the required energy for such work and so turned to such works as St. Peter’s and other architectural projects.

24. The correct answer is (H). Choice (F) is incorrect because I is incorrect. Although reference is made to the coarse nature of Michelangelo’s dress habits (he left his boots on for so long that when he took them off, the author says they came away “like the skin of a molting serpent”—Paragraph 2), no mention is made of his sense of humor. In fact, from the description the author gives of Michelangelo in the last paragraph, one might think the artist had no sense of humor at all. Choice (G) is incorrect because although III is correct, I is incorrect. Choice (H) is the best answer because although II and III are supported by Paragraph 3 with the phrases “his intensity of purpose and fierce energy” and “for [Michelangelo’s] mental powers one of his colossal statues would seem a more fitting mold.” Choice (J) is incorrect because, although II and III are correct, I is incorrect.
25. The correct answer is (A). Choice (A) is the best answer because the beginning of Paragraph 2, specifically the lines “art became his religion and required of him the sacrifice of all that might keep him below his highest level of power for work,” indicate that the rest of the paragraph will describe the elements that Michelangelo sacrificed for his work. Sleep and food are two of these elements. Choice (B) is incorrect because although in Paragraph 6 the lines “Michelangelo [was] affected by a degree of neuropathy bordering closely upon hysterical disease” imply that Michelangelo was not of sound mind, the next lines “What a pity that more of us do not suffer from such degrees of neuropathy and how much better for most of us if we had such enthusiasm for perfection” imply that, to the author, such madness is desirable. Choice (C) is incorrect because there is no indication in the passage that Michelangelo was anything but prolific. In fact, in the first paragraph, the lines “He toiled ‘furiously’ in all his mighty undertakings that body and mind remained one and in abundant health for nearly four score and ten years” indicate that, since Michelangelo worked throughout his almost ninety years, he was indeed prolific. Choice (D) is incorrect because, although Michelangelo was intent on controlling his health, the implication of the second paragraph is that he limited his food and health in order to devote every minute possible to his art.

26. The correct answer is (H). Choice (F) is incorrect because dress cannot bruise the flesh. Choice (G) is incorrect because dress cannot darken the flesh. Choice (H) is correct because the context of “mortify” makes it clear that Michelangelo’s dress habits had little to do with beautification. Choice (J) is incorrect because, if mortify meant warmth, Michelangelo would be more likely to take the boots off than leave them on for long periods of time.

27. The correct answer is (B). Choice (A) is incorrect because although the passage may imply that living the way Michelangelo did may help other people live as long as Michelangelo did, it is not the main idea of the passage. Choice (B) is the best answer because it is a paraphrase of the first paragraph, in particular, the lines “there is nothing so conducive to mental and physical wholesomeness as saturation of body and mind with work.” Choice (C) is incorrect because in Paragraph 2, the author states that Michelangelo remained healthy not simply because he wished to but because he took scrupulous care of himself. He knew if he did not remain healthy, he could not work. Also, in Paragraph 5, the author implies that Michelangelo stayed healthy because he remained active, even when he couldn’t pursue manual labor as he once had. Choice (D) is incorrect because, although in Paragraph 6 the author refers to Michelangelo’s devotion to his art as a type of madness, the author clearly does not consider the artist truly mad because he states that such devotion is an admirable, beneficial state of mind. In addition, the question of the artist’s sanity is not the main idea of the passage.

28. The correct answer is (F). Choice (F) is the best answer because only I is correct, supported by the statement in Paragraph 2 that “he ate comparatively little and slept less than many men because he worked better.” Choice (G) is incorrect because, although I is correct—see explanation for choice (F)—II is wrong; paragraph 6 indicates that
Michelangelo’s miserliness was an undesirable quality that his good qualities, the ones that helped preserve him, balanced out. Choice (H) is incorrect for the same reason that choice (G) was incorrect. Michelangelo’s pessimism was an undesirable quality that his good qualities, the ones that helped preserve him, balanced out. Choice (J) is incorrect because II and III are wrong.

29. The correct answer is (D). Choice (A) is incorrect because whether or not Michelangelo’s last sculptures were not as great as his earlier work is a matter of opinion. There are some that disagree completely with that statement. Choice (B) is incorrect because whether or not Michelangelo’s good qualities balanced out his bad is a matter of opinion. There are some who believe that certain bad qualities can never be outweighed by any good. Choice (C) is incorrect because, again, the statement is a matter of opinion and impossible to determine for certain. Choice (D) is the best answer because the statement is a fact, supported by Paragraph 5.

30. The correct answer is (G). Choice (F) is incorrect because no reference is made in the passage to the subject matter of Michelangelo’s work. Choice (G) is the best answer because the description the author gives of Michelangelo in Paragraph 3 is of a man whose appearance is flawed and not as befitting a man of his genius as one of his statues would be. Choice (H) is incorrect because several references are made to Michelangelo’s great intellectual capacity. In Paragraph 1, it is stated that his “body and mind remained one and in abundant health for nearly four score and ten years.” In Paragraph 3, reference is made to his mental powers being the equivalent in size to “one of his colossal statues.” Choice (J) is incorrect because, although reference is made to Michelangelo’s statues as “colossal” (Paragraph 3), this does not mean he never created smaller-scale statues.

31. The correct answer is (C). Choice (A) is incorrect because Paragraph 11 says that mosquitoes benefit from more midge larvae. Choice (B) is incorrect because the passage does not mention the effect that fly larvae have on mosquitoes. Choice (C) is the best answer because Paragraph 11 begins with the statement that “Biologists found that the more midges there were in a pitcher plant, the better off the mosquitoes were.” Choice (D) is incorrect because the passage does not suggest that mosquitoes benefit from “any change” in the amount of bacteria. Since mosquitoes eat the bacteria, it may be assumed that a decrease in the amount of bacteria would harm them.

32. The correct answer is (J). Choice (F) is incorrect because I is wrong: The roots of the pitcher plant are never mentioned. Choice (G) is incorrect because although II is correct, III is also correct. Choice (H) is incorrect because I is wrong: The roots of the pitcher plant are never mentioned. Choice (J) is the best answer because II is correct (supported by information in Paragraph 4) and III is correct (supported by information in Paragraph 4).

33. The correct answer is (C). Choice (C) is the best answer because Paragraph 6 states that “Each larva has a life span of about a year, which is also the life span of each pitcher plant leaf.”

34. The correct answer is (F). Choice (F) is the best answer because Paragraph 3 says the “pitcher plant does not produce enzymes.” Choice (G) is incorrect because Paragraphs 5–8 discuss the insect species
Practise Test 3

lives in the pitcher plant. Choice (H) is incorrect because Paragraph 4 states that the plant has “a highly acidic mixture.” Choice (J) is incorrect because Paragraph 3 states that the pitcher plant “absorbs nutrients” from its internal ecosystem.

35. The correct answer is (D). Choice (A) is incorrect because the passage does not mention fly larvae being a danger to anyone. Choice (B) is incorrect because according to Paragraph 7, fly larvae float on the top of the pitcher pool. Choice (C) is incorrect because Paragraph 11 says “since the mosquitoes brought no harm to the midges,” which suggests that the mosquitoes did not affect the midges. Choice (D) is the best answer because Paragraph 7 states “The fly larvae are much larger than the midge and mosquito larvae.”

36. The correct answer is (H). Choice (F) is incorrect because the plant’s root system is never mentioned. Choice (G) is incorrect because the surplus of water is not mentioned as a reason that the pitcher plant cannot extract nitrogen from the soil. Choice (H) is the best answer because the first paragraph says “it’s simply too acidic for the bacteria that break down dead plant matter to grow in.” Choice (J) is incorrect because the insect larvae are not mentioned as a reason that the pitcher plant cannot extract nitrogen from the soil.

37. The correct answer is (A). Choice (A) is the best answer because Paragraph 8 states “The mosquito has to wait for the midge to finish eating, since the mosquito can only consume very small particles of insect that the midge chews up first.” Choice (B) is incorrect because the pitcher plant only absorbs the nutrients after they have been completely broken down by the larvae. Choice (C) is incorrect because the passage does not say that the insect parts must be frozen to be eaten by the mosquito larvae. Choice (D) is incorrect because if the insect parts were completely consumed by the fly larvae, there would be no parts left for the midge or mosquito larvae to eat.

38. The correct answer is (H). Choice (F) is incorrect because the passage does not say the tubes were used to trap mosquitoes. Choice (G) is incorrect because the passage does not say the tubes were used to test the acidity of the bog soil. Choice (H) is the best answer because according to Paragraph 9, “These tubes were then used in a variety of experiments to determine just how the insect larvae in pitcher plants process their food.” It can be assumed that since the tubes were filled with pitcher plant water and used to examine the interactions within the plant, the tubes were designed to simulate the form of the plant. Choice (J) is incorrect because the passage does not say that fly larvae compete with other larvae in the pitcher plant.

39. The correct answer is (B). Choice (A) is incorrect because downward-pointing hairs are mentioned in Paragraph 4. Choice (B) is the best answer because Paragraph 3 states that the “pitcher plant does not produce enzymes.” Choice (C) is incorrect because purple veins are mentioned in Paragraph 4. Choice (D) is incorrect because a highly slippery section of the leaf is mentioned in Paragraph 4.

40. The correct answer is (G). Choice (F) is incorrect because unlike a person producing food for others, the midge and fly larvae consume what comes to them, leaving the scraps for the mosquito larvae. Choice (G) is the best answer because the vulture example is the only example where the consumer of the pro-
cessed food (the vulture) eats what is left over by the original consumer (the wolf), which mirrors the relationship between midge and mosquito larvae as described in the passage. Choice (H) is incorrect because the shark benefits from the fish’s cleaning, and the midge does not benefit from its food processing for the mosquito (see Paragraph 11). Choice (J) is incorrect because it describes a competitive system (the “taking of food from other smaller birds”), which Paragraphs 7 and 11 clearly state that midges and mosquitoes do not compete for resources in the pitcher plant.

Section 4: SCIENCE REASONING
1. The correct answer is (D). Looking at the table, Resistor B has a current of 345 milliamps when the temperature is 23 degrees and the voltage is 3 volts.

2. The correct answer is (F). Current for Resistor C at 5 volts and 25 degrees was 90 milliamps, and for every 1 volt increase, the current increases by 18 milliamps. The current at 6 volts would be 108 milliamps.

3. The correct answer is (C). When exposed to different temperatures, Resistor A and Resistor B are not affected.

4. The correct answer is (H). A thermistor is a device that shows different resistances based on sensitivity to temperature; therefore, Resistor C could be the one thermistor.

5. The correct answer is (D). Resistor B does not have a linear relationship between voltage and current.

6. The correct answer is (F). Resistor A seems to be an ohmic device because there is a linear relationship between voltage and current. If Resistor A released heat into the water, it would not be considered an ohmic device.

7. The correct answer is (C). Choice (C) is correct because although most nutrients are decreasing, the table shows a net gain for these two.

8. The correct answer is (G). Review Table 1 to see that the largest percentage decreases are shown for choice (G), Silica and Aluminum.

9. The correct answer is (B). The purpose of using the different techniques was to insure that the scientists could capture the different sizes of material exiting the ecosystem.

10. The correct answer is (J). This experiment was designed to track the effects of logging on watersheds that were already losing nutrients. The design of the experiment and the design/display of the results in Table 2 show the ecologists’ concern about loss of nutrients to be of crucial importance. Choice (H) is the only option that reflects this concern.

11. The correct answer is (A). Close examination of the results displayed in Table 2 show that there is no pattern to the loss of substances in the undisturbed watershed and that the loss is relatively small. The logged area is losing nutrients, and this is increasing year to year. The only answer that reflects this comparison is choice (A).

12. The correct answer is (J). Nutrients are more dramatically depleted in the logged area, so a way to retain some of the nutrients would be useful. If tree bark contains many nutrients, keeping it in the system would help toward this end.

13. The correct answer is (C). The element with the atomic weight of 85.5 is rubidium, and its melting point is 39 degrees.

14. The correct answer is (J). Sodium’s density is 0.97 g/cm³, and cesium’s den-
15. **The correct answer is (B).** According to the table, as atomic number increases, melting point decreases.

16. **The correct answer is (J).** Cesium has a higher atomic number than rubidium and a higher density. Potassium has a higher atomic weight than lithium and a higher density.

17. **The correct answer is (D).** Melting point seems to decrease with increase of atomic number. If another metal existed with a greater atomic number, the melting point would be higher than that of cesium. Density does not clearly increase as atomic number increases, so it would be difficult to predict the density of the element.

18. **The correct answer is (G).** The oldest rocks are at the higher altitudes, according to the table.

19. **The correct answer is (C).** Gabbro has the highest crystallization temperature of the rocks listed.

20. **The correct answer is (F).** The vertical axis is the altitude.

21. **The correct answer is (A).** The highest crystallization temperatures are found with peridotite. Peridotite is found 40 miles inland.

22. **The correct answer is (J).** The age of rocks is not related to the distance from the shore that the rocks are found. The oldest rocks are found closest to the coast and furthest from the coast.

23. **The correct answer is (B).** Limestone is found 80 miles inland, and andesite is found 120 to 140 miles inland. The andesite is further east than the limestone. The limestone is 6.0 million years old. The andesite is 3.6 to 4.0 million years old. Andesite from volcanoes would have had to erupt after the deposit of the limestone.

24. **The correct answer is (G).** Paleontologist A believes that morphological (body) similarities can just as reasonably be assumed to represent the effects of convergent evolution on distant lineages inhabiting similar environments.

25. **The correct answer is (A).** Paleontologist A believes that dinosaurs and birds share a common ancestor. A fossil find from before the age of the dinosaurs with common features would support this view.

26. **The correct answer is (H).** Paleontologist B assumes that the body similarities between dinosaurs and early birds must be evidence that birds came forth from the dinosaur lineage. This view does subscribe to the idea of transitional forms. Mass extinction is not relevant to this view.

27. **The correct answer is (D).** Paleontologist B believes that birds arose out of a lineage of dinosaurs.

28. **The correct answer is (F).** This contradicts the theory of Paleontologist B because Paleontologist B suggests that birds arose from dinosaurs. Paleontologist A suggested that the two arose from an extremely distant ancestor, and the theory of convergent evolution is not inconsistent with birds appearing before dinosaurs.

29. **The correct answer is (C).** Paleontologist A postulates the existence of a very distant common ancestor for birds and dinosaurs. The development of birds much later than that of dinosaurs might seem to refute this argument. However, the rate of evolutionary change is not constant across different lineages. Dinosaurs may have developed relatively rap-
idly from thecodonts, for example, whereas birds did not evolve until much later.

30. **The correct answer is (G).** Close examination of Table 2 shows that the only factor being changed is the number of species of bacteria present.

31. **The correct answer is (B).** Examining the results in Tables 1 and 2 shows that although in Experiment 2 fewer *Paramecium* survived overall when their number of species was increased from 1 to 2, increasing the number of species of their food sources, the bacteria, did produce a relative increase in their survival rate.

32. **The correct answer is (F).** Looking at Tables 1 and 2, it appears that increasing the number of species of *Paramecium* from one to two was most detrimental to their overall survival.

33. **The correct answer is (D).** Experiment 3 added a predator of *Paramecia*. The number of bacteria species remained at 3; we have no information that the time or the culture method was changed.

34. **The correct answer is (J).** The results of this experiment suggest that increasing diversity in terms of trophic levels was ultimately harmful to the survival of the *Paramecium* species under study. It was not beneficial to all species because of the decreasing survival rates for the *Paramecia*.

35. **The correct answer is (B).** Neptune’s density is 1,638 kg/m³. Saturn has a density of 687 kg/m³, Uranus has a density of 1,318 kg/m³, and Jupiter has a density of 1,326 kg/m³.

36. **The correct answer is (J).** Neptune has the lowest temperature, so, based on that measure, it would seem to be the furthest from the sun.

37. **The correct answer is (C).** Mercury has an orbital inclination of 7.000 degrees and an orbital eccentricity of 0.2056. Pluto has an orbital inclination of 17.14 degrees and an orbital eccentricity of 0.2488. Therefore, there are two planets that would be recategorized.

38. **The correct answer is (H).** Pluto would lose its designation as a planet because its mass is smaller than that of Earth’s Moon.

39. **The correct answer is (B).** The gaseous planets would be expected to be less dense than the ones made of solid material.

40. **The correct answer is (G).** Venus and Mercury do have the longest rotation periods. Mars and Earth do have similar rotation periods. The planets with the greatest mass do have the shortest rotation period. As black-body temperature decreases, the rotation periods do not necessarily decrease.
PART V

LIFE AFTER THE ACT

ASSESSMENT

APPENDIX A Applying to the College of Your Choice

APPENDIX B Finding Financial Aid

APPENDIX C Choosing the Right College

APPENDIX D Who Are You?
Applying to the College of Your Choice

WHEN TO APPLY

After you’ve narrowed your list of possible colleges down to a handful of schools, it’s time to start the application process. So, when should you start?

All schools fall into one of three types of admission categories:

- **Selective admission**—with firm applications deadlines, generally these fall in January.
- **Rolling admission**—where there is no firm application deadline, and applicants are accepted (and rejected) until the freshman classes are full.
- **Open admission**—used by many two-year colleges, where there is no admission deadline and the schools accept anyone with a high school diploma until classes begin.

All that said, you should probably start preparing your applications in November and December and submit all your applications no later than January. There is little benefit to submitting much earlier than that, and there is a downside if you submit later. When in doubt, contact the college of your choice to find out its recommended application date.

ABOUT THE EARLY ACTION AND EARLY DECISION OPTIONS

Some colleges offer Early Action and/or Early Decision plans that enable you to apply to your first-choice schools early and receive early notification of your acceptance or rejection—often as early as December. These plans have benefits for both you and the schools. Early applicants get the first chance at financial aid packages, fellowships, and student housing, and they can put the whole college application process behind them and enjoy the rest of their senior year. The colleges get to start constructing their freshman class profile—with a group of students who are really committed to attending their school. The plans have drawbacks, as well, so let’s look at them in a bit more detail.
Under most Early Action plans, you can apply to schools as early as November and receive notification of acceptance as early as January or February. Most Early Action plans require that you accept or reject admission by May 1. You can apply to a number of schools (if they offer this plan, that is) and compare the financial aid packages and offers before you accept. If you are relatively certain of which schools you're really interested in attending, and if you fit the “profile” of their average applicant, Early Action gives you a chance to compete in a smaller applicant pool and let your first-choice schools know right up front that you're interested in them. If you need time to shop around, though, or if you need as much as time as possible to boost your academic performance, Early Action might not be for you. Check each college's published guidelines for its Early Action plan before you commit to this route.

Early Decision plans offer many of the same benefits as Early Action, but they involve some restrictions, too. As a rule, you make your Early Decision applications in November and receive notification as early as December. Under most Early Decision plans, you can only have one Early Decision application underway at any one time. You can apply to other schools but only under their regular admissions plan. And most Early Decision plans require you to accept admission if it is offered to you and if it’s accompanied by an adequate financial aid package. If you're accepted by your first-choice school, you have to withdraw all other outstanding applications. Obviously, this plan can prevent you from comparing financial aid offers from other schools. Because it might be a binding agreement, Early Decision is right for a more select group of students. It’s well worth considering if:

• You know with certainty your first-choice school, and you fit its applicant profile.
• You don’t need time to boost your academic performance prior to applying.
• You don’t need to negotiate the highest possible financial aid package.

And, as with Early Action plans, before you decide to participate in Early Decision, carefully read the college’s published guidelines for the program.

HOW TO APPLY

When you’re ready to apply, what is involved? Although each school has its own specific admissions guidelines (and you should contact each school to get a copy of these), there are some general guidelines used by most major institutions. In fact, many colleges are now using something called the Common Application, an eight-page form created by the National Association of Secondary School Principals.

NOTE

There is one general exception to the application rule. Many schools offer honors programs and honors scholarships, and these programs and scholarships often have earlier application deadlines, sometimes as early as the Fall.
For any school using the Common Application, you only have to fill out one form, which can then go to multiple colleges. You can get copies of the Common Application from your high school guidance office; you’ll have to get institution-specific application forms from the individual schools.

In addition, many schools now accept applications either via software or online forms. (See “Applying On Line,” for more information on applying on line.) If your school is one of those that let you apply on line, take advantage of the opportunity—at the very least, it will save you a few stamps!

FILLING OUT THE APPLICATION

The Common Application and most private application forms include the following sections:

• Personal Data—including information such as your name, address, possible areas of concentration, language spoken, and whether or not you’ll be applying for financial aid.

• Educational Data—such as the school you currently attend, your graduation date, the name of your high school counselor, etc.

• Test Information—specifically your SAT or ACT Assessment scores.

• Family—information about your family—father’s name, mother’s name, where they went to school, their occupations, that sort of thing.

• Academic Honors—where you should describe any scholastic distinctions or honors you have won (since the ninth grade).

• Extracurricular, Personal, and Volunteer Activities—where you get to impress the judges with all the things you do outside of school. This is more important than it might sound, most often the second item read by admission officers, who want to make sure you have a well-rounded background. Make sure you include sports, volunteer work (not paid work!), and other non-academic activities—and list them in order of importance.

• Work Experience—where you list all the jobs you’ve held during the past three years. Don’t forget to fill in the section where you elaborate on the most important of these activities (work and other) and why they were important to you.

• Personal Statement—otherwise known as the essay. Some schools require this; many don’t. For those that do, you’re often asked to evaluate an important experience in your life; discuss a national, local, or personal issue; or describe how one person has influenced your life. Take your time with these, and make sure what you write has meaning and is written well.

TIP

You really should visit your first-choice school before you opt for its Early Decision plan (the summer before your senior year is a good time to visit the colleges that you think you might want to attend). If you commit to an Early Decision plan without first having visited the campus, you’re committing yourself to a largely unknown academic destination. Take the time to look before you leap!
OTHER MATERIALS TO SUBMIT

In addition to the application form, you’ll also need to submit some or all of the following, depending on school guidelines:

- **Recommendation letters** from one or more of your teachers (although some colleges have predefined forms they use instead of free-form letters).
- **Counselor form** (also known as the School Report), often a separate form that must be completed by your school counselor.
- **SAT/ACT Assessment results**, which some colleges require to be submitted directly by your high school.
- **Major-specific requirements**. Some individual schools and majors have their own specific requirements. For example, most schools require music majors to arrange and pass an audition.
- **Application fee**.

You should submit these materials directly to the admissions offices of the colleges you have selected—unless you’re applying online.

COLLEGE ADMISSIONS TIMELINE

Taking into account everything discussed in this appendix (and a lot more!), the following table provides you with a detailed timeline to plan your college admissions activities.

### COLLEGE ADMISSIONS TIMELINE

<table>
<thead>
<tr>
<th>When</th>
<th>What to do</th>
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</thead>
<tbody>
<tr>
<td><strong>Junior Year of High School</strong></td>
<td>Make sure that PSAT/NMSQT registration is handled by your guidance counselor staff (except in regions where ACT Assessment test is prevalent). Find out and save the date. Ask your guidance department about college fairs in your area and college admission-representative visits to the school. Attend fairs and sessions with reps at school. Familiarize yourself with guidance-office resources.</td>
</tr>
<tr>
<td>When</td>
<td>What to do</td>
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</tr>
<tr>
<td>October</td>
<td>Make sure PSAT/NMSQT date is on your calendar. Read the student bulletin and try the practice questions. Schedule a day trip to visit nearby colleges. Don’t worry if these are places where you won’t apply; the goal is to explore different types of schools, so aim for variety. Discuss which characteristics are attractive and which aren’t.</td>
</tr>
<tr>
<td>December</td>
<td>Questions about PSAT scores? Contact your guidance counselor. If necessary, discuss strategies for improving weak areas. Evaluate different SAT prep options, as needed. Take advantage of college students home for vacation. Ask them questions. Take an introductory look at financial aid forms, just to see what you’ll need by this time next year.</td>
</tr>
<tr>
<td>January</td>
<td>Evaluate your academic progress so far. Are your grades up to par? Are course levels on target? Do your study habits need improvement? Begin thinking about worthwhile summer plans (job, study, camp, volunteer work, travel, etc.). Mark projected SAT I &amp; II or ACT Assessment test dates on your calendar. Also mark registration deadlines.</td>
</tr>
<tr>
<td>February</td>
<td>Look ahead to SAT or ACT Assessment registration deadlines for the tests you plan to take. Are you about to miss one? Mark appropriate dates on your calendar. (A few juniors have reason to take the SAT I in March. If you will do so, heed February registration deadline.) Buy a general guidebook to U.S. colleges and universities. Start checking out prospective schools via their Web sites.</td>
</tr>
<tr>
<td>March</td>
<td>Consider and plan spring-vacation college visits. Begin listing target colleges in a notebook or computer spreadsheet or database. Begin calling, writing, or e-mailing target colleges to request publications. Set aside an area for college propaganda. Invest in folders for materials from front-runner schools.</td>
</tr>
</tbody>
</table>
### COLLEGE ADMISSIONS TIMELINE (CONT.)

<table>
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<tr>
<th>When</th>
<th>What to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>March (cont.)</td>
<td>Look ahead to SAT or ACT Assessment registration deadlines for the tests you plan to take. Are you about to miss one? Mark appropriate test and registration dates on your calendar. Make sure you discuss plans to take Advanced Placement exams with teachers and/or guidance counselor as needed.</td>
</tr>
<tr>
<td>April</td>
<td>Look ahead to SAT or ACT Assessment registration deadlines for the tests you plan to take. Are you about to miss one? Mark appropriate test and registration dates on your calendar. Decide on senior year classes. Include at least one math course or lab science, as well as the most challenging courses possible. Recognize that colleges weigh senior classes and grades as heavily as the junior record. Update your activities record.</td>
</tr>
<tr>
<td>May</td>
<td>Look ahead to SAT or ACT Assessment registration deadlines for the tests you plan to take. Are you about to miss one? Mark the appropriate test and registration dates on your calendar. Assess the need for and affordability of special services such as standardized test-prep courses, independent college counselors, and private group tour programs. Do you need to take the TOEFL (Test of English as a Foreign Language)? Select date and oversee registration.</td>
</tr>
<tr>
<td>June</td>
<td>Look ahead to SAT or ACT Assessment registration deadlines for the tests you plan to take. Are you about to miss one? Mark the appropriate test and registration dates on your calendar. Make sure you have a job or constructive activities throughout most of the summer. Study, jobs, and volunteer work always rate high with admission officials. Consider and plan summer and fall college visits. Request publications from additional target colleges. Plan and execute supplemental submissions</td>
</tr>
<tr>
<td>Summer</td>
<td></td>
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</tbody>
</table>
### When

#### Senior Year of High School

**September**
- Discuss plans and goals for the months ahead; pros and cons of target schools.
- Look ahead to SAT or ACT Assessment registration for the tests you plan to take. Are you about to miss one? Mark the appropriate test and registration dates on your calendar.
- Ask your guidance counselor about college fairs in your area and college admission representative visits to the school. Make certain that you attend fairs and sessions with representatives at schools.
- Finalize fall college visit plans. Include campus overnights where possible. Visit!
- Request additional publications and applications from target colleges.
- If applicable, take appropriate Early Action and Early Decision application steps, as outlined in the published guidelines of your first-choice schools.

**October**
- Look ahead to SAT or ACT Assessment registration for the tests you plan to take. Are you about to miss one? Mark the appropriate test and registration dates on your calendar.
- Draw up a master schedule of application and financial aid due dates, and then put them on your calendar.
- Begin considering essay topics and requesting teacher recommendations.
- Visit colleges. Include interviews on campus (or with local alumni representatives).
- Attend college fairs.
- For another look at college life, rent a movie like *Animal House* or *School Daze*.
- Again, review Early Decision and Early Action options and requirements, and take appropriate actions.

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<th>When</th>
<th>What to do</th>
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<tbody>
<tr>
<td>Summer (cont.)</td>
<td>such as audition tapes and art slides/portfolio, if required and/or appropriate. Review and update target college list. Include pros and cons. Make tentative plans for Fall visits. Begin to explore Early Action and Early Decision options at first-choice schools. Get the materials you need and read them carefully.</td>
</tr>
<tr>
<td>When</td>
<td>What to do</td>
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<tr>
<td>November</td>
<td>Look ahead to SAT or ACT Assessment registration for the tests you plan to take. Are you about to miss one? Mark the appropriate test and registration dates on your calendar. Reduce target college long list to a short list, where applications will be made. Plan a Thanksgiving break that includes college visits (to almost empty campuses). What is the status of your applications? Get someone to proofread your applications and essay(s).</td>
</tr>
<tr>
<td>December</td>
<td>Look ahead to SAT or ACT Assessment registration for the tests you plan to take. Are you about to miss one? Mark the appropriate test and registration dates on your calendar. Pick up financial aid material from guidance office and attend planning workshops, if available. Check out financial aid resources on the Internet. Make sure that teachers and guidance counselors are up-to-date with reference forms and that transcripts are being sent to all short-list colleges. Some Early Decision notifications may be sent this month—be on the lookout if you’ve applied under this plan.</td>
</tr>
<tr>
<td>January</td>
<td><strong>Begin filling out financial aid forms.</strong> Finish and mail these forms as soon as possible and <strong>never late</strong>. <strong>Complete all applications</strong>, including those with later deadlines. Don’t forget to photocopy everything and save it in accordion files. If SATs are being taken this month, are “Rush” scores required? Ask target colleges, if you’re not certain.</td>
</tr>
<tr>
<td>February</td>
<td>Unless confirmations have been received, call colleges to check on completion of applications. Record the name of the person with whom you spoke. Track down missing records. If you’ve made Early Action applications, colleges should send notifications by the end of this month. Be on the lookout for yours, and follow up if necessary.</td>
</tr>
<tr>
<td>March</td>
<td><strong>WAIT!</strong></td>
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# APPENDIX A: Applying to the College of Your Choice

<table>
<thead>
<tr>
<th>When</th>
<th>What to do</th>
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<tbody>
<tr>
<td>April</td>
<td>Keep in mind that “thin” letters aren’t always rejections. Some schools send out enrollment forms later.</td>
</tr>
<tr>
<td></td>
<td>Rejoice in acceptances; keep rejections in perspective.</td>
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<tr>
<td></td>
<td>Plan “crunch-time” visits to campuses, as needed, to help prompt final decisions.</td>
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<tr>
<td></td>
<td>Compare financial aid decisions, where applicable. Contact financial aid offices with questions.</td>
</tr>
<tr>
<td></td>
<td>Make sure you return Wait-List cards, as needed. Contact admission offices to check on Wait-List status. Send updated records and other information, if available. Write an upbeat “Please take me, and this is why you should” letter.</td>
</tr>
<tr>
<td></td>
<td><strong>Make your final decision.</strong> Have your parents send the required deposit. Don’t dawdle and miss the May 1 deadline or colleges can give away your place. Also notify those schools you won’t be attending, especially if an aid offer was made.</td>
</tr>
<tr>
<td>May</td>
<td>Take AP exams, if appropriate.</td>
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<tr>
<td></td>
<td>Stay abreast of housing choices, etc. When will forms be mailed? Should you be investigating living-situations options? When is a freshman orientation? (Some schools have spring and summer programs.) When is course registration?</td>
</tr>
<tr>
<td>June</td>
<td>Write a thank-you note to anyone who might have been especially helpful. Guidance counselors are often unsung heroes. Don’t forget teachers who wrote recommendations, admission counselors or secretaries, tour guides, or other students.</td>
</tr>
<tr>
<td></td>
<td>Consider summer school if you want to accelerate or place out of requirements. ALWAYS check with colleges first to make sure credits will count. Get permission in writing when it’s questionable.</td>
</tr>
<tr>
<td></td>
<td>Make sure that a final high school transcript is sent to the college you will attend. (Most schools do this automatically.)</td>
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</tbody>
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Finding Financial Aid

FIGURING OUT FINANCIAL AID

After you know what different schools might cost, it's time to work out what you and your family can afford to pay. Then you'll know how much financial aid you can apply for. The principle behind financial aid is that students who can't afford the full cost of college should still have the opportunity to go.

WHAT YOU WILL PAY

Taking the difference between what the college costs (including room and board, books, and other supplies) and what you can afford to pay gives the amount of your need. This deceptively simple term, “need,” doesn’t necessarily mean what you think it ought to mean—or what you would like for it to mean. It’s a specific, technical term for the amount you cannot pay on your own—the amount left after your Expected Family Contribution (EFC) is subtracted from your cost of education. (For more information about the EFC, check out Best College Deals on www.petersons.com/bcd.)

Your EFC is the total amount that you, as a family, are expected to contribute toward college costs. This number is determined by analyzing your overall financial circumstances and comparing them to the circumstances of other families. Family income is the major factor in determining your EFC, not the balances of your savings accounts or the worth of your parents’ home/trust funds and other assets.

Your EFC figure might vary from school to school, depending on which formula the college uses to determine financial need. Although your EFC might seem to be an unattainable amount, it can be financed if you carefully plot out a strategy that combines different economic sources, including loans, savings, a part-time job for the student, and current income.
WHAT’S COVERED BY FINANCIAL AID

Financial aid, which makes up the difference between the EFC and the cost of attending the school of your choice, comes in three basic flavors:

- **Grants and scholarships** don’t need to be repaid or maintained by a job. Grants are usually based on need alone, while scholarships are given to students who have met some criteria, such as academic or athletic merit.
- **Loans** are the most widely available source of financial aid. They must be repaid some day, but the interest rates for student loans are often lower than for commercial loans, and payments are deferred until the student has completed college.
- **Work-study** lets students work 10–15 hours per week in order to gain the money to pay for school.

You and the financial aid officer at the college of your choice will negotiate a financial assistance package that will probably contain a combination of all three of these varieties of aid.

SOURCES OF FINANCIAL AID

Your aid will most likely come from a number of sources, from the most massive federal programs down to institutional funds unique to your school. Aid might come from the state, private foundations, the college, or even an employer. If the aid comes from a federal government program or a state agency, it is known as public aid; sources like employers, donors, and foundations are known as private aid.

FEDERAL AID

The federal government is by far the largest source of financial aid, providing nearly 70 percent of the aid that is awarded each year. In 2002–03, the federal government, through the Department of Education, made available more than $70 billion in student aid. So, it pays to know something about the major federal programs, since they will be your first source of aid.

Pell Grants

The Pell Grants program was once known as the Basic Educational Opportunity Grant program, and you might still see it referred to as such in older materials. Pell Grants are distributed based on family need and education costs at your school. The maximum grant available is currently $4,000 per year, but this figure changes from year to year depending on how Congress funds the program.
Eligibility for Pell Grants is determined by the standard Federal Methodology formula that was passed into law by Congress and is used to calculate your EFC. If that figure falls below a certain threshold, you’ll be eligible for a Pell Grant. After you’ve applied for aid, you’ll receive a Student Aid Report that gives your EFC number and tells you if you qualify. The amount of the grant you may receive is not standardized. Different schools, with their varying tuitions, disburse different amounts.

Federal Loan Programs

There are two main kinds of low-interest loans for students and parents: the Federal Direct Student Loans (Direct Loan) program and the Federal Family Education Loan (FFEL) program. Collectively, they’re called Stafford Loans.

Direct Loans come directly from the federal government. FFEL loans involve private lenders like banks, credit unions, and savings and loans. Aside from that difference, the two loan programs are pretty much the same; the program from which you get your money depends on the program in which your school participates. The interest rate on these loans varies from year to year, but the maximum is 8.25 percent, and often the interest rate is lower while you’re in school. You’ll also have to pay a fee of up to 4 percent, deducted from each loan disbursement; this money goes to the federal government to help reduce the cost of the loans.

If financial need remains after subtracting your EFC, your Pell Grant eligibility, and aid from other sources, you can borrow a Stafford Loan to cover all or part of the remaining need. This is a subsidized loan; the government pays the interest while you’re in school and for six months after you graduate.

Even if you have no remaining need, you can still borrow a Stafford Loan for your EFC or the annual Stafford Loan borrowing limit, whichever is less. (The borrowing limit ranges from $2,625 to $10,500 a year, depending on a number of factors, including your year in school and whether you’re classified as an independent or dependent student.) However, this is an unsubsidized loan; you’re responsible for paying all of the interest.

Parents who are applying for financial aid go for what are called PLUS Loans. Like the Stafford Loans, PLUS Loans are available from both the Direct Loan and the FFEL program. The yearly borrowing limit on PLUS Loans is equal to the cost of attending the college minus any financial aid you get; so if it costs $6,000 per year to attend college and the student has received $4,000 in other financial aid, that student’s parents can borrow up to $2,000. The interest rate varies from year to year, but the maximum is 9 percent.

Campus-Based Programs

“Campus-based” simply means that financial aid officers at each school administer the programs.
Three of the federal programs are campus-based (not all schools participate in all three programs):

- **Federal Supplemental Educational Opportunity Grants (FSEOG):** These grants are awarded to undergraduates based on financial need: “exceptional financial need” is the way the government brochures put it. Pell Grant recipients with the lowest EFCs will be the first in line for one of these grants. Depending on your need, when you apply, and the funding level at your school, you might receive between $100 and $4,000 a year.

- **Federal Work-Study (FWS):** This is basically a part-time job. Most undergraduates are paid by the hour and often at minimum wage (graduate students might receive a salary). Jobs are awarded based on need, the size of FWS funds at your school, and the size of your aid package. The program encourages community service work and work related to your field of study, so it can also help you get your foot in the door by giving you work experience in your chosen field.

- **Federal Perkins Loans:** These are low-interest loans for students with “exceptional” financial need. They’re also an exceptionally good deal at just 5 percent interest, and you don’t have to start repaying until nine months after you graduate. Undergraduates can borrow $4,000 a year, up to a total of $20,000.

How much aid you receive from a campus-based program is based on your financial need, how much other aid you’re receiving, and the availability of funds at your school. Unlike Pell Grants or Stafford Loans, the campus-based programs aren’t entitlement programs. The government gives each school a set amount of cash; when it’s gone, it is really gone—no more campus-based aid can be had until the next year’s allotment comes through. Not every eligible student will receive aid from these programs. The schools set their own deadlines, so ask at your school’s financial aid office and apply as early as possible to catch some of the money before it runs out.

**Other Federal Aid**

The Department of Education is not alone in providing financial aid; the federal government has several other ways of helping students get through school. Scholarships, loans, job training, and money to pay back existing loans are all available from a variety of federal programs, including the following:

- The branches of the Armed Forces maintain ROTC units on many campuses, which are a rich lode of scholarships geared toward helping minority students and boosting the number of students entering important-but-strained career fields, such as the health professions. For more information, call (800) USA-ROTC.

- The Department of Veterans Affairs (VA) offers aid for veterans, reservists, those who serve in the National Guard, and widows and orphans of veterans. For more information on these programs, call (800) 827-1000 and speak with a Veterans Benefits Counselor or visit www.va.gov.
• The Corporation for National and Community Service administers a program called AmeriCorps, which enables students to pay for education in exchange for one year of public service. Visit www.americorps.com for more information.

• The U.S. Public Health Service provides a variety of loan, scholarship, and loan repayment programs to students studying to enter the health professions. Visit www.hhs.gov for more information.

• The Department of Labor administers the Workforce Investment Act, a tuition aid program for the economically disadvantaged and others facing employment barriers. For more information, visit www.doleta.gov.

STATE AID

It’s part of a continuing trend among the states to increase their support for higher education, and all fifty states offer grant aid. However, each state is different, and some states spend far more than others. Five states—California, Illinois, New Jersey, New York, and Pennsylvania—award about 60 percent of the national total, $1.6 billion altogether in undergraduate need-based aid.

COLLEGE FUNDS

This money includes everything from athletic to academic (or merit) scholarships, which don’t take need into account; merit aid is used by colleges to attract the students that they want. Next to the federal government, colleges are the largest sources of aid.

The last few years have also been building years for college and university endowments, with hundreds of millions of dollars flowing into schools as diverse as Harvard University and the University of Washington. Some, but certainly not all, of this endowment money has gone into scholarship funds. Other college funds might find their way to students in the form of tuition discounts for prepayment, aid in receiving loans, and other innovative programs. Most schools also keep funds on hand for short-term emergency loans for students.

EMPLOYERS

Many employers help put students through college through the burgeoning field of cooperative education, in which students alternate semesters of school with semesters of work. Not only does this provide professional skills and a leg up in the employment game, but it also puts money into the student’s pocket. It is best developed at technical and engineering schools like Georgia Tech, which places hundreds of students into positions in a five-year degree program, but all kinds of institutions offer cooperative education programs—almost 1,000 schools boast such programs.
PRIVATE SCHOLARSHIPS

This is a relatively small part of the financial aid picture, and many carry daunting eligibility requirements—the old “left-handed cricket player from Alaska” problem. There’s a lot more money to be drawn from federal and state programs, but hundreds of millions of dollars are nonetheless available in private scholarships—not an amount to turn up your nose at. Just remember to go after the big money first and early, and then look around for whatever private scholarships you can pick up.

FINDING FINANCIAL AID ON LINE

The Internet contains a treasure trove of financial aid resources, including applications that you can file electronically, in-depth information about grants and loans, college connections, scholarship searches, and more.

Almost every financial aid agency that you’ll deal with—from the Department of Education to your college’s financial aid office—maintains a Web site that provides applications, deadline dates, the latest news, and more important information that you need to know. There are also numerous Web sites from “unofficial” third-party sources that can also help you with researching financial aid; these sites often include insider advice, tips, and tricks that the official sources won’t give you.

THE DEPARTMENT OF EDUCATION

A great place to start looking into the nuts and bolts of student financial aid is the source of so much of it—the federal government. The Department of Education maintains three separate Web sites that provide a great deal of reliable information:

- **The Office of Postsecondary Education** will tell you about the different kinds of federal aid and how to go about applying for that aid. You’ll also find a free electronic version of the federal financial application that you can submit directly from the site. Go to www.ed.gov/about/offices/list/ope/index.html
- **Project EASI** (Easy Access for Students and Institutions) is a Department of Education program aimed at streamlining the financial aid process. The Web site takes you step-by-step through the entire process and offers down-to-earth, straightforward advice. Go to easi.ed.gov/.
- **Think College** is the Department of Education’s college-preparation information resource. This site provides information about recently enacted government programs that help pay for college, such as the higher education tax credits of the Taxpayer Relief Act. The site also offers good advice geared toward parents and high school students on how to prepare for paying for college. Go to www.ed.gov/students/prep/college/thinkcollege/edlite-index.html.

www.petersons.com/arco
STATE PROGRAMS

All fifty states offer innovative financial aid programs, such as prepaid tuition funds and college savings plans. And of course, you can find up-to-date information about the majority of these programs on the Web.

For a comprehensive list of college savings programs by state, go to the listing at the College Savings Plan Network Web site (www.collegesavings.org/). In addition, you might find more information about such plans by contacting your state’s financial aid office.

COLLEGE WEB SITES

It’s getting hard to find a college these days that doesn’t have a home page on the Web to advertise itself to prospective students. Of course, surfing the Web sites of schools that you’re interested in is a fun—and effective—way to narrow down your list. But many colleges’ sites also have pointers to the information provided by the school’s financial aid office. This online financial aid “office” can be an extremely valuable resource, giving you access to up-to-date application deadlines, required forms, available scholarships, and more for your school of choice. So, surf over to your new school and check out its Web site!

To get started, search for the Web sites of specific college aid offices at the FinAid site (www.finaid.org).

THIRD-PARTY RESOURCES

There’s a great deal of other excellent information on the Web as well. The best place to start is www.petersons.com. The Web site is a gold mine. It includes access to scholarship databases, information on grants and loans, a tool called Best College Deals, and links to school financial aid offices.

Another useful resource is Peterson’s Get a Jump! The Financial Aid Answer Book, which gives parents and students advice and information on the ins and outs of the financial aid process.

A STEP-BY-STEP GUIDE TO APPLYING FOR FINANCIAL AID

Although the financial aid application process might seem dauntingly complex, when you break it down into its separate steps, there’s really not that much to it. Much of your time will be spent filling out the requisite financial aid forms and then waiting to see what you get.
BEFORE YOU APPLY: ASSEMBLING THE PAPERWORK

Before you start accumulating forms and wearing down the point of your number two pencil, you should prepare for your applications by assembling the following records, necessary for many of the common aid forms:

• Earned income for the year
• Federal taxes paid for the year
• Untaxed income received (such as Social Security benefits)
• Money held in checking and savings accounts
• Value of any current investments
• Value of any business or farm owned by your family

For each item on this list, you’ll need both the student’s and the parents’ records, unless you’re an independent student—in which case, you’ll need these records for you and for your spouse.

GETTING AND FILLING OUT FINANCIAL AID FORMS

The forms that you’ll need to fill out to apply for financial aid vary from state to state and from institution to institution, depending on the “need analysis service” used by that state or institution. Your school will let you know which forms you must complete and will provide them to you. Although they’re not easy, none of these forms are impossible to fill out on your own.

The most common forms are the following:

• The U.S. Department of Education’s Free Application for Federal Student Aid (FAFSA)
• The College Scholarship Service’s CSS Financial Aid PROFILE (available in high school guidance counselor offices, college financial aid offices, and on line at www.collegboard.com/)
• The Pennsylvania Higher Education Assistance Agency’s Application for Pennsylvania State Grant and Federal Student Aid (PHEAA)
• The Student Aid Application for California (SAAC)
• The Illinois State Scholarship Commission’s Application for Federal and State Student Aid (AFSSA)

Your school’s application instructions will give you the information you need about applying for other forms of aid—several states, for instance, require that you fill out still more forms to apply for their own aid programs. It’s also a good idea for students applying for private or institutional funds to check with the schools in which they are interested to see if additional forms are required or if other procedures must be followed. The school’s own application and the state applications might have separate deadlines that you have to meet.

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After you’ve applied, the processing agency will take between four and six weeks to turn your application around. You might be asked to confirm information or to correct the forms and then return them to be processed again. The reprocessing will add another two or three weeks to your wait.

Getting the FAFSA

There are a number of ways to apply for federal financial aid—but it all starts with the FAFSA. You have several options for getting a copy of the FAFSA and submitting it to a federal aid processing center:

- You can apply electronically through your school.
- You can use the FAFSA Express software; it runs on computers that use the Windows operating system and have a modem. Computers with the FAFSA Express program can be found at many high schools, public libraries, and Educational Opportunity Centers. Or you can order the software on diskette by calling (800) 801-0576, or download a copy yourself from the Department of Education’s Web site.
- You can forego technology altogether and get the version of the form that comes on old-fashioned paper. Ask at your high school guidance office, college financial aid office, or write directly to:

  Federal Student Aid Information Center
  P.O. Box 84
  Washington, D.C. 20044-0084
  (800) 4-FEDAID

Filling Out the FAFSA

Be as accurate and as neat as you can when completing the FAFSA. Use a pen with black ink or a number two pencil that can easily be read by a computer. Don’t jot notes in the margin that might interfere with processing the form. And don’t attach any explanatory documents, like tax returns—they’ll just wind up in the shredder.
KEEPING TRACK OF PAPERWORK: WHAT TO DO WITH THE STUDENT AID REPORT

After processing your data, you’ll begin to receive a lot of paper. Your application for federal aid through the FAFSA or the other forms will be used to generate a Student Aid Report (SAR), which arrives within four weeks after submitting the FAFSA. The SAR compares all your data and generates a Student Aid Index number (which lets you know whether you qualify for a Pell Grant) and an Estimated Family Contribution (EFC) number (which will be used to see whether you qualify for campus-based programs like FSEOG, Federal Work-Study, Federal Perkins Loans, and the Stafford Loan programs).

If you qualify for a Pell Grant, your SAR will arrive in three parts:
• **Part 1**, the Information Summary, tells you how to check the SAR for errors.
• **Part 2**, the Information Review Form, is used to correct any errors in the SAR.
• **Part 3**, the Pell Grant Payment Document, is used by your school to decide how much money you will receive.

Immediately make copies of Part 1 and send one to the financial aid office of each school to which you applied. You’ll submit all three parts of the SAR to the school that you ultimately decide to attend.

Didn’t get the Pell Grant? Don’t worry—very few applicants do. But now you have something very important—your EFC number. Send that information to your financial aid administrator, who will use it to figure out whether you qualify for other federal student aid.

RECEIVING YOUR AWARD LETTER

After the school has all the information it needs, it can put together an aid package that will probably include a combination of grants (precious few), loans (too many), and work-study employment. You’re notified of what your aid package contains in an award letter. This document gives you an idea of your probable cost of attendance, how your need was determined, what your need turned out to be, and the composition of that aid package. If you’re satisfied with the aid package, you sign the documents that come with the form and send them back to the school.

Even if you haven’t decided which school to attend, you should move quickly to accept the aid package from each school that offers one. Accepting the aid package does not obligate you to attend the school, but it’s the only way to keep your options open. Schools set response deadlines: If you don’t respond to your aid letter within that time, you could miss out on the funds that have been offered to you. This isn’t to say that you should keep a number of colleges on a string—choose your college as quickly as possible so that the schools you don’t choose can distribute the money to other students.

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APPENDIX B: Finding Financial Aid

But before you leap to accept that award letter, evaluate your offers with a cold eye. Don’t be fooled by big numbers; pay special attention to how much of the offer is made up of grants and how much is made up of loans. Are all the costs of attending the school listed in the aid package, or will the costs of books, personal expenses, and travel add on to that amount? Which schools are tossing in special awards for academic or athletic merit? If scholarships are offered, are they renewable or are they one-shot wonders that will leave you high and dry next year? Break out your calculator and compare the loan interest rates offered by different institutions, and check out whether the payback requirements for those loans are especially onerous. And as for work-study offers, keep in mind the study load before you, and ask yourself whether you’ll be able to juggle work and school right off the bat. And remember, financial aid offers might be negotiable. Compare all of the offers that you receive, then contact the admissions office of any school with which you want to negotiate. Your offer might be non-negotiable, but you won’t know until you ask.

TIP
Always save a copy of your application and worksheets as a backup, whether filing electronically or submitting a paper form. The school might need to see these copies later, or you might need to refer to them if you find errors in your aid package.
## PUTTING IT ALL TOGETHER: THE FINANCIAL AID CALENDAR

The following table presents a calendar of important dates to remember when applying for college and for financial aid. Use this calendar as a checklist to ensure that you get everything done on time; to get the most aid, get applications in early.

### CALENDAR OF IMPORTANT FINANCIAL AID DATES

<table>
<thead>
<tr>
<th>When</th>
<th>What to Do</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Junior Year of High School</strong></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>Take the PSAT/NMSQT.</td>
</tr>
<tr>
<td>Fall/Winter</td>
<td>Send for college brochures and financial aid information.</td>
</tr>
<tr>
<td>Spring</td>
<td>Begin campus tours; talk to financial aid advisers at colleges.</td>
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<tr>
<td></td>
<td>Sign up for AP courses for senior year, if available.</td>
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<tr>
<td><strong>Senior Year of High School</strong></td>
<td></td>
</tr>
<tr>
<td>September–December</td>
<td>Narrow down your college choices.</td>
</tr>
<tr>
<td></td>
<td>Ask schools for admission applications and financial aid forms.</td>
</tr>
<tr>
<td></td>
<td>Get a copy of the FAFSA.</td>
</tr>
<tr>
<td></td>
<td>Send in applications for admission to college.</td>
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<tr>
<td></td>
<td>Take the SAT or ACT Assessment.</td>
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<tr>
<td>January 1</td>
<td>Send in the FAFSA and other required financial aid applications.</td>
</tr>
<tr>
<td>February–March</td>
<td>Make sure that the colleges received your applications and that you’ve completed all the required financial aid applications for each college.</td>
</tr>
<tr>
<td>April 1</td>
<td>Most college acceptances and rejections have been sent out by now; send in your nonrefundable deposit to the college of your choice.</td>
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<tr>
<td>May</td>
<td>Take any AP tests.</td>
</tr>
<tr>
<td></td>
<td>Follow up with housing, financial aid, and other college offices.</td>
</tr>
<tr>
<td>June 30</td>
<td>Your financial aid application must be received by the processing agency listed on the form.</td>
</tr>
<tr>
<td></td>
<td>Your school’s financial aid office must have received your application and student aid report.</td>
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Choosing the Right College

WHICH COLLEGE IS RIGHT FOR YOU?

Choosing a college is a long and arduous process—but it can also be a lot of fun.

This will be one of the most important decisions you’ll ever make. You’re choosing where you’re going to spend the next four (or more!) years of your life, where you’re going to learn the skills you’ll need for your adult life, and where you’ll meet friends you will cherish for all of your life. You don’t want to make the wrong choice, but you still have to make a choice—and probably sooner than you’d like!

So, how do you determine which is the right college for you?

First, make sure you choose the college that offers the best mix of academics, environment, and extracurricular activities for your particular needs and wants. Don’t choose a school just on its academic merits; remember, you’ll be spending the next four years of your life there, so you better make sure you enjoy the non-academic life on campus, too!

You also have to take into account where the college is (how far away from your parents do you really want to be?) and how much it costs to attend. Your dream school might be too far away or simply cost too much to make it practical. (Although even if a college appears out of reach monetarily, you should always evaluate the potential for financial aid at that institution.)

If you have an idea of what career you wish to pursue after graduation, you should look for universities that are known for their excellence in the field that interests you. When comparing the merits of different schools, be sure to examine the caliber of the faculty, average class size in upper-division courses, its academic reputation, and finally, the facilities. Visiting the prospective campus can be the most decisive factor in your choice of a school.
Even if a school meets your requirements, though, you might not meet theirs. You should examine the admissions requirements of each school that you are interested in very carefully to determine which offer the most realistic opportunities for gaining admission. Consider things like the school’s SAT and ACT Assessment standards and whether or not they require an interview. Don’t waste your time, money, or hope applying to schools that you have little, if any, chance of getting into.

In a nutshell, then, here are some of the key points to consider when choosing a college:

- **Size.** Are you more comfortable at a college (1,000–2,500 population), a small university (2,500–6,000), or a big university (7,000 and up)? Colleges and small universities might offer a more comfortable environment with more extracurricular camaraderie, while big universities offer more extracurricular activities and more class and subject selection.

- **Location.** Do you prefer a school situated in a rural setting, a town, a small city, or a megalopolis. Does the location of the school in any way enhance the curriculum? How far away from home do you want to be—one hour, one gas tank, or one airplane ticket? How much will it cost you to travel home—and how often will you be making the trip? What are the local transportation options? Can you park a car on campus—or do you have to take the bus?

- **Curriculum.** Which is most important to you, a liberal arts, professional, or technical degree? What is the school known for? What are its academic strengths and weaknesses? Do they offer the courses and the degree track that you really want?

- **Faculty.** What percentage of the faculty has attained the terminal degree (Ph.D., master’s, etc.) in their field? Are professors available to meet with students outside of their classrooms? How many classes will actually be taught by a professor vs. a teaching assistant? Is there an academic advising program? What about tutoring?

- **Job placement.** What percentage of students have job offers when they graduate? What percentage of alums continue on to graduate school? How strong is the alumni network?

- **Admissions requirements.** Are they academically rigorous? Too much so? Can you pass muster—or can too many others pass muster?

- **Costs and financial aid.** Can you afford this particular institution? What financial aid can you obtain to help you afford it? Are there any “hidden” costs of living on this campus?
• **Housing/food.** Are there different types of on-campus housing options? Do you have to live in a dorm? With how many roommates? What off-campus housing is available? What about fraternities and sororities? What are your dining options? Just how bad is the cafe food? Where is the closest pizza place—and do they deliver?

• **Extracurricular activities.** What do you like to do outside of class? What sports activities are available for non-athletic majors? What about music, theater, and clubs? Where are the closest nightspots?

• **Social atmosphere/student body.** Is this a fun place to live? Too much fun? Is the school known as a “party” campus? Is it elitist or populist? Are the students there people you’d choose to hang out with, given the choice?

How do you find the answers to all these questions? There are numerous sources of information available to you, from official university brochures to comprehensive college selection Web sites. However, the best sources of information are often the college’s students—and you can meet them either on campus or on line.

**TIPS ON VISITING CAMPUSES**

You should try to visit as many schools as possible before deciding where to apply. This is helpful in many ways, especially if you get accepted into more than one school and have to choose between them. A campus visit is even more important if you’re applying under an Early Decision Plan and must commit to that school if you’re accepted. Remember, the school you choose is going to be your home for the next four to five years; make sure it’s a place you really want to live.

Walking and talking, observing, and interacting are things you can only do in person. Here are some things to look for when you visit a school:

• **Walk around.** By all means, check out the campus. Walk around, take in the sights. Does it seem cold and impersonal or warm and friendly? Is this a campus you’ll remember twenty years from now? Visit the student center, and find out what activities the university has to offer—free movies, games, lectures, etc. See whether or not the classrooms and lecture halls are relatively close together. Will you have to do a great deal of walking? What is the campus transportation like? How will you get to your favorite off-campus places, for shopping, eating, and socializing?

• **Check out the weather.** What’s the weather like? Learn the weather patterns of the area. What are the winters like? How cold does it get—and how much snow will you have to hike through between classes? How much rain can you expect? When does it start warming up—and how hot does it get? What about the humidity? Make sure that, weather-wise, this can be a comfortable place for you to live.

**TIP**

Don’t forget that you can get a lot of information about a college by checking out its campus newspaper. Almost every college journalism department produces a campus ‘rag.’ The school’s Web site may have contact information for the campus newspaper, or you can ask the Admissions Office for information on how you can get a copy. While you’re at it, find out the name of the local city newspaper and get a copy of it, too. You’ll learn a lot from these papers about the cultural climate, the cost of living, and other critical aspects of the school’s locale.
• **Visit the dorms.** Take a look at everything—the bathrooms, bedrooms, lounges, you name it. Are the rooms big enough? Are they clean? Quiet enough for studying? If possible, stay the night and take a trip to the dining hall and try the food. Can you keep it down? If there is more than one dorm or dining area, then check out several, and determine your preferences.

• **Visit the classrooms.** Stop by the departments that you might be majoring in, and pick up their course lists. Take the time to ask questions of the people working in each department. Find out a little about the first-year professors you might have.

• **Talk to people!** Most importantly, stop and strike up conversations with some of the students. Ask them what they think about the school, their course work, the social scene, the Greek system, the dorms, the cafeteria food, or anything else that you were wondering about. Find out from the students what are the best dorms, which places have the best pizza, where are the best parties, who are the best professors. Maybe you’ll even make a few new friends and exchange phone number or e-mail addresses. Students are your best resource—use them!

When you do visit, visit during the school year, not during Spring, Summer, or Christmas break. You should also try to avoid making visits during midterms and finals, or during the first few weeks of a new school year, before students are truly settled in. Also, it’s probably better to visit during the week, if you can; a lot of students go home on weekends, and the atmosphere isn’t quite the same.

**TIP**

Whenever possible, contact the college admissions office a week or two ahead of time to arrange some portions of your on-campus visit. They’ll send you a campus map, and they can help you set up meetings with faculty, give you directions to specific classrooms, or arrange for sleeping accommodations in a dorm. Don’t worry—you don’t have to turn over control of your visit to the admissions office. But their assistance can help make your visit more productive.
Who Are You?
The Questions and Answers to Set You on Your Way

Are you looking for a formula, a tried-and-true method for choosing the right major? Unfortunately, it doesn’t exist. But here’s some good advice that will set you on your way, from bestselling author Chip Bell: “Effective questions bring insight, which fuels curiosity, which cultivates wisdom.”

This section will help you gain insight from the person who is best equipped to answer the major decision question: You. Finding the right major is all about understanding life’s possibilities, asking yourself the right questions, and listening for the answers.

Start by opening your eyes and looking at the people around you. Begin with the people you know—your parents, your family, and your friends and acquaintances. What do these people do for a living? What are their jobs? If your friends are students like yourself, what do their parents do for a living?

Once you’ve exhausted your personal connections, open your eyes a little wider and look at what other people are doing. Make a list of the careers that sound interesting to you—try to identify at least five—and ask yourself why these careers sound interesting, making sure to be as specific as possible. All too often, we overlook our own curiosity. The simple act of putting your observations down on paper (or on a computer screen) will help you understand and identify aspects of a particular career that make you want to learn more about it.

For now, ignore the financial rewards of a particular career. You don’t want to start your search for the perfect major with a search for the biggest paycheck. There will be plenty of time to think about money and salaries later. Money is an important consideration, but the search for financial reward for its own sake will lead you astray.
THE TWELVE-YEAR EXPERIMENT

By the time you finish high school, you will have slogged through twelve years of facts, rules, dates, theories, methods, equations, and a host of other details that you may or may not need later on in life. Besides taking in all this information (and being asked to memorize and regurgitate it in various ways), you’ve also learned something about yourself. Hopefully. Whether you look back on your school career as the best time of your life or the worst, it’s still your life. Whatever you do, don’t ignore your past experiences.

The formal and informal knowledge you have gained is your own database of personal facts and figures. Start by looking at the obvious: your academic career. Those subjects that you’ve enjoyed up to this point are a good indication of what you will enjoy in a major. Don’t just focus on the classes that you aced, although you certainly don’t want to ignore them either. Perhaps you’ve always found mathematics to be a cakewalk; you regularly completed all your homework assignments while watching reruns of The Osbournes. But the class you looked forward to every day was art because you loved using your imagination to create. Chances are, you’re more likely to enjoy a major in the field of art than a major in mathematics. Better yet, perhaps you should look into a major that combines the analytical skills used in math and the creative skills used in art. Architecture might be the perfect major.

A big part of figuring out what major is right for you is understanding both your abilities and your interests. In most cases, your abilities are related to your interests—if you have always done well in English, then you probably enjoy reading and writing. But there are always exceptions, so it’s important that you also consider your abilities and interests separately and look for where they intersect.

What about your extracurricular activities, like the school newspaper, literary magazine, or various clubs? Were you involved in student government? Did you ever take part in volunteer activities in the community? What about organizing school events or activities? How about athletics, outings, or special events like field trips? Looking back and analyzing your extracurricular activities will give you a better idea of your interests, which will help you choose a major that is right for you.

FOUR QUESTIONS TO CONSIDER

While taking stock of yourself and those in your immediate family and social circles, you’ll also want to get a feel for “what’s out there,” and a surefire way for doing that is by talking to people in the workplace. You’ll want to begin by asking four questions.

First Question

Ask people to rank the three most important skills they need to function in their jobs. Every job requires a few crucial skills. Perhaps it’s analyzing numbers, creating slogans, solving problems, greeting people, making sales pitches over the phone, fixing
machines, building structures, or motivating others to do their jobs. Again, you want to know: What are three skills they use every day?

**Second Question**

What are the tools needed to do the job? Every job requires tangible tools, like wrenches, hammers, microscopes, and even our hands, but there are also intangible tools—creativity, the ability to prioritize, coping mechanisms for stress, and knowing how to work in a team environment. You will learn a lot about different careers by asking people what tools they use in their work.

**Third Question**

Where do people work? This is a good question because the physical environment of the job often affects our enjoyment of the work. Is it an office building, a factory or industrial setting, a hospital or health-care facility, a hotel, a laboratory, a classroom, a studio, a gallery or museum, a government agency or department, a retail store, a national park, or a farm? Or do they work out of their home?

**Fourth Question**

Finally, you should ask people what their major was in college and how they came to their present position. What path did they travel to get from their major to their current job? Even if you have no idea what kind of career you want, it’s important to see connections between a major and a career. People with the same career started out with different majors, and people who had the same majors ended up in different careers. What were the steps that led them from their major to their present career? Ask people what route they took.

**THE MOST IMPORTANT QUESTION: WHO ARE YOU?**

Here are some questions that will help you determine what kind of person you are and what kind of major might be right for you.

Do you find yourself drawn to artistic or creative endeavors, such as art, music, film, or fields that require an artistic sensibility, such as publishing or advertising? If so, you may be interested in these majors:

- Advertising
- English language and literature
- Creative writing
- Publishing
- Journalism
- Public relations
• Computer graphics
• Furniture designer/ maker
• Crafts, folk art, and artisanry
• Commercial photography
• Fashion design/ illustration
• Drawing
• Ceramics
• Music
• Drama/theater arts

Are you an inquisitive person? Do you think like a scientist or a detective? Do you enjoy the physical sciences, working with numbers, equations, or theories? Do you like doing experiments or dealing with data? Do you enjoy mathematics? Are you intellectual by nature? If so, you may be interested in these majors:

• Chemical, computer, or engineering science
• Systems engineering
• Biology
• Molecular biology
• Neuroscience
• Pathology
• Mathematics
• Chemistry
• Physics
• Aerospace science
• Nuclear physics
• Fluid and thermal sciences
• Pharmacology
• Computer science

Do you see yourself as a natural salesperson, someone who is willing to stand up in front of an audience and dazzle them with your personality and convince them that they need to buy your product? If so, you may be interested in these majors:

• General sales and marketing operations
• Communications
• Advertising
• Public relations
• Speech/rhetorical studies
• Psychology
• American government/politics
• Business administration/management
• Office supervision/management
• Marketing

Do you enjoy interacting with and helping people in various capacities? Do you consider yourself a “people” person? Do you care about how people feel? If so, you might be interested in some of these majors:

• Education
• Cosmetic services
• Mortuary science
• Family/community studies
• Dietetics/human nutritional studies
• Marriage and family counseling
• Child development, care, and guidance
• Athletic training/sports medicine
• Psychology
• Social work
• Law enforcement
• Health services technician
• Physician assistant
• Premedicine or predentistry
• Nursing
• Public health
• Physical therapy

Are you someone who enjoys thinking about and discussing current events and social topics? Are you comfortable exploring different ideas as they relate to people, politics, and culture? If so, you may be interested in these majors:

• City/urban/community planning
• English literature
• Area studies
• Journalism and broadcast journalism
• Education
• Foreign languages/literatures
• Law and legal studies
• Religion and philosophy
• Psychology
• Economics
• History
• International affairs
• Organizational behavior studies

Are you good with your hands and naturally mechanical? Do you enjoy working with tools, gauges, machines, and other technological devices, either repairing, building, or servicing machines? Would you rather be working in a physical context than sitting behind a desk? If so, you may be interested in these majors:

• Farm/ranch management
• Crop production management
• Agricultural animal health
• Plant protection
• Wildlife management
• Natural resources management
• Industrial electronics installer or repairer
• Aviation systems/avionics maintenance technologist
• Maritime science
• Architecture

MORE TO PONDER

Would you rather be spending time helping children, or would you rather spend time helping adults? If you enjoy spending time with children, teaching might be an ideal career. If you would rather help adults, you might want to think about social work.

Do you enjoy working as part of a large team in a competitive Environment, or are you more self-motivated and work better by yourself? If you would rather work as part of a large team in a competitive environment, business, marketing, or sales might be the right kind of careers to get into. If you’d rather work alone in a noncompetitive environment, you may be interested in a more solitary career, like writing, library science, or design.

Do you consider yourself analytical, or do you consider yourself artistic? If you are more the analytical type, you might want to consider becoming a scientist, engineer, or computer technician. If you are more artistic, you could be a photographer, graphic designer, or advertising executive.

Do you want a career in which you go to work every day knowing what to expect? Or would you rather have a career in which every day brings something new and unexpected? If you prefer consistency in life, you might want to think about accounting. If you’re ready and willing to take on whatever is thrown at you, journalism might be the perfect career for you.
Would you rather work with language and effective communication, or would you rather work with numbers, statistics, or measurements? If you would rather work with language and writing, then you might want to be a translator or a diplomat or a public relations executive. If you want to work with numbers, statistics, or measurements, you might want to consider actuarial science.

You've spent the last twelve years learning about the world and racking up experiences and knowledge about yourself. Making the major decision means asking the right questions, collecting the information, and analyzing your own feelings in preparation for the rest of your life. College is simply the next stage of the experiment. It is an opportunity to expand your knowledge and take everything that you've learned up to that point and figure out how to make a life out of it. The major decision is the first step.
COLLEGE ADMISSIONS/FINANCIAL AID COUNTDOWN SENIOR YEAR

SEPTEMBER
- Continue honing list of target schools, on-campus interviews, and alumni interviews.
- Get financial aid information from guidance counselors and give teacher recommendations to appropriate teachers.
- Register for October ACT Assessment, October SAT I, or November SAT I.
- Begin Early Action/Early Decision steps now. Check deadlines with appropriate schools.

OCTOBER
- Register for December ACT Assessment, December SAT I, or November SAT II.
- Take October ACT Assessment, October SAT I exam.
- Draw up a master schedule of application and financial aid due dates and mark them on your calendar.
- Continue working on college essays and personal statements. Follow up on teacher recommendations.
- Submit Early Decision and Early Action applications.

NOVEMBER
- Reduce college “long list” to “short list” where applications will be sent.
- Plan Thanksgiving-break visit to college campuses.
- Get someone to proofread your applications and essays.
- Take the November SAT I or SAT II; prepare for December ACT Assessment.
- Send first-quarter grades to colleges; send test scores (include ETS numbers) for ED/EA applications and regular admissions.

DECEMBER
- Pick up any additional financial aid forms you need and attend financial aid workshops, if possible. Follow up with guidance and teachers on references letters and transcripts.
- Take ACT Assessment, SAT II subject tests this month.
- Submit all regular applications.
- If accepted on Early Decision, withdraw remaining applications. If deferred on Early Decision, send follow-up letter to college.

JANUARY
- Fill out financial aid forms. Finish and mail as soon as possible. NEVER BE LATE WITH THESE!
- Complete all applications regardless of later deadlines. Photocopy everything. If taking SAT I or II this month, are RUSH scores required? Ask target colleges if you’re not sure. Register for February ACT Assessment now.

FEBRUARY
-ACT Assessment administered this month.
- Call those colleges that didn’t confirm receipt of completed applications.

MARCH
- It’s not too late to apply to more schools—get any remaining applications out this month.
- Actively seek and pursue scholarship opportunities and draw up your financial aid plan to pay for next year’s expenses.

APRIL
- Prepare for May AP exams.
- Plan “crunch time” visits to campuses and compare financial-aid decisions.
- Return “Wait List” cards as needed. Check admissions offices for Wait-List status.
- Make your decision! Send the deposit or your place won’t be held; for most schools, May 1st is the deadline, so do it now.
- Notify those schools you won’t be attending.

MAY
- Take AP exams where appropriate.
- Check housing options: When will forms be mailed? Should you check alternative arrangements?
- Start thinking about summer employment—last chance to build up a ‘nest egg’ for freshman year!

JUNE
- Write thank-you notes to anyone who helped you: guidance counselors, teachers, admissions counselors, etc.
- Make sure final high school transcripts are sent to the college you’ll attend.
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