



2022 2023

Full-length practice ACT test,
including the optional writing test
Information about the multiple-choice and
writing sections
Test-taking strategies
What to expect on test day

Esta publicación también se puede ver o
descargar en español

A Message to Students

This booklet is an important first step as you get ready for college and your career.

The information here is intended to help you do your best on the ACT to gain admission to colleges and universities. Included are helpful hints and test-taking strategies, as well as a complete practice ACT, with “retired” questions from earlier tests given on previous test dates at ACT test sites. Also featured are a practice writing test, a sample answer document, answer keys, and self-scoring instructions.

Read this booklet carefully and take the practice tests well before test day. That way, you will be familiar with the tests, what they measure, and strategies you can use to do your best on test day.

You may also want to consider *The Official ACT® Self-Paced Course, Powered by Kaplan®* to learn test content and strategies in a virtual classroom. To view all of our test preparation options, go to www.act.org/the-act/testprep.

Contents

Preparing for the ACT® Test	1
A Message to Students	2
Overview of the ACT	2
Test-Taking Strategies	3
Prohibited Behavior at the Test Center	5
Content of the ACT Sections	6
Taking the Practice Tests	10
Practice Multiple-Choice Sections	11
Practice Writing Test	52
Practice Answer Document	55
Scoring Your Tests	63

The ACT test consists of four multiple-choice sections—English, mathematics, reading, and science—with an optional writing section. Some colleges and universities require or accept ACT writing scores, so you may consider taking the writing section.

Test	Questions	Minutes per Test
English	75	45
Mathematics	60	60
Reading	40	35
Science	40	35
Writing (optional)	1 essay	40

After the science test you should expect to take a shorter, multiple-choice test covering one of the previous subject areas. The results of the fifth test help develop future test questions and will not be reflected on your scores, so please try your best.

Test Strategies for the ACT

Each multiple-choice section contains questions with either four or five answers from which you are to choose the correct or best answer.

If you do not complete all your sections and want to test again, you will need to re-register and pay for a new test date. Once you access test content, you cannot request a Test Date Change.

Here are three strategies to help you prepare for the ACT:

Get familiar with the content of the sections.

Review the information in this booklet. Note which content areas make up a large proportion of the sections. The topics included in each content area are examples of possible topics; they do not include all possibilities.

Update your knowledge and skills in the content areas.

Review content areas that you have studied but are not fresh in your mind. Refresh your knowledge in the content areas that make up large portions of the test.

Study content areas you are not familiar with.

If some content areas of the ACT are unfamiliar to you, consider taking coursework in those areas before you take the test.

Tips for Taking the Multiple-Choice Sections

Pace yourself.

It is important that you have enough time to read the passages/questions and figure out your responses. For each section, subtract the number of minutes you estimate you will spend skimming the passages or reading the information provided, then divide the total number of remaining minutes allowed by the number of questions to determine the estimated time you should spend on each question. If possible, spend less time on each question and use the remaining time allowed for a section to review your work and return to the questions in that section that were most difficult for you.

The time limits set for each section give nearly everyone enough time to finish all questions. However, you will want to pace yourself to avoid spending too much time on one passage or puzzling over an answer to a specific problem. Go on to other questions and come back if there is time.

Read the directions carefully.

Before you begin each section, read the directions carefully.

The English, reading, and science sections ask for the best answer. Read and consider all of the answer choices and choose the answer that best responds to the question.

The mathematics section asks for the correct answer. You may want to work out the answer you feel is correct and look for it among the choices given. If your answer is not among the choices provided, reread the question and consider all the answer choices.

Read each question carefully.

You need to understand exactly what each question asks. Some questions will require you to go through several steps to find the correct or best answer, while others can be answered more quickly.

Answer the easy questions first.

A good strategy is to answer the easy questions and skip the questions you find difficult. After answering the easy questions, go back and answer the more difficult questions if you have time.

Use logic on more difficult questions.

When you return to the more difficult questions, try to use logic to eliminate incorrect answers. Compare the answer choices to each other and note how they differ. Such differences may provide clues as to what the question requires. Eliminate as many incorrect answers as you can, then make an educated guess from the remaining answers.

Answer every question.

Your scores in the sections will be based only on the number of questions that you answer correctly; there is no penalty for guessing. Try to answer every question within the time allowed for each section.

Review your work.

If there is time left after you have answered every question in a section, go back and check your work. You will not be allowed to go back to any other section or mark responses to a section after time has been called in that section.

When testing on an answer document:

Be precise in choosing your responses.

If you are taking the ACT on paper, make sure that you properly select the desired answer on your answer document. Marks on your answer document that extend beyond the intended oval may be scored as incorrect.

Erase completely.

If you want to change a multiple-choice answer on paper, make sure you erase completely. Do not cross out answers or use correction fluid or tape; you must erase. Smudges or unintended marks may cause errors in scoring.

Get Ready

Prepare well in advance for the ACT.

Know what to expect on test day. Review the information in this booklet and at www.actstudent.org.

Take the practice tests in the order they are shown in this booklet, time yourself, and review your responses using the answer keys.

Carefully review the test-day checklist at www.act.org/the-act/checklist.

Get plenty of rest the night before the tests.

Note: Most procedures in this booklet refer to testing on a National test date at an ACT test center (within the United States, US territories, or Puerto Rico). Procedures may differ slightly if you take a different administration of the ACT test.

On Test Day

Report on Time

For National test dates, you must report to your assigned test site by the time stated on your admission ticket (usually 8:00 a.m.). If you are late, you will not be admitted to test. If your ticket does not list a specific test room, the test staff or posted signs will direct you.

What to Bring

A printed copy of your admission ticket. Your ticket contains important information that helps connect your answer document to the registration on file. If you have lost your ticket, you can print another through your MyACT account. If you do not bring your ticket on test day, your scores may be delayed.

Acceptable photo identification. You will not be permitted to test if your ID does not meet ACT requirements. See ACT requirements for ID on your ticket or at www.act.org/the-act/id.

Number 2 Pencil. Bring sharpened No. 2 pencils and good erasers (no mechanical pencils or ink pens). Do not bring any other writing instruments. You will not be allowed to use them.

Note: International test sites are provided approved whiteboards and erasable markers.

Watch. You may bring a watch to pace yourself, but do not bring a watch with an alarm. During testing, your watch must be removed and placed on your desk face up. If your alarm sounds during testing, you'll be dismissed and your answers will not be scored.

Calculator. Bring a permitted calculator to be used on the mathematics test only. You are not required to use a calculator at all, but if you do, it is your responsibility to know whether your calculator is permitted. For a current copy of the calculator policy, please visit www.act.org/calculator-policy.html.

Snacks. You may consume snacks and drinks outside the test room during the break.

What NOT to Bring

Textbooks, foreign language or other dictionaries, scratch paper, notes, or other aids

Highlighter pens, colored pens or pencils, or correction fluid/tape

Any electronic device, other than a permitted calculator

Reading material

In the Test Room

Test staff will direct you to a seat. If you need a left-handed desk, tell the staff as you enter.

Do not leave the test room after you have been admitted.

Only pencils, erasers, a permitted calculator, your watch (if brought to the test center), and your paper ticket will be allowed on your desk.

You will be required to put all other personal belongings away.

Reporting time for the test will be 8:00 a.m. Testing will begin as soon as all examinees who are present at 8:00 a.m. are checked in and seated.

Listen carefully to all directions read by the test staff.

It is important that you follow all directions carefully.

You will normally be dismissed at about 12:35 p.m. if you take the ACT (no writing), or at about 1:35 p.m. if you take the ACT with writing.

For Students Approved to Test at National Test Sites With One and One-Half Time

Testing with one and one-half time is available on the multiple-choice and/or writing sections for students with diagnosed disabilities and/or limited English proficiency.

If you are approved for one and one-half time at a National test site, you will have 50% additional time to complete each section.

The full ACT:

Test	Questions	Minutes per Test
English	75	70
Mathematics	60	90
Reading	40	55
Science	40	55
Writing (optional)	1 essay	60

After Testing

Voiding Your Test on Test Day

If you have to leave the test site before completing all sections, you must decide whether or not you want your test scored and then inform the test staff of your decision. If you do not, your test will be scored.

If you do not complete all your sections and want to test again, you will need to re-register and pay for a new test date. Once you access test content, you cannot request a Test Date Change.

Testing More Than Once

If you wish to take the test again to increase your scores, ACT will calculate and report a superscore for students who have taken the ACT test more than once. This gives colleges the option to use the student's best scores from all test administrations, rather than scores from just one sitting, in their admission and scholarship decisions.

For information about superscoring, see **www.act.org/the-act/superscore**.

For more information about retaking the ACT, see **www.act.org/the-act/retaking**.

Testing More Than Once In the Same Administration

You may not receive scores from more than one test taken during a scheduled National or International test date. For example, you may test on Saturday, on an authorized non-Saturday date, or on a rescheduled test date—but not on more than one of those days on a particular test date. If you are admitted and allowed to test a second time on a particular test date, we will report only the scores from the first test. The second set of scores will be canceled without refund.

Requesting a Copy of Your Test Questions and Answers

On certain test dates, you may order (for an additional fee) a copy of the multiple-choice test questions used to determine your scores, a list of your answers, and the answer key. If you took the writing section, you will also receive a copy of the writing prompt, scoring guidelines, and the scores assigned to your essay.

This service is not available for all test dates and is available only for National testing or Special testing in the United States, US Territories, and Puerto Rico. Restrictions apply.

If you are interested in this service, check **www.act.org/the-act/tir** for more detail.

A complete list of the prohibited behaviors was provided during the registration process. The following behaviors can also result in dismissal. Please be reminded of the following:

For paper testing, you may not fill in or alter responses to any multiple-choice questions or continue to write or alter the essay after time has been called. This includes fixing stray marks.

For paper testing, you may not look at any section of the test outside of the designated time for that test.

You may not access an electronic device (other than your testing computer and mouse, when testing online) at any time during testing or during breaks. All other devices must be powered off and placed out of sight from the time you are admitted to the test room until you are dismissed.

You may not give or receive assistance by any means. This includes looking at another person's test.

The test is confidential and remains so even after the exam is complete. You may not remove any materials from the test room. You may not discuss or share test questions, answers, or test form identification numbers during test administration, during breaks, or after the test.

You may not disclose test questions or answers in any way or at any time, including through social media, in whole or in part.

You may not eat, drink, or use reading materials in the test room.

If you are observed or suspected of engaging in prohibited behavior, you will be dismissed and your test will not be scored.

English Section

The English section consists of several essays, or passages, each followed by a set of multiple-choice questions.

For paper testing, some questions refer to underlined portions of the passage and offer several alternatives to the underlined portion. For online testing, these questions will refer to highlighted portions of the passage. You decide which choice is most appropriate in the context of the passage.

Some questions ask about an underlined or highlighted portion, a section of the passage, or the passage as a whole. You decide which choice best answers the question posed.

Many questions offer “NO CHANGE” to the passage as one of the choices.

The English section puts you in the position of a writer who makes decisions to revise and edit a text. Essays in different genres provide a variety of rhetorical situations. These passages are chosen for their appropriateness in assessing writing and language skills and to reflect students’ interests and experiences.

Four scores are reported for the English section: a score for the section overall and three reporting category scores based on specific knowledge and skills. The approximate percentage of the section devoted to each reporting category is:

Production of Writing (29–32%)

This category requires you to apply your understanding of the purpose and focus of a piece of writing.

Topic Development: Demonstrate an understanding of, and control over, the rhetorical aspects of texts. Identify the purposes of parts of texts, determine whether a text or part of a text has met its intended goal, and evaluate the relevance of material in terms of a text’s focus.

Organization, Unity, and Cohesion: Use various strategies to ensure that a text is logically organized, flows smoothly, and has an effective introduction and conclusion.

Knowledge of Language (15–17%)

These questions require you to demonstrate effective language use through ensuring precise and concise word choice and maintaining consistency in style and tone.

Conventions of Standard English (52–55%)

These questions require you to apply an understanding of the conventions of standard English grammar, usage, and mechanics to revise and edit text.

Sentence Structure and Formation: Apply understanding of sentence structure and formation in a text and make revisions to improve the writing.

Punctuation: Recognize common problems with standard English punctuation and make revisions to improve the writing.

Usage: Recognize common problems with standard English usage in a text and make revisions to improve the writing.

Tips for Taking the English Section

Be aware of the writing style used in each passage.

The passages cover a variety of topics and are written in a variety of styles. It is important that you take into account the writing style used in each passage. When responding to a question, be sure to understand the context of the question. Consider how the sentence containing an underlined or highlighted portion fits in with the surrounding sentences and into the passage as a whole.

Examine the underlined or highlighted portions of the passage.

Before responding to a question with an underlined or highlighted portion, carefully examine what is underlined or highlighted in the text. Consider the elements of writing included in each underlined or highlighted portion.

Some questions will ask you to base your decision on some specific element of writing, such as the tone or emphasis the text should convey.

Some questions will ask you to choose the alternative to the underlined or highlighted portion that is NOT or LEAST acceptable.

The answer choices for each question will contain changes in one or more of those elements of writing.

Be aware of questions with no underlined portions.

You will be asked some questions about a section of the passage or about the passage as a whole, in light of a given rhetorical situation. Questions of this type are often identified by a question number in a box located at the appropriate point in the passage or by a highlighted asterisk in brackets.

Questions about the entire passage are placed at the end of the passage. For paper testing, these questions are introduced by a horizontal box enclosing the following instruction: “Questions __ and __ ask about the preceding passage as a whole.” For online testing, similar instructions will appear above the individual questions.

Note the differences in the answer choices.

Many of the questions in the section will involve more than one aspect of writing. Examine each answer choice and how it differs from the others. Be careful not to choose an answer that corrects one error but causes a different error.

Determine the best answer.

When a question asks you to choose the best alternative to an underlined or highlighted portion, consider the following approach:

Decide how the underlined or highlighted portion might best be phrased in standard written English or in terms of the particular question posed.

If the underlined or highlighted portion is the best answer, select “NO CHANGE.”

If not, check to see whether your phrasing is one of the other answer choices. If you do not find your phrasing, choose the best of the answers presented.

For questions cued by a number in a box or a highlighted asterisk in brackets, decide which choice is most appropriate in terms of the question posed or the stated rhetorical situation.

Reread the sentence, using your selected answer. Once you have selected the answer you feel is best, reread the corresponding sentence(s) of the passage, inserting your selected answer at the appropriate place in the text to make sure it is the best answer within the context of the passage.

Mathematics Section

The mathematics section is designed to assess the mathematical skills students have typically acquired in courses taken up to the beginning of grade 12.

Most questions are self-contained. Some questions may belong to a set of several questions (e.g., each about the same graph or chart).

The material covered emphasizes the major content areas that are prerequisites to successful performance in entry-level courses in college mathematics. Knowledge of basic formulas and computational skills are assumed as background for the problems, but recall of complex formulas and extensive computation are not required.

Note: You may use a permitted calculator on the mathematics section. See

www.act.org/calculator-policy.html *for details about prohibited models and features.*

Nine scores are reported for the mathematics section: a score for the section overall and eight reporting category scores based on specific mathematical knowledge and skills. The approximate percentage of the section devoted to each reporting category is:

Preparing for Higher Math (57–60%)

This category covers the more recent mathematics that students are learning, starting when they began using algebra as a general way of expressing and solving equations. This category is divided into five subcategories:

Number and Quantity (7–10%): Demonstrate knowledge of real and complex number systems. Reason with numerical quantities in many forms, including expressions with integer and rational exponents and vectors and matrices.

Algebra (12–15%): Solve, graph, and model multiple types of expressions. Interpret and use many different kinds of equations, such as linear, polynomial, radical, and exponential relationships. Find solutions to systems of equations, even when represented by a simple matrix equation, and apply results to real-world contexts.

Functions (12–15%): Demonstrate knowledge of function: definition, notation, representation, and application. Use functions including linear, radical, piecewise, polynomial, exponential, and logarithmic. Manipulate and translate functions, as well as interpret and use important features of graphs.

Geometry (12–15%): Apply your knowledge of shapes and solids, using concepts such as congruence and similarity relationships or surface area and volume measurements. Apply your understanding to composite objects and solve for missing values in triangles, circles, and other figures. Use trigonometric ratios and equations of conic sections.

Statistics & Probability (8–12%): Describe center and spread of distributions. Apply and analyze data collection methods. Understand and model relationships in bivariate data. Calculate probabilities by recognizing the related sample spaces.

Integrating Essential Skills (40–43%)

This category focuses on measuring how well you can synthesize and apply your understandings and skills to solve more complex problems. The questions ask you to address concepts such as:

- rates and percentages
- proportional relationships
- area, surface area, and volume
- average and median
- expressing numbers in different ways

You will solve non-routine problems that involve combining skills in chains of steps, applying skills in varied contexts, understanding connections, and demonstrating fluency.

Modeling

This category represents all questions that involve producing, interpreting, understanding, evaluating, and improving models. Each question is also counted in other appropriate reporting mathematics categories. This category is an overall measure of how well you use modeling skills across mathematical topics.

Tips for Taking the Mathematics Section

If you use a calculator, use it wisely.

All of the mathematics problems can be solved without a calculator. Many of the problems are best done without a calculator. Use good judgment in deciding when, and when not, to use a calculator. For example, for some problems you may wish to do scratch work to clarify your thoughts on the question before you begin using a calculator to do computations.

Solve the problem.

To work out solutions to the problems, you will usually do scratch work. You may wish to glance over the answer choices after reading the questions. However, working backwards from all five answer choices can take a lot of time and may not be effective.

Find your solution among the answer choices.

Once you have solved the problem, look for your answer among the choices. If your answer is not included among the choices, carefully reread the problem to see whether you missed important information. Pay careful attention to the question being asked. If an equation is to be selected, check to see whether the equation you think is best can be transformed into one of the answer choices provided.

Make sure you answer the question.

The solutions to many questions will involve several steps. Make sure your answer accounts for all the necessary steps. Frequently, an answer choice is an intermediate result, not the final answer.

Make sure your answer is reasonable.

Sometimes an error in computation will result in an answer that is not practically possible for the situation described. Always think about your answer to determine whether it is reasonable.

Check your answer.

You may arrive at an incorrect solution by making common errors in the problem-solving process. If there is time remaining before the end of the mathematics section, it is important that you reread the questions and check your answers to make sure they are correct.

Reading Section

The reading section measures your ability to read closely, reason logically about texts using evidence, and integrate information from multiple sources.

The questions focus on the mutually supportive skills that readers must bring to bear in studying written materials across a range of subject areas. Specifically, questions will ask you to:

- determine main ideas
- locate and interpret significant details
- understand sequences of events
- make comparisons
- comprehend cause-effect relationships
- determine the meaning of context-dependent words, phrases, and statements
- draw generalizations
- analyze the author's or narrator's voice and method
- analyze claims and evidence in arguments
- integrate information from multiple texts

The reading section is composed of multiple parts. Some parts consist of one long prose passage and others consist of shorter prose passages. The passages represent the levels and kinds of text commonly encountered in first-year college curricula.

Each passage is preceded by a heading that identifies the author and source, and may include important background information to help you understand the passage. Each portion contains a set of multiple-choice questions. These questions do not test the rote recall of facts from outside the passage or rules of formal logic, nor do they contain isolated vocabulary questions. In sections that contain two shorter passages, some of the questions involve both of those passages.

Four scores are reported for the reading section: a score for the section overall and three reporting category scores based on specific knowledge and skills. Score reports also include an Understanding Complex Texts indicator. The approximate percentage of the section devoted to each reporting category is:

Key Ideas & Details (52–60%)

This category requires you to read texts closely to determine central ideas and themes; summarize information and ideas accurately; and show an understanding of relationships and draw logical inferences and conclusions, including understanding sequential, comparative, and cause-effect relationships.

Craft & Structure (25–30%)

These questions ask you to:

- determine word and phrase meanings
- analyze an author's word choice rhetorically
- analyze text structure
- understand the author's purpose and perspective
- analyze characters' points of view
- interpret authorial decisions rhetorically
- differentiate between various perspectives and sources of information

Integration of Knowledge & Ideas (13–23%)

This category requires you to understand authors' claims, differentiate between facts and opinions, and use evidence to make connections between different texts that are related by topic. Some questions will require you to analyze how authors construct arguments and to evaluate reasoning and evidence from various sources.

Visual and Quantitative Information in the Reading Section

One passage may be accompanied by an element like a graph, figure, or table that contains information relevant to the reading task. In the passage containing these visual and quantitative elements, some of the questions will ask you to identify or interpret information from the graphic or integrate the information from the passage and graphic to determine the best answer.

Tips for Taking the Reading Section

Read each passage carefully.

Before you begin answering a question, read all of the content carefully. Be conscious of relationships between or among ideas. Take note about important ideas in the passages.

Refer to the passages when answering the questions.

Answers to some of the questions will be found by referring to what is explicitly stated in the text of the passages. Other questions will require you to determine implicit meanings and to draw conclusions, comparisons, and generalizations. Consider the text before you answer any question.

Science Section

The science section measures the interpretation, analysis, evaluation, reasoning, and problem-solving skills required in the natural sciences. The section presents several authentic scientific scenarios, each followed by a number of multiple-choice questions.

The content includes biology, chemistry, Earth/space sciences (e.g., geology, astronomy, and meteorology), and physics. Advanced knowledge in these areas is not

required, but background knowledge acquired in general, introductory science courses may be needed to correctly answer some of the questions.

The science section focuses on multidimensional assessment, with questions that assess science content in concert with science skills and practices.

The questions require you to:

- recognize and understand the basic features of, and concepts related to, the provided information
- examine critically the relationship between the information provided and the conclusions drawn or hypotheses developed
- generalize from given information to gain new information, draw conclusions, or make predictions.

Note: You are not permitted to use a calculator in the science section.

Four scores are reported for the science section: a score for the section overall and three reporting category scores based on scientific knowledge, skills, and practices. The approximate percentage of the section devoted to each reporting category is:

Interpretation of Data (40–50%)

This category asks you to manipulate and analyze scientific data presented in scientific tables, graphs, and diagrams (e.g., recognize trends in data, translate tabular data into graphs, interpolate and extrapolate, and reason mathematically).

Scientific Investigation (20–30%)

This category requires you to understand experimental tools, procedures, and design (e.g., identify controls and variables) and compare, extend, and modify experiments (e.g., predict the results of additional trials).

Evaluation of Models, Inferences, & Experimental Results (25–35%)

These questions ask you to judge the validity of scientific information and formulate conclusions and predictions based on that information (e.g., determine which explanation for a scientific phenomenon is supported by new findings).

The science section presents information in three formats:

Data Representation (25–35%): This format presents graphic and tabular material similar to that found in science journals and texts. The questions associated with this format measure skills such as recognizing relationships among data in tables and graphs; interpolation and extrapolation; and translating tabular data into graphs.

Research Summaries (45–60%): This format provides descriptions and results of one or more related experiments. The questions focus on the design of the experiments and the interpretation of experimental results.

Conflicting Viewpoints (15–20%): This format presents two or more explanations for the same scientific phenomena that, because they are based on differing premises or incomplete data, are inconsistent with one another. The questions focus on the understanding, analysis, and comparison of alternative viewpoints or hypotheses.

Tips for Taking the Science Section

Read the passage carefully.

Before you begin answering a question, read the scientific material provided. It is important that you read the entire text and examine any tables, graphs, or figures. You may take notes about important ideas. Some of the information sets will describe experiments. You should consider the experimental design, including the controls and variables, because questions are likely to address this component of scientific research.

Note the different viewpoints in passages.

Some material will present conflicting viewpoints, and the questions will ask you to distinguish among them. It may be helpful for you to take notes summarizing each viewpoint about specific portions of the section.

Writing Section (Optional)

If you register for the ACT with writing, you will take the writing section after the four multiple-choice sections. Your score in the writing section will not affect your scores on the multiple-choice or your Composite score.

The writing section is a 40-minute essay test that measures your writing skills—specifically, writing skills taught in high school English classes and in entry-level college composition courses.

The section consists of one writing prompt that describes a complex issue and provides three different perspectives on the issue. You are asked to read the prompt and write an essay in which you develop your own perspective on the issue. Your essay must analyze the relationship between your own perspective and one or more other perspectives. You may adopt one of the perspectives given in the prompt as your own, or you may introduce one that is completely different from those given. Your score will not be affected by the perspective you take on the issue.

Five scores are reported for the writing section: a single subject-level writing score reported on a scale of 2–12 and four domain scores that are based on an analytic scoring rubric. The subject score is the rounded average of the four domain scores. The four writing domains are:

Ideas and Analysis

Scores in this domain reflect the ability to generate productive ideas and engage critically with multiple perspectives on the given issue. Competent writers understand the issue they are invited to address, the purpose for writing, and the audience. They generate ideas that are relevant to the situation.

Development and Support

Scores in this domain reflect the ability to discuss ideas, offer rationale, and bolster an argument. Competent writers explain and explore their ideas, discuss implications, and illustrate through examples. They help the reader understand their thinking about the issue.

Organization

Scores in this domain reflect the ability to organize ideas with clarity and purpose. Organizational choices are integral to effective writing. Competent writers arrange their essay in a way that clearly shows the relationship between ideas, and they guide the reader through their discussion.

Language Use and Conventions

Scores in this domain reflect the ability to use written language to convey arguments with clarity. Competent writers make use of the conventions of grammar, syntax, word usage, and mechanics. They are also aware of their audience and adjust the style and tone of their writing to communicate effectively.

Tips for Taking the Writing Section

Pace yourself.

Budget your time based on your experience in taking essay tests in school or when you have done writing within a time limit. It is unlikely that you will have time to draft, revise, and recopy your essay.

Plan.

Before writing, carefully read and consider all prompt material. Be sure you understand the issue, the different perspectives on the issue, and your essay task.

Planning questions are included with the prompt that will help you analyze the different perspectives and develop your own. Use these questions to think critically about the prompt and generate an effective response. How would you best organize and support your ideas in a written argument. Spend time structuring or outlining your response.

Note: The planning questions are optional and are not scored.

Write.

Establish the focus of your essay by making clear your argument and its main ideas.

Explain and illustrate your ideas with sound reasoning and meaningful examples.

Discuss the significance of your ideas: what are the implications of what you have to say, and why is your argument important to consider?

As you write, ask yourself if your logic is clear, if you have supported your claims, and if you have chosen precise words to communicate your ideas.

Review your essay.

Try to make your essay as polished as you can. Take a few minutes before time is called to read over your essay and correct any mistakes.

If you take the ACT on paper, be sure to write your essay legibly. If you find words that are hard to read, recopy them. Make corrections and revisions neatly, between the lines. Do not write in the margins, if applicable.

Practice.

There are many ways to prepare for the writing section. Read newspapers and magazines, watch/listen to news analyses online, on TV, or on radio, or participate in discussions and debates, thinking carefully about other perspectives in relation to your own.

One good way to prepare for the writing section is to practice writing with different purposes for different audiences. The writing you do in your classes will help you, as will writing a personal journal, stories, essays, editorials, or other writing you do on your own.

It is also a good idea to practice writing within a time limit. Taking the practice writing test will give you a sense of how much additional practice you may need. You might want to take the practice writing section even if you do not plan to take the ACT with writing. It will help you build skills that are important in college-level learning and the world of work.

It is a good idea to take the practice tests under conditions as similar as possible to those you will experience on test day. The following tips will help you:

If taking the ACT (no writing), the four multiple-choice tests require 2 hours and 55 minutes to complete. Take them in order, in one sitting, with a 10- to 15-minute break between Tests 2 and 3.

You will need only sharpened, soft lead No. 2 pencils and good erasers. Remove all other items from your desk.

You will not be allowed to use unapproved scratch paper, but you can use the test booklet to make notes.

If you plan to use a permitted calculator on the mathematics test, use the same one you will use on test day.

Use a digital timer or clock to time yourself on each practice test. Set your timer for five minutes less than the time allowed for each test so you can get used to the verbal announcement of five minutes remaining.

Give yourself only the time allowed for each test.

Detach and use the sample answer document on pages 55–56.

Read the test directions on the first page of each multiple-choice test. These are the same directions that will appear in your test booklet on test day.

Start your timer and begin with Test 1. Continue through Test 4, taking a 10- to 15-minute break between Tests 2 and 3. Use the timing table on page 1 to time each section of the test.

Score your multiple-choice tests using the information beginning on page 63.

If you plan to take the ACT with writing, read the directions on the first page of the practice ACT writing test (page 52). These are the same directions that will appear in your test booklet on test day. Start your timer (set for 40 minutes), then read the prompt on page 53. After you understand what the prompt is asking you to do, plan your essay and then write or print it on lined paper. On test day, if you test on paper, your answer document will have lined pages on which you will write your essay. Score your essay using the information on pages 68–69.

Practice Multiple-Choice Sections

EXAMINEE STATEMENTS, CERTIFICATION, AND SIGNATURE

1. **Statements:** I understand that by registering for, launching, starting, or submitting answer documents for an ACT® test, I am agreeing to comply with and be bound by the *Terms and Conditions: Testing Rules and Policies for the ACT® Test* (“Terms”).

I UNDERSTAND AND AGREE THAT THE TERMS PERMIT ACT TO CANCEL MY SCORES IN CERTAIN CIRCUMSTANCES. THE TERMS ALSO LIMIT DAMAGES AVAILABLE TO ME AND REQUIRE ARBITRATION OF CERTAIN DISPUTES. BY AGREEING TO ARBITRATION, ACT AND I BOTH WAIVE THE RIGHT TO HAVE THOSE DISPUTES HEARD BY A JUDGE OR JURY.

I understand that ACT owns the test questions and responses, and I will not share them with anyone by any form of communication before, during, or after the test administration. I understand that taking the test for someone else may violate the law and subject me to legal penalties.

I consent to the collection and processing of personally identifying information I provide, and its subsequent use and disclosure, as described in the ACT Privacy Policy (www.act.org/privacy.html). I also permit ACT to transfer my personally identifying information to the United States, to ACT, or to a third-party service provider, where it will be subject to use and disclosure under the laws of the United States, including being accessible to law enforcement or national security authorities.

2. **Certification:** Copy the italicized certification below, then sign, date, and print your name in the spaces provided.

*I agree to the **Statements** above and certify that I am the person whose information appears on this form.*

Your Signature

Today's Date

Print Your Name



The **ACT**®

Form 2176CPRE

Directions

This booklet contains tests in English, mathematics, reading, and science. These tests measure skills and abilities highly related to high school course work and success in college. **Calculators may be used on the mathematics test only.**

The questions in Tests 1–4 are numbered, and the suggested answers for each question are lettered. On the answer document, the rows of ovals are numbered to match the questions, and the ovals in each row are lettered to correspond to the suggested answers.

For each question, first decide which answer is best. Next, locate on the answer document the row of ovals numbered the same as the question. Then, locate the oval in that row lettered the same as your answer. Finally, fill in the oval completely. Use a soft lead pencil and make your marks heavy and black. **Do not use ink or a mechanical pencil.**

Mark only one answer to each question. If you change your mind about an answer, erase your first mark thoroughly before marking your new answer. For each question, make certain that you mark in the row of ovals with the same number as the question.

Only responses marked on your answer document will be scored. Your score on each test will be based only on the number of questions you answer correctly during the time allowed for that test. You will **not** be penalized for guessing. **It is to your advantage to answer every question even if you must guess.**

You may work on each test **only** when the testing staff tells you to do so. If you finish a test before time is called for that test, you should use the time remaining to reconsider questions you are uncertain about in that test. You may **not** look back to a test on which time has already been called, and you may **not** go ahead to another test. To do so will disqualify you from the examination.

Lay your pencil down immediately when time is called at the end of each test. You may **not** for any reason fill in or alter ovals for a test after time is called for that test. To do so will disqualify you from the examination.

For Test 5, follow the directions on the first page of that test.

Do not fold or tear the pages of your test booklet.

DO NOT OPEN THIS BOOKLET UNTIL TOLD TO DO SO.

ENGLISH TEST

45 Minutes—75 Questions

DIRECTIONS: In the five passages that follow, certain words and phrases are underlined and numbered. In the right-hand column, you will find alternatives for the underlined part. In most cases, you are to choose the one that best expresses the idea, makes the statement appropriate for standard written English, or is worded most consistently with the style and tone of the passage as a whole. If you think the original version is best, choose “NO CHANGE.” In some cases, you will find in the right-hand column a question about the underlined part. You are to choose the best answer to the question.

You will also find questions about a section of the passage, or about the passage as a whole. These questions do not refer to an underlined portion of the passage, but rather are identified by a number or numbers in a box.

For each question, choose the alternative you consider best and fill in the corresponding oval on your answer document. Read each passage through once before you begin to answer the questions that accompany it. For many of the questions, you must read several sentences beyond the question to determine the answer. Be sure that you have read far enough ahead each time you choose an alternative.

PASSAGE I

The following paragraphs may or may not be in the most logical order. Each paragraph is numbered in brackets, and question 14 will ask you to choose where Paragraph 3 should most logically be placed.

Bar Codes: A Linear History

[1]

In 1948, graduate students, Norman Woodland
and Bernard Silver, took on a problem that had troubled
retailers for years: how to keep track of store inventories.

Inspired by the dots and dashes of Morse code, however,
Woodland and Silver created a system of lines that could
encode data. Called a *symbolology*, the pattern created by
the spacing and widths of the lines encodes information
by representing different characters.

1. A. NO CHANGE
B. students, Norman Woodland and Bernard Silver
C. students Norman Woodland and Bernard Silver
D. students Norman Woodland and Bernard Silver,

2. F. NO CHANGE
G. in other words,
H. consequently,
J. DELETE the underlined portion.



[2]

The first bar code was composed of four white lines set at specific distances from each other on a black ³

background. The first line was always present. 4

Depending on the presence or absence of the remaining three lines, up to seven different arrangements were

susceptible and, therefore, seven different encodings. ⁵

Today, twenty-nine white lines making more than half a billion encodings possible. ⁶

[3]

To create a bar code scanner, Woodland and Silver adapted technology from an optical movie sound system. Their prototype scanner used a 500-watt bulb, a photomultiplier tube (a device that detects light), and an oscilloscope (a device that translates electronic signals into readable information). Although successful, the concoction ⁷

was both large and costly. For example, progress stalled ⁸ until the 1970s, when laser technology (both more compact and less expensive) became available.

[4]

In today's scanners, a laser sends light back and forth across a bar code. While the black lines absorb the light, the white lines reflect it back at a fixed mirror inside the scanner. ⁹ In this way, the scanner reads the symbology and decodes the information.

3. A. NO CHANGE
B. distances so that each was separated, one from the
C. locations, each one set apart from the
D. lengths of distance from each
4. The writer is considering deleting the preceding sentence. Should the sentence be kept or deleted?
F. Kept, because it begins the description that is completed in the sentence that follows.
G. Kept, because it gives a clear image of what the first bar code looked like.
H. Deleted, because it provides an extra detail that is not relevant to the subject of the paragraph.
J. Deleted, because it contradicts a point made later in the paragraph.
5. A. NO CHANGE
B. responsible
C. possible
D. capable
6. F. NO CHANGE
G. which make
H. to make
J. make
7. A. NO CHANGE
B. contraption
C. substance
D. stuff
8. F. NO CHANGE
G. As a result,
H. However,
J. Even so,
9. A. NO CHANGE
B. them
C. ones
D. one



[5]

10 Today,

being that there are one- and
¹¹
two-dimensional bar codes using numeric
and alphanumeric symbologies. Bar codes
are used not only for a pack of gum or an airline
ticket, but also for research. In one study, for
instance, tiny bar codes were placed on bees tracking
¹²
their activities. Shaping the way we gather, track, and
share information, we have almost certainly exceeded
¹³
even Woodland and Silver's expectations.

Questions 14 and 15 ask about the preceding passage as a whole.

10. Which of the following true statements, if added here, would most effectively lead into the new subject of the paragraph?
- F. In the 1940s, Woodland and Silver were graduate students at the Drexel Institute of Technology in Philadelphia.
 - G. Woodland and Silver were granted a patent for their bar code on October 7, 1952.
 - H. Bar code equipment has been available for retail use since 1970.
 - J. Bar codes themselves have advanced as well.
11. A. NO CHANGE
B. there are
C. where
D. DELETE the underlined portion.
12. F. NO CHANGE
G. had been placed on bees trying to track
H. placed on bees, which would track
J. were placed on bees to track
13. A. NO CHANGE
B. exceeding Woodland and Silver's expectations about bar codes has almost certainly been done.
C. bar codes have almost certainly exceeded even Woodland and Silver's expectations.
D. it is almost certain that we have exceeded even Woodland and Silver's expectations.
14. For the sake of the logic and coherence of the essay, Paragraph 3 should be placed:
- F. where it is now.
 - G. before Paragraph 1.
 - H. after Paragraph 1.
 - J. after Paragraph 5.
15. Suppose the writer's primary purpose had been to describe how a specific technological advancement changed business practices. Would this essay accomplish that purpose?
- A. Yes, because it offers an overview of current bar code technology and indicates the variety of ways in which bar codes are used by specific businesses.
 - B. Yes, because it explains how bar codes and scanners made it easier for stores to keep track of their inventories.
 - C. No, because it focuses primarily on the development of bar codes and only briefly mentions how businesses have implemented the use of bar codes.
 - D. No, because it focuses on why businesses needed new technology but does not explain how bar codes were able to serve that need.

PASSAGE II

Glowing on an Adventure

As I pulled my camera out of my backpack, I felt a tap on my arm.

“No photographs,” whispered the woman next to me, pointing up to the cave ceiling. “The flash will
16

make them stop glowing,” she said, whispering.
17

She was referring to the thousands of glowworms that clung to the limestone ceiling and, with their radiant bodies, flooded the cave in aquamarine light. While
18

I was traveling on canoe on a group tour through
19
the renowned Glowworm Grotto of New Zealand’s Waitomo Caves. Were it not for the twinkling light of these *Arachnocampa luminosa*, a species unique to New Zealand and abundant in these caves, this meandering subterranean passageway would feel as though it were downright ensconced in shadows.
20

I sheepishly tucked the camera away and focused again on the glowworms. Collectively, they resembled the cosmos, a sea of stars in a clear night sky. Beautiful—yet what made them glow?

“Bioluminescence,” the woman said, peculiarly sensing my curiosity. 21 A badge

was pinned to her shirt indicated she was a
22
biochemist, here, I guessed, to research the organism.

16. F. NO CHANGE
G. me, and then pointing
H. me and she pointed
J. me, she pointed
17. A. NO CHANGE
B. glowing,” she said as she pointed up to the ceiling.
C. glowing,” she said in a hushed, whispering voice.
D. glowing.”
18. F. NO CHANGE
G. Although
H. Since
J. DELETE the underlined portion.
19. A. NO CHANGE
B. with
C. by
D. in
20. F. NO CHANGE
G. end up pretty hard to see.
H. have not a lot of light.
J. be utterly dark.
21. At this point, the writer wants to emphasize the idea that the narrator found the woman’s comment peculiar. Which of the following best accomplishes that goal?
A. I figured she had been to the caves before.
B. Surprised, I hesitantly turned toward her.
C. She had a notepad in her hand.
D. I happened to agree.
22. F. NO CHANGE
G. had been
H. it was
J. DELETE the underlined portion.

She explained that to attract prey, glowworms (not really worms at all, but the larval stage of a fungus gnat) emit light through their translucent skin; via a ²³ cellular chemical reaction. The cells produce luciferin, a chemical pigment that reacts with oxygen to produce light that shines through the organism's tail-end intestine.

From its mouth, she showed me, all glowworms dangle shimmering silken ²⁴ threads glossed in beads of mucus. Cave-dwelling

insects are trapped in these threads, then reeled in ²⁵ like fish on a line, and finally lured by the light. ²⁵ The light responds to environmental factors. The

sound of splashing water, however, ²⁶ might signal

that prey is nearby, causing them to ²⁷

brighten. 28

23. A. NO CHANGE

B. skin, and via

C. skin. Via

D. skin via

24. F. NO CHANGE

G. all of the glowworms are dangling

H. each of the glowworms dangle

J. each glowworm dangles

25. A. NO CHANGE

B. lured by the light, then trapped in these threads, and finally reeled in like fish on a line.

C. reeled in like fish on a line, then trapped in these threads, and finally lured by the light.

D. trapped in these threads, then lured by the light, and finally reeled in like fish on a line.

26. F. NO CHANGE

G. on the other hand,

H. for example,

J. above all,

27. A. NO CHANGE

B. the light

C. these

D. DELETE the underlined portion.

28. Which of the following choices, if added here, would best conclude the paragraph and refer back to the conversation at the beginning of the essay?

F. Insects are likely attracted to the light because the sky-like appearance of the glowworms fools the insects into believing they are outdoors.

G. She told me that the cave is usually quiet, with only occasional noises, such as tour boats passing through the water.

H. A camera flash, she reminded me, may also spell danger, and the glowworms' light is doused.

J. The light is also brighter in a hungry larva than in those that have just eaten.

Our trip neared its end. I spotted
a dragonfly in the cave. I knew its
29

fate, it would be ensnared, just as I had
30
been by the brilliance of these luminescent
glowworms.

29. The writer is considering revising the underlined portion to the following:

soaring toward the light.

Should the writer make this revision?

- A. Yes, because the revised phrase more specifically describes the dragonfly's actions to help support the narrator's claim that she knew what its fate would be.
- B. Yes, because the revised phrase adds information that explains why the light of the glowworms was suddenly dim.
- C. No, because the original phrase more clearly establishes that the trip is ending and that the narrator sees the dragonfly as they exit the cave.
- D. No, because the original phrase builds on the suspense established in the narrative regarding the fate of the dragonfly.

30. F. NO CHANGE
G. fate; and
H. fate:
J. fate

PASSAGE III

A Rose by the Name Antique

With shears in hand, I clip a thin branch
from the rosebush in my backyard garden. I place this
clipping into the basket next to me and crouch under
31
this again. I snip a few more branches and then rise
32
to head to the greenhouse. There, I will deposit these
clippings in rich soil; roots will take hold, buds will sprout,
33
and a new plant will find a home in my garden.

My roses are not your average hybrid-tea roses (those
long-stemmed, special occasion roses with well-formed
buds). Mine are antique roses, old, or heirloom varieties,
34
that have existed in gardens worldwide for centuries.

31. A. NO CHANGE
B. basket next, to me
C. basket, next to me
D. basket next to me,
32. F. NO CHANGE
G. the rosebush
H. one
J. it
33. Which choice most closely maintains the sentence pattern the writer establishes after the semicolon?
- A. NO CHANGE
 - B. I will see new buds that have been sprouting,
 - C. followed by the buds, which have sprouted,
 - D. then come the sprouting buds after that,
34. F. NO CHANGE
G. roses, old or heirloom, varieties,
H. roses old, or heirloom varieties
J. roses, old or heirloom varieties

Compared to vibrant hybrid-tea colors, antique rose colors
35

tend to be silenced. Their stems are also shorter, and their
36
buds are a bit droopier. Their fragrance, however, is
unmatched. And unlike the hybrid-tea whose long stems
make into a rosebush that is rather scraggly looking,
37

antique rosebushes can be grown in a variety of colors,
38
handsomely landscaping gardens.

The plant thrives best when it is exposed to six hours
39
of direct sunlight daily. The plant can withstand extreme
39

temperatures and survive nearly anywhere. It's also easier
40

to grow antiques. Cultivating hybrid-teas having involved
41
a process of grafting two species of rose together, but the
grafted area remains weak and susceptible to viruses.

Antiques, on the other hand, are less prone to disease
because they are grown simply by placing cuttings from
a parent plant into nutrient-rich soil. They require far less
42
pruning, fertilizing, and nurturing than their hybrid-tea

35. A. NO CHANGE
B. vibrant hybrid-tea, colors,
C. vibrant, hybrid-tea colors
D. vibrant hybrid-tea colors

36. F. NO CHANGE
G. reduced.
H. muted.
J. lower.

37. A. NO CHANGE
B. about
C. like
D. for

38. The writer wants to add a detail here that best completes the contrast to hybrid-tea roses in the first part of the sentence. Which choice best accomplishes that goal?
F. NO CHANGE
G. are lush and shapely,
H. can grow quite large,
J. tend to be less thorny,

39. Which choice best introduces the main focus of the paragraph?
A. NO CHANGE
B. The varieties of antique roses are numerous, the most popular of which are the silken peach *Mutabilis* and the crimson *Louis Phillippe*.
C. Aside from the rose's beauty, what gardeners like me most appreciate is that antiques are incredibly durable and low maintenance.
D. While I am fond of bush varieties, I am also drawn to climbing varieties that can be placed against walls, fences, or trellises.

40. F. NO CHANGE
G. They're
H. Their
J. Its

41. A. NO CHANGE
B. which involves
C. involves
D. involving

42. F. NO CHANGE
G. Antiques, requiring
H. Antiques require
J. Requiring



counterparts, antiques can reportedly survive without any care from human hands, a fact that surprises many.

[1] I dig small holes in a pot of soil, place each clipping a half inch deep, and pack down the soil around them. [2] Back in my greenhouse, I strip the clippings of all leaves and branches. [3] Then I wait: the roots will take hold and, eventually, buds will sprout. 44

43. The writer wants to add a detail here that emphasizes the antique rose's ability to survive without human care. Which choice best accomplishes that goal?
- A. NO CHANGE
 - B. blooming year after year even at abandoned sites.
 - C. making them more popular among gardeners.
 - D. often blooming between midspring and fall.
44. Which sequence of sentences makes this paragraph most logical?
- F. NO CHANGE
 - G. 2, 1, 3
 - H. 3, 1, 2
 - J. 1, 3, 2

Question 45 asks about the preceding passage as a whole.

45. Suppose the writer's primary purpose had been to describe the process of planting a particular flower. Would this essay accomplish that purpose?
- A. Yes, because the essay discusses the steps involved in growing and maintaining antique rosebushes.
 - B. Yes, because the writer explains the specific conditions needed to plant antique roses and how long it takes for new buds to sprout.
 - C. No, because the essay is more focused on comparing the qualities and cultivation of antique and hybrid-tea roses.
 - D. No, because while the writer mentions growing antique roses in his garden, the essay is more focused on the history of antiques in gardens worldwide.

PASSAGE IV

Jeremy Frey, Weaving Heritage Into Modern Art

[1]

The winning piece was a basket, it was eighteen inches tall with a curved, vasetype silhouette. [A] It was made of ash wood finely woven into bold stripes of black and white that ran from its crown to its base. [B]

46. **F.** NO CHANGE
G. this work of art reached
H. the object stood
J. DELETE the underlined portion.



In the ninety-year history of the Santa Fe Indian

Market—the largest Indian art festival in the nation—the

47

2011 event marked the first time a basket won best of

show. The creator of the piece, thirty-three-year-old

Passamaquoddy Indian Jeremy Frey from Princeton,

Maine, the basket sold at auction for \$16,000.

48

[2]

[C] Frey describes his baskets as

“cutting-edge traditional.” [D] He primarily

weaves a classic material, wood from the brown

ash tree, but, unlike most contemporary basketmakers,

49

he harvests, cuts, pounds, dries, and dyes the wood

himself. Then creating highly elaborate versions

50

of the sturdy utility baskets that have been used

by generations of Passamaquoddy fishermen from

51

Maine. He honors tradition, but he highlights

artistic design. For example, his baskets feature

complex weaving on areas that are often hidden

52

and therefore typically not embellished. Many

traditional baskets have basic, woven lids.

47. A. NO CHANGE

B. Market the largest Indian art festival—in the nation—

C. Market, the largest Indian art festival, in the nation

D. Market, the largest Indian art festival in the nation

48. F. NO CHANGE

G. looked on as the

H. as his

J. his

49. A. NO CHANGE

B. but, unlike most, contemporary basketmakers

C. but unlike, most contemporary basketmakers,

D. but, unlike most contemporary basketmakers

50. F. NO CHANGE

G. Going on to create

H. Frey creates

J. Creating

51. If the writer were to delete the underlined portion, the essay would primarily lose:

A. an indication that Frey honors Passamaquoddy cultural heritage by creating baskets that look nearly identical to traditional pieces.

B. a mention of a physical characteristic of the earliest baskets used by Passamaquoddy fishermen.

C. a detail that connects Frey’s basketry work to long-standing Passamaquoddy traditions.

D. a point revealing that Frey’s baskets are used by Passamaquoddy fishermen today.

52. Which choice provides the clearest and most specific information about which parts of Frey’s baskets are being referred to in the sentence and about Frey’s manner of weaving those parts?

F. NO CHANGE

G. a remarkable level of detail on certain sections, the

H. intricately woven interiors and bottoms,

J. characteristic interiors and bottoms,



Frey's porcupine quill lids are often decorated
53

with art inlaid on birch bark; as far as lids go,
54
I wouldn't say that's basic. And while braids of
54

grass are customarily woven into ash baskets
55

to make them better, Frey incorporates braided
56
cedar bark to create striking new textures.

[3]

Now that he's a nationally recognized artist of who
57
has rejuvenated the art of basketry, Frey feels his role
is to inspire. He's on the board of the Maine Indian
Basketmakers Alliance, a group that works to help
preserve it by reaching out to young members of Native
58
communities in the state. His other goal is to continue to
stand out. The woven grass bracelets he saw on a recent
59
trip to Hawaii have influenced how he shapes the bases
of some of his newer baskets, as he finds yet another way
to make traditional Passamaquoddy weaving something
spectacularly his own.

53. Which placement of the underlined portion makes clear that the art that decorates the lid, not the lid itself, is made of porcupine quill?

- A. Where it is now
- B. After the word *are*
- C. After the word *often*
- D. After the word *with*

54. F. NO CHANGE

- G. bark, which is not exactly formulating a lid through a conventional ideology.
- H. bark; this is just part of his really artistic way.
- J. bark.

55. A. NO CHANGE

- B. has been
- C. is seen
- D. is

56. Which choice provides the clearest and most specific reason that grass is woven into ash baskets?

- F. NO CHANGE
- G. for the sake of the objects,
- H. for a useful purpose,
- J. to strengthen them,

57. A. NO CHANGE

- B. being whom
- C. whom
- D. who

58. F. NO CHANGE

- G. this art
- H. that
- J. DELETE the underlined portion.

59. A. NO CHANGE

- B. distinguish himself from other weavers so as a weaver he is set apart from them.
- C. remain to be someone who gets noticed.
- D. keep on being fully distinct.

Question 60 asks about the preceding passage as a whole.

60. The writer is considering adding the following sentence to the essay:

The black stripes were woven flat, sharply setting off the white stripes, which were woven to form raised columns of perfectly even points that seemed to cascade down the piece.

If the writer were to add this sentence, it would most logically be placed at:

- F. Point A in Paragraph 1.
- G. Point B in Paragraph 1.
- H. Point C in Paragraph 2.
- J. Point D in Paragraph 2.

PASSAGE V

The Flow of Time

Nine hundred years ago, Emperor Zhezong of China,
⁶¹
 ordered the design and construction of a clock
built to keep time more accurately than other clocks.
⁶²

This would be no simple timepiece and because
⁶³

Chinese dynasties continued to astrology, they relied
⁶⁴
 on complicated clocks that not only kept time but also
 helped track stars, planets, the sun, and the moon. An
eminent scientist and bureaucrat named Su Song lead
⁶⁵
 Zhezong's ambitious project.

Using his expertise in calendrical science,
⁶⁶

Su Song created a spectacular timepiece housed within
⁶⁷
 an ornate forty-foot-tall tower. At the tower's top sat an
 armillary sphere, or a nest of metal rings representing
⁶⁸
 celestial reference points such as the horizon and
 the sun's path—that rotated in sync with the
 earth, enabling precise astronomical observations.
 Inside the tower, a sphere depicting the sky
 revolved to display the stars that were overhead.

61. A. NO CHANGE
 B. ago, Emperor Zhezong, of China
 C. ago, Emperor Zhezong of China
 D. ago Emperor Zhezong of China,
62. F. NO CHANGE
 G. to keep time more accurately than clocks that had previously come before it.
 H. more accurate at keeping time correctly than any other clock of the time.
 J. more accurate than any other.
63. A. NO CHANGE
 B. timepiece. Because
 C. timepiece, because
 D. timepiece because
64. F. NO CHANGE
 G. adhered
 H. linked
 J. fixed
65. A. NO CHANGE
 B. imminent scientist and bureaucrat named Su Song lead
 C. imminent scientist and bureaucrat named Su Song led
 D. eminent scientist and bureaucrat named Su Song led
66. Given that all the choices are accurate, which one best indicates that Su Song relied on engineering achievements from earlier times?
 F. NO CHANGE
 G. Building on centuries of Chinese clock-making knowledge,
 H. While authoring his treatise on astronomical clockwork,
 J. After first crafting a working small-scale wooden model,
67. A. NO CHANGE
 B. secured between
 C. encased around
 D. nestled among
68. F. NO CHANGE
 G. sphere—
 H. sphere:
 J. sphere,

Besides, below the star sphere, the tower's open
⁶⁹
 sides exposed a detailed model of a five-story pagoda.

Automated figurines would appear in the pagoda's
 doorways and ring bells to announce hours, sunsets,
⁷⁰
 seasons, and other chronological events.

The clock's inner workings were equally remarkable.
⁷¹
 Hidden in the tower, a waterwheel eleven feet in diameter
⁷²
 powered the entire clock. Therefore, water would pour at
 a constant rate into one of the wheel's thirty-six buckets.
 When the bucket was full, the water's weight pulled it
 down, rotating the waterwheel. Then a stop mechanism
 halted the wheel and positioned the next bucket for filling.

Chinese clockmakers had long used waterwheels, but
⁷³
 Su Song's stop mechanism, which regulated the inertia
 of the waterwheel, represented significant innovation.

Unfortunately, after Su Song's clock ran
 for thirty years, invaders stole it. Later the clock
 vanished altogether. It would be a few hundred years
until with the refinement of mechanical clocks in Europe
⁷⁴

other clocks approached the complexity of Su Song's
⁷⁵
 masterpiece.

69. A. NO CHANGE
 B. Sooner or later,
 C. Lastly,
 D. Thus,

70. Which of the following alternatives to the underlined portion would NOT be acceptable?
 F. bells, which served to announce
 G. bells, they announced
 H. bells that announced
 J. bells, announcing

71. A. NO CHANGE
 B. reveals themselves as being
 C. was shown to be
 D. has proved

72. F. NO CHANGE
 G. In other words, water
 H. For example, water
 J. Water

73. A. NO CHANGE
 B. nevertheless,
 C. regardless,
 D. DELETE the underlined portion.

74. F. NO CHANGE
 G. until—with the refinement of mechanical clocks in Europe—
 H. until with the refinement (of mechanical clocks in Europe)
 J. until, with the refinement, of mechanical clocks in Europe

75. A. NO CHANGE
 B. eventually became able to draw anywhere near to the complexity
 C. grew to attain such a high degree as that
 D. could even fathom coming within reach

END OF TEST 1

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.



MATHEMATICS TEST

60 Minutes—60 Questions

DIRECTIONS: Solve each problem, choose the correct answer, and then fill in the corresponding oval on your answer document.

Do not linger over problems that take too much time. Solve as many as you can; then return to the others in the time you have left for this test.

You are permitted to use a calculator on this test. You may use your calculator for any problems you choose,

but some of the problems may best be done without using a calculator.

Note: Unless otherwise stated, all of the following should be assumed.

1. Illustrative figures are NOT necessarily drawn to scale.
2. Geometric figures lie in a plane.
3. The word *line* indicates a straight line.
4. The word *average* indicates arithmetic mean.

1. The numbers 1 through 15 were each written on individual pieces of paper, 1 number per piece. Then the 15 pieces of paper were put in a jar. One piece of paper will be drawn from the jar at random. What is the probability of drawing a piece of paper with a number less than 9 written on it?

- A. $\frac{1}{9}$
- B. $\frac{1}{15}$
- C. $\frac{6}{15}$
- D. $\frac{7}{15}$
- E. $\frac{8}{15}$

2. Which of the following expressions is equivalent to $-4x^3 - 12x^3 + 9x^2$?

- F. x^8
- G. $-7x^8$
- H. $-8x^3 + 9x^2$
- J. $-16x^3 + 9x^2$
- K. $-16x^6 + 9x^2$

3. When $x = 2$, $10 + 3(12 \div (3x)) = ?$

- A. 12
- B. 16
- C. 26
- D. 34
- E. 104

4. $|6 - 4| - |3 - 8| = ?$

- F. -7
- G. -3
- H. 3
- J. 7
- K. 21

5. The expression $(4c - 3d)(3c + d)$ is equivalent to:

- A. $12c^2 - 13cd - 3d^2$
- B. $12c^2 - 13cd + 3d^2$
- C. $12c^2 - 5cd - 3d^2$
- D. $12c^2 - 5cd + 3d^2$
- E. $12c^2 - 3d^2$

6. Of the 180 students in a college course, $\frac{1}{4}$ of the students earned an A for the course, $\frac{1}{3}$ of the students earned a B for the course, and the rest of the students earned a C for the course. How many of the students earned a C for the course?

- F. 75
- G. 90
- H. 105
- J. 120
- K. 135

7. The number of fish, f , in Skipper's Pond at the beginning of each year can be modeled by the equation $f(x) = 3(2^x)$, where x represents the number of years after the beginning of the year 2000. For example, $x = 0$ represents the beginning of the year 2000, $x = 1$ represents the beginning of the year 2001, and so forth. According to the model, how many fish were in Skipper's Pond at the beginning of the year 2006?

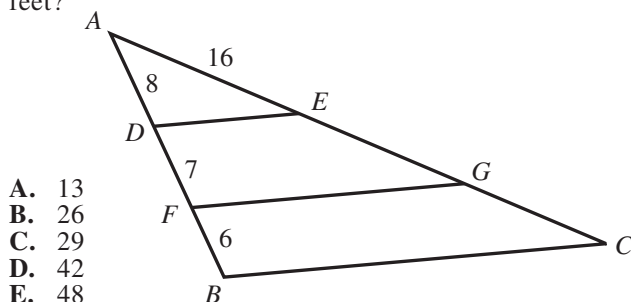
- A. 96
- B. 192
- C. 384
- D. 1,458
- E. 46,656



8. Manish drove from Chicago to Baton Rouge. At 8:00 a.m., he was 510 km from Baton Rouge. At 1:00 p.m., he was 105 km from Baton Rouge. Which of the following values is closest to Manish's average speed, in kilometers per hour, from 8:00 a.m. to 1:00 p.m. ?

F. 58
G. 68
H. 81
J. 94
K. 102

9. In the figure shown below, E and G lie on $\overline{AC}$, D and F lie on $\overline{AB}$, $\overline{DE}$ and $\overline{FG}$ are parallel to $\overline{BC}$, and the given lengths are in feet. What is the length of $\overline{AC}$, in feet?



A. 13
B. 26
C. 29
D. 42
E. 48

10. Katerina runs 15 miles in $2\frac{1}{2}$ hours. What is the average number of *minutes* it takes her to run 1 mile?

F. 6
G. 10
H. $12\frac{1}{2}$
J. $16\frac{2}{3}$
K. $17\frac{1}{2}$

11. A bag contains 8 red marbles, 9 yellow marbles, and 7 green marbles. How many additional red marbles must be added to the 24 marbles already in the bag so that the probability of randomly drawing a red marble is $\frac{3}{5}$?

A. 11
B. 16
C. 20
D. 24
E. 32

12. In the standard (x,y) coordinate plane, the point $(2,1)$ is the midpoint of $\overline{CD}$. Point C has coordinates $(6,8)$. What are the coordinates of point D ?

F. $(-2, -\frac{7}{2})$
G. $(-2, -6)$
H. $(4, \frac{9}{2})$
J. $(10, 10)$
K. $(10, 15)$

13. At his job, the first 40 hours of each week that Thomas works is *regular time*, and any additional time that he works is *overtime*. Thomas gets paid \$15 per hour during regular time. During overtime Thomas gets paid 1.5 times as much as he gets paid during regular time. Thomas works 46 hours in 1 week and gets \$117 in deductions taken out of his pay for this week. After the deductions are taken out, how much of Thomas's pay for this week remains?

A. \$492
B. \$573
C. \$609
D. \$618
E. \$735

14. At Sweet Stuff Fresh Produce the price of a bag of grapes depends on the total number of bags purchased at 1 time, as shown in the table below. In 2 trips to Sweet Stuff this week, Janelle purchased 3 bags of grapes on Monday and 4 bags of grapes on Wednesday. How much money would Janelle have saved if she had instead purchased 7 bags of grapes in 1 trip on Monday?

Number of bags	Price per bag
1–3	\$3.00
4–6	\$2.80
7–9	\$2.60
10 or more	\$2.50

F. \$0.20
G. \$1.00
H. \$1.40
J. \$2.00
K. \$2.50

15. What is 3% of 4.14×10^4 ?

A. 1,242
B. 1,380
C. 12,420
D. 13,800
E. 124,200



16. What value of x satisfies the equation $-3(4x - 5) = 2(1 - 5x)$?

F. $-\frac{17}{2}$

G. $-\frac{17}{22}$

H. -1

J. $\frac{3}{17}$

K. $\frac{13}{2}$

17. In right triangle $\triangle ABC$ shown below, the given lengths are in millimeters. What is $\sin A$?

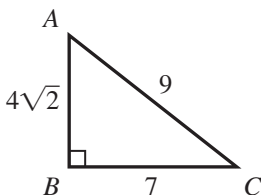
A. $\frac{4\sqrt{2}}{9}$

B. $\frac{4\sqrt{2}}{7}$

C. $\frac{7\sqrt{2}}{8}$

D. $\frac{7}{9}$

E. $\frac{9}{7}$



18. $\left(\frac{27}{64}\right)^{-\frac{2}{3}} = ?$

F. $-\frac{9}{16}$

G. $-\frac{9}{32}$

H. $\frac{9}{32}$

J. $\frac{16}{9}$

K. $\frac{32}{9}$

19. Loto begins at his back door and walks 8 yards east, 6 yards north, 12 yards east, and 5 yards north to the barn door. About how many yards less would he walk if he could walk directly from the back door to the barn door?

- A. 8
B. 19
C. 23
D. 26
E. 31

20. For a given set of data, the standard score, z , corresponding to the raw score, x , is given by $z = \frac{x - \mu}{\sigma}$, where μ is the mean of the set and σ is the standard deviation. If, for a set of scores, $\mu = 78$ and $\sigma = 6$, which of the following is the raw score, x , corresponding to $z = 2$?

F. 90

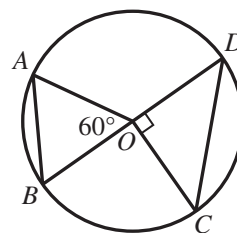
G. 84

H. 80

J. 76

K. 66

21. In the figure below, A , B , C , and D lie on the circle centered at O .



Which of the following does NOT appear in the figure?

- A. Acute triangle
B. Equilateral triangle
C. Isosceles triangle
D. Right triangle
E. Scalene triangle

22. What is the slope of a line, in the standard (x,y) coordinate plane, that is parallel to $x + 5y = 9$?

F. -5

G. $-\frac{1}{5}$

H. $\frac{1}{5}$

J. $\frac{9}{5}$

K. 9

23. Given $y = \frac{x}{x-1}$ and $x > 1$, which of the following is a possible value of y ?

A. -1.9

B. -0.9

C. 0.0

D. 0.9

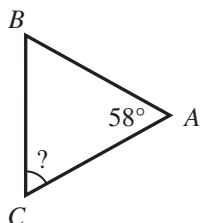
E. 1.9



24. The set of all positive integers that are divisible by both 15 and 35 is infinite. What is the least positive integer in this set?

F. 5
G. 50
H. 105
J. 210
K. 525

25. In $\triangle ABC$ shown below, the measure of $\angle A$ is 58° , and $\overline{AB} \cong \overline{AC}$. What is the measure of $\angle C$?



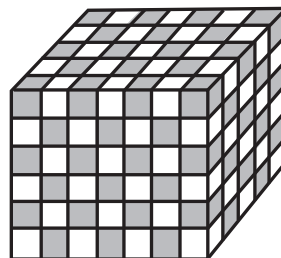
- A. 32°
B. 42°
C. 58°
D. 61°
E. 62°
26. About 1.48×10^8 square kilometers of Earth's surface is land; the rest, about 3.63×10^8 square kilometers, is water. If a returning space capsule lands at a random point on Earth's surface, which of the following is the best estimate of the probability that the space capsule will land in water?

F. 80%
G. 71%
H. 65%
J. 41%
K. 29%

27. On the first 7 statistics tests of the semester, Jamal scored 61, 76, 79, 80, 80, 84, and 91. The mean, median, and mode of his scores were 79, 80, and 80, respectively. On the 8th statistics test, Jamal scored 90. How do the mean, median, and mode of all 8 of his scores compare to the mean, median, and mode of his first 7 scores?

	Mean	Median	Mode
A.	equal	greater	greater
B.	greater	greater	greater
C.	greater	greater	equal
D.	greater	equal	greater
E.	greater	equal	equal

28. The solid rectangular prism shown below was built by alternating congruent black cubes and white cubes such that 2 cubes of the same color have at most 1 edge touching. What is the total number of *white* cubes that were used to build the prism?



F. 45
G. 102
H. 105
J. 140
K. 210

29. One side of square $ABCD$ has a length of 12 meters. A certain rectangle whose area is equal to the area of $ABCD$ has a width of 8 meters. What is the length, in meters, of the rectangle?

A. 12
B. 16
C. 18
D. 20
E. 24

30. The average of a list of 4 numbers is 92.0. A new list of 4 numbers has the same first 3 numbers as the original list, but the fourth number in the original list is 40, and the fourth number in the new list is 48. What is the average of this new list of numbers?

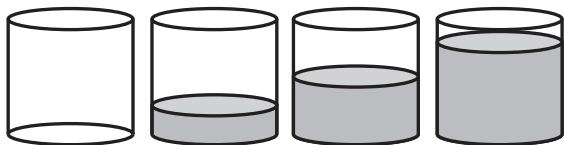
F. 81.0
G. 92.0
H. 94.0
J. 94.4
K. 96.6

31. The vector $\mathbf{i}$ represents 1 mile per hour east, and the vector $\mathbf{j}$ represents 1 mile per hour north. Maria is jogging south at 12 miles per hour. One of the following vectors represents Maria's velocity, in miles per hour. Which one?

A. $-12\mathbf{i}$
B. $-12\mathbf{j}$
C. $12\mathbf{i}$
D. $12\mathbf{j}$
E. $12\mathbf{i} + 12\mathbf{j}$



32. Four identical glasses are shown below. One glass is empty, and the other 3 glasses are $\frac{1}{4}$ full, $\frac{1}{2}$ full, and $\frac{4}{5}$ full of water, respectively. If the water were redistributed equally among the 4 glasses, what fractional part of each glass would be filled?



- F. $\frac{2}{11}$
 G. $\frac{8}{11}$
 H. $\frac{3}{22}$
 J. $\frac{31}{60}$
 K. $\frac{31}{80}$
33. Aurelio is purchasing carpet tiles to cover an area of his living room floor that is $8\frac{1}{3}$ feet wide by 10 feet long. Each carpet tile is a square 20 inches wide by 20 inches long. What is the minimum number of carpet tiles that Aurelio must purchase to cover this area of his living room floor?
- A. 5
 B. 11
 C. 21
 D. 30
 E. 84
34. In the standard (x,y) coordinate plane, a circle with its center at $(8,5)$ and a radius of 9 coordinate units has which of the following equations?
- F. $(x - 8)^2 + (y - 5)^2 = 81$
 G. $(x - 8)^2 + (y - 5)^2 = 9$
 H. $(x + 8)^2 + (y + 5)^2 = 81$
 J. $(x + 8)^2 + (y + 5)^2 = 9$
 K. $(x + 5)^2 + (y + 8)^2 = 81$

Use the following information to answer questions 35–38.

Many humans carry the gene Yq77. The Yq test determines, with 100% accuracy, whether a human carries Yq77. If a Yq test result is positive, the human carries the Yq77 gene. If a Yq test result is negative, the human does NOT carry Yq77. Sam designed a less expensive test for Yq77 called the Sam77 test. It produces some incorrect results. To determine the accuracy of the Sam77 test, both tests were administered to 1,000 volunteers. The results from this administration are summarized in the table below.

	Positive Yq test	Negative Yq test
Positive Sam77 test	590	10
Negative Sam77 test	25	375

35. It cost \$2,500 to administer each Yq test and \$50 to administer each Sam77 test. What was the total cost to administer both tests to all the volunteers?
- A. \$1,537,500
 B. \$1,556,750
 C. \$1,568,250
 D. \$2,500,000
 E. \$2,550,000
36. What percent of the volunteers actually carry Yq77 ?
- F. 57.5%
 G. 60.0%
 H. 60.5%
 J. 61.5%
 K. 62.5%
37. For how many volunteers did the Sam77 test give an incorrect result?
- A. 10
 B. 25
 C. 35
 D. 385
 E. 400
38. One of the volunteers whose Sam77 test result was positive will be chosen at random. To the nearest 0.001, what is the probability the chosen volunteer does NOT possess Yq77 ?
- F. 0.017
 G. 0.026
 H. 0.035
 J. 0.041
 K. 0.063

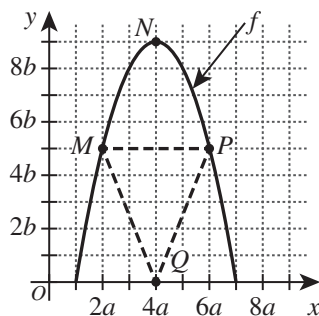


39. Given matrices $X = \begin{bmatrix} -1 & 0 \end{bmatrix}$ and $Y = \begin{bmatrix} -2 \\ -1 \end{bmatrix}$, which of the following matrices is XY ?
- A. $\begin{bmatrix} -4 \end{bmatrix}$
 B. $\begin{bmatrix} -3 \end{bmatrix}$
 C. $\begin{bmatrix} -2 \end{bmatrix}$
 D. $\begin{bmatrix} 2 \end{bmatrix}$
 E. $\begin{bmatrix} 3 \end{bmatrix}$
40. Regardless of how the graph is oriented in the standard (x,y) coordinate plane, NO graph in one of the following categories has a vertical line of symmetry. Which one?
- F. Line
 G. Square
 H. Pentagon
 J. Parallelogram
 K. Scalene triangle
41. The equation $24x^2 + 2x = 15$ has 2 solutions. What is the greater of the 2 solutions?
- A. $\frac{3}{4}$
 B. $\frac{4}{3}$
 C. $\frac{5}{6}$
 D. $\frac{7}{6}$
 E. $\frac{11}{15}$
42. Which of the following expressions is equal to $(\sin 60^\circ)(\cos 30^\circ) + (\cos 60^\circ)(\sin 30^\circ)$?
- F. $\cos(60^\circ - 30^\circ)$
 G. $\cos(60^\circ + 30^\circ)$
 H. $\sin(60^\circ - 30^\circ)$
 J. $\sin(60^\circ + 30^\circ)$
 K. $\sin\left(\frac{60^\circ + 30^\circ}{2}\right)$
43. What is the area, in square units, of a circle that has a circumference 12π units long?
- A. 6π
 B. 12π
 C. 24π
 D. 36π
 E. 144π
44. A barrel contains 25 liters of a solvent mixture that is 40% solvent and 60% water. Lee will add pure solvent to the barrel, without removing any of the mixture currently in the barrel, so that the new mixture will contain 50% solvent and 50% water. How many liters of pure solvent should Lee add to create this new mixture?
- F. 2.5
 G. 5
 H. 10
 J. 12.5
 K. 15
45. For all $x \neq \pm y$, $\frac{x}{x+y} + \frac{y}{x-y} = ?$
- A. $\frac{1}{x-y}$
 B. $\frac{x+y}{x-y}$
 C. $\frac{x+y}{2x}$
 D. $x^2 + y^2$
 E. $\frac{x^2 + y^2}{x^2 - y^2}$
46. Mary, James, and Carlos sold $\frac{1}{4}$ -page advertisements for the school yearbook. Mary sold twice as many as Carlos did, and James sold 3 times as many as Mary did. What fraction of these advertisements did Carlos sell?
- F. $\frac{1}{9}$
 G. $\frac{1}{7}$
 H. $\frac{1}{6}$
 J. $\frac{1}{5}$
 K. $\frac{1}{3}$
47. In a window display at a flower shop, there are 3 spots for 1 plant each. To fill these 3 spots, Emily has 6 plants to select from, each of a different type. Selecting from the 6 plants, Emily can make how many possible display arrangements with 1 plant in each spot?
- (Note: The positions of the unselected plants do not matter.)
- A. 3
 B. 6
 C. 15
 D. 120
 E. 216



Use the following information to answer questions 48–50.

The quadratic function f and $\triangle MPQ$ are graphed in the standard (x,y) coordinate plane below. Points $M(2a, 5b)$, $N(4a, 9b)$, and $P(6a, 5b)$ are on f . Point $Q(4a, 0)$ is NOT on f .



48. In terms of a and b , what is the area, in square coordinate units, of $\triangle MPQ$?

F. $8ab$
 G. $10ab$
 H. $12ab$
 J. $15ab$
 K. $20ab$

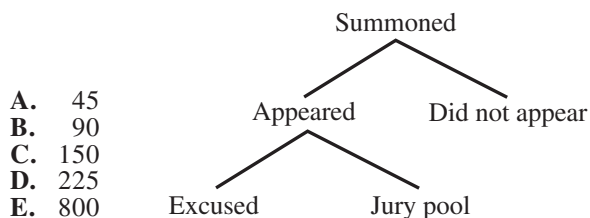
49. Point M will remain fixed, and point Q will move to the right along the x -axis. As Q continues to move to the right, which of the following statements describes what will happen to the slope of $\overline{MQ}$?

A. It will decrease and eventually be negative.
 B. It will decrease but never be negative.
 C. It will stay the same.
 D. It will increase but never be positive.
 E. It will increase and eventually be positive.

50. One of the following values is equal to $f(5a)$. Which one?

F. $3a$
 G. $5a$
 H. $5b$
 J. $8a$
 K. $8b$

51. Twelve jurors are needed for an upcoming trial. The diagram below illustrates a part of the process of jury selection. The 12 jurors will be selected from a jury pool of about 60 people. The court records show a trend that only 40% of the people who are summoned for jury duty actually appear and that of the people who appear, $\frac{1}{3}$ are excused. If this same trend continues, how many people should be summoned to have as close as possible to 60 people in the jury pool?



A. 45
 B. 90
 C. 150
 D. 225
 E. 800

52. What is the 275th digit after the decimal point in the repeating decimal $0.\overline{6295}$?

F. 0
 G. 2
 H. 5
 J. 6
 K. 9

53. Given that $f(x) = x^2 - 4$ and $g(x) = x + 3$, what are all the values of x for which $f(g(x)) = 0$?

A. -5 and -1
 B. -3 , -2 , and 2
 C. -1 and 1
 D. 1 and 5
 E. $-\sqrt{5}$ and $\sqrt{5}$

54. Given that p is a positive number, n is a negative number, and $|p| > |n|$, which of the following expressions has the greatest value?

F. $\left| \frac{p-n}{p} \right|$
 G. $\left| \frac{p-n}{n} \right|$
 H. $\left| \frac{p+n}{p-n} \right|$
 J. $\left| \frac{p+n}{p} \right|$
 K. $\left| \frac{p+n}{n} \right|$



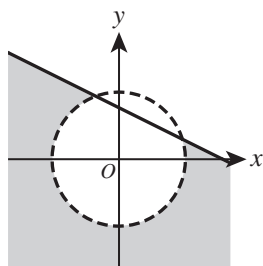
55. If $i = \sqrt{-1}$, then $\frac{i+i^2+i^3}{i^3+i^4+i^5} = ?$

- A. -3
- B. -1
- C. $\frac{1}{2}$
- D. 1
- E. 3

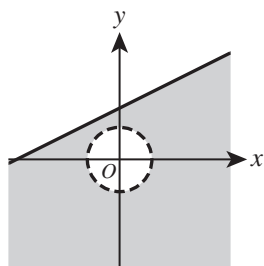
56. In one of the following graphs in the standard (x,y) coordinate plane, the solution set to the system of inequalities below is shown shaded. Which one?

$$\begin{cases} x + 2y \leq 6 \\ 3x^2 > 12 - 3y^2 \end{cases}$$

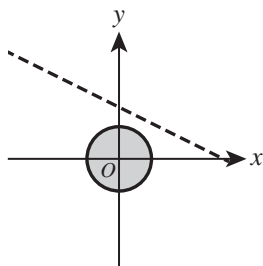
F.



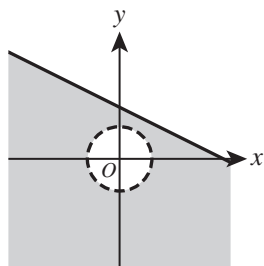
J.



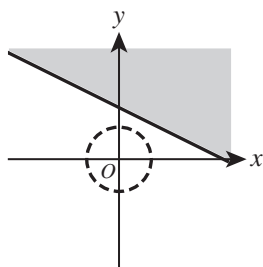
G.



K.



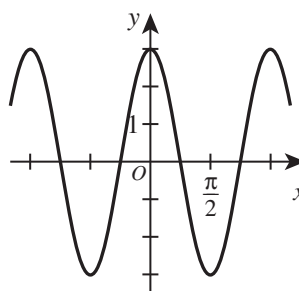
H.



57. Let a , b , c , and d be real numbers. Given that $ac = 1$, $\frac{b+c}{d}$ is undefined, and $abc = d$, which of the following *must* be true?

- A. $a = 0$ or $c = 0$
- B. $a = 1$ and $c = 1$
- C. $a = -c$
- D. $b = 0$
- E. $b + c = 0$

58. A cosine function is shown in the standard (x,y) coordinate plane below.

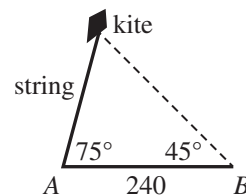


One of the following equations represents this function. Which one?

- F. $y = 2 \cos\left(\frac{x}{3}\right)$
- G. $y = 2 \cos(3x)$
- H. $y = 3 \cos\left(\frac{x}{3}\right)$
- J. $y = 3 \cos\left(\frac{x}{2}\right)$
- K. $y = 3 \cos(2x)$

59. The figure below shows a flying kite. At a certain moment, the kite string forms an angle of elevation of 75° from point A on the ground. At the same moment, the angle of elevation of the kite at point B , 240 ft from A on level ground, is 45° . What is the length, in feet, of the string?

- A. $60\sqrt{3}$
- B. $80\sqrt{6}$
- C. 144
- D. 180
- E. 240



60. If a publisher charges \$15 for the first copy of a book that is ordered and \$12 for each additional copy, which of the following expressions represents the cost of y books?

- F. $12y + 3$
- G. $12y + 15$
- H. $15y - 3$
- J. $15y + 3$
- K. $15y + 12$

END OF TEST 2

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.

DO NOT RETURN TO THE PREVIOUS TEST.

READING TEST

35 Minutes—40 Questions

DIRECTIONS: There are several passages in this test. Each passage is accompanied by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

Passage I

LITERARY NARRATIVE: Passage A is adapted from the memoir *The Piano Shop on the Left Bank* by Thad Carhart (©2001 by T.E. Carhart). Passage B is adapted from the article “Me and My Violin” by Arnold Steinhardt (©2014 by Listen: Life with Classical Music).

Passage A by Thad Carhart

Even when Luc was busy and could not talk he always made me welcome and allowed me to wander around the inner sanctum of the back room on my own. When things were quieter, he seemed glad of the company and would tell me about the pianos that had just arrived. Our talks made real for me one of his fundamental beliefs, that each and every piano had completely individual characteristics, even if of the same manufacturer and age.

Sometimes he knew all the details, had even met the owners and talked about their instrument with them and knew intimately how they had treated it. Other times he knew nothing beyond what he could see, feel, or hear. Most often pianos came to him from auctions and charity sales, their history anonymous. But even then, like an expert in artifacts, he could deduce a great deal: whether a piano had been played much or little, whether it had been in an environment with the proper level of humidity (one of his cardinal rules), whether there had been children in the household, even whether it had recently been transported by ship. (“The worst thing you can possibly do to a piano,” he told me more than once.) At these moments he was part detective, part archaeologist, part social critic.

His attitude about how people treated their pianos seemed to mirror his philosophy of life. While regretting the depredations worked by children on keyboards and strings, he regarded them as tolerable because the piano was at least used and, as he put it, “*au sein de la famille*” (“at the heart of the family”). It was more than just any piece of furniture, but it was that, too, and if drinks were spilled and stains bit into shiny finishes, it was the price one paid for initiating the young to a joy that should stem from familiarity rather than reverence.

Those who preserved their piano as an altar upon which the art of music was to be worshipped irritated

Luc, but he was deeply respectful of serious musicians who used and depended upon their instrument for their livelihood.

Passage B by Arnold Steinhardt

Marc Lifschey, one of the greatest oboists of his era, told me that after retiring as a performer and teacher, he sold his oboe. On the face of it, giving up an instrument you no longer use seems perfectly reasonable, but nevertheless I was taken aback. Marc was not merely an excellent oboist; he was a great artist. Still, Marc didn’t do it alone. He and his oboe did it together. Even in retirement, wouldn’t Marc have some sort of lasting relationship with his oboe that transcended performing on it? Wouldn’t he want to keep it if for no other reason than as a reminder of the magnificent music the two of them had made together?

Joseph Roisman, the distinguished first violinist of the Budapest String Quartet, seemed to be content to give up his beloved Lorenzo Storioni when he agreed to sell it to me after the Quartet retired. But when I finally met with him, he had second thoughts. “Steinhardt,” he said to me plaintively, “I’ll sell the violin to you some day, but for now I’m enjoying playing chamber music with my friends every Friday night.” And that is exactly what he did until his death a year or two later.

Lifschey and Roisman dealt with retirement in different ways, but their stories made me wonder about not only what I’ll do with my violin if and when I retire, but also about the very nature of a musician’s day-to-day, year-to-year relationship with his instrument.

I began playing violin when I was six years old, and now I’m seventy-six. It has been an integral part of my life for the last seven decades. Does that make the violin my very close friend? Well, yes. Sometimes. The violin obviously can’t speak with words, but when I ask something of it, the instrument can respond with an astonishing range of substance and emotion. This is friendship on a most exalted level.

There are other moments, however, when the violin stubbornly refuses to do my bidding—when it only reluctantly plays in tune, or makes the sound I want, or delivers the music’s essence for which I strive. Then I have to cajole, bargain or adjust to its every

whim. Some friend; more like an adversary, you might
80 say.

Or is the violin my partner? A woman once went
backstage to congratulate the great violinist Jascha
Heifetz after a concert. “What a wonderful sound your
violin has, Mr. Heifetz!” she exclaimed. Heifetz leaned
85 over his violin that lay in its open case, listened intently
for a moment, and said, “Funny, I don’t hear a thing.”
My violin also lies mute in its case without me—but, on
the other hand, I stand mute on the concert stage with-
out it.

1. In Passage A, the parenthetical information in line 19 and lines 21–23 mainly serves to:
 - A. specify how Luc identified certain aspects of a piano’s history.
 - B. portray Luc as overly judgmental about piano transportation.
 - C. describe the types of rules that visitors to Luc’s shop were required to follow.
 - D. indicate some of Luc’s firm beliefs about piano care.
2. Based on the assertion in Passage A that Luc’s “attitude about how people treated their pianos seemed to mirror his philosophy of life” (lines 25–26), which of the following statements would most nearly describe Luc’s philosophy of life?
 - F. It’s better to live a full and imperfect life than not participate because something might go wrong.
 - G. Life is a fragile gift that must be cherished and kept safe at all times.
 - H. Living well is like playing the piano well; it requires dedication and practice.
 - J. It’s important not to take life’s opportunities for granted because they may not come a second time.
3. As it is used in line 32, the phrase *bit into* most nearly means:
 - A. pinched.
 - B. ingested.
 - C. marred.
 - D. severed.
4. In the third paragraph of Passage B (lines 61–65), the author most clearly shifts from:
 - F. making an argument against musicians selling their instruments to using evidence from his life to support that argument.
 - G. introducing musicians he admires to explaining why he hopes people admire him as a musician.
 - H. examining his own emotions about his violin to explaining why musicians must develop a partnership with their instruments.
 - J. discussing the connection between other musicians and their instruments to pondering his own connection with his violin.
5. In Passage B, the statement that Lifschey “was not merely an excellent oboist; he was a great artist” (lines 44–45) can best be described as:
 - A. a fact supported by details about Lifschey’s career.
 - B. a fact confirmed by experts quoted in the passage.
 - C. an opinion that the author attributes to Lifschey’s colleagues and students.
 - D. an opinion that the author asserts but does not explain.
6. In Passage B, it can most reasonably be inferred that Heifetz’s response to the woman who congratulates him is intended to point out that:
 - F. the woman hears Heifetz’s violin differently than Heifetz does.
 - G. the woman isn’t qualified to judge the quality of Heifetz’s violin.
 - H. Heifetz enjoyed the woman’s humorous comment.
 - J. Heifetz’s violin doesn’t make sounds by itself.
7. In Passage B, the author most directly indicates that the violin is sometimes an adversary by stating that it:
 - A. lies mute in its case.
 - B. makes him adjust to its whims.
 - C. responds with a range of emotion.
 - D. can’t speak with words.
8. Compared to Passage A, Passage B is more directly focused on the:
 - F. damage a musician can do to an instrument.
 - G. characteristics of an instrument that give clues to its history.
 - H. interdependence between musician and instrument.
 - J. benefits of making instruments available to young children.
9. In contrast to the way the pianos are described in Passage A, the passage author’s violin in Passage B is described as:
 - A. exhibiting unique characteristics.
 - B. having an active personality of its own.
 - C. sustaining damage from careless children.
 - D. being important to daily life.
10. Which of the following assertions about instruments is most strongly supported by details provided in both Passage A and Passage B?
 - F. Familiarity with your instrument is an important part of the joy of playing music.
 - G. Instruments should be revered and never treated like furniture.
 - H. Selling your instrument shows disrespect for the music you have made together.
 - J. Maintaining proper humidity levels is essential to preserving an instrument.

Passage II

INFORMATIONAL: This passage is adapted from the article “Notes from a Wedding” by Lauren Wilcox Puchowski (©2010 by Lauren Wilcox Puchowski).

It was never Kenney Holmes’s intention to become a wedding singer. The grandson of West Indian immigrants, Holmes was raised in Gordon Heights, on Long Island, in what he calls “a small black community
5 founded by like-minded thinkers,” families of immigrants and Southern blacks who, as Holmes says, “didn’t come here to fool around” and who handed down to their children their own keen sense of ambition.

10 “We grew up in that kind of atmosphere,” he says, “of positive thinking, of getting educated, whether or not you had a degree.”

Like any American boy in the 1950s and ’60s, he was fascinated with popular music: He listened to the
15 area’s one radio station, which “mostly played Sinatra”; sometimes in the evenings, with a coat hanger stuck into the top of his portable radio, he could pick up a faint signal from WWRL, a rhythm and blues station in New York City. When he was a teenager, his brother
20 brought home a guitar. “I was 16, it was a Sunday night,” he says. “I sat down and played ‘I Can’t Get No Satisfaction.’ I was addicted.”

While he was not a virtuoso, he was, he discovered, good at making money at it. He learned three
25 songs—“Satisfaction” by the Rolling Stones, “And I Love Her” by the Beatles, and “Shotgun” by Junior Walker and the All Stars—and formed a band. “We went out and sold it,” he says. “We could play those three songs all night. We got pretty popular out on the
30 island, playing battle of the bands, fire halls, high school proms, for \$10 a night.”

Still, a career as a musician was not what he, or his family, had had in mind. Over the next few years, he says: “I did everything I could not to be a guitar player.
35 I went to college not to be a guitar player.” Thinking he would be a psychiatrist, he took pre-med classes but didn’t complete a degree. Along the way, he continued playing nightclubs and parties.

In his mid-20s, he visited his brother in Washington. Washington looked, to Holmes, like a good place to
40 be an ambitious, career-minded black man, but it also had a thriving music scene in nightclubs and hotel lounges, and the next 15 years played out as a sort of tussle between his creative pursuits and his more business-driven impulses. Trying to work his way up in the
45 music scene, he played five and six nights a week in nightclubs and wrote his own music. He started a recording studio called Sound Ideas, which trawled local talent for the makings of a hit song, but he found
50 the pickings slim.

The club scene, after a long while, began to wear on him, as well. Unwilling to resign himself to the life

of a starving artist, when an agent approached him in the early ’90s about specializing in wedding and private
55 parties, Holmes decided to try it.

It was a revelation. “I could make in one night what I used to make in five,” he says. And “it changed the culture of what I was doing.”

Holmes was well-suited for the role of event band-
60 leader. His production skills helped him control his band’s sound, and his familiarity with country, big-band and classical music made him popular with audiences who wanted, as he says, “a tango or a Viennese waltz,” as well as Wilson Pickett.

65 Because business ebbs and flows with the seasons and the economy, Holmes has always kept a variety of sidelines, including a job driving a limousine for nine years to put his oldest daughter through a private high school and college. These days, at gigs, he hands out a
70 stack of million-dollar “bills” printed with his image and his current enterprises: bandleader, commercial mortgage broker, hard money lender.

Holmes uses as many as eight musicians and two singers for weddings. He accepts turnover as a fact of
75 running a band, but his current core lineup has, in the mercurial world of part-time performers, been fairly steady. Sam Brawner, the drummer, and Atiba Taylor, the sax player, have played with him for three and four years, respectively, and Bruce Robinson, the key-
80 boardist, has played with him for 15.

This is perhaps partly because Holmes insists on making music. During performances, he lets his musicians take the lead and uses specialized, stripped-down tracks, called digital sequences, to set the tempo and fill
85 in musical parts when necessary, ultimately preferring the messy alchemy of live music to something more canned. The musicians say that this is in contrast to other bandleaders they’ve worked for, who often rely heavily on recordings and use musicians more as visual
90 props. Holmes’s respect for the music endears him to his musicians. “These guys play from the heart,” says Robinson. “They’re not just trying to get through the gig.”

11. The main purpose of the passage is to:

- A. explain why Holmes’s musical tastes gradually changed over time.
- B. describe how Holmes’s hectic professional life affects his personal life.
- C. highlight the different instruments Holmes mastered in becoming a famous musician.
- D. document how Holmes eventually became an enterprising bandleader.

12. One theme of the passage is that:
- F. one's previous experiences and pursuits can be useful in achieving success.
 - G. talent is the most important factor in achieving success in both business and music.
 - H. recognizing one's limitations is necessary in overcoming one's failures.
 - J. pursuing one's dreams should take precedence over more practical matters.
13. Which of the following events referred to in the passage occurred last chronologically?
- A. Taylor joined Holmes's band.
 - B. Brawner joined Holmes's band.
 - C. Holmes started driving a limousine.
 - D. Holmes started Sound Ideas.
14. Based on the passage, the residents of Gordon Heights in the 1950s and 1960s would best be described as:
- F. artistic and sophisticated.
 - G. driven and optimistic.
 - H. friendly and easygoing.
 - J. generous and dependable.
15. The main purpose of the third paragraph (lines 13–22) is to:
- A. indicate why Holmes preferred rhythm and blues to Sinatra songs.
 - B. establish that Holmes's parents disapproved of his interest in music.
 - C. reveal that Holmes was considered a musical prodigy.
 - D. describe what inspired Holmes to start playing music.
16. The main idea of the fourth paragraph (lines 23–31) is that:
- F. Holmes was better at playing music than he was at promoting his band.
 - G. Holmes's band was able to earn money despite having a limited repertoire.
 - H. Holmes's band became a national phenomenon despite the band members' lack of musical talent.
 - J. Holmes would have had more success early on if he had taken the time to learn more songs.
17. Based on the passage, the main reason Holmes eventually preferred playing music at weddings and private parties to playing music in clubs was that:
- A. he could play a wider variety of music at weddings and private parties.
 - B. audiences at weddings and private parties were easier to please.
 - C. weddings and private parties were more profitable.
 - D. weddings and private parties required less travel.
18. The main idea of the eleventh paragraph (lines 73–80) is that:
- F. Holmes often has to alter his musical style based on which band members are available to play a gig.
 - G. Holmes typically needs more band members to play at weddings than he needs to play at private parties.
 - H. Holmes's core lineup of band members has been relatively consistent for a business with a high turnover rate.
 - J. Holmes's core lineup of band members is constantly changing because Holmes expects his musicians to travel long distances.
19. It can most reasonably be inferred from the passage that Holmes's band members like playing music with Holmes in part because, in contrast to other band leaders, Holmes:
- A. is familiar with big band, classical, and country music.
 - B. allows band members to showcase their talents during gigs.
 - C. played music in the Washington club scene for fifteen years.
 - D. uses sophisticated elements like digital sequences during gigs.⁴
20. In the passage, the phrase *something more canned* (lines 86–87) most nearly refers to:
- F. sound effects.
 - G. music videos.
 - H. improvised music.
 - J. recorded music.

Passage III

INFORMATIONAL: This passage is adapted from the article “Photography Changes How Cultural Groups Are Represented and Perceived” by Edwin Schupman (©2012 by The Smithsonian Institution).

The author of the passage is a citizen of the Muscogee (Creek) Nation of Oklahoma.

Using photographs as educational resources presents particular challenges and must be done with care. There is always more than face value in any photo, and historical photos of American Indians are no exception.

Photography’s rise in the late nineteenth century coincided with great change in American Indian communities—an era that capped over three hundred years of diseases, wars, cultural disruption, and land dispossession. As Indian people struggled to adapt to catastrophic changes to their old ways of living, photographers took thousands of studio portraits and made what they believed to be neutral ethnographic images of the “vanishing Indian.” As Indian cultures bent under pressure to assimilate into mainstream America, photographers routinely captured images that compared the new “civilized” Indian to the tradition-bound “savages.” Indian delegations that traveled to Washington, D.C., to defend tribal treaty rights were photographed in studios and in front of federal buildings. Photographers also accompanied government expeditions to the West where they documented traditional cultures, leading the way for tourists and commercial photographers who followed, carrying their cameras and preconceptions into Native American communities. These efforts generated a legacy of photographic images of American Indian people that can serve today as rich educational resources. But if used carelessly, they can also fuel romanticized and stereotypical perceptions of American Indians.

Consider some of the many photographs of Goyathlay, the Apache man who Mexicans named “Geronimo.” He and other Chiricahua Apaches fought a protracted war from 1863 to 1886 against the United States for the right to live in their traditional homelands rather than on reservations.

The Chiricahua Apaches’ fight for freedom captured the American imagination in the late nineteenth century. “Geronimo,” especially, became a legendary figure and a media phenomenon whose legacy has lasted into the twenty-first century. He became synonymous with courage, daring, and savage ruthlessness. World War II paratroopers shouted his name as they jumped from airplanes into combat. Movies, television shows, comic books, popular songs, posters, T-shirts, and American cities have borne his image and name. One photo that shows Goyathlay and three other Chiricahuas in their camp just prior to surrendering to U.S. forces in 1886 documents a critical and difficult day for the people who had fought so diligently for their freedom.

In another well-known studio portrait, circa 1890, Goyathlay poses with a rifle. To late-nineteenth-century Americans, Geronimo was a dangerous enemy, yet at the same time a curiosity and romantic symbol of the “Wild West.” This photo personifies the renegade image but, strangely, it was taken about two to four years after Goyathlay surrendered—while he was a prisoner of war. Why, then, was this photo taken? What meaning did it convey at the time? What must have been in Goyathlay’s mind? What does the photo mean today? Is it loaded with historical truths or is it as empty as the prisoner’s bullet chamber?

A few years later, Goyathlay was photographed again, this time in a more pastoral pose and place—holding a melon in a garden with his wife and three of their children. What was the meaning behind this photo? Did people of the time see it as a simple family photo, or did it personify the government’s policy toward Indians at the time—subduing feared and hated warriors, “re-educating” them, and teaching them to farm in order to guide them toward a “better” way of life? Ironically, the Apaches had long farmed as part of the traditional life they fought so tenaciously to protect.

The educational potential of photographs is enormous. However, photographs are not objective; they can easily tell as many lies as truths. As much as any written document, they have to be read with care in order to be understood accurately in unbiased and non-stereotypical terms. Every photo of people contains history, culture, and context. To do justice to the subjects and their stories, it is crucial to fill in the information gaps. In addition to conducting background research, try putting yourself inside these photos—stand next to Goyathlay, his peers, his wife, and their children, and imagine their lives—you might begin to understand the world from their points of view. Framed with factual information and viewed empathetically, each photograph can reach its richest potential as a significant educational opportunity and resource.

21. Which of the following rhetorical techniques does the author repeatedly use in the passage as a means to engage the reader?
- A. Fortright attacks on what he labels as readers’ misunderstanding of basic historical fact
 - B. Open-ended questions and appeals directed to readers
 - C. Direct quotations from past readers of his work that capture their responses to his ideas
 - D. Descriptions of his own experiences as a citizen of the Muscogee (Creek) Nation of Oklahoma

22. It can most reasonably be inferred that the author's statements about the educational use of photographs apply to photographs taken during what time period?
- F. Any time period since photographs were first taken
 - G. In the nineteenth century exclusively
 - H. Any time period prior to the digital age, but not beyond
 - J. Only in the ten years after photographers first joined government expeditions to the West
23. Which of the following words is most nearly given a negative connotation in the passage?
- A. Educational (line 1)
 - B. Old (line 10)
 - C. Romanticized (line 28)
 - D. Traditional (line 34)
24. Which of the following actions referred to in the passage most clearly characterizes a hypothetical event rather than an actual event?
- F. "Traveled to" (line 17)
 - G. "Defend" (line 18)
 - H. "Farmed" (line 72)
 - J. "Stand next to" (line 83)
25. Particular photographs of Goyathlay are referred to and described by the author to support his claim that:
- A. accurately understanding a photograph depends on knowing the circumstances in which a photograph was taken.
 - B. photographs can be used to date events in the life of a legendary figure like Goyathlay.
 - C. anyone can control his or her public image by becoming more involved in the field of photography.
 - D. the merits of a photograph from the nineteenth century depend on who took the photograph.
26. The author most strongly suggests that one reason commercial photographers began to photograph Native American communities was that commercial photographers were:
- F. instructed to do so by the US government.
 - G. devoted to creating educational resources about Native American communities.
 - H. committed to overcoming their preconceived ideas about the West.
 - J. influenced to do so by the photographers who had joined government expeditions to the West.
27. In the passage, the author notes that a strange aspect of the photo of Goyathlay with a rifle is that the photo was taken:
- A. by an unknown photographer.
 - B. when Goyathlay was a prisoner of war.
 - C. with Goyathlay's permission.
 - D. by a US government photographer.
28. The author directly refers to which of the following aspects of the photograph of Goyathlay in a garden as being ironic?
- F. Goyathlay was not a gardener but instead was in the midst of trying to stop the US government's attack on his people.
 - G. Goyathlay's people had long practiced farming, but the photo seemed to suggest that Goyathlay had learned farming from others.
 - H. People do not automatically think of Goyathlay as a man of peace.
 - J. For years it was assumed to be a photograph of someone other than Goyathlay.
29. The author indicates that for the sake of an unbiased interpretation, compared to reading written documents with care, reading photographs with care is:
- A. significantly more important.
 - B. slightly more important.
 - C. just as important.
 - D. slightly less important.
30. In line 86, the word *framed* is used figuratively to describe:
- F. the way background research can support the proper viewing of a photograph.
 - G. a common means of preserving a photograph.
 - H. a technique in which a photograph is displayed with factual information surrounding it.
 - J. the manner in which many photographs of Goyathlay are displayed in museums.

Passage IV

INFORMATIONAL: This passage is adapted from *Summer World: A Season of Bounty* by Bernd Heinrich (©2009 by Bernd Heinrich).

Adaptations of plants to deserts include dormancy and a variety of structural and behavioral adaptations. The majority of desert plants depend on a strategy that capitalizes on small size. They are annuals that spring
5 up from dry, dormant, heat-resistant seeds. Some of these seeds may wait up to half a century before they are activated. The plants' challenge is to be quick enough to respond to rain so that they can produce their seeds before the earth dries up again, while not jumping
10 the gun to start growth until there is sufficient water for them to grow to maturity for seed production. Some achieve this balance on a tightrope by "measuring" rainfall. They have chemicals in their seeds that inhibit germination, and a minimum amount of rain is required
15 before these are leached out. Others have seed coats that must be mechanically scarred to permit sufficient wetting for germination, and the scarring happens only when they are subjected to flash floods in the riverbeds where they grow. A plant in the Negev Desert releases
20 its seed from a tough capsule only under the influence of water through a mechanism that resembles a Roman ballistic machine. Its two outer sepals generate side-ways tension that can fling two seeds out of the fruit, but the two seeds are held inside by a lock mechanism
25 at the top. However, when the sepals are sufficiently wetted, then the tension increases to such an extent that the lock mechanism snaps, and the capsule "explodes" and releases the seeds.

In moist regions where it rains predictably (though
30 not necessarily in abundance), we help agricultural plants to capture the precipitation by scarring the soil to facilitate the infiltration of the water into it, and hence into the roots. Least runoff and maximum water absorption are achieved by plowing the soil. However, such a
35 strategy would not work in a true desert such as the Negev. A different program is required there because rain is infrequent and plowing would facilitate only the evaporation of scarce water from the soil. The solution applied by the peoples who inhabited the Negev in past
40 centuries was a practice they called "runoff farming." Farmers had mastered harnessing the flash floods that rush down into the gullies by catching the runoffs—not only by making terraces but also by building large cisterns into which the water was directed to be held for
45 later use. Remnants of these constructions still exist.

Water-storage mechanisms have been invented by other organisms living in deserts, but mainly through modifications of body plan. Many plants, especially
50 cacti and euphorbia, have the ability to swell their roots or stems with water stores. Possibly the most familiar is the saguaro cactus, *Carnegiea gigantea*, of the Sonoran desert in the American southwest. It has a shallow root system that extends in all directions to distances of
55 about its height, fifty feet. In one rainstorm the root system can soak up 200 gallons of water, which are

transferred into its tall trunk. This trunk is pleated like an accordion and can swell to store tons of water that can last the plant for a year. The cactus has no leaves, but the stem is green and can photosynthesize and
60 produce nutrients as well as store water. The saguaro's survival strategy requires it to grow extremely slowly. But it lives a century or more.

Some desert animals similarly store water. The frog *Cyclorana platycephala*, from the northern Aus-
65 tralian desert, fills up and greatly expands its urinary bladder to use as a water bag before burying itself in the soil, where it spends most of the year waiting for the next rain. While in the ground it sloughs off skin and forms around itself a nearly waterproof cocoon that
70 resembles a plastic bag and reduces evaporative water loss.

Desert ants of a variety of species (of at least seven different genera) in American as well as Aus-
75 tralian deserts collectively called "honeypot ants" have evolved a solution that combines water storage with energy storage. Ants typically feed each other; and some of the larger worker ants may take up more liquid than the others, and others may bring more. Those that take the fluid may gorge themselves until they distend
80 their abdomens up to the size of a grape, by which time they are unable to move from the spot. They then hang in groups of dozens to hundreds from the ceiling of a chamber in the ant nest, where they are then the specialized so-called repletes that later regurgitate fluid
85 when the colony members are no longer bringing the fluid in but rather needing it.

31. The fourth paragraph (lines 63–71) marks a shift in the focus of the passage from:
- A. plants that store water above ground to plants that store water below ground.
 - B. animals that don't go dormant to animals that do go dormant.
 - C. desert-dwelling plants to desert-dwelling animals.
 - D. inhabitants of the Negev Desert to inhabitants of northern Australian deserts.
32. Based on the passage, the author's use of the word "measuring" (line 12) most nearly describes the way that some desert plants:
- F. have roots that are extremely sensitive to moisture levels in the soil.
 - G. have methods of delaying seed germination until a certain amount of water is present.
 - H. are visibly more vigorous after a rainfall.
 - J. can calculate how many inches of rain have fallen in recent days.

33. Which of the following statements best summarizes the process by which the frog *Cyclorana platycephala* survives in the desert?
- A. The frog stores water in its body, buries itself, and conserves water until emerging at the next rain.
 - B. The frog buries itself, waits for rain, absorbs rain-water through its skin, and emerges.
 - C. The frog forms a nearly waterproof cocoon around itself, buries itself, and waits to emerge until it needs water.
 - D. The frog buries itself, absorbs water through its skin, and goes dormant until springtime.
34. Based on the passage, which of the following plants and animals employ a communal strategy to survive in the desert?
- F. The saguaro cactus only
 - G. The saguaro cactus and the frog *Cyclorana platycephala* only
 - H. The frog *Cyclorana platycephala* and honeypot ants only
 - J. Honeypot ants only
35. The passage most strongly suggests that compared to the frog *Cyclorana platycephala*, the honeypot ants are unique in that they:
- A. can store water inside their bodies.
 - B. live in Australian deserts.
 - C. combine water storage with energy storage.
 - D. go dormant during dry times.
36. Which of the following provides the best paraphrase of lines 7–11?
- F. Annual plants survive in deserts by making seeds swiftly when conditions are right.
 - G. Annual plants in deserts make seeds during dry conditions so the seeds will be ready when rain arrives.
 - H. Dry conditions require the seeds of desert plants to start germination prior to the arrival of rain.
 - J. The seeds of annual plants in deserts are designed to wait years for the right conditions for growth.
37. Based on the passage, it can most reasonably be inferred that the scarring some seeds require before germination is accomplished through:
- A. intense drying experienced between rainfalls.
 - B. internal tension from the seed capsule's sepals.
 - C. chemicals in the seeds.
 - D. abrasion sustained during flash floods.
38. As it is used in line 26, the word *extent* most nearly means:
- F. length.
 - G. degree.
 - H. reach.
 - J. boundary.
39. According to the passage, which of the following actions did people in the Negev Desert take in order to farm there?
- A. Plowing the soil
 - B. Widening gullies
 - C. Constructing terraces
 - D. Constructing aqueducts
40. Based on the passage, the pleats in the body of the saguaro cactus:
- F. increase the efficiency of photosynthesis.
 - G. allow the cactus to expand for storing water.
 - H. reduce evaporative water loss.
 - J. regulate the cactus's growth.

END OF TEST 3

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.

DO NOT RETURN TO A PREVIOUS TEST.

**SCIENCE TEST***35 Minutes—40 Questions*

DIRECTIONS: There are several passages in this test. Each passage is followed by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

You are NOT permitted to use a calculator on this test.

Passage I

In a particular *playa* (relatively flat, dry desert basin) evidence shows that some large rocks have moved along the surface, leaving shallow trails in the clay sediment, some up to several hundred meters long. Three scientists provided explanations for how these rocks moved.

Scientist 1

In the spring, snowmelt from surrounding mountains runs downhill and collects in the playa. At night, cold temperatures cause this water to freeze around the rocks. When temperatures rise again, the ice begins to melt, leaving a layer of mud on the surface and ice “rafts” around the rocks. The buoyancy of the ice rafts floats the rocks on top of the mud such that even light winds can then push the rocks along the surface. Evidence of this lifting is seen in that the trails left by rocks are both shallow and only about 2/3 as wide as the rocks themselves. Due to the combination of ice, mud, and light winds, the rocks are able to move several hundred meters in a few days.

Scientist 2

Snowmelt from surrounding mountains does collect in the playa during the spring. However, the temperature in the playa does not get cold enough for ice to form. When the playa’s surface gets wet, the top layer of clay transforms into a slick, muddy film. In addition, dormant algae present in the dry clay begin to grow rapidly when the clay becomes wet. The presence of mud and algae reduces friction between the rocks and the clay. Even so, relatively strong winds are required to push the rocks along the wet surface, forming trails. Due to the combination of mud, algae, and strong winds, the rocks are able to move several hundred meters in a few hours.

Scientist 3

Water does collect in the playa, producing mud and ice. However, neither mud nor ice is responsible for the rocks’ movements. The playa is located along a fault line between tectonic plates. Minor vertical shifts in the plates cause the rocks to move downhill, leaving trails. Due to the combination of tectonic plate movement and strong winds, the rocks are able to move only a few meters over several years.

- According to Scientist 2, friction between the rocks and the clay is reduced by which of the following?
 - Ice only
 - Algae only
 - Ice and mud only
 - Mud and algae only
- Suppose a researcher observed that wind speeds greater than 80 miles per hour are needed to move the rocks in the playa. This observation is consistent with which of the scientists’ explanations?
 - Scientists 1 and 2 only
 - Scientists 1 and 3 only
 - Scientists 2 and 3 only
 - Scientists 1, 2, and 3
- Suppose that no seismic activity was recorded in the playa where the trails left by the rocks are found. This finding would *weaken* which of the scientists’ explanations?
 - Scientist 1 only
 - Scientist 3 only
 - Scientist 1 and Scientist 2 only
 - Scientist 2 and Scientist 3 only
- Suppose it were discovered that a particular rock formed a 200 m long trail in 72 hr. Would this discovery support Scientist 1’s explanation?
 - Yes; Scientist 1 indicated the rocks can move several hundred meters in a few hours.
 - Yes; Scientist 1 indicated the rocks can move several hundred meters in a few days.
 - No; Scientist 1 indicated the rocks can move several hundred meters in a few hours.
 - No; Scientist 1 indicated the rocks can move several hundred meters in a few days.



5. Suppose that during one year there was no measurable movement of any rocks in the playa during the spring. Scientists 1 and 2 would most likely both agree that this was due to the absence of which of the following factors?
- A. Algae
 - B. Snowmelt
 - C. Strong winds
 - D. Subzero temperatures
6. Suppose that air temperature in the playa varies between 4°C and 47°C . Would this information support the explanation of Scientist 2 ?
- F. Yes, because ice cannot form in that temperature range.
 - G. Yes, because ice can form in that temperature range.
 - H. No, because ice cannot form in that temperature range.
 - J. No, because ice can form in that temperature range.
7. Based on Scientist 1's explanation, a rock trail that is 33 cm wide was most likely made by a rock with approximately what width?
- A. 10 cm
 - B. 25 cm
 - C. 50 cm
 - D. 65 cm

**Passage II**

When certain substances are added to diet cola, CO_2 gas is produced, generating a foam. Two experiments were done to study this process.

In each trial, an apparatus like that shown in Figure 1 was used as follows: A jar was nearly filled with H_2O and fitted with a 2-holed lid. One end of a tube (Tube B) was inserted through one of the holes and submerged. The other end of Tube B was placed in an empty graduated cylinder. Another tube (Tube A) was inserted through the other hole in the lid. A certain solid substance was inserted into the other end of Tube A, and the substance was secured by a clamp. Tube A was then attached to a freshly opened bottle containing 355 mL of diet cola. The clamp was removed, releasing the substance into the diet cola. The foam that was produced traveled into the jar, and liquid was transferred into the cylinder. The mass of CO_2 produced was calculated based on the volume of liquid that was measured in the cylinder after foaming had ceased.

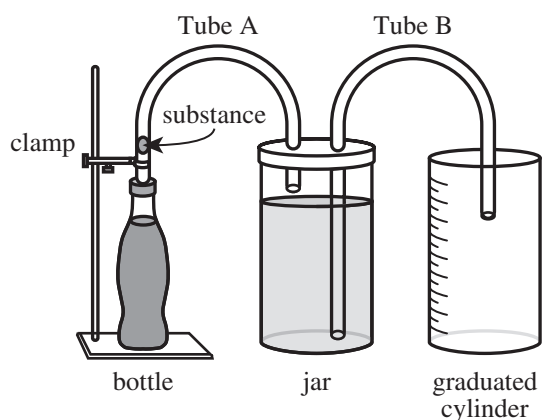


Figure 1

Experiment 1

In each of Trials 1–4, a different 1 of 4 substances of equal mass—a piece of chalk, a sugar cube, a fruit-flavored piece of candy, or a mint-flavored piece of candy—was added to a bottle of diet cola at 3°C . See Table 1.

Table 1			
Trial	Substance	Volume of liquid in cylinder (mL)	Mass of CO_2 produced (g)
1	chalk	699	1.36
2	sugar cube	570	1.11
3	fruit candy	525	1.02
4	mint candy	631	1.23

Experiment 2

In each of Trials 5–8, Trial 4 from Experiment 1 was repeated, except that the temperature of the diet cola was different in each trial. See Table 2.

Table 2			
Trial	Temperature ($^\circ\text{C}$)	Volume of liquid in cylinder (mL)	Mass of CO_2 produced (g)
5	10	598	1.13
6	25	539	0.969
7	45	501	0.844
8	60	476	0.766

Tables 1 and 2 adapted from Christopher J. Huber and Aaron M. Massari, "Quantifying the Soda Geyser." ©2014 by Division of Chemical Education, Inc., American Chemical Society.



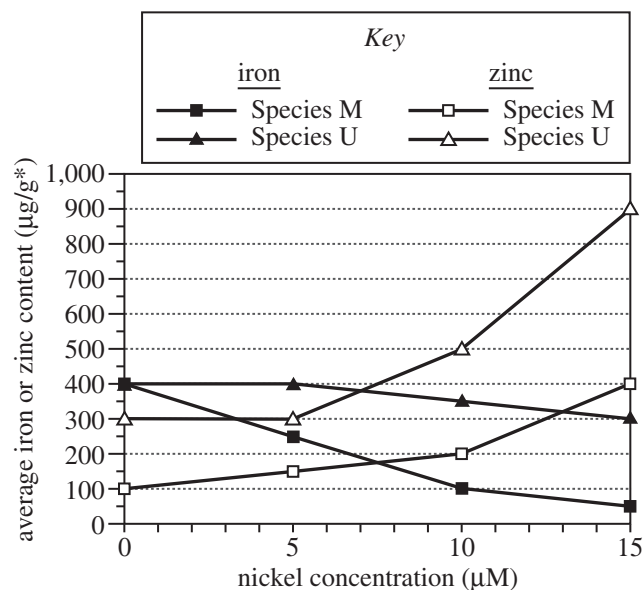
8. If another trial had been performed in Experiment 2 and 450 mL of liquid had been measured in the cylinder, the temperature of the diet cola in this trial would most likely have been:
- F. less than 25°C.
 - G. between 25°C and 45°C.
 - H. between 45°C and 60°C.
 - J. greater than 60°C.
9. Suppose Trial 6 had been repeated, but the bottle of diet cola had been opened and then left undisturbed at 25°C for 12 hours *before* it was attached to the apparatus. Would the mass of CO₂ produced in this trial likely be greater than 0.969 g or less than 0.969 g?
- A. Greater, because over the 12 hours, the concentration of CO₂ in the diet cola would have decreased.
 - B. Greater, because over the 12 hours, the concentration of CO₂ in the diet cola would have increased.
 - C. Less, because over the 12 hours, the concentration of CO₂ in the diet cola would have decreased.
 - D. Less, because over the 12 hours, the concentration of CO₂ in the diet cola would have increased.
10. One *millimole* (mmol) of CO₂ has a mass of 0.044 g. How many trials resulted in the production of at least 1 mmol of CO₂?
- F. 1
 - G. 4
 - H. 5
 - J. 8
11. According to Figure 1, which of Tube A and Tube B, if either, had at least one end submerged in a liquid before the clamp was removed?
- A. Tube A only
 - B. Tube B only
 - C. Both Tube A and Tube B
 - D. Neither Tube A nor Tube B
12. Is the relationship between the volume of liquid in the cylinder at the end of the experiment and the mass of CO₂ produced a direct relationship or an inverse relationship?
- F. Direct; as the volume of liquid that was measured in the cylinder increased, the mass of CO₂ produced increased.
 - G. Direct; as the volume of liquid that was measured in the cylinder increased, the mass of CO₂ produced decreased.
 - H. Inverse; as the volume of liquid that was measured in the cylinder increased, the mass of CO₂ produced increased.
 - J. Inverse; as the volume of liquid that was measured in the cylinder increased, the mass of CO₂ produced decreased.
13. Consider these steps that were performed in each trial.
1. Removing clamp
 2. Measuring liquid in cylinder
 3. Inserting a solid substance into Tube A
 4. Attaching Tube A to a bottle of diet cola
- According to the procedure, these steps were performed in what sequence?
- A. 3, 1, 2, 4
 - B. 3, 4, 1, 2
 - C. 4, 2, 3, 1
 - D. 4, 3, 1, 2
14. Assume that *room temperature* is 25°C. In how many trials was the diet cola tested at a temperature *lower* than room temperature?
- F. 1
 - G. 2
 - H. 5
 - J. 8

Passage III

Scientists studied the effects of pH and of nickel concentration on plant growth and on the uptake of iron and zinc by plants. Recently germinated seedlings of Species M and Species U were fed 1 of 12 nutrient solutions (Solutions 1–12) for 8 days and then were harvested. Solutions 1–12 differed only in pH and/or nickel concentration. Table 1 shows, for each species, the average dry mass of the plants that were fed each nutrient solution. Figure 1 shows, for each species, the average iron content and the average zinc content of the plants that were fed Solutions 1–4.

Table 1				
Solution	pH	Nickel concentration (μM^*)	Average dry mass (g) of plants of Species:	
			M	U
1	7	0	33.9	10.7
2	7	5	28.8	10.7
3	7	10	23.8	9.6
4	7	15	18.7	8.5
5	6	0	33.9	9.2
6	6	5	28.8	9.2
7	6	10	23.8	8.1
8	6	15	18.7	7.0
9	5	0	27.8	7.7
10	5	5	22.7	7.7
11	5	10	17.6	6.6
12	5	15	12.4	5.4

* μM = micromoles per liter



* $\mu\text{g/g}$ = micrograms of iron or zinc per gram of plant dry mass

Figure 1

15. According to Figure 1, as the nickel concentration in the nutrient solutions increased, the average iron content of Species M plants:
- increased only.
 - decreased only.
 - increased, then decreased.
 - decreased, then increased.



16. According to Table 1, the Species U plants that were fed the solution that had a pH of 6 and a nickel concentration of $10\text{ }\mu\text{M}$ had an average dry mass of:

F. 7.0 g.
 G. 8.1 g.
 H. 9.2 g.
 J. 23.8 g.

17. According to Table 1, Species M plants that were fed a nutrient solution with which of the following combinations of pH and nickel concentration had the greatest average dry mass?

	pH	nickel concentration
A.	6	$0\text{ }\mu\text{M}$
B.	6	$5\text{ }\mu\text{M}$
C.	5	$0\text{ }\mu\text{M}$
D.	5	$5\text{ }\mu\text{M}$

18. According to Table 1 and Figure 1, the Species M plants that were fed Solution 3 had an average zinc content of:

F. $100\text{ }\mu\text{g/g}$.
 G. $150\text{ }\mu\text{g/g}$.
 H. $200\text{ }\mu\text{g/g}$.
 J. $400\text{ }\mu\text{g/g}$.

19. According to Table 1 and Figure 1, for the Species M plants that were fed Solutions 1–4, what was the order of the nutrient solutions, from the solution that resulted in the lowest average iron content to the solution that resulted in the highest average iron content?

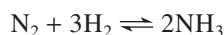
A. 1, 2, 3, 4
 B. 1, 4, 3, 2
 C. 4, 2, 1, 3
 D. 4, 3, 2, 1

20. According to Table 1, compared to the average dry mass of Species U plants that were fed Solution 3, the average dry mass of Species M plants that were fed Solution 6 was approximately:

F. $\frac{1}{3}$ as great.
 G. $\frac{1}{2}$ as great.
 H. 2 times as great.
 J. 3 times as great.

Passage IV

Ammonia (NH_3) can be produced according to the chemical equation



The *equilibrium arrow* ($\rightleftharpoons$) indicates that this reaction proceeds in both directions until it is at *equilibrium*, so that both the forward reaction (production of NH_3) and the backward reaction (production of N_2 and H_2) occur at the same rate. Equilibrium can be shifted forward or backward by changing the temperature, pressure, or concentration of reactants or products.

Two experiments were done using the following apparatus to produce NH_3 .

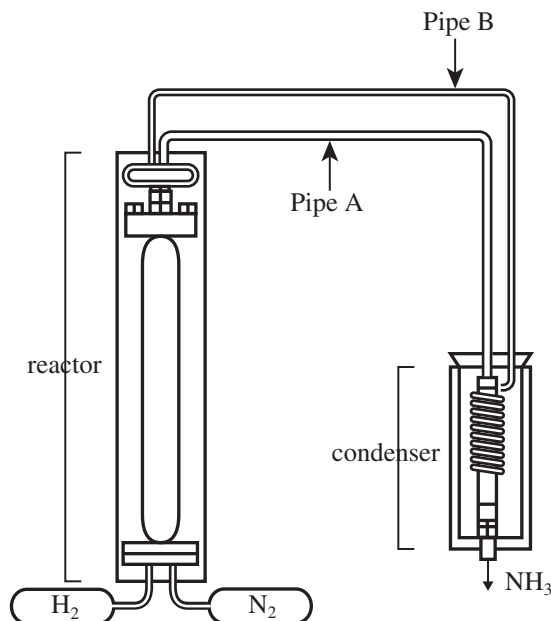


diagram of apparatus

In each trial, Steps 1–4 occurred:

1. A fresh catalyst (Catalyst W, X, Y, or Z), 160 kg of H_2 , and 745 kg of N_2 were placed in the reactor.
2. The H_2 and N_2 reacted at a constant temperature and a constant pressure until equilibrium was established.
3. A mixture of NH_3 and any unreacted H_2 and N_2 flowed through Pipe A to a -50°C condenser at 1 atmosphere (atm) of pressure.
4. NH_3 condensed and exited the apparatus. (H_2 and N_2 do not condense at -50°C .) Any unreacted H_2 and N_2 flowed into Pipe B, returning to the reactor.

Steps 2–4 reoccurred in cycles until no more H_2 and N_2 returned from the condenser.

Experiment 1

A set of 9 trials was conducted with each of the 4 catalysts. For each set, the pressure was 150 atm; within each set, the temperature was different for each trial. Figure 1 shows, for each trial, the number of cycles of Steps 2–4.

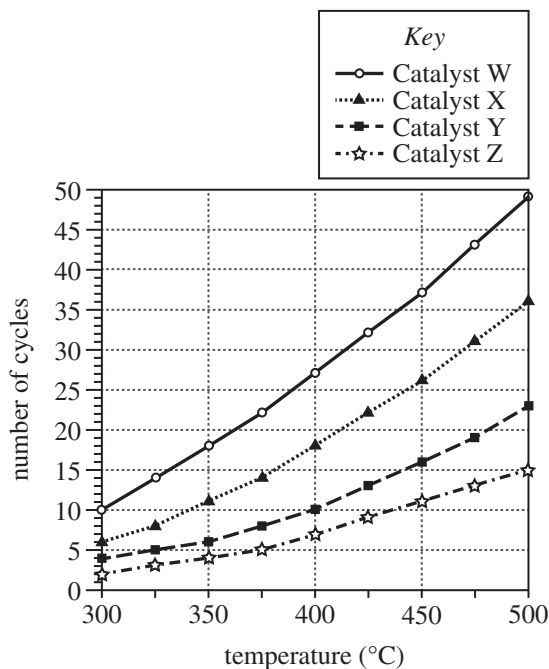


Figure 1

Experiment 2

Four sets of 9 trials each were conducted with Catalyst Z. For each set, the temperature was different; within each set, the pressure was different for each trial. Figure 2 shows, for each trial, the amount of NH_3 produced in the first cycle of Steps 2–4.

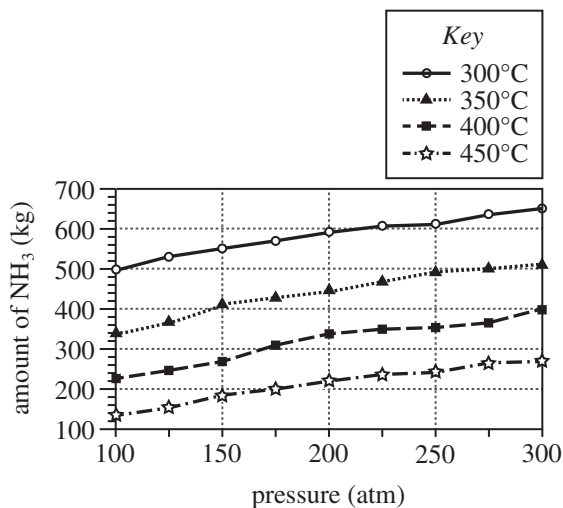


Figure 2



Diagram and figures adapted from Jayant M. Modak, "Haber Process for Ammonia Synthesis." ©2002 by Indian Academy of Sciences.

21. According to the results of Experiment 1, for any given catalyst, as the temperature was increased, the number of cycles needed to complete the reaction:
- increased only.
 - decreased only.
 - increased, then decreased.
 - decreased, then increased.
22. In Experiment 1, 26 cycles were needed to complete the reaction at 450°C when which catalyst was used?
- Catalyst W
 - Catalyst X
 - Catalyst Y
 - Catalyst Z
23. The movement of H_2 and N_2 through the apparatus as Steps 1–4 occurred is best represented by which of the following expressions?
- Reactor → condenser → Pipe A → Pipe B
 - Condenser → reactor → Pipe A → Pipe B
 - Reactor → Pipe A → condenser → Pipe B
 - Condenser → Pipe A → reactor → Pipe B
24. Consider the results of Experiment 1 for 375°C. All the H_2 and N_2 were consumed in less than 20 cycles when which catalysts were used?
- Catalysts W and X only
 - Catalysts Y and Z only
 - Catalysts W, X, and Y only
 - Catalysts X, Y, and Z only
25. If a trial had been performed in Experiment 2 at 425°C and 225 atm, the amount of NH_3 produced would most likely have been:
- less than 230 kg.
 - between 230 kg and 320 kg.
 - between 320 kg and 410 kg.
 - greater than 410 kg.
26. At 1 atm of pressure, the melting point of NH_3 is $-77^\circ C$ and the boiling point of NH_3 is $-33^\circ C$. Based on this information and the description of the apparatus, when the NH_3 exited the condenser, was it more likely a solid or a liquid?
- Solid, because the temperature of the condenser was lower than the melting point of NH_3 and the boiling point of NH_3 .
 - Solid, because the temperature of the condenser was between the melting point of NH_3 and the boiling point of NH_3 .
 - Liquid, because the temperature of the condenser was higher than the melting point of NH_3 and the boiling point of NH_3 .
 - Liquid, because the temperature of the condenser was between the melting point of NH_3 and the boiling point of NH_3 .
27. Consider the trial in Experiment 2 that produced 550 kg of NH_3 . Based on Figure 1, the number of cycles that were needed to complete the reaction in this trial was most likely:
- less than 5.
 - between 5 and 10.
 - between 10 and 15.
 - greater than 15.



Passage V

As a sound wave travels through a medium, the wave becomes *attenuated* (loses energy). The attenuation coefficient, α , is the rate at which the wave's *intensity level* (a measure of sound volume) decreases with distance as a result of this energy loss; the greater the value of α , the greater the decrease in intensity level with distance. Figure 1 shows, for waves of 3 different frequencies (in hertz, Hz), how α (in decibels per kilometer, dB/km) varies with temperature in air at 10% relative humidity.

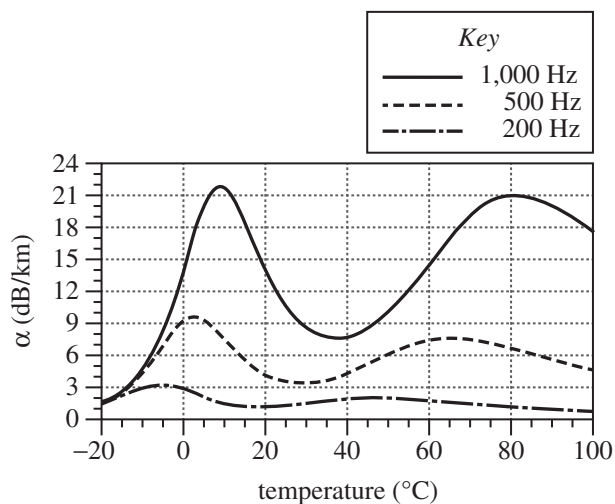


Figure 1

Figure 2 shows, for waves of 3 different frequencies, how α varies with relative humidity in air at 20°C.

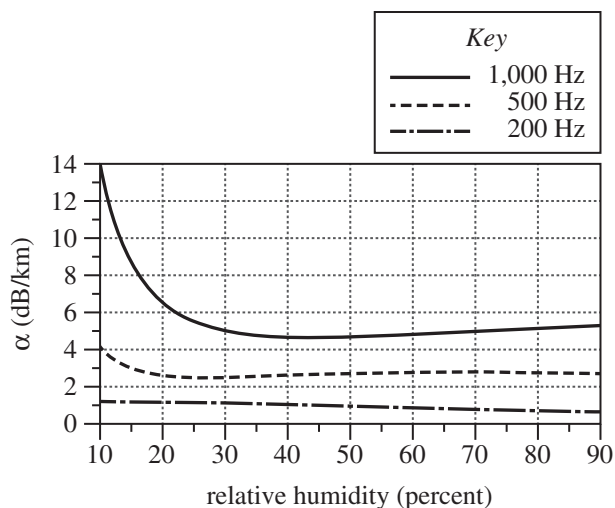


Figure 2

Figures adapted from Richard Lord, "Calculation of Absorption of Sound by the Atmosphere." ©2004 National Physical Laboratory.



28. What is the approximate maximum α shown in Figure 1 for a 200 Hz sound wave in air at 10% relative humidity, and at approximately what temperature does that maximum occur?

	α (dB/km)	temperature ($^{\circ}\text{C}$)
F.	3.0	-5
G.	3.0	35
H.	9.5	-5
J.	9.5	35

29. Based on Figure 2, the attenuation coefficient for a 1,000 Hz sound wave in air at 20°C reaches a *minimum* value at a relative humidity closest to which of the following?

A. 25%
B. 45%
C. 65%
D. 85%

30. For the range of temperatures and the range of relative humidities shown in Figures 1 and 2, respectively, is α for a 200 Hz sound wave more strongly affected by changes in temperature or by changes in relative humidity?

F. Temperature, because the maximum variation in α is about 0.5 dB/km in Figure 1 but about 2.5 dB/km in Figure 2.
G. Temperature, because the maximum variation in α is about 2.5 dB/km in Figure 1 but about 0.5 dB/km in Figure 2.
H. Relative humidity, because the maximum variation in α is about 0.5 dB/km in Figure 1 but about 2.5 dB/km in Figure 2.
J. Relative humidity, because the maximum variation in α is about 2.5 dB/km in Figure 1 but about 0.5 dB/km in Figure 2.

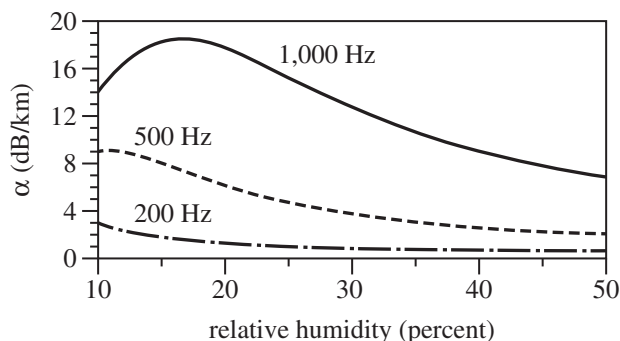
31. Consider a 1,000 Hz sound wave in air at 10% relative humidity. At how many of the temperatures shown in Figure 1 does α for this wave have a value of 18 dB/km?

A. 2
B. 3
C. 4
D. 5

32. Suppose that 2 sound waves—a 150 Hz wave and a 1,100 Hz wave—are simultaneously emitted from a speaker into air at 20°C and 45% relative humidity. Based on Figure 2, as the waves travel away from the speaker, the intensity level of which wave will more likely decrease at the greater rate due to attenuation?

F. The 150 Hz wave, because the value of α is lesser for the 150 Hz wave than for the 1,100 Hz wave.
G. The 150 Hz wave, because the value of α is greater for the 150 Hz wave than for the 1,100 Hz wave.
H. The 1,100 Hz wave, because the value of α is lesser for the 1,100 Hz wave than for the 150 Hz wave.
J. The 1,100 Hz wave, because the value of α is greater for the 1,100 Hz wave than for the 150 Hz wave.

33. The graph below shows, for sound waves of 3 different frequencies, how α varies with relative humidity in air at a particular temperature.



Based on Figure 1, the particular air temperature is most likely which of the following?

A. -20°C
B. 0°C
C. 20°C
D. 100°C



Passage VI

Three studies compared the effects of 5 sweeteners (Sweeteners Q–U) on food consumption by rats and on the concentrations of *leptin* and *ghrelin* (hormones that regulate appetite) in the blood of rats. Sweeteners Q–U differ only in the percent by mass of fructose and of glucose (see Table 1).

Table 1		
Sweetener	Percent by mass of:	
	fructose	glucose
Q	0	100
R	42	58
S	50	50
T	55	45
U	100	0

Study 1

Each of 5 groups (Groups 1–5) of rats was assigned a solution having a 100 g/L concentration of 1 of the 5 sweeteners. Each rat was placed in a separate cage and provided unlimited access to the assigned sweetener solution and to solid food for 56 days. Table 2 shows, for each group, the amounts of sweetener solution and solid food consumed per rat per day. On Day 56, blood was collected from each rat for analysis in Studies 2 and 3.

Table 2			
Group	Sweetener	Amount consumed per rat per day	
		sweetener solution (mL)	solid food (g)
1	Q	73	9
2	R	55	14
3	S	52	16
4	T	48	18
5	U	29	23

Table 2 adapted from Heather R. Light et al., “The Type of Caloric Sweetener Added to Water Influences Weight Gain, Fat Mass, and Reproduction in Growing Sprague-Dawley Female Rats.” ©2009 by the Society for Experimental Biology and Medicine.

Study 2

A 1 mL blood sample from each rat was placed in a separate test tube containing 0.2 mL of *Indicator N* (which reacts with leptin to form a blue dye). The concentration of blue dye in each tube was directly proportional to the leptin concentration in the blood sample. Table 3 shows the leptin concentration per sample for each group.

Table 3		
Group	Sweetener	Leptin concentration per sample (pM*)
1	Q	804
2	R	622
3	S	553
4	T	475
5	U	251
*picomolar		

Study 3

Study 2 was repeated, except that *Indicator P* (which reacts with ghrelin to form a yellow dye) was used instead of *Indicator N*. The concentration of yellow dye in each tube was directly proportional to the ghrelin concentration in the blood sample (see Table 4).

Table 4		
Group	Sweetener	Ghrelin concentration per sample (pM)
1	Q	852
2	R	1,125
3	S	1,279
4	T	1,450
5	U	1,758

Tables 3 and 4 adapted from Andreas Lindqvist, Annemie Baelemans, and Charlotte Erlanson-Albertsson, “Effects of Sucrose, Glucose and Fructose on Peripheral and Central Appetite Signals.” ©2008 by Elsevier B.V.



34. In Study 1, as the ratio of fructose to glucose in the sweetener solutions increased, the amount of sweetener solution consumed per rat per day:
- F. increased only.
 - G. decreased only.
 - H. increased and then decreased.
 - J. decreased and then increased.
35. In Study 1, the amount of sweetener solution consumed daily by each rat could be measured because which of the following steps had been taken?
- A. The rats' access to solid food had been restricted.
 - B. The rats' access to solid food had not been restricted.
 - C. The rats had been placed in the same cage.
 - D. The rats had been placed in separate cages.
36. Suppose that a sweetener composed of 46% fructose and 54% glucose by mass had been tested in Study 1. Based on Table 1 and the results of Study 3, the ghrelin concentration per sample would most likely have been:
- F. less than 852 pM.
 - G. between 852 pM and 1,125 pM.
 - H. between 1,125 pM and 1,279 pM.
 - J. greater than 1,279 pM.
37. Consider the claim "The group of rats that consumed the lowest amount of solid food per rat per day was also the group that had the lowest concentration of leptin per sample." Do the results of Studies 1 and 2 support this claim?
- A. Yes; the rats in Group 1 consumed the lowest amount of solid food per rat per day and also had the lowest concentration of leptin per sample.
 - B. Yes; the rats in Group 5 consumed the lowest amount of solid food per rat per day and also had the lowest concentration of leptin per sample.
 - C. No; the rats in Group 1 consumed the lowest amount of solid food per rat per day, but the rats in Group 5 had the lowest concentration of leptin per sample.
 - D. No; the rats in Group 5 consumed the lowest amount of solid food per rat per day, but the rats in Group 1 had the lowest concentration of leptin per sample.
38. Which of the following groups of rats should have been included in Study 1 to serve as a control for the effect of consuming a sweetener solution on the consumption of solid food by rats? A group of rats that had access:
- F. only to water.
 - G. only to solid food.
 - H. only to water and solid food.
 - J. to neither water nor solid food.
39. Consider the sweetener that resulted in a solid food consumption of 16 g per rat per day in Study 1. Based on Table 1, how many grams of fructose would be present in 200 g of this sweetener?
- A. 50 g
 - B. 100 g
 - C. 150 g
 - D. 200 g
40. The experimental designs of Studies 2 and 3 were identical with respect to which of the factors listed below, if either?
- I. The chemical indicator that was used
 - II. The hormone with which the chemical indicator reacted
- F. I only
 - G. II only
 - H. Both I and II
 - J. Neither I nor II

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.

Practice Writing Test

Your Signature: _____
(Do not print.)

Print Your Name Here: _____

Your Date of Birth:									
		-			-				
Month			Day			Year			

Form 21BM20



WRITING TEST BOOKLET

You must take the multiple-choice tests before you take the writing test.

Directions

This is a test of your writing skills. You will have **forty** (40) minutes to read the prompt, plan your response, and write an essay in English. Before you begin working, read all material in this test booklet carefully to understand exactly what you are being asked to do.

You will write your essay on the lined pages in the **answer document** provided. Your writing on those pages will be scored. You may use the unlined pages in this test booklet to plan your essay. Your work on these pages will not be scored.

Your essay will be evaluated based on the evidence it provides of your ability to:

- clearly state your own perspective on a complex issue and analyze the relationship between your perspective and at least one other perspective
- develop and support your ideas with reasoning and examples
- organize your ideas clearly and logically
- communicate your ideas effectively in standard written English

Lay your pencil down immediately when time is called.

DO NOT OPEN THIS BOOKLET UNTIL TOLD TO DO SO.



PO Box 168
Iowa City, IA 52243-0168

©2021 by ACT, Inc. All rights reserved.

NOTE: This test material is the confidential copyrighted property of ACT, Inc., and may not be copied, reproduced, sold, scanned, emailed, or otherwise transferred without the prior express written permission of ACT, Inc. Violators of ACT's copyrights are subject to civil and criminal penalties.

Extracurricular Activities and Codes of Conduct

For many students, extracurricular activities are a meaningful part of the high school experience. These activities allow students to develop their skills in areas such as sports, music, and drama while building relationships with peers and gaining experience performing or competing. But at many schools, students who participate in extracurricular activities are subject to special codes of conduct. These codes often establish high standards for academic performance and behavior, and students must meet the standards to stay eligible for their activities. Should students who participate in extracurricular activities be subject to special codes of conduct?

Read and carefully consider these perspectives. Each suggests a particular way of thinking about the question above.

Perspective One

All school rules and standards must apply equally to every student. It is unfair to hold students who play sports or music to higher standards than students who do not.

Perspective Two

Participation in school activities is a privilege, not a right. It is fair to ask students to earn this privilege by studying hard and behaving themselves.

Perspective Three

School programs should be open to all students. Not all students can meet high standards, which means not all students can participate in extracurricular activities.

Essay Task

Write a unified, coherent essay in which you address the question of whether students who participate in extracurricular activities should be subject to special codes of conduct. In your essay, be sure to:

- clearly state your own perspective and analyze the relationship between your perspective and at least one other perspective
- develop and support your ideas with reasoning and examples
- organize your ideas clearly and logically
- communicate your ideas effectively in standard written English

Your perspective may be in full agreement with any of those given, in partial agreement, or completely different.

Planning Your Essay

Your work on these prewriting pages will not be scored.

Use the space below and on the back cover to generate ideas and plan your essay. You may wish to consider the following as you think critically about the task:

Strengths and weaknesses of different perspectives on the issue

- What insights do they offer, and what do they fail to consider?
- Why might they be persuasive to others, or why might they fail to persuade?

Your own knowledge, experience, and values

- What is your perspective on this issue, and what are its strengths and weaknesses?
- How will you support your perspective in your essay?

Note

- For your practice essay, you will need scratch paper to plan your essay and four lined sheets of paper for your response.
- On test day, if you are taking the paper test, you will receive a test booklet with space to plan your essay and an answer document with four lined pages on which to write your response.
- Read pages 68–69 for information and instructions on scoring your practice writing test.

The ACT® with Writing 2022–2023 Answer Document

EXAMINEE STATEMENTS, CERTIFICATION, AND SIGNATURE

- 1. Statements:** I understand that by registering for, launching, starting, or submitting answer documents for an ACT® test, I am agreeing to comply with and be bound by the *Terms and Conditions: Testing Rules and Policies for the ACT® Test* ("Terms").

I UNDERSTAND AND AGREE THAT THE TERMS PERMIT ACT TO CANCEL MY SCORES IN CERTAIN CIRCUMSTANCES. THE TERMS ALSO LIMIT DAMAGES AVAILABLE TO ME AND REQUIRE ARBITRATION OF CERTAIN DISPUTES. BY AGREEING TO ARBITRATION, ACT AND I BOTH WAIVE THE RIGHT TO HAVE THOSE DISPUTES HEARD BY A JUDGE OR JURY.

I understand that ACT owns the test questions and responses, and I will not share them with anyone by any form of communication before, during, or after the test administration. I understand that taking the test for someone else may violate the law and subject me to legal penalties. I consent to the collection and processing of personally identifying information I provide, and its subsequent use and disclosure, as described in the ACT Privacy Policy (www.act.org/privacy.html). I also permit ACT to transfer my personally identifying information to the United States, to ACT, or to a third-party service provider, where it will be subject to use and disclosure under the laws of the United States, including being accessible to law enforcement or national security authorities.

- 2. Certification:** Copy the italicized certification below, then sign and date in the spaces provided.

*I agree to the **Statements** above and certify that I am the person whose information appears on this form.*

Your Signature Today's Date



USE A NO. 2 PENCIL ONLY.
(Do NOT use a mechanical pencil, ink, ballpoint, correction fluid, or felt-tip pen.)

A NAME, MAILING ADDRESS, AND TELEPHONE
(Please print.)

Last Name First Name MI (Middle Initial)

House Number & Street (Apt. No.); or PO Box & No.; or RR & No.

City State/Province ZIP/Postal Code

Area Code Number Country

ACT, Inc.—Confidential Restricted when data present

ALL examinees must complete block A – please print.

Blocks B, C, and D are required for all examinees. Find the MATCHING INFORMATION on your ticket. Enter it EXACTLY the same way, even if any of the information is missing or incorrect. Fill in the corresponding ovals. If you do not complete these blocks to match your previous information EXACTLY, your scores will be **delayed up to 8 weeks**.

ACT®

PO BOX 168, IOWA CITY, IA 52243-0168

B MATCH NAME
(First 5 letters of last name)

A	A	A	A	A
B	B	B	B	B
C	C	C	C	C
D	D	D	D	D
E	E	E	E	E
F	F	F	F	F
G	G	G	G	G
H	H	H	H	H
I	I	I	I	I
J	J	J	J	J
K	K	K	K	K
L	L	L	L	L
M	M	M	M	M
N	N	N	N	N
O	O	O	O	O
P	P	P	P	P
Q	Q	Q	Q	Q
R	R	R	R	R
S	S	S	S	S
T	T	T	T	T
U	U	U	U	U
V	V	V	V	V
W	W	W	W	W
X	X	X	X	X
Y	Y	Y	Y	Y
Z	Z	Z	Z	Z

C MATCH NUMBER

1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9
0	0	0	0	0	0	0	0	0	0

D DATE OF BIRTH

Month	Day	Year
☐ January		
☐ February		
☐ March	1	1
☐ April	2	2
☐ May	3	3
☐ June	4	4
☐ July	5	5
☐ August	6	6
☐ September	7	7
☐ October	8	8
☐ November	9	9
☐ December	0	0

PLEASE DO NOT WRITE IN THIS AREA.

SERIAL #

Marking Directions: Mark only **one** oval for each question. Fill in response completely. Erase errors cleanly without smudging.

Correct mark: ☐ ☒ ☐

Do NOT use these incorrect or bad marks.

Incorrect marks: ☒ ☒ ☒ ☒

Overlapping mark: ☐ ☐ ☒

Cross-out mark: ☐ ☒

Smudged erasure: ☐ ☐ ☒

Mark is too light: ☒ ☐ ☐

BOOKLET NUMBER

1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9
0	0	0	0	0	0	0	0	0

FORM

--	--	--

Print your 3-character **Test Form** in the boxes above and fill in the corresponding oval at the right.

BE SURE TO FILL IN THE CORRECT FORM OVAL.

☐ PRE

TEST 1: ENGLISH

1 (A B C D)	14 (F G H J)	27 (A B C D)	40 (F G H J)	53 (A B C D)	66 (F G H J)
2 (F G H J)	15 (A B C D)	28 (F G H J)	41 (A B C D)	54 (F G H J)	67 (A B C D)
3 (A B C D)	16 (F G H J)	29 (A B C D)	42 (F G H J)	55 (A B C D)	68 (F G H J)
4 (F G H J)	17 (A B C D)	30 (F G H J)	43 (A B C D)	56 (F G H J)	69 (A B C D)
5 (A B C D)	18 (F G H J)	31 (A B C D)	44 (F G H J)	57 (A B C D)	70 (F G H J)
6 (F G H J)	19 (A B C D)	32 (F G H J)	45 (A B C D)	58 (F G H J)	71 (A B C D)
7 (A B C D)	20 (F G H J)	33 (A B C D)	46 (F G H J)	59 (A B C D)	72 (F G H J)
8 (F G H J)	21 (A B C D)	34 (F G H J)	47 (A B C D)	60 (F G H J)	73 (A B C D)
9 (A B C D)	22 (F G H J)	35 (A B C D)	48 (F G H J)	61 (A B C D)	74 (F G H J)
10 (F G H J)	23 (A B C D)	36 (F G H J)	49 (A B C D)	62 (F G H J)	75 (A B C D)
11 (A B C D)	24 (F G H J)	37 (A B C D)	50 (F G H J)	63 (A B C D)	
12 (F G H J)	25 (A B C D)	38 (F G H J)	51 (A B C D)	64 (F G H J)	
13 (A B C D)	26 (F G H J)	39 (A B C D)	52 (F G H J)	65 (A B C D)	

TEST 2: MATHEMATICS

1 (A B C D E)	11 (A B C D E)	21 (A B C D E)	31 (A B C D E)	41 (A B C D E)	51 (A B C D E)
2 (F G H J K)	12 (F G H J K)	22 (F G H J K)	32 (F G H J K)	42 (F G H J K)	52 (F G H J K)
3 (A B C D E)	13 (A B C D E)	23 (A B C D E)	33 (A B C D E)	43 (A B C D E)	53 (A B C D E)
4 (F G H J K)	14 (F G H J K)	24 (F G H J K)	34 (F G H J K)	44 (F G H J K)	54 (F G H J K)
5 (A B C D E)	15 (A B C D E)	25 (A B C D E)	35 (A B C D E)	45 (A B C D E)	55 (A B C D E)
6 (F G H J K)	16 (F G H J K)	26 (F G H J K)	36 (F G H J K)	46 (F G H J K)	56 (F G H J K)
7 (A B C D E)	17 (A B C D E)	27 (A B C D E)	37 (A B C D E)	47 (A B C D E)	57 (A B C D E)
8 (F G H J K)	18 (F G H J K)	28 (F G H J K)	38 (F G H J K)	48 (F G H J K)	58 (F G H J K)
9 (A B C D E)	19 (A B C D E)	29 (A B C D E)	39 (A B C D E)	49 (A B C D E)	59 (A B C D E)
10 (F G H J K)	20 (F G H J K)	30 (F G H J K)	40 (F G H J K)	50 (F G H J K)	60 (F G H J K)

TEST 3: READING

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

TEST 4: SCIENCE

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

A horizontal number line with 11 equally spaced tick marks. The first tick mark on the left is labeled '0'. Each subsequent tick mark to the right is labeled with an integer from 1 to 10. The line extends slightly beyond the 10 mark on both ends.

L

The logo for The ACT Writing Test. It features a stylized graphic of three vertical bars of increasing height on the left, followed by the text "The ACT® Writing Test" in a bold, sans-serif font.

NOTE: When finished, close document with page 1 facing you.

PLEASE DO NOT WRITE IN THIS AREA.

[illegible]

2

Do not write in this shaded area.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

3

PLEASE DO NOT WRITE IN THIS AREA.

[illegible]

4

Do not write in this shaded area.

Close document with
page 1 facing you.

PO Box 168
Iowa City, IA 52243-0168

62

How to Score the Multiple-Choice Tests

Follow the instructions below and on the following pages to score your practice multiple-choice tests and review your performance.

Raw Scores

The number of questions you answered correctly on each test and in each reporting category is your **raw score**. Because there are many forms of the ACT, each with different questions, some forms will be slightly easier (and some slightly harder) than others. A raw score of 67 on one form of the English test, for example, may be about as difficult to earn as a raw score of 70 on another form of that test.

To compute your raw scores, check your answers with the scoring keys on pages 64–66. Count the number of correct answers for each of the four tests and seventeen reporting categories and enter the number in the blanks provided on those pages. These numbers are your raw scores on the tests and reporting categories.

Scale Scores

To adjust for the small differences that occur among different forms of the ACT, the raw scores for tests are converted into **scale scores**. Scale scores are printed on the reports sent to you and your college and scholarship choices.

When your raw scores are converted into scale scores, it becomes possible to compare your scores with those of examinees who took different test forms. For example, a scale score of 26 on the English test has the same meaning regardless of the form of the ACT on which it is based.

To determine the scale scores corresponding to your raw scores on the practice test, use Table 1 on page 67, which explains the procedures used to obtain scale scores from raw scores. This table shows the raw-to-scale score conversions for each test. Because each form of the ACT is unique, each form has somewhat different conversion tables. Consequently, this table provides only approximations of the raw-to-scale score conversions that would apply if a different form of the ACT were taken. Therefore, the scale scores obtained from the practice tests don't match precisely the scale scores received from an actual administration of the ACT.

Computing the Composite Score

The **Composite score** is the average of the four scale scores in English, mathematics, reading, and science. If you left any of these tests blank, do not calculate a Composite score. If you take the ACT with writing, your writing results do **not** affect your Composite score.

Comparing Your Scores

Information about comparing your scores on the practice multiple-choice tests with the scores of recent high school graduates who took the ACT can be found at www.act.org/the-act/scores.

Your scores and percent at or below are only **estimates** of the scores that you will receive during an actual administration of the ACT. Test scores are only one indicator of your level of learning. Consider your scores in connection with your grades, your performance in outside activities, and your career interests.

ACT College and Career Readiness Standards

The ACT College and Career Readiness Standards describe the types of skills, strategies, and understandings you will need to make a successful transition from high school to college. For English, mathematics, reading, and science, standards are provided for six score ranges that reflect the progression and complexity of the skills in each of the academic areas measured by the ACT tests. For writing, standards are provided for five score ranges. The ACT College and Career Readiness Standards and benchmark scores for each test can be found at www.act.org.

Reviewing Your Performance on the Multiple-Choice Tests

Consider the following as you review your scores:

Did you run out of time? Reread the information in this booklet on pacing yourself. You may need to adjust the way you use your time in responding to the questions.

Did you spend too much time trying to understand the directions for the tests? The directions for the practice tests are the same directions that will appear in your test booklet on test day. Make sure you understand them before test day by reviewing them again.

Review the questions that you missed. Did you select a response that was an incomplete answer or that did not directly respond to the question being asked? Try to figure out what you overlooked in answering the missed questions.

Did a particular type of question confuse you? Did the questions you missed come from a particular reporting category? In reviewing your responses, check to see whether a particular type of question or a particular reporting category was more difficult for you.

Scoring Keys for the ACT Practice Tests

Use the scoring key for each test to score your answer document for the multiple-choice tests. Mark a “1” in the blank for each question you answered correctly. Add up the numbers in each reporting category and enter the total number correct for each reporting category in the blanks provided. Also enter the total number correct for each test in the blanks provided. The total number correct for each test is the sum of the number correct in each reporting category.

Test 1: English—Scoring Key

2176CPRE

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

Key	Reporting Category*		
	POW	KLA	CSE
39. C			
40. F			
41. C			
42. J			
43. B			
44. G			
45. C			
46. J			
47. A			
48. G			
49. A			
50. H			
51. C			
52. H			
53. D			
54. J			
55. A			
56. J			
57. D			
58. G			
59. A			
60. G			
61. C			
62. J			
63. B			
64. G			
65. D			
66. G			
67. A			
68. G			
69. C			
70. G			
71. A			
72. J			
73. A			
74. G			
75. A			

*Reporting Categories

POW = Production of Writing

KLA = Knowledge of Language

CSE = Conventions of Standard English

Number Correct (Raw Score) for:

Production of Writing (POW) _____
(23)

Knowledge of Language (KLA) _____
(12)

Conventions of Standard English (CSE) _____
(40)

Total Number Correct for English Test _____
(POW + KLA + CSE) (75)

Key	Reporting Category*						
	PHM					IES	MDL
	N	A	F	G	S		
1. E						—	—
2. J		—					
3. B						—	
4. G						—	
5. C		—					
6. F						—	—
7. B			—				—
8. H			—				—
9. D				—			
10. G	—						—
11. B					—		—
12. G				—			—
13. D						—	—
14. J						—	—
15. A		—					
16. K		—					
17. D				—			
18. J	—						
19. A				—			—
20. F					—		
21. E						—	
22. G				—			
23. E			—				
24. H						—	
25. D						—	
26. G						—	—
27. E						—	
28. H						—	—
29. C						—	—
30. H					—		

Key	Reporting Category*						
	PHM					IES	MDL
	N	A	F	G	S		
31. B	—						—
32. K						—	—
33. D						—	—
34. F				—			
35. E						—	—
36. J						—	
37. C					—		—
38. F					—		—
39. D	—						
40. K				—			
41. A		—					
42. J			—				
43. D						—	
44. G		—					—
45. E		—					
46. F						—	—
47. D					—		—
48. G						—	
49. D			—				
50. K			—				
51. D						—	—
52. K						—	
53. A			—				
54. G						—	
55. B	—						
56. K		—					
57. D						—	
58. K			—				
59. B				—			—
60. F						—	—

Combine the totals of these columns and put in the blank for PHM in the box below.

*Reporting Categories

PHM = Preparing for Higher Math

N = Number & Quantity

A = Algebra

F = Functions

G = Geometry

S = Statistics & Probability

IES = Integrating Essential Skills

MDL = Modeling

Number Correct (Raw Score) for:

Preparing for Higher Math (PHM)
(N + A + F + G + S)

(35)

Integrating Essential Skills (IES)

(25)

Total Number Correct for Mathematics Test
(PHM + IES)

(60)

Modeling (MDL)
(Not included in total number correct for
mathematics test raw score)

(24)

Test 3: Reading—Scoring Key

2176CPRE

Key	Reporting Category*		
	KID	CS	IKI
1. D		___	
2. F	___		
3. C		___	
4. J		___	
5. D			___
6. J	___		
7. B	___		
8. H			___
9. B			___
10. F			___
11. D		___	
12. F	___		
13. B	___		
14. G	___		
15. D		___	
16. G	___		
17. C	___		
18. H	___		
19. B	___		
20. J		___	

Key	Reporting Category*		
	KID	CS	IKI
21. B		___	
22. F	___		
23. C		___	
24. J		___	
25. A			___
26. J	___		
27. B	___		
28. G	___		
29. C	___		
30. F		___	
31. C		___	
32. G	___		
33. A	___		
34. J	___		
35. C	___		
36. F	___		
37. D	___		
38. G		___	
39. C	___		
40. G	___		

*Reporting Categories

KID = Key Ideas & Details

CS = Craft & Structure

IKI = Integration of Knowledge & Ideas

Number Correct (Raw Score) for:

Key Ideas & Details (KID) _____
(23)

Craft & Structure (CS) _____
(12)

Integration of Knowledge & Ideas (IKI) _____
(5)

Total Number Correct for Reading Test _____
(KID + CS + IKI) (40)

Test 4: Science—Scoring Key

2176CPRE

Key	Reporting Category*		
	IOD	SIN	EMI
1. D			___
2. H			___
3. B			___
4. G			___
5. B			___
6. F			___
7. C			___
8. J		___	
9. C		___	
10. J	___		
11. B		___	
12. F	___		
13. B		___	
14. H		___	
15. B	___		
16. G	___		
17. A	___		
18. H	___		
19. D	___		
20. J	___		

Key	Reporting Category*		
	IOD	SIN	EMI
21. A	___		
22. G	___		
23. C		___	
24. J	___		
25. B		___	
26. J		___	
27. A			___
28. F	___		
29. B	___		
30. G			___
31. C	___		
32. J	___		
33. B	___		
34. G	___		
35. D		___	
36. H		___	
37. C			___
38. H		___	
39. B	___		
40. J		___	

*Reporting Categories

IOD = Interpretation of Data

SIN = Scientific Investigation

EMI = Evaluation of Models,
Inferences & Experimental Results

Number Correct (Raw Score) for:

Interpretation of Data (IOD) _____
(18)

Scientific Investigation (SIN) _____
(12)

Evaluation of Models, Inferences &
Experimental Results (EMI) _____
(10)

Total Number Correct for Science Test _____
(IOD + SIN + EMI) (40)

Table 1**Explanation of Procedures Used to Obtain Scale Scores from Raw Scores**

On each of the four multiple-choice tests on which you marked any responses, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale scores. For each test, locate and circle your raw score or the range of raw scores that includes it in the table below. Then, read across to either outside column of the table and circle the scale score that corresponds to that raw score. As you determine your scale scores, enter them in the blanks provided on the right. The highest possible scale score for each test is 36. The lowest possible scale score for any test on which you marked any responses is 1.

Next, compute the Composite score by averaging the four scale scores. To do this, add your four scale scores and divide the sum by 4. If the resulting number ends in a fraction, round it to the nearest whole number. (Round down any fraction less than one-half; round up any fraction that is one-half or more.) Enter this number in the blank. This is your Composite score. The highest possible Composite score is 36. The lowest possible Composite score is 1.

ACT Test 2176CPRE	Your Scale Score
-------------------	------------------

English	_____
---------	-------

Mathematics	_____
-------------	-------

Reading	_____
---------	-------

Science	_____
---------	-------

Sum of scores	_____
----------------------	-------

Composite score (sum ÷ 4)	_____
----------------------------------	-------

NOTE: If you left a test completely blank and marked no items, do not list a scale score for that test. If any test was completely blank, do not calculate a Composite score.

To calculate your writing score, use the rubric on pages 68–69.

Scale Score	Raw Scores				Scale Score
	Test 1 English	Test 2 Mathematics	Test 3 Reading	Test 4 Science	
36	72-75	58-60	39-40	38-40	36
35	70-71	56-57	38	37	35
34	68-69	54-55	37	36	34
33	67	53	35-36	35	33
32	66	51-52	34	34	32
31	65	49-50	33	—	31
30	64	48	—	33	30
29	62-63	46-47	32	32	29
28	61	44-45	31	31	28
27	60	41-43	30	—	27
26	58-59	39-40	29	30	26
25	56-57	37-38	28	28-29	25
24	53-55	35-36	27	26-27	24
23	51-52	33-34	26	25	23
22	48-50	31-32	24-25	23-24	22
21	45-47	30	23	22	21
20	42-44	28-29	21-22	20-21	20
19	40-41	26-27	20	19	19
18	38-39	24-25	19	17-18	18
17	36-37	21-23	17-18	15-16	17
16	33-35	17-20	16	13-14	16
15	30-32	13-16	14-15	12	15
14	27-29	10-12	12-13	11	14
13	25-26	8-9	11	10	13
12	23-24	6-7	9-10	9	12
11	19-22	5	7-8	8	11
10	16-18	4	6	7	10
9	13-15	—	5	6	9
8	11-12	3	—	5	8
7	9-10	—	4	4	7
6	7-8	2	3	3	6
5	6	—	—	—	5
4	4-5	1	2	2	4
3	3	—	—	1	3
2	2	—	1	—	2
1	0-1	0	0	0	1

How to Score the Writing Test

It is difficult to be objective about one's own work. However, it is to your advantage to read your own writing critically, as doing so can help you grow as a writer and as a reader. It may also be helpful for you to give your practice essay to another reader, such as a classmate, parent, or teacher. To rate your essay, you and your reader(s) should review the guidelines and sample essays at www.actstudent.org and then use the scoring rubric below to assign your practice essay a score of 1 (low) through 6 (high) in each of the four writing domains (Ideas and Analysis, Development and Support, Organization, Language Use).

Scoring Rubric (below)

The rubric presents the standards by which your essay will be evaluated. Readers will use this rubric to assign your essay four unique scores, one per writing domain. To score your essay, determine which scorepoint, in each domain, best describes the features of your writing. Because each domain receives its own score, the four scores you assign need not be identical. For example, you may find that your essay exhibits stronger skill in organization than in the development of ideas. In this case, you may determine that your essay should receive a higher score in Organization than in Development and Support.

The ACT Writing Test Scoring Rubric

	<i>Ideas and Analysis</i>	<i>Development and Support</i>	<i>Organization</i>	<i>Language Use</i>
Score 6: Responses at this scorepoint demonstrate effective skill in writing an argumentative essay.	The writer generates an argument that critically engages with multiple perspectives on the given issue. The argument's thesis reflects nuance and precision in thought and purpose. The argument establishes and employs an insightful context for analysis of the issue and its perspectives. The analysis examines implications, complexities and tensions, and/or underlying values and assumptions.	Development of ideas and support for claims deepen insight and broaden context. An integrated line of skillful reasoning and illustration effectively conveys the significance of the argument. Qualifications and complications enrich and bolster ideas and analysis.	The response exhibits a skillful organizational strategy. The response is unified by a controlling idea or purpose, and a logical progression of ideas increases the effectiveness of the writer's argument. Transitions between and within paragraphs strengthen the relationships among ideas.	The use of language enhances the argument. Word choice is skillful and precise. Sentence structures are consistently varied and clear. Stylistic and register choices, including voice and tone, are strategic and effective. While a few minor errors in grammar, usage, and mechanics may be present, they do not impede understanding.
Score 5: Responses at this scorepoint demonstrate well-developed skill in writing an argumentative essay.	The writer generates an argument that productively engages with multiple perspectives on the given issue. The argument's thesis reflects precision in thought and purpose. The argument establishes and employs a thoughtful context for analysis of the issue and its perspectives. The analysis addresses implications, complexities and tensions, and/or underlying values and assumptions.	Development of ideas and support for claims deepen understanding. A mostly integrated line of purposeful reasoning and illustration capably conveys the significance of the argument. Qualifications and complications enrich ideas and analysis.	The response exhibits a productive organizational strategy. The response is mostly unified by a controlling idea or purpose, and a logical sequencing of ideas contributes to the effectiveness of the argument. Transitions between and within paragraphs consistently clarify the relationships among ideas.	The use of language works in service of the argument. Word choice is precise. Sentence structures are clear and varied often. Stylistic and register choices, including voice and tone, are purposeful and productive. While minor errors in grammar, usage, and mechanics may be present, they do not impede understanding.
Score 4: Responses at this scorepoint demonstrate adequate skill in writing an argumentative essay.	The writer generates an argument that engages with multiple perspectives on the given issue. The argument's thesis reflects clarity in thought and purpose. The argument establishes and employs a relevant context for analysis of the issue and its perspectives. The analysis recognizes implications, complexities and tensions, and/or underlying values and assumptions.	Development of ideas and support for claims clarify meaning and purpose. Lines of clear reasoning and illustration adequately convey the significance of the argument. Qualifications and complications extend ideas and analysis.	The response exhibits a clear organizational strategy. The overall shape of the response reflects an emergent controlling idea or purpose. Ideas are logically grouped and sequenced. Transitions between and within paragraphs clarify the relationships among ideas.	The use of language conveys the argument with clarity. Word choice is adequate and sometimes precise. Sentence structures are clear and demonstrate some variety. Stylistic and register choices, including voice and tone, are appropriate for the rhetorical purpose. While errors in grammar, usage, and mechanics are present, they rarely impede understanding.

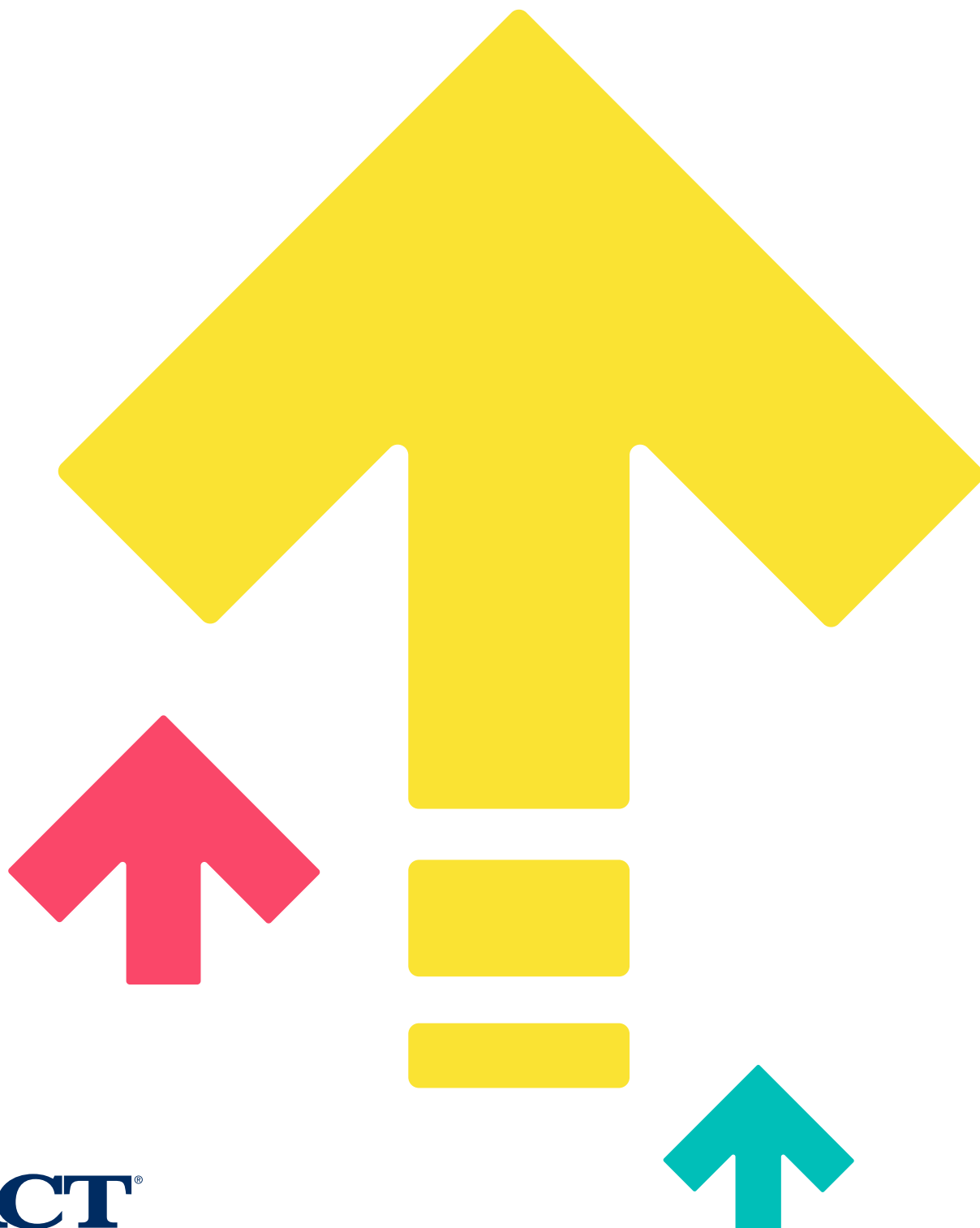
The ACT Writing Test Scoring Rubric

	<i>Ideas and Analysis</i>	<i>Development and Support</i>	<i>Organization</i>	<i>Language Use</i>
Score 3: Responses at this scorepoint demonstrate some developing skill in writing an argumentative essay.	The writer generates an argument that responds to multiple perspectives on the given issue. The argument's thesis reflects some clarity in thought and purpose. The argument establishes a limited or tangential context for analysis of the issue and its perspectives. Analysis is simplistic or somewhat unclear.	Development of ideas and support for claims are mostly relevant but are overly general or simplistic. Reasoning and illustration largely clarify the argument but may be somewhat repetitious or imprecise.	The response exhibits a basic organizational structure. The response largely coheres, with most ideas logically grouped. Transitions between and within paragraphs sometimes clarify the relationships among ideas.	The use of language is basic and only somewhat clear. Word choice is general and occasionally imprecise. Sentence structures are usually clear but show little variety. Stylistic and register choices, including voice and tone, are not always appropriate for the rhetorical purpose. Distracting errors in grammar, usage, and mechanics may be present, but they generally do not impede understanding.
Score 2: Responses at this scorepoint demonstrate weak or inconsistent skill in writing an argumentative essay.	The writer generates an argument that weakly responds to multiple perspectives on the given issue. The argument's thesis, if evident, reflects little clarity in thought and purpose. Attempts at analysis are incomplete, largely irrelevant, or consist primarily of restatement of the issue and its perspectives.	Development of ideas and support for claims are weak, confused, or disjointed. Reasoning and illustration are inadequate, illogical, or circular, and fail to fully clarify the argument.	The response exhibits a rudimentary organizational structure. Grouping of ideas is inconsistent and often unclear. Transitions between and within paragraphs are misleading or poorly formed.	The use of language is inconsistent and often unclear. Word choice is rudimentary and frequently imprecise. Sentence structures are sometimes unclear. Stylistic and register choices, including voice and tone, are inconsistent and are not always appropriate for the rhetorical purpose. Distracting errors in grammar, usage, and mechanics are present, and they sometimes impede understanding.
Score 1: Responses at this scorepoint demonstrate little or no skill in writing an argumentative essay.	The writer fails to generate an argument that responds intelligibly to the task. The writer's intentions are difficult to discern. Attempts at analysis are unclear or irrelevant.	Ideas lack development, and claims lack support. Reasoning and illustration are unclear, incoherent, or largely absent.	The response does not exhibit an organizational structure. There is little grouping of ideas. When present, transitional devices fail to connect ideas.	The use of language fails to demonstrate skill in responding to the task. Word choice is imprecise and often difficult to comprehend. Sentence structures are often unclear. Stylistic and register choices are difficult to identify. Errors in grammar, usage, and mechanics are pervasive and often impede understanding.

Calculating Your Writing Subject Score

Complete these steps to calculate your Writing Subject Score (2–12 score range).

Score Calculation Steps	Domain	Rubric Score	Domain Score
1. Determine Rubric Score for each Domain 2. Multiply each Rubric Score by 2 to get Domain Score	Ideas and Analysis	_____	x 2 = _____
	Development and Support	_____	x 2 = _____
	Organization	_____	x 2 = _____
	Language Use and Conventions	_____	x 2 = _____
3. Find the Sum of all Domain Scores (range 8–48)	Sum of Domain Scores _____		
4. Divide Sum by 4 (range 2–12)*	Writing Subject Score _____		
*Round value to the nearest whole number. Round down any fraction less than one-half; round up any fraction that is one-half or more.			



ACT is committed to representing the diversity of society in all its aspects, including race, ethnicity, and gender. Questions, passages, and writing prompts are chosen to reflect a range of cultures and are written to not disadvantage any particular group of examinees. ACT employs extensive reviews and statistical procedures to ensure the fairness of test materials.

ACT conducts research and periodically updates tests to provide test content that reflects classroom instruction and continues to be a relevant predictor of college and career readiness. There may be subtle differences between the ACT practice test in this booklet and the test students take on test day.

ACT endorses the *Code of Fair Testing Practices in Education* and the *Code of Professional Responsibilities in Educational Measurement*, which guide the conduct of those involved in educational testing. ACT is committed to ensuring that each of its testing programs upholds the guidelines in each Code. You may locate copies of these Codes through the following organizations:

- Code of Fair Testing Practices in Education: American Psychological Association (www.apa.org)
- Code of Professional Responsibilities in Educational Measurement: National Council on Measurement in Education (www.ncme.org)

NOTE: This booklet is covered by federal copyright laws that prohibit the reproduction of the test questions without the prior express, written permission of ACT, Inc. No portion of this booklet may be copied or distributed without written permission of ACT.