

# Form A11

(June 2018)



The **ACT**®

2017 | 2018

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If you wish to order a photocopy of your answer document—including, if you took the writing test, a copy of your written essay—please use the order form on the inside back cover of this booklet.





## 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

## From Salad to Symphony

[1]

Though they can often be seen lugging bags stuffed with fresh vegetables home from Beijing markets, brothers Nan Weidong and Nan Weiping are not chefs—they are

musicians. [A] Their instruments of choice is considered  
rather unusual: a pan pipe fashioned from carrots,  
an ocarina created from a sweet potato,  
other brightly colored vegetables. Gourds,

2

daikon radishes, and other vegetables, are used  
to round out the “orchestra.”

3

1. A. NO CHANGE  
B. does seem  
C. are  
D. is
2. Which choice best maintains the pattern established in the sentence's two previous examples?  
F. NO CHANGE  
G. vegetable instruments of all shapes and sizes.  
H. a flute made from a bamboo shoot.  
J. a certain type of root vegetable.
3. A. NO CHANGE  
B. other; vegetables are used  
C. other vegetables are used,  
D. other vegetables are used
4. F. NO CHANGE  
G. were  
H. and were  
J. DELETE the underlined portion.

[2]

From an early age, the Nan brothers, raised on a vegetable farm in China's Anhui province, who were taught to play conventional musical instruments by their father, a music teacher. [B] The siblings' love of music and passion for performance led them to begin



experimenting with vegetable musical instruments a few years ago.

[3]

Working by hand while constructing their edible instruments,<sup>5</sup> the brothers manually bore holes into the vegetables by using long metal drill bits, snacking on discarded pieces as they work. [C] Weiping says that to create a low pitch, which makes<sup>6</sup> a deep hole.

Nonetheless,<sup>7</sup> a high pitch requires a shallow hole.

Other factors, like,<sup>8</sup> the diameter of the hole and changes in air temperature and humidity, also

affects<sup>9</sup> the sound quality.

[4]

[1] A newly picked vegetable that sits at the market for even one day may lose much of its water content, producing a pitch that is out of tune. [2] Because of this,<sup>10</sup> the brothers must carve a fresh set of instruments before each performance. [3] Still, the most critical ingredient in creating high-quality sound, Weidong says,<sup>11</sup> is the

vegetables' high water content.<sup>12</sup>

5. A. NO CHANGE  
B. Eating unused vegetable parts while they construct  
C. Using metal tools to construct  
D. To construct
  
6. F. NO CHANGE  
G. having made  
H. by making  
J. he makes
  
7. A. NO CHANGE  
B. Conversely,  
C. Otherwise,  
D. Even so,
  
8. F. NO CHANGE  
G. factors—like  
H. factors, like  
J. factors like
  
9. A. NO CHANGE  
B. affects  
C. affect  
D. effect
  
10. F. NO CHANGE  
G. such vegetables produce  
H. it will produce  
J. this produces
  
11. A. NO CHANGE  
B. sound, Weidong says  
C. sound Weidong says,  
D. sound Weidong says
  
12. Which sequence of sentences makes this paragraph most logical?  
F. NO CHANGE  
G. 1, 3, 2  
H. 2, 1, 3  
J. 3, 1, 2



[5]

While the brothers' musical repertoire is as varied as their instruments, ranging from traditional Chinese flute music to modern pop songs. [D] They maintain that different vegetables have different scales and are therefore suited to different types of music. Since 2011, the Nan brothers have performed regularly, playing a wide variety of music on their edible instruments and bringing a whole new meaning to the idea of playing with your food. [14]

13. A. NO CHANGE  
B. With the brothers' musical repertoire being  
C. Having the brothers' musical repertoire be  
D. The brothers' musical repertoire is
14. At this point, the writer is considering adding the following true statement:  
Each pitch is tested and perfected with the help of an old electronic tuner.  
Should the writer make this addition here?  
F. Yes, because it supports the idea that the brothers exercise care and attention to detail as they craft their vegetable instruments.  
G. Yes, because it helps explain how vegetables can be turned into precise musical instruments.  
H. No, because it provides information about the process of creating instruments that is not relevant at this point in the essay.  
J. No, because it conflicts with the idea that the brothers have a strong musical background.

Question 15 asks about the preceding passage as a whole.

15. The writer wants to add the following sentence to the essay:  
As teenagers, they performed with a local theater company.  
The sentence would most logically be placed at:  
A. Point A in Paragraph 1.  
B. Point B in Paragraph 2.  
C. Point C in Paragraph 3.  
D. Point D in Paragraph 5.

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**PASSAGE II****Nature Meets Art**

[1]

Located in Olympic Sculpture Park in Seattle, artist Mark Dion's *Neukom Vivarium* has been called a combination of art and ecology, sculpture and nature.



The installation contains a sixty-foot-long nurse log, it is a slowly decaying piece of tree trunk that provides a home and nutrients for young plants and supports a variety of microbial life. [A] This single log offers visitors to the

17

urban park, a glimpse into the complicated cycle of life unfolding in the forests outside the city.

[2]

*Vivarium* comes from the Latin word *vivus*, which means “alive”—a fitting description for a piece of art that exemplifies a thriving forest ecosystem. [B] Dion found the log, part of a western hemlock lying in a Washington

19

forest, and, transporting it to the city along with some of the soil, fungi, and plants that had surrounded the tree. [C] Working with a team of scientists and architects, Dion installed the log in a specially constructed eighty-foot-long greenhouse. The greenhouse is customized with magnifying glasses and microscopes that disclose minute details of the life supported by the log. Repeated visits to the

21

installation reveals the larger process of decay and transformation.

[3]

In the wild, this complex, interconnected system of life would have had no trouble sustaining itself. In the city, however, maintaining the nurse log requires a great number of energy and technology. [D]

23

16. F. NO CHANGE  
G. the term “nurse log” is defined as  
H. this type of log is  
J. DELETE the underlined portion.

17. A. NO CHANGE  
B. log, in addition to acting as a home and providing nutrients for young plants, offers visitors  
C. massive piece of tree (a sixty-foot log) offers visitors  
D. decaying nurse log offers visitors who come

18. F. NO CHANGE  
G. park a glimpse into the complicated cycle of life  
H. park a glimpse into the complicated cycle of life,  
J. park, a glimpse into the complicated cycle of life,

19. A. NO CHANGE  
B. laying within  
C. lying with  
D. laying in

20. F. NO CHANGE  
G. and, to transport  
H. and transported  
J. transported

21. A. NO CHANGE  
B. log, repeating  
C. log repeating  
D. log, repeated

22. F. NO CHANGE  
G. has revealed  
H. is revealing  
J. reveal

23. A. NO CHANGE  
B. a great amount in  
C. great amounts of  
D. great numbers in

Humidity is electronically monitored, the soil is  
constantly replenished with nutrients, and sunlight is  
filtered through green-hued glass designed to mimic  
the color of a forest canopy. 25

[4]

For Dion, the amount of work in the middle  
of a busy city required to sustain this ecosystem  
26

conveys an important message. According with the  
27 artist, the constant effort substitutes for what nature does instinctively, which highlights the fact that “it’s incredibly difficult, expensive, and technological to approximate that system.” In other words, nature, once destroyed is virtually  
28 impossible to reconstruct.

24. F. NO CHANGE  
G. constantly provided with and restored by nutrients on a regular basis,  
H. often constantly replenished with healthful nutrients,  
J. constantly replenished with restorative nutrients regularly,

25. If the writer were to delete the preceding sentence, the paragraph would primarily lose a statement that:  
A. explains why good air quality and healthy soil are necessary to maintain nature-based exhibits.  
B. illustrates how much effort is required to ensure that the exhibit survives in an urban setting.  
C. describes how the greenhouse is more important to the installation than is the nurse log.  
D. emphasizes how difficult it was for Dion to build the greenhouse.

26. The best placement for the underlined portion would be:  
F. where it is now.  
G. before the word *the*.  
H. after the word *this*.  
J. after the word *ecosystem*.

27. A. NO CHANGE  
B. In accordance with  
C. In accord with  
D. According to

28. F. NO CHANGE  
G. destroyed, is virtually,  
H. destroyed, is virtually  
J. destroyed is virtually,

Questions 29 and 30 ask about the preceding passage as a whole.

29. The writer is considering adding the following parenthetical information to the essay:

(The *Neukom* in the installation's title refers to the name of the work's patrons.)

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

  - A. Point A in Paragraph 1.
  - B. Point B in Paragraph 2.
  - C. Point C in Paragraph 2.
  - D. Point D in Paragraph 3.

30. Suppose the writer's primary purpose had been to describe how one artist uses a work of art to educate people about an issue the artist feels is important. Would this essay accomplish that purpose?

  - F. Yes, because it describes how Dion saw that local forests were being destroyed and then decided to make a sculpture out of a fallen tree.
  - G. Yes, because it describes Dion's nature-based installation and explains the message Dion hopes to convey through *Neukom Vivarium*.
  - H. No, because it focuses on what Dion's installation looks like and how it contributes to the Olympic Sculpture Park.
  - J. No, because it fails to indicate what *Neukom Vivarium*'s viewers actually learn from the installation.

**PASSAGE III****Internet Gain: Andreessen's Mosaic**

Before Mosaic—the web browser widely credited with popularizing the World Wide Web—was invented, the Internet wasn't user-friendly. Internet navigation required knowledge of specific typed commands; online documents, consisting almost entirely of text, were hard to locate and download. Given these obstructive hindrances, many people assumed the web would remain the domain of technology experts and never have mass appeal. Marc Andreessen believed the opposite, everyone would want the Internet.

34

[www.crackab.com](http://www.crackab.com)

As a student worker, for the National Center for Supercomputing Applications, (NCSA) at the University

35

of Illinois, Andreessen became enthralled by the Internet. In 1992, he conceived of a browser that would simplify web navigation. Rather than typing specific commands, people would be able to access different web pages by clicking on icons. He showed his idea to fellow student Eric Bina, who helped refine the program. The two then worked with the NCSA to develop Mosaic, which became available in 1993. Free to anyone with an Internet connection, Mosaic quickly became popular.

36

37

31. A. NO CHANGE  
B. navigation, which required  
C. navigation that required  
D. navigation requiring
32. F. NO CHANGE  
G. What with the problematic issues,  
H. Because of these difficulties,  
J. Owing to the messiness,
33. A. NO CHANGE  
B. opposite; because  
C. opposite:  
D. opposite
34. Which of the following statements, if added here, would provide the best transition to the discussion of Andreessen's browser?  
F. He thought Internet speeds would eventually increase.  
G. The amount of information online was immense.  
H. Few people had Internet access at the time.  
J. People just needed the right tool.
35. A. NO CHANGE  
B. worker, for the National Center for Supercomputing Applications, (NCSA),  
C. worker for the National Center for Supercomputing Applications, (NCSA),  
D. worker for the National Center for Supercomputing Applications (NCSA)
36. Which choice most strongly conveys that Andreessen developed a strong affinity for the Internet?  
F. NO CHANGE  
G. first gained access to  
H. spent many hours on  
J. saw the utility of
37. A. NO CHANGE  
B. the NCSA made the program  
C. they made Mosaic  
D. it became



Approximately 60,000 copies of the browser were  
<sup>38</sup> downloaded in its first year.

Mosaic was soon not the first web browser, but  
<sup>39</sup> it surpassed all rivals. Unlike other browsers, Mosaic was easy to install, and it worked on every operating system. It was the first browser to display pictures and text on the same page <sup>40</sup>. Featuring hyperlinks,

the user of the program was able to visit other web <sup>41</sup> pages with one click. "With Mosaic," said one writer, "the online world appears to be a vast, interconnected universe of information." <sup>42</sup>

Even though it gave way to other, more sophisticated browsers within a few years, Mosaic showed average users the significance of the Internet. Comparatively, its simplicity encouraged people to <sup>43</sup> create and upload their own content. In the year

Mosaic was discharged, 623 websites existed.

<sup>44</sup>

38. F. NO CHANGE  
G. That year, approximately 60,000 copies of the browser  
H. Approximately 60,000 copies of the browser (Mosaic)  
J. Approximately, but not exactly, 60,000 copies of the browser
39. The best placement for the underlined portion would be:  
A. where it is now.  
B. after the word *Mosaic*.  
C. after the word *browser* (and before the comma).  
D. after the word *it*.
40. At this point, the writer is considering adding the following phrase (adjusting the punctuation as needed):  
adding much-needed visual appeal  
Should the writer make this addition?  
F. Yes, because it reveals that Mosaic was the first browser to display pictures alongside text.  
G. Yes, because it emphasizes that using Mosaic made web browsing more enjoyable.  
H. No, because it implies that the text-based documents on the Internet weren't useful.  
J. No, because it suggests that, initially, Mosaic was similar to other web browsers.
41. A. NO CHANGE  
B. the program's user was enabled  
C. the program enabled the user  
D. it was easy for the user
42. If the writer were to delete the preceding sentence, the essay would primarily lose a statement that:  
F. argues that, before Mosaic, few people searched the Internet for information.  
G. specifies some of the features that made Mosaic popular among its users.  
H. credits Mosaic with making the Internet feel more coherent to users.  
J. compares the designs of later web browsers to Mosaic's design.
43. A. NO CHANGE  
B. Moreover,  
C. Conversely,  
D. Instead,
44. F. NO CHANGE  
G. relinquished,  
H. released,  
J. emitted,



Four years later, there were more than 600,000.

<sup>45</sup>

45. Given that all the choices are true, which one best concludes the essay by using specific information to complete the contrast begun in the previous sentence?

- A. NO CHANGE
  - B. Mosaic's point-and-click interface revolutionized the way people used the Internet.
  - C. Andreessen would go on to develop another highly successful web browser.
  - D. Since then, the web has expanded at an exponential rate.
- 

#### PASSAGE IV

#### A Poetic Olympics

[1]

During athletic festivals in ancient Greece, great poets were placed alongside champion athletes. This has never been true of the modern Olympic Games. [A] The Olympic literary competition, reintroduced in 1912 in Stockholm and included in the Games for decades, is poorly remembered and rarely missed. The only genuine

<sup>47</sup>

public excitement for even the very first modern, Olympic literary contest was focused on the scandal surrounding the winning poem. [B]

[2]

French aristocrat Baron Pierre de Coubertin, who in 1896 founded the modern Olympic Games, he insisted that talent in the fine arts was as important as skill in athletics. After years of opposition from officials whom felt that the modern Games should focus solely on athletics, Coubertin implemented fine arts competitions, known as the Pentathlon of Muses, in 1912. [C]

46. Which choice most clearly emphasizes the overwhelmingly positive reception great poets enjoyed during athletic festivals in ancient Greece?

- F. NO CHANGE
- G. celebrated
- H. accepted
- J. liked

47. Given that all the choices are accurate, which one best connects this sentence to the information that follows in the next sentence?

- A. NO CHANGE
- B. was featured along with competitions in music composition, architecture, sculpture, and painting.
- C. is sometimes commented upon when the Olympic Games are held today.
- D. was an homage to the traditions of the people of ancient Greece.

48. F. NO CHANGE

- G. very, first, modern Olympic
- H. very first, modern Olympic,
- J. very first modern Olympic

49. A. NO CHANGE

- B. insistent in his belief
- C. insisting
- D. insisted

50. F. NO CHANGE

- G. themselves whom
- H. who
- J. which



For the literary contest, it would submit an unpublished  
51

work; Coubertin did not establish a length requirement.

52 After a long deliberation during the literary event's first

year; finally judges named duo George Hohrod and Martin  
53 Eschbach as gold medalists for their poem "Ode to Sport."

[3]

The judges, so impressed by "Ode to Sport" that  
54 they called it "the perfect poem," refused to award either  
silver or bronze medals to any other literary competitors.

Weeks, after the Games had come to an end, the judges  
55 attempted to contact Hohrod and Eschbach given that  
the two had not come forward to receive their medals.

The judges discovered that neither author existed.

56

51. A. NO CHANGE  
B. competitors  
C. those  
D. they

52. Given that all the choices are accurate, which one provides information about the Olympic literary contest that is most clearly relevant at this point in the essay?  
F. NO CHANGE  
G. work. At the Olympic Games in Paris in 1924, a poem about fencing called "Sword Songs" was the winning piece.  
H. work, though critics mocked some of the limitations placed on writers.  
J. work, preferably a poem, that was "inspired by the idea of sport."

53. A. NO CHANGE  
B. year, judges  
C. year, then judges  
D. year. Judges

54. F. NO CHANGE  
G. judges, and having been  
H. judges had been  
J. judges were

55. A. NO CHANGE  
B. Weeks after the Games had come to an end,  
C. Weeks, after the Games had come to an end  
D. Weeks after the Games had come to an end

56. Given that all the choices are true, which one most effectively leads the reader from the information about Hohrod and Eschbach in the preceding sentence to the information about Coubertin in the next sentence?  
F. NO CHANGE  
G. After "Ode to Sport" won, Swedish art academies claimed that the contest, with its thematic focus on sport, lacked purpose.  
H. Submissions began to arrive in anticipation of the next Olympic literary competition.  
J. The judges had read the winning poem, "Ode to Sport," aloud to spectators.



A few years later, Coubertin admitted that he himself had submitted “the perfect poem” pseudonymously. [57]

[4]

The judges argued that they did not know that Coubertin had written “Ode to Sport.” But once Coubertin’s ruse was uncovered, distrust for the already unpopular competition expanded as a result—and the feeling endured. [D] The literary competition was dropped after the 1948 London Games. Many of the winning poems have since vanished, with only their titles remaining. Few literary historians think that much has been lost.

Questions 59 and 60 ask about the preceding passage as a whole.

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

Over the years, the contest attracted many people who wanted to be poets but few talented poets, and even contest organizers began to doubt the quality of the submissions.

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

- A. Point A in Paragraph 1.
- B. Point B in Paragraph 1.
- C. Point C in Paragraph 2.
- D. Point D in Paragraph 4.

57. At this point, the writer is considering adding the following sentence:

The founder of the modern Olympic Games, Coubertin was also the person who brought about the fine arts competitions.

Given that the information is true, should the writer make this addition here?

- A. Yes, because it makes clear why Coubertin didn’t include his real name on his poetry submission.
- B. Yes, because it suggests that Coubertin knew that the poem he submitted was particularly well written.
- C. No, because it repeats information about Coubertin that is provided earlier in the essay.
- D. No, because it doesn’t make clear whether Coubertin had discussed “Ode to Sport” with the judges of the literary competition.

58. F. NO CHANGE

- G. increased even though dislike of it was not new—
- H. grew—
- J. blew up because of this unveiling—

60. Suppose the writer’s primary purpose had been to explain a lesser-known aspect of a widely known event. Would this essay accomplish that purpose?

- F. Yes, because it outlines Coubertin’s most important accomplishments as the founder of the modern Olympic Games.
- G. Yes, because it describes an element of the modern Olympic Games that was relatively short lived and is not very well remembered.
- H. No, because it instead considers the merits of fine arts competitions being a part of popular athletic events.
- J. No, because it instead discusses the poem “Ode to Sport” and explains why the poem influenced Coubertin to compete in literary competitions.

## PASSAGE V

### Capturing the Arctic

San Francisco native, Louise Arner Boyd,  
first saw the blue glaciers and glittering fjords  
of the Arctic ice cap during a 1924 photography  
expedition to Spitsbergen, a Norwegian island.  
[www.crackab.com](http://www.crackab.com)

61. A. NO CHANGE  
B. native Louise Arner Boyd  
C. native Louise Arner Boyd,  
D. native, Louise Arner Boyd

62. F. NO CHANGE  
G. cap, which she had never before seen,  
H. cap—both glaciers and fjords—  
J. cap initially



In the United States, little was known about the Arctic: its

63

nearly frozen seas, packed with icebergs, made boat travel  
to the area treacherous. But Boyd, an amateur naturalist  
and practiced photographer, made exploring this wide,

frigid terrain her life's focus. She would lead seven Arctic  
expeditions, six by sea and one by air, mainly to the east  
coast of Greenland.

Boyd's first two Arctic trips, taken in a small ship  
with a small crew, were designed for photographing the  
magnificent glaciers. Soon her interest in the region  
expanded beyond capturing its beauty. She secured a  
larger, sturdier ship, the *Veslekari*, and invited several  
scientists to travel with her. Over the course of three  
1930s voyages, she led her team to the farthest

reaches of the Arctic, in 1938, the group anchored

67

close south of the North Pole. Botanists gathered

68

plant specimens from the tundra—paleogeologists  
studied the ancient ice fields, and hydrogeographers  
searched for mountains on the ocean floor.

63. A. NO CHANGE  
B. their  
C. it's  
D. its'

64. If the writer were to delete the underlined portion (adjusting the punctuation as needed), the essay would primarily lose:  
F. an indication that the purpose of the 1924 photography expedition Boyd participated in was to photograph icebergs.  
G. an explanation of a technique used by seafarers to make traveling the dangerous seas near Spitsbergen safer.  
H. an example of a particular danger facing people who might have attempted to travel the Arctic by boat.  
J. a reason most seafaring boats in the 1920s weren't equipped to navigate around icebergs.

65. Given that all the choices are accurate, which one most strongly suggests that Boyd conceived of and managed the seven Arctic expeditions?  
A. NO CHANGE  
B. be a part of  
C. experience  
D. embark on

66. Given that all the choices are true, which one most effectively leads the reader from the first sentence of this paragraph to the information that follows in the next two sentences?  
F. NO CHANGE  
G. Boyd had the opportunity to present some of these early photographs to the king and queen of England.  
H. In 1960, Boyd became the first woman to be elected to the board of the American Geographical Society.  
J. On both journeys, the crew came ashore on a group of islands called Franz Josef Land.

67. A. NO CHANGE  
B. Arctic and  
C. Arctic;  
D. Arctic

68. F. NO CHANGE  
G. nearby  
H. about  
J. just

69. A. NO CHANGE  
B. tundra,  
C. tundra:  
D. tundra



Boyd took thousands of photographs. She worked with the best equipment available, including a tripod-mounted large-format camera that freed crisp,  
70

high-resolution images of the landscape. She knew about  
71 photogrammetry, the science of making 3-D measurements from photographic images, Boyd used precise methods to choose locations and camera positions for its shots. Her  
72 well-executed photos, featured in her book *The Fiord*

*Region of East Greenland*, provided the basis for the first  
73 accurate large-scale maps of the east coast of the country.

The polar expert's final Arctic journey in 1955 was  
74 over the North Pole, in a chartered flight. Her aerial  
75 photos document the trip. Today, scientists are exploring how Boyd's photographs and writing, along with her team's studies, might be used to monitor environmental change in the Arctic.

70. F. NO CHANGE  
G. delivered  
H. performed  
J. disengaged
71. A. NO CHANGE  
B. The advanced knowledge she had of  
C. She had advanced knowledge of  
D. Knowledgeable about
72. F. NO CHANGE  
G. his or her  
H. their  
J. her
73. A. NO CHANGE  
B. established the foundation that was the spring-board to  
C. gave support that assisted in the making of  
D. lent themselves to the purpose of creating
74. Which choice provides the clearest indication that Boyd's chartered flight over the North Pole was her final Arctic journey ever, not only her final Arctic journey in the year 1955?  
F. NO CHANGE  
G. The polar expert's final Arctic journey in 1955 was a chartered flight over the North Pole.  
H. A chartered flight over the North Pole in 1955 was the polar expert's final Arctic journey.  
J. A chartered flight over the North Pole was the polar expert's final Arctic journey in 1955.

Question 75 asks about the preceding passage as a whole.

75. Suppose the writer's primary purpose had been to explain the way Boyd's photographs were used to make maps of the east coast of Greenland. Would this essay accomplish that purpose?  
A. Yes, because the writer hints that because Boyd had studied photogrammetry, she deliberately created photographs that could be used to make maps.  
B. Yes, because the writer makes clear that Boyd had photographed a region that, before her expeditions, had not been thoroughly documented.  
C. No, because although the writer mentions that Boyd's photographs were used to make maps, the writer does not elaborate on how this was done.  
D. No, because the writer instead focuses on describing how Boyd positioned her camera to create high-resolution images of glaciers.

**END OF TEST 1**

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

**2****2**

## 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.

### DO YOUR FIGURING HERE.

1. Xuan sold 9 used books for \$9.80 each. With the money from these sales, she bought 4 new books and had \$37.80 left over. What was the average amount Xuan paid for each new book?

- A. \$ 5.60
- B. \$ 9.45
- C. \$10.08
- D. \$12.60
- E. \$22.05

2. A point at  $(-5, 7)$  in the standard  $(x, y)$  coordinate plane is translated right 7 coordinate units and down 5 coordinate units. What are the coordinates of the point after the translation?

- F.  $(-12, 12)$
- G.  $(0, 0)$
- H.  $(2, 2)$
- J.  $(2, 12)$
- K.  $(12, 12)$

3. Shantiel left her home at 9:00 a.m. on Tuesday and traveled 648 miles. When she arrived at her destination it was 3:00 a.m. the next day. Given that her home and her destination are in the same time zone, which of the following is closest to her average speed, in miles per hour, for this trip?

- A. 72
- B. 54
- C. 36
- D. 31
- E. 18

**2** ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ **2**

4. The text message component of each of Juan's monthly phone bills consists of \$10.00 for the first 300 text messages sent that month, plus \$0.10 for each additional text message sent that month. On Juan's most recent phone bill he was charged a total of \$16.50 for text messages. For how many text messages in total was Juan charged on this bill?

F. 235  
G. 285  
H. 315  
J. 365  
K. 465

5. Which of the following matrices is equal to

$$\begin{bmatrix} 9 & 8 \\ -4 & 7 \end{bmatrix} + \begin{bmatrix} -6 & 6 \\ 5 & 4 \end{bmatrix} ?$$

- A.  $\begin{bmatrix} 3 & 14 \\ 1 & 11 \end{bmatrix}$   
B.  $\begin{bmatrix} 3 & 14 \\ 9 & 11 \end{bmatrix}$   
C.  $\begin{bmatrix} 15 & 14 \\ 9 & 11 \end{bmatrix}$   
D.  $\begin{bmatrix} 17 & 0 \\ 3 & 9 \end{bmatrix}$   
E.  $\begin{bmatrix} -14 & 86 \\ 59 & 4 \end{bmatrix}$

6. A function,  $f$ , is defined by  $f(x,y) = 3x^2 - 4y$ . What is the value of  $f(4,3)$ ?

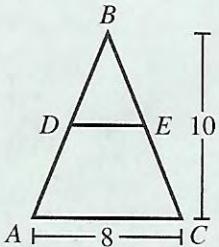
- F. 11  
G. 24  
H. 36  
J. 65  
K. 132

7. A certain group consists of 5 children, 3 of whom are age 10 and 2 of whom are age 5. What is the mean age of the children in the group?

- A. 5  
B. 7  
C. 7.5  
D. 8  
E. 10

8. In the figure shown below,  $\overline{AC} \parallel \overline{DE}$ ;  $BD = AD$ ;  $D$  and  $E$  are on  $\overline{AB}$  and  $\overline{BC}$ , respectively;  $AC = 8$  feet; and the height of  $\triangle ABC$  is 10 feet. What is  $DE$ , in feet?

- F. 2  
G. 3  
H. 4  
J. 5  
K. 6



**DO YOUR FIGURING HERE.**

**2****2**

9. In a poll of 500 registered voters, 337 voters favored a proposal to increase funding for local schools. Suppose the poll is indicative of how the 22,000 registered voters will vote on the proposal. Which of the following values is closest to how many of the 22,000 registered voters will be expected to vote in favor of the proposal?

- A. 13,200
- B. 14,830
- C. 21,840
- D. 22,000
- E. 32,640

10. Diego purchased a car that had a purchase price of \$13,400, which included all other costs and tax. He paid \$400 as a down payment and got a loan for the rest of the purchase price. Diego paid off the loan by making 48 payments of \$300 each. The total of all his payments, including the down payment, was how much more than the car's purchase price?

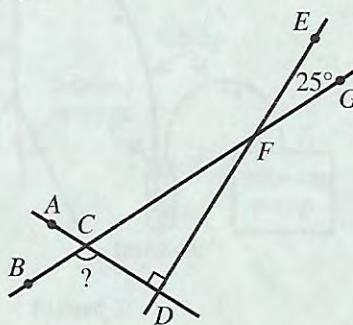
- F. \$ 1,000
- G. \$ 1,400
- H. \$13,000
- J. \$14,400
- K. \$14,800

11. In the standard  $(x,y)$  coordinate plane, what is the slope of the line  $4x + 7y = 9$ ?

- A.  $-\frac{4}{7}$
- B.  $\frac{4}{9}$
- C. -4
- D. 4
- E. 9

12. In the figure below,  $\overleftrightarrow{AD}$  intersects  $\overleftrightarrow{BG}$  at  $C$  and is perpendicular to  $\overleftrightarrow{DE}$ . Line  $\overleftrightarrow{DE}$  intersects  $\overleftrightarrow{BG}$  at  $F$ . Given that the measure of  $\angle EFG$  is  $25^\circ$ , what is the measure of  $\angle BCD$ ?

- F.  $65^\circ$
- G.  $115^\circ$
- H.  $120^\circ$
- J.  $130^\circ$
- K.  $155^\circ$

**DO YOUR FIGURING HERE.**

**2** △ △ △ △ △ △ △ △ △ **2**

13. What is the sum of the 2 solutions of the equation  $x^2 + x - 30 = 0$ ?

A. -30  
B. -6  
C. -1  
D. 0  
E. 5

14. The volume of a sphere is  $\frac{4\pi r^3}{3}$ , where  $r$  is the radius of the sphere. What is the volume, in cubic yards, of a sphere with a *diameter* of 4 yards?

F.  $\frac{32}{3}\pi$   
G.  $\frac{64}{3}\pi$   
H.  $32\pi$   
J.  $48\pi$   
K.  $\frac{256}{3}\pi$

15. What is the smallest integer greater than  $\sqrt{85}$ ?

A. 5  
B. 9  
C. 10  
D. 12  
E. 43

16. The 3 statements below are true for the elements of sets  $A$ ,  $B$ ,  $C$ , and  $D$ .

- I. All elements of  $A$  are elements of  $B$ .  
II. All elements of  $C$  are elements of  $D$ .  
III. No elements of  $D$  are elements of  $B$ .

Which of the following statements *must* be true?

F. All elements of  $A$  are elements of  $C$ .  
G. All elements of  $B$  are elements of  $D$ .  
H. All elements of  $C$  are elements of  $B$ .  
J. No elements of  $A$  are elements of  $B$ .  
K. No elements of  $A$  are elements of  $C$ .

17. In the standard  $(x,y)$  coordinate plane, the midpoint of  $\overline{AB}$  is at  $(2,1)$ , and  $A$  is at  $(8,10)$ . What is the  $x$ -coordinate of  $B$ ?

A. -4  
B. -6  
C. -8  
D. 3  
E. 5

**DO YOUR FIGURING HERE.**

2



2

DO YOUR FIGURING HERE.

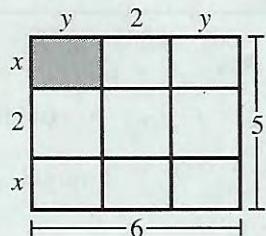
18. Lena will pick 1 card at random from a pack of 25 baseball cards. Each card features the fielding position for 1 of 25 different baseball players. Each player in the pack has only 1 fielding position. The table below lists the frequency of fielding positions in the pack. What is the probability that the card Lena picks will feature an outfielder or a pitcher?

Fielding position	Frequency
Catcher	4
Infielder	6
Pitcher	8
Outfielder	7

- F. 9%  
 G. 28%  
 H. 32%  
 J. 56%  
 K. 60%
19. According to a soil analysis, a certain lawn requires an application of 40.0 kg of nitrogen phosphate when the average temperature is 75.0°F. To avoid burning the grass, the required application amount decreases 1.2 kg for each 1.0°F that the average temperature is above 75.0°F. To the nearest 0.1 kg, what is the required application amount of nitrogen phosphate when the average temperature is 83.0°F?
- A. 30.4  
 B. 30.8  
 C. 33.3  
 D. 38.4  
 E. 38.8

20. In the figure below, all segments that meet do so at right angles. What is the area, in square units, of the shaded region?

- F.  $2\frac{1}{4}$   
 G. 3  
 H.  $3\frac{1}{3}$   
 J. 4  
 K. 7



21. The perimeter of a certain scalene triangle is 100 inches. The side lengths of the triangle are represented by  $5x$ ,  $3x + 30$ , and  $2x + 10$ , respectively. What is the length, in inches, of the longest side of the triangle?

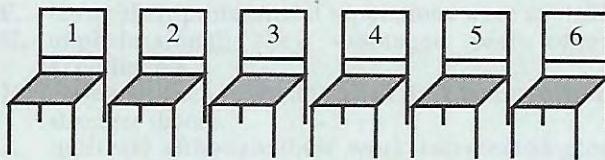
- A. 6  
 B. 22  
 C. 30  
 D. 48  
 E. 72

2



2

22. The mayor of Westbrook is deciding how to assign the 6 council members to the row of seats below.



From how many different arrangements can she choose?

- F. 21  
G. 36  
H. 64  
J. 720  
K. 6,000,000
23. The sum of 2 and 200% of 1 has the same value as which of the following calculations?

- A. 100% of 2  
B. 150% of 2  
C. 300% of 2  
D. 300% of 1  
E. 400% of 1

24. The graph in the standard  $(x,y)$  coordinate plane below is represented by one of the following equations. Which equation?

[www.crackab.com](http://www.crackab.com)

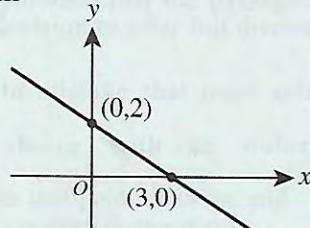
F.  $y = -\frac{3}{2}x + 2$

G.  $y = -\frac{3}{2}x + 3$

H.  $y = -\frac{2}{3}x + 2$

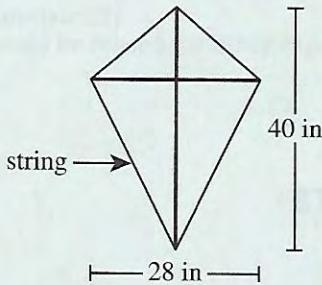
J.  $y = -\frac{2}{3}x + 3$

K.  $y = \frac{2}{3}x + 2$



25. Kamini is constructing the kite shown below. The kite includes 2 perpendicular supports, one of length 40 inches and the other of length 28 inches. The ends of the supports are connected with string to form a 4-sided figure that is symmetric with respect to the longer support. A layer of paper will cover the interior of the 4-sided figure. Which of the following is closest to the area, in square inches, that Kamini will cover with paper?

- A. 101  
B. 280  
C. 560  
D. 840  
E. 980



[www.crackab.com](http://www.crackab.com)

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**DO YOUR FIGURING HERE.**

2

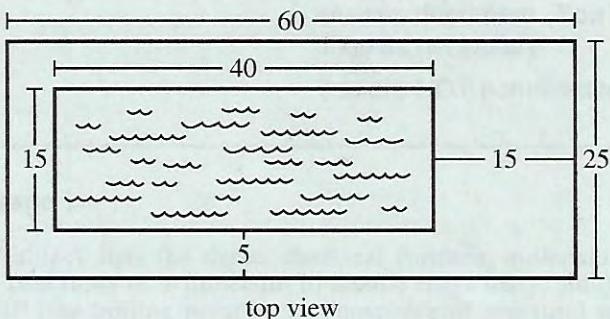


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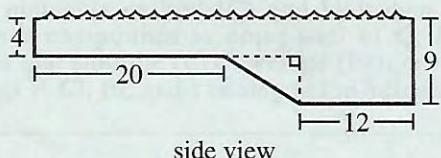
## DO YOUR FIGURING HERE.

Use the following information to answer questions 26–29.

The top view and side view of a 40-foot-long swimming pool are shown in the figure below. All dimensions given are in feet.



top view



side view

The top view shows the top rectangular surface of the pool and the surrounding rectangular patio. All 4 walls of the pool are vertical and perpendicular to the top surface. The side view shows a cross section along the length of the pool. All cross sections parallel to the side view are congruent. The shallow end has a constant depth of 4 ft. The deep end has a constant depth of 9 ft. A rectangular surface connects the shallow and deep ends.

26. What is the area, in square feet, of the patio surrounding the pool?

- F. 500
- G. 600
- H. 900
- J. 1,100
- K. 1,350

27. Johann put up a fence along the outer edge of the patio. Given that the materials for the fence cost \$12 per foot, what was the total cost of the materials for the fence?

- A. \$1,020
- B. \$1,320
- C. \$1,800
- D. \$2,040
- E. \$3,360

# 2



# 2

- 28.** A full lap is 2 times the length of the pool. Johann swam 5 full laps of the pool in  $4\frac{1}{2}$  minutes. Which of the following values is closest to Johann's average swimming speed, in feet per minute?

F. 35  
 G. 45  
 H. 60  
 J. 90  
 K. 120

- 29.** The side view of the pool is placed in the standard  $(x,y)$  coordinate plane, keeping the same orientation and scale, such that both vertical segments showing depth are parallel to the  $y$ -axis. Which of the following values is closest to the slope of the line segment connecting the shallow end to the deep end?

A. -0.44  
 B. -0.63  
 C. -0.75  
 D. -1.33  
 E. -1.60

---

**DO YOUR FIGURING HERE.**

- 30.** A construction company builds 3 different models of houses (A, B, and C). They order all the bathtubs, shower stalls, and sinks for the houses from a certain manufacturer. Each model of house contains different numbers of these bathroom fixtures. The tables below give the number of each kind of these fixtures required for each model and the cost to the company, in dollars, of each type of fixture.

Fixture	Model		
	A	B	C
Bathtubs	1	1	2
Shower stalls	0	1	1
Sinks	1	2	4

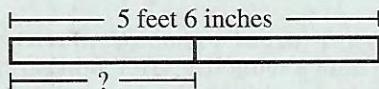
Fixture	Cost
Bathtub	\$250
Shower stall	\$150
Sink	\$120

The company plans to build 3 A's, 4 B's, and 6 C's. What will be the cost to the company of exactly enough of these bathroom fixtures to put the required number in all of these houses?

F. \$ 1,940  
 G. \$ 2,070  
 H. \$ 8,940  
 J. \$ 9,180  
 K. \$10,450

**2****2**

31. Shown below, a board 5 feet 6 inches long is cut into 2 equal parts. What is the length, to the nearest inch, of each part?



**DO YOUR FIGURING HERE.**

32. A company that builds bridges used a pile driver to drive a post into the ground. The post was driven 18 feet into the ground by the first hit of the pile driver. On each hit after the first hit, the post was driven into the ground an additional distance that was  $\frac{2}{3}$  the distance the post was driven in the previous hit. After a total of 4 hits, the post was driven how many feet into the ground?

- F.  $28\frac{8}{9}$   
G. 30  
H.  $43\frac{1}{3}$   
J. 48  
K. 54

33. In the standard  $(x,y)$  coordinate plane,  $A'$  is the image resulting from the reflection of the point  $A(2,-3)$  across the  $y$ -axis. What are the coordinates of  $A'$ ?

- A.  $(-3, 2)$   
B.  $(-2, -3)$   
C.  $(-2, 3)$   
D.  $(2, 3)$   
E.  $(3, -2)$

**2** **2**

34. To increase the mean of 4 numbers by 3, by how much would the sum of the 4 numbers have to increase?

F.  $\frac{3}{4}$   
 G. 1  
 H.  $\frac{4}{3}$   
 J. 7  
 K. 12

35. Which of the following expressions is equivalent to  $(3 + x)^{-100}$ ?

A.  $-3^{100} - x^{100}$   
 B.  $-300 - 100x$   
 C.  $\frac{1}{3^{100}} + \frac{1}{x^{100}}$   
 D.  $\frac{1}{(3x)^{100}}$   
 E.  $\frac{1}{(3+x)^{100}}$

36. Consider the graph of the equation  $y = \frac{3x-12}{2x-6}$  in the standard  $(x,y)$  coordinate plane. Which of the following equations represents the *vertical asymptote* of the graph?

F.  $x = 2$   
 G.  $x = 3$   
 H.  $x = 4$   
 J.  $x = 6$   
 K.  $x = 12$

37. For every pair of real numbers  $x$  and  $y$  such that  $xy = 0$  and  $\frac{x}{y} = 0$ , which of the following statements is true?

A.  $x = 0$  and  $y = 0$   
 B.  $x \neq 0$  and  $y = 0$   
 C.  $x = 0$  and  $y \neq 0$   
 D.  $x \neq 0$  and  $y \neq 0$   
 E. None of the statements is true for every such pair of real numbers  $x$  and  $y$ .

**DO YOUR FIGURING HERE.**



## DO YOUR FIGURING HERE.

Use the following information to answer questions 38–40.

Walter recently vacationed in Paris. While there, he visited the Louvre, a famous art museum. Afterward, he took a 3.7-kilometer cab ride from the Louvre to the Eiffel Tower. A tour guide named Amélie informed him that 2.5 million rivets were used to build the tower, which stands 320 meters tall.

38. Walter's cab ride lasted 15 minutes. Which of the following values is closest to the average speed, in miles per hour, of the cab?

(Note: 1 mile  $\approx$  1.6 kilometers)

- F. 9
- G. 15
- H. 21
- J. 24
- K. 35

39. When written in scientific notation, the number of rivets used to build the Eiffel Tower is equal to which of the following expressions?

- A.  $2.5 \times 10^6$
- B.  $2.5 \times 10^7$
- C.  $2.5 \times 10^8$
- D.  $25 \times 10^6$
- E.  $25 \times 10^7$

40. At a certain point, the angle of elevation formed by the level ground and the line from that point to the top of the Eiffel Tower is  $70^\circ$ . Which of the following expressions is equal to the distance, in meters, between that point and the center of the base of the tower?

- F.  $320 \cos 70^\circ$
- G.  $320 \sin 70^\circ$
- H.  $320 \tan 70^\circ$
- J.  $\frac{320}{\sin 70^\circ}$
- K.  $\frac{320}{\tan 70^\circ}$

41. When the vector  $a\mathbf{i} + 3\mathbf{j}$  is added to the vector  $-2\mathbf{i} + b\mathbf{j}$ , the sum is  $6\mathbf{i} - 6\mathbf{j}$ . What are the values of  $a$  and  $b$ ?

- A.  $a = -9$  and  $b = 8$
- B.  $a = -8$  and  $b = 9$
- C.  $a = -4$  and  $b = 3$
- D.  $a = 4$  and  $b = -3$
- E.  $a = 8$  and  $b = -9$

# 2



# 2

- 42.** Given  $c = 10b^3 + 50$ , which of the following is an expression for  $b$  in terms of  $c$ ?

- F.  $\left(\frac{c}{10} - 5\right)^{\frac{1}{3}}$
- G.  $\left(\frac{c}{10} + 5\right)^{\frac{1}{3}}$
- H.  $\frac{1}{10}(c - 50)^{\frac{1}{3}}$
- J.  $c^3 + 5$
- K.  $10c^3 + 50$

- 43.** Given  $f(x) = x^2 + 3x$  and  $g(x) = x + 1$ , what is  $f(g(x))$ ?

- A.  $x^2 + 5x + 4$
- B.  $x^2 + 3x + 1$
- C.  $x^3 + 5x^2 + 4x$
- D.  $x^3 + 4x^2 + 3x$
- E.  $x^4 + 4x^3 + 3x^2$

- 44.** The diameter of one circle is 12 inches long. The diameter of a second circle is 25% longer than the diameter of the first circle. To the nearest square inch, how much larger is the area of the second circle than the area of the first circle?

- F. 7
- G. 28
- H. 44
- J. 64
- K. 254

- 45.** What is the product of the mean and the median of the first 6 prime numbers?

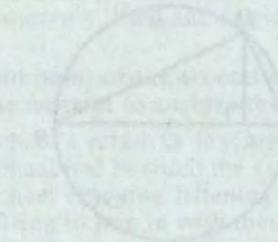
(Note: 2 is the first prime number.)

- A. 27
- B. 37
- C. 39
- D. 41
- E. 42

- 46.** For all real values of  $x$ , which of the following equations is true?

- F.  $\sin(7x) + \cos(7x) = 7$
- G.  $\sin(7x) + \cos(7x) = 1$
- H.  $7 \sin(7x) + 7 \cos(7x) = 14$
- J.  $\sin^2(7x) + \cos^2(7x) = 7$
- K.  $\sin^2(7x) + \cos^2(7x) = 1$

**DO YOUR FIGURING HERE.**



# 2





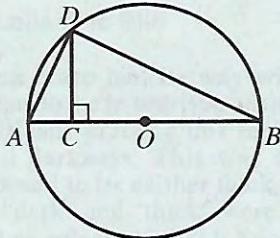







# 2

47. In the figure shown below,  $A$ ,  $B$ , and  $D$  lie on a circle whose center is  $O$ , a diameter is  $\overline{AB}$ ,  $\overline{CD}$  is perpendicular to  $\overline{AB}$  at  $C$ , the length of  $\overline{AD}$  is 5 m, and the length of  $\overline{BD}$  is 12 m. What is the length, in meters, of  $\overline{CD}$ ?



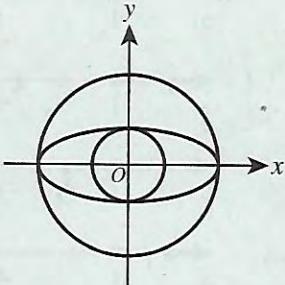
- A.  $\frac{60}{13}$
  - B.  $\frac{65}{12}$
  - C. 13
  - D.  $\frac{156}{5}$
  - E. 60
48. If  $a$  and  $b$  are real numbers such that  $a > 0$  and  $b < 0$ , then which of the following is equivalent to  $|a| - |b|$ ?
- F.  $|a - b|$
  - G.  $|a + b|$
  - H.  $|a| + |b|$
  - J.  $a - b$
  - K.  $a + b$
49. If  $x < y$  and  $y < 4$ , then what is the greatest possible integer value of  $x + y$ ?
- A. 0
  - B. 3
  - C. 4
  - D. 7
  - E. 8
50. Given that  $y$  varies directly as the square of  $x$ , if  $y = 20$  when  $x = 2$ , what is  $y$  when  $x = 3$ ?
- F. 75
  - G. 45
  - H. 30
  - J. 21
  - K. 15

**DO YOUR FIGURING HERE.**

DO YOUR FIGURING HERE.

51. Shown below in the standard  $(x,y)$  coordinate plane are 2 circles and 1 ellipse, each centered at  $(0,0)$ . The larger circle has equation  $x^2 + y^2 = 25$  and intersects the ellipse at exactly 2 points, both on the  $x$ -axis. The smaller circle has equation  $x^2 + y^2 = 4$  and intersects the ellipse at exactly 2 points, both on the  $y$ -axis. Which of the following equations represents the ellipse?

- A.  $\frac{x^2}{2} + \frac{y^2}{5} = 1$
- B.  $\frac{x^2}{4} + \frac{y^2}{25} = 1$
- C.  $\frac{x^2}{5} + \frac{y^2}{2} = 1$
- D.  $\frac{x^2}{25} + \frac{y^2}{4} = 1$
- E.  $\frac{x^2}{100} + \frac{y^2}{16} = 1$



52. The mean of 5 integers is 52. The median of these 5 integers is 82. Three of the integers are 0, 12, and 82. Which of the following could be one of the other integers?

- F. 52
- G. 66
- H. 84
- J. 86
- K. 105

53. An integer is *abundant* if its positive integer factors, excluding the integer itself, have a sum that is greater than the integer. How many of the integers 6, 8, 10, and 12 are abundant?

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

54. Vanna walked at a rate of 2 miles per hour for 10 minutes and then walked at a rate of 3 miles per hour for 5 minutes. Which of the following gives the average rate, in miles per hour, at which she walked over this 15-minute period?

- F.  $\frac{1}{3}$
- G.  $\frac{7}{3}$
- H.  $\frac{7}{24}$
- J.  $\frac{7}{180}$
- K.  $\frac{35}{2}$

**2****2**

55. The ratio of Alani's height to Baahir's height is 5:7. The ratio of Baahir's height to Connor's height is 4:3. What is the ratio of Alani's height to Connor's height?

- A. 2:3
- B. 8:11
- C. 15:28
- D. 20:21
- E. 28:15

56. For all  $x > 0$ , which of the following expressions is NOT equivalent to  $\sqrt[3]{x^2}$ ?

- F.  $\sqrt[3]{x}$
- G.  $\sqrt[6]{x^2}$
- H.  $\sqrt[3]{\sqrt{x^2}}$
- J.  $x^{\frac{1}{3}}$
- K.  $x^{\frac{2}{3}}$

57. If the length of a rectangle is increased by 25% and the width is decreased by 10%, the area of the resulting rectangle is larger than the area of the original rectangle by what percent?

- A. 2.5%
- B. 12.5%
- C. 15%
- D. 22.5%
- E. 35%

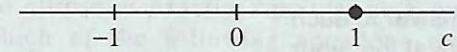
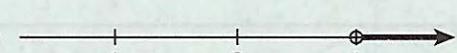
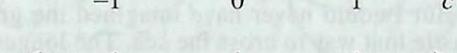
58. Five balls, numbered 1, 2, 3, 4, and 5, are placed in a bin. Two balls are drawn at random without replacement. What is the probability that the sum of the numbers on the balls drawn is 7?

- F.  $\frac{1}{5}$
- G.  $\frac{2}{5}$
- H.  $\frac{4}{5}$
- J.  $\frac{5}{9}$
- K.  $\frac{4}{25}$

**DO YOUR FIGURING HERE.**

59. Consider the family of functions  $y = f(x) = \sin x + c$ , where  $c$  is a real number. Which of the following number lines represents the graph of all and only the possible values of  $c$  for which the graph of  $y$  has no  $x$ -intercepts?

DO YOUR FIGURING HERE.

- A. 
- B. 
- C. 
- D. 
- E. 

60. Tameka calculates that she needs 360 square feet of new carpet. But the type of carpet that she wants is priced by the square yard. How many square yards of carpet does she need?

- F. 15  
G. 40  
H. 60  
J. 90  
K. 120

**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:** This passage is adapted from the novel *The Cat's Table* by Michael Ondatje (©2011 by Michael Ondatje).

The ship *Oronsay* is departing from Colombo, Ceylon (a city in what is today Sri Lanka), in the early 1950s.

Michael was eleven years old that night when, green as he could be about the world, he climbed aboard the first and only ship of his life. It felt as if a city had been added to the coast, better lit than any town or village. He went up the gangplank, watching only the path of his feet—nothing ahead of him existed—and continued till he faced the dark harbour and sea. There were outlines of other ships farther out, beginning to turn on lights. He stood alone, smelling everything, then came back through the noise and the crowd to the side that faced land. A yellow glow over the city. Already it felt there was a wall between him and what took place there. Stewards began handing out food and cordials. He ate several sandwiches, and after that he made his way down to his cabin, undressed, and slipped into the narrow bunk. He'd never slept under a blanket before, save once in Nuwara Eliya. He was wide awake. The cabin was below the level of the waves, so there was no porthole. He found a switch beside the bed and when he pressed it his head and pillow were suddenly lit by a cone of light.

He did not go back up on deck for a last look, or to wave at his relatives who had brought him to the harbour. He could hear singing and imagined the slow and then eager parting of families taking place in the thrilling night air. I do not know, even now, why he chose this solitude. Had whoever brought him onto the *Oronsay* already left? In films people tear themselves away from one another weeping, and the ship separates from land while the departed hold on to those disappearing faces until all distinction is lost.

I try to imagine who the boy on the ship was. Perhaps a sense of self is not even there in his nervous stillness in the narrow bunk, in this green grasshopper or little cricket, as if he has been smuggled away accidentally, with no knowledge of the act, into the future.

\*\*\*

What had there been before such a ship in my life? A dugout canoe on a river journey? A launch in Trincomalee harbour? There were always fishing boats on our horizon. But I could never have imagined the grandeur of this castle that was to cross the sea. The longest journeys I had made were car rides to Nuwara Eliya and Horton Plains, or the train to Jaffna, which we boarded at seven a.m. and disembarked from in the late afternoon. We made that journey with our egg sandwiches, a pack of cards, and a small Boy's Own adventure.

But now it had been arranged I would be travelling to England by ship, and that I would be making the journey alone. No mention was made that this might be an unusual experience or that it could be exciting or dangerous, so I did not approach it with any joy or fear. I was not forewarned that the ship would have seven levels, hold more than six hundred people including a captain, nine cooks, engineers, a veterinarian, and that it would contain a small jail and chlorinated pools that would actually sail with us over two oceans. The departure date was marked casually on the calendar by my aunt, who had notified the school that I would be leaving at the end of the term. The fact of my being at sea for twenty-one days was spoken of as having not much significance, so I was surprised my relatives were even bothering to accompany me to the harbour. I had assumed I would be taking a bus by myself and then change onto another at Borella Junction.

There had been just one attempt to introduce me to the situation of the journey. A lady named Flavia Prins, whose husband knew my uncle, turned out to be making the same journey and was invited to tea one afternoon to meet with me. She would be travelling in First Class but promised to keep an eye on me. I shook her hand carefully, as it was covered with rings and bangles, and she then turned away to continue the conversation I had interrupted. I spent most of the hour listening to a few uncles and counting how many of the trimmed sandwiches they ate.

On my last day, I found an empty school examination booklet, a pencil, a pencil sharpener, a traced map of the world, and put them into my small suitcase.

As I got into the car, it was explained to me that after I'd crossed the Indian Ocean and the Arabian Sea and the Red Sea, and gone through the Suez Canal into

the Mediterranean, I would arrive one morning on a small pier in England and my mother would meet me there. It was not the magic or the scale of the journey  
 85 that was of concern to me, but that detail of how my mother could know when exactly I would arrive in that other country.

And if she would be there.

1. The passage can most reasonably be described as being divided into two sections that, taken together, explore:
  - A. Michael's first week on the *Oronsay* as told from two perspectives, one being that of Michael's mother.
  - B. elements of Michael's journey as told from two perspectives, one being that of Michael as a young boy.
  - C. two outcomes of Michael's journey, both presented from the perspective of Michael as an adult.
  - D. Michael's relationship with his family, presented from the perspective of two of Michael's relatives.
2. The description of the *Oronsay* as having seven levels, nine cooks, a veterinarian, a small jail, and chlorinated pools (lines 52–56) most strongly supports which of the following statements about the *Oronsay* or its passengers?
  - F. "It felt as if a city had been added to the coast" (lines 5–4).
  - G. "The cabin was below the level of the waves, so there was no porthole" (lines 18–19).
  - H. "I do not know, even now, why he chose this solitude" (lines 26–27).
  - J. "But now it had been arranged I would be travelling to England by ship" (lines 47–48).
3. As it is used in lines 65–66, the phrase "introduce me to the situation of the journey" most nearly means:
  - A. list for the narrator the people he will likely meet on his trip.
  - B. explain to the narrator what his mother knows about his trip.
  - C. draw for the narrator a map of the exact route of his trip.
  - D. prepare the narrator in general for the circumstances of his trip.
4. Based on the passage, Michael's relatives arrange for and approach Michael's journey to England in a manner that can best be described as:
  - F. fearful and tense.
  - G. excited and frantic.
  - H. meticulous and generous.
  - J. understated and matter-of-fact.

5. The passage makes clear that once Michael boards the *Oronsay*, he feels that the city he is leaving has become:
  - A. morally corrupt.
  - B. physically shut off from him.
  - C. aesthetically beautiful.
  - D. figuratively lifted and carried with him.
6. The main point of the second paragraph (lines 22–31) is for the narrator to analyze the circumstance of:
  - F. Michael's relatives leaving the harbor as soon as Michael had boarded the *Oronsay*.
  - G. Michael enjoying listening to families singing but refusing to join in with them.
  - H. Michael not returning to the deck to wave goodbye to his relatives.
  - J. Michael's relatives weeping as the *Oronsay* departed.
7. The interaction between Michael and Flavia Prins that is described in the passage most strongly suggests that although Prins has promised to keep an eye on Michael during his journey, she is:
  - A. fairly indifferent to him and not particularly focused on his well-being.
  - B. likely going to retract her promise as a result of Michael's rude behavior during tea.
  - C. planning to make sure someone else provides him with constant attention and care.
  - D. intending to ignore him, if not make certain that his journey is difficult.
8. In the passage, Michael is metaphorically referred to as:
  - F. a smuggler.
  - G. rings and bangles.
  - H. green grass.
  - J. a little cricket.
9. The passage indicates that Michael's journey to England will require:
  - A. relying on the expertise of a team of captains.
  - B. disembarking the *Oronsay* midjourney.
  - C. avoiding traveling on the Red Sea.
  - D. spending twenty-one days at sea.
10. It can most reasonably be inferred from the passage that the narrator counts the sandwiches his uncles eat (lines 73–75) mainly because the narrator:
  - F. wants to know how many sandwiches he will be given to eat once he boards the ship.
  - G. hopes that his uncles like the sandwiches.
  - H. feels bored as the adults converse.
  - J. is nervous around his loud uncles.

**Passage II**

**SOCIAL SCIENCE:** Passage A is adapted from "The Unified Theory of Gumbo" by Lolis Eric Elie (©2012 by Smithsonian Institution). Passage B is adapted from "The Borscht Belt" by Julia Ioffe (©2012 by Condé Nast).

**Passage A by Lolis Eric Elie**

As the Cajun craze had its way with America in the 1980s, I began to hear tourists, visitors and transplants to New Orleans praising this or that gumbo for its thickness and darkness. This was strange to me.

5 Gumbo was supposed to be neither thick nor dark. Even more important, "dark" and "thick" were being used not as adjectives, but as achievements. It was as if making a dark gumbo was a culinary accomplishment on par with making a featherlight biscuit or a perfectly barbecued 10 beef brisket. Naturally, I viewed these developments with suspicion and my suspicion focused on the kitchen of Commander's Palace and its celebrated chef, Paul Prudhomme.

Prudhomme hails from Cajun Country, near Opelousas, Louisiana. He refers to his cooking not so much as Cajun, but as "Louisiana cooking," and thus reflective of influences beyond his home parish. For years I blamed him for the destruction of the gumbo universe. Many of the chefs and cooks in New Orleans 20 restaurants learned under him or under his students. Many of these cooks were not from Louisiana, and thus had no homemade guide as to what good gumbo was supposed to be. As I saw it then, these were young, impressionable cooks who lacked the loving guidance 25 and discipline that only good home training can provide.

My reaction was admittedly nationalistic, since New Orleans is my nation. The Cajun incursion in and of itself didn't bother me. We are all enriched immeasurably when we encounter other people, other languages, other traditions, other tastes. What bothered me was the tyrannical influence of the tourist trade. Tourist trap restaurants, shops, cooking classes, and at times it seemed the whole of the French Quarter, were given 35 over to providing visitors with what they expected to find. There was no regard for whether the offerings were authentic New Orleans food or culture. Suddenly andouille sausage became the local standard even though most New Orleanians had never heard of it.

40 Chicken and andouille gumbo suddenly was on menus all over town. This was the state of my city when I moved back here in 1995.

**Passage B by Julia Ioffe**

As a self-appointed guardian of authentic Russian fare, Maksim Syrnikov, who has spent the past two 45 decades studying traditional Russian cuisine, has a problem: Russians don't hold Russian food in particularly high esteem. When they eat out, they favor more exotic cuisines, like Italian or Japanese. The tendency to find foreign food more desirable is a prejudice that

50 goes back centuries—to a time when the Russian aristocracy spoke French, not Russian. Russian food is pooh-poohed as unhealthy and unsophisticated.

Among the many things that annoy Syrnikov is the fact that a good number of the despised Russian dishes 55 aren't even Russian. "I did an informal survey of eighteen- to twenty-five-year-olds in Moscow and St. Petersburg, and asked them, 'Name some traditional Russian dishes,'" Syrnikov told me. "What they named was horrible: borscht, which is Ukrainian, and potatoes, 60 which are an American plant. In the middle of the eighteenth century, there were *riots* because people didn't want to grow potatoes." He insists that real Russian food contained no potatoes, no tomatoes, few beets, and little meat. Instead, there were a lot of grains, fish, and 65 dairy, as well as honey, cucumbers, turnips, cabbage, apples, and the produce of Russia's vast forests—mushrooms and berries. Because of the climate, little of this was eaten fresh; it was salted, pickled, or dried for the long winter. Most of Russia ate this way until the twenty- 70 tenth century.

By exploring the Russian food that existed before potatoes, Syrnikov hopes to help Russians reacquaint themselves with the country's agrarian roots, and to convince them that their national cuisine can be just as 75 flavorful as anything they might find in a sushi bar. He spends his time travelling through the countryside in search of old recipes, trying them himself, and blogging about his experiences. Often, he is brought in as a consultant on projects to make a restaurant authentically 80 Russian. Recently, he hatched a plan for a user-generated database of folk recipes. "My idea is to send out a call across all of Russia," he told me. "If you have a grandmother who makes *shnashki*"—disk-shaped pastries—"take a picture of them, write down the 85 recipe. To me, it's absolutely obvious that, if we don't wake up and find out from these old women and set it down on paper, in twenty years we won't have anyone to ask. Russian culture will lose a very significant part of itself."

Questions 11–13 ask about Passage A.

11. The author of Passage A mentions "a featherlight biscuit" and "a perfectly barbecued beef brisket" (lines 9–10) primarily to:
- contrast their deliciousness with the inferior taste of a dark and thick gumbo.
  - offer additional examples of New Orleans cuisine that was, in the author's view, being corrupted.
  - illustrate the types of authentic New Orleans food that tourists used to gravitate toward.
  - provide examples of what the author views as real culinary successes, in contrast to dark gumbo.

12. It can reasonably be inferred that the author of Passage A thinks that in comparison to authentic Cajun cuisine, Prudhomme's "Louisiana cooking":

- F. demands less creativity.
- G. requires more discipline.
- H. is much easier to master.
- J. reflects broader influences.

13. The author of Passage A most directly indicates that he originally attributed the ruin of the gumbo universe to which of the following?

- A. Tourists monopolizing New Orleans's entire French Quarter
- B. The Cajun craze that took hold of the United States in the 1980s
- C. The sudden prevalence of chicken and andouille gumbo in the 1990s
- D. The pervasive influence of Prudhomme on New Orleans restaurants

Questions 14–17 ask about Passage B.

14. The author of Passage B most strongly indicates that Syrnikov believes Russians tend not to favor their national cuisine mainly because:

- F. they are embarrassed by their country's agrarian history and want to distance themselves from it.
- G. the prejudices held by Russia's ruling class long ago led to a ban on traditional Russian cuisine.
- H. they consider food from other countries to be more appealing and more refined.
- J. only old women know how to make traditional Russian dishes like *shanishki*.

15. The author of Passage B describes some of Syrnikov's common activities in lines 75–81 primarily to:

- A. suggest that Syrnikov feels overwhelmed by the scope and number of his projects.
- B. emphasize Syrnikov's dedication to helping Russians rediscover their true culinary roots.
- C. imply that Syrnikov plans to open his own authentic Russian restaurant after completing his research.
- D. downplay Syrnikov's lack of culinary training by focusing on his experience with traditional folk recipes.

16. According to Passage B, Syrnikov makes which of the following claims regarding potatoes?

- F. Potatoes were once a staple ingredient in traditional Russian cuisine.
- G. Potatoes were grown throughout Russia until the twentieth century.
- H. Potatoes were unpopular in eighteenth-century Russia.
- J. Potatoes actually originated in Ukraine, not in Russia.

17. As he is presented in Passage B, Syrnikov most clearly indicates that he believes failing to record traditional Russian folk recipes will:

- A. force Russian cuisine to reinvent itself.
- B. ruin his existing database of folk recipes.
- C. result in a significant loss of Russian culture.
- D. lead younger generations of Russians to learn folk recipes from their grandmothers.

Questions 18–20 ask about both passages.

18. Which of the following statements best captures a main difference in the focus of the two passages?

- F. Passage A focuses on the author's interactions with Prudhomme, while Passage B focuses on Syrnikov's frustration with the ignorance of the general Russian public.
- G. Passage A focuses on how the tourist trade affected New Orleans cuisine, while Passage B focuses on how communities are working together to preserve authentic Russian fare.
- H. Passage A focuses on the author's prejudice against food from non-Cajun cultures, while Passage B focuses on Syrnikov's attempt to spread awareness about what Russian cuisine truly is.
- J. Passage A focuses on the author's struggle with public perception of authentic New Orleans food, while Passage B focuses on Syrnikov's efforts to correct misconceptions about Russian cuisine.

19. With regard to their own region's authentic cuisine, both New Orleans transplants in Passage A and modern Russians in Passage B are characterized as being:

- A. perplexed.
- B. disdainful.
- C. misinformed.
- D. knowledgeable.

20. Both passages support the idea that learning how to cook traditional and authentic regional food is best accomplished by:

- F. gleaning knowledge from cooks native to the area.
- G. studying under professional chefs in a restaurant.
- H. traveling and learning about other cultures' foods.
- J. receiving hands-on training in a culinary school.

### Passage III

**HUMANITIES:** This passage is adapted from the article “An Interview with C. E. Morgan” by Thomas Fabisiak (©2010 by University of North Carolina-Chapel Hill).

*All the Living* is C. E. Morgan’s debut novel. Set in rural Kentucky in the 1980s, her novel follows a young couple’s struggles as they take responsibility for a family farm.

**Thomas Fabisiak:** In what way does the fact that your descriptive work in *All the Living* focuses on landscape make it a political act?

**C. E. Morgan:** I think it’s akin to the moral force that’s there in fiction in the presentation of character. Fiction asks us to bring sustained attention to the Other; when a reader chooses to continue reading a novel, regardless of the likability of a character, the sustained attention to that character has moral ramifications. Landscape writing—most especially when it’s done at length and in a style that deviates from prose norms, so that its very presentation is interruptive or “estranging” as the formalists might have said—encourages the reader to stop, reread, listen, imagine, reconsider, admire, appreciate with new eyes. The reader might complain that this kind of writing draws attention to itself, but this kind of writing doesn’t merely draw attention to its own aesthetic strategies—it also draws attention to land. The land is imperiled; we know that. Land is always imperiled wherever the human puts his or her foot. The attention paid to landscape in a narrative is, I believe, attention that’s paid to land itself, not just to marks on a page. Deep appreciation can result from an engagement with that kind of beauty, and that can manifest in action. That is how it might be seen as a political act to do this kind of writing (particularly about a region, such as this one, rural Kentucky, that is continuously being ravaged by corporations that consumers unwittingly feed).

**30 Thomas Fabisiak:** In addition to landscape, though, *All the Living* also involves a sustained focus on work, and specifically on work on the land, farming, taking care of animals, etc. Together these suggest an overarching pastoral quality. Without wanting you to interpret *All the Living* for readers, because you’ve told me that you hate imposing yourself into people’s encounters with the book, I’m wondering if you could say something about your focus on work, and whether and to what extent it is related to the focus on landscape more generally. One thing that occurred to me repeatedly as I was reading the book was that, as a writer, you work very meticulously, and take “your work” as seriously, perhaps, as “the work” itself in the sense of the finished book, etc. Would I be wrong to think that there may be a latent ethical, if not political, component to this aspect of your writing as well, both in your own commitment to hard work and in the ongoing presence of the theme of work in the novel?

**C. E. Morgan:** Well, while there are many novels I admire that depict working-class labor (*Anna Karenina* and *In the Skin of the Lion* and *Germinal*) are the first

that spring to mind), the presence of work—agrarian or domestic—in *All the Living* was not a self-conscious choice. For that matter, even though I conceptualize 55 landscape writing as overtly political, that doesn’t mean I self-consciously insert it in a text where it doesn’t belong. With *All the Living*, I don’t feel I made choices in the first draft of the novel. It felt like the book just came, and it came with an inborn temperament, tenor, 60 and set of characters and concerns. I obeyed the book. Or perhaps, because a text is not a willful or sentient being (though it sometimes feels like it!), it might be more accurate to say I obeyed the hazy, deepest part of the brain, which bypasses the intellect as it constructs 65 meaning via image, myth, poetry: our essential languages.

For myself, though you’re right that I work intensely on any project when I have one, I don’t think of my writing as a job. I think of it as a vocation, and as such, 70 there’s a huge gulf between what I do and capitalist notions of productivity, though the work is disseminated in the marketplace through a capitalist framework. I’m very wary of rigorous work ethic for the sake of rigorous work ethic—this idea that a writer should 75 produce a novel every year or two years, that they should be punching a clock somehow. A lot of people seem to buy into that; it’s hard not to in this culture. But I don’t want to produce just to produce. I don’t want to write just to write, or publish just to get a pay- 80 check. I see no value in that. Frankly, the world doesn’t need more books; it needs better books. Vocation is tied up with notions of service, and as an artist you serve people by giving them your best, the work you produce that you truly believe to be of value, not just what 85 you’re capable of producing if you work ten hours a day every day for forty years.

**21.** The structure of the passage can best be described as an interview in which the interviewee:

- A. defends herself against harsh commentary by the interviewer.
- B. challenges the interviewer, urging him to ask her relevant questions.
- C. turns questions asked to her back to the interviewer, inviting a casual dialogue.
- D. responds to the interviewer’s questions with involved, abstract answers.

**22.** In the passage, Morgan argues that, for the reader, landscape writing might feel particularly “interruptive or ‘estranging’” (line 12) when it is presented:

- F. in an otherwise plot-driven novel.
- G. by an unskilled or inexperienced writer.
- H. at length and in an unconventional prose style.
- J. in the opening pages of a novel.

23. Based on the passage, how would Morgan respond to a reader's complaint that landscape writing "draws attention to itself" (line 16)?
- A. She would agree but claim that landscape writing also draws attention to land.
  - B. She would agree but claim that if the writer had been focused, landscape writing should be engaging.
  - C. She would disagree, arguing that landscape writing focuses solely on drawing attention to land.
  - D. She would disagree, arguing that some readers are simply not willing to read landscape writing.
24. In the passage, Morgan most strongly suggests that a reader's attention to the land while reading a landscape narrative might lead the reader to:
- F. act to protect the land.
  - G. forget that the land is in peril.
  - H. misinterpret the writer's purpose.
  - J. research the writer's academic background.
25. As it is used in line 22, the word *marks* most nearly refers to:
- A. creases and smudges.
  - B. words and symbols.
  - C. notches and ticks.
  - D. lines and boundaries.
26. As it is used in line 24, the phrase "that kind of beauty" most specifically refers to the beauty of the:
- F. human being.
  - G. intellect.
  - H. political act.
  - J. land.
27. The passage makes clear that, from a previous exchange with Morgan, Fabisiak knows that Morgan does not like to do which of the following?
- A. Interpret *All the Living* for her readers
  - B. Tell her readers that, like the characters in *All the Living*, she lives in Kentucky
  - C. Work ten hours a day every day
  - D. Discuss which regions of the United States she plans to write about
28. The passage most strongly suggests that Morgan focuses on depicting which types of work in her novel *All the Living*?
- F. Corporate or agrarian
  - G. Agrarian or domestic
  - H. Domestic or creative
  - J. Creative or corporate
29. Morgan directly compares a writer being expected to produce a novel every year or two years to the act of having to:
- A. work overtime.
  - B. assemble products in a factory.
  - C. punch a clock.
  - D. sell goods on commission.
30. In the passage, Morgan makes clear her perspective that an artist is serving people when that artist takes which of the following approaches to his or her work?
- F. Continually offering new work that the artist knows people will want to buy
  - G. Regularly studying others' work and learning from it
  - H. Creating and presenting work that the artist believes to be valuable
  - J. Modifying the focus of the work when people's interest in it wanes

## Passage IV

**NATURAL SCIENCE:** This passage is adapted from *Free Radicals* by Michael Brooks (©2011 by Michael Brooks).

As the twentieth century began, Robert Millikan was fast approaching forty. All around him, physics was at its most exhilarating, yet Millikan had done practically nothing. So he decided to measure  $e$ , the charge  
5 on the electron.

Millikan's idea was simple. A droplet of water that had been given an electric charge would be attracted to a metal plate which carried an opposite charge. He arranged his apparatus so that the electrical attraction  
10 pulled the droplet up, while gravity pulled it down. This gave him a way to measure  $e$ . First he would find the mass of the droplet. Then he would measure the voltage needed for the attraction to the metal plate to cancel out the downward pull of gravity. From those two pieces of  
15 information he could get a measure of the charge on the droplet.

The experiment was far from simple to carry out, however. Finding that the water droplets tended to evaporate before any measurements could be made,  
20 Millikan set to the task of trying the same trick with oil droplets.

In 1910, at the age of forty-two, he finally published a value for  $e$ . It was meant to be his career-defining publication. Eventually, it was—but Millikan  
25 still had years of difficult and dirty work ahead of him.

The Austrian physicist Felix Ehrenhaft refuted Millikan's results with a similar set of experiments that seemed to show that electrical charge can be infinitely small. There is no fundamental, minimum unit of  
30 charge, Ehrenhaft said; there is no 'electron'. The series of experiments the desperate Millikan then performed were to cast a lasting shadow over his scientific integrity.

According to biologist Richard Lewontin, Millikan  
35 'went out of his way to hide the existence of inconvenient data'. David Goodstein, a physics professor, says Millikan 'certainly did not commit scientific fraud'. So where does the truth lie?

The debate hangs on a phrase in Millikan's 1913 paper refuting Ehrenhaft and showing that every measurement of electric charge gives a value of  $e$  or an integer multiple of  $e$ . In his 1913 paper, Millikan says that his data table '*contains a complete summary of the results obtained on all of the 58 different drops upon which complete series of observations were made*'. The statement is written in italics, as if to give it special weight. The notebooks for the 1913 paper show that Millikan actually took data on 100 oil droplets. Did Millikan cherry-pick the data in order to confirm his  
50 original result and crush Ehrenhaft underfoot?

He certainly had motive. In Millikan's 1910 paper he had made the 'mistake' of full disclosure with state-

ments such as, 'Although all of these observations gave values of  $e$  within 2 percent of the final mean, the  
55 uncertainties of the observations were such that . . . I felt obliged to discard them'. This admirable honesty about the selection of data points had given Ehrenhaft ammunition that he used enthusiastically in his long  
60 feud with Millikan. Perhaps, with the italicised statement, Millikan was making sure that he gave his foe no more.

That would certainly explain something that is otherwise inexplicable. Millikan aborted the experimental run on twenty-five of the droplets in the work  
65 reported in the 1913 paper. According to Goodstein, Millikan preferred to use droplets that showed a change in charge, gaining or losing an electron (as he saw it) during the measurement. Millikan may also have judged some droplets to be too small or too large to  
70 yield reliable data, Goodstein says. If they were too large, they would fall too rapidly to be reliably observed. Too small, and their fall (and thus the charge result) would be affected by random collisions with air molecules. Goodstein interprets the italicised statement  
75 as an assertion that there were only fifty-eight 'complete enough' sets of data.

But Goodstein undoes his defence by stating that in order to make the 'too large' or 'too small' distinction, *all* the data would need to have been taken in the  
80 first place.

Millikan certainly did not convince his peers straight away. The arguments with Ehrenhaft rumbled on long enough for Millikan's Nobel Prize to be delayed for three years—it eventually came in 1923.

85 But here's the point: Millikan was right about the electron and its charge. Few laboratories managed to replicate Ehrenhaft's results, but students now replicate Millikan's results all across the world. No one now believes that the fundamental unit of charge is anything  
90 other than Millikan's  $e$ .

To get his Nobel Prize, Millikan had to play hard and fast with what we might call 'accepted practice'.

31. The main purpose of the passage is to use the example of Millikan to show:
  - A. how a theory becomes accepted.
  - B. that some well-accepted scientific ideas have a sullied past.
  - C. the challenges scientists faced in measuring  $e$ .
  - D. that some scientists get credit for work that is not their own.

32. Based on the passage, the debate between Millikan and Ehrenhaft is best described as:
- F. tense; their professional reputations were at stake.
  - G. unprofessional; they sabotaged each other's experiments.
  - H. collegial; each wanted to push the other to create a stronger theory.
  - J. indirect; although their work intersected along some lines, they were primarily working in different fields.
33. The passage indicates that the debate regarding Millikan's integrity centers on:
- A. others' ability to replicate the results of Ehrenhaft's experiments more readily than those of Millikan's experiments.
  - B. Millikan's decision to switch from using water droplets to oil droplets.
  - C. certain statements Millikan made about the apparatus he used in his experiments.
  - D. a discrepancy between data in Millikan's 1913 paper and information in his notebooks.
34. It can reasonably be inferred that the passage author considers Millikan's decision to offer full disclosure in his 1910 paper as:
- F. an understandable mistake that most scientists rightfully avoid.
  - G. an admirable choice with an unfortunate consequence.
  - H. a strategic decision that paid off in the end.
  - J. a naive decision revealing desperation.
35. The passage indicates that in his experiment to measure  $e$ , Millikan switched from water to oil droplets because:
- A. other physicists had found that oil droplets were easier to work with.
  - B. with oil he found it easier to form droplets with little variation in size.
  - C. oil droplets allowed him to take accurate measurements more consistently.
  - D. oil droplets could be reused for other experiments.
36. In the passage, the primary purpose of the ninth paragraph (lines 62–76) is to:
- F. present Goodstein's defense of Millikan's choices regarding the data reported in Millikan's 1913 paper.
  - G. argue against Goodstein's interpretation of Millikan's motives.
  - H. summarize the current prevailing view of Millikan's methods.
  - J. offer an overview of Millikan's explanation of how he organized and presented his data.
37. The passage indicates that Ehrenhaft's experiments led him to make which of the following assertions in refuting the claims in Millikan's 1910 paper?
- A. There is no electron.
  - B. Millikan's value for  $e$  is too low.
  - C. Millikan failed to take prevailing scientific theories into account.
  - D. The value of  $e$  varies with the substance one is measuring.
38. Based on the passage, the author's assertion that Millikan's experiments "were to cast a lasting shadow over his scientific integrity" (lines 32–33) is best described as:
- F. an opinion based on casual assumptions about scientists working in the early 1900s.
  - G. an opinion based on the passage author's efforts to imagine himself in Millikan's position.
  - H. a reasoned judgment based on consideration of the debate sparked by these experiments.
  - J. a fact that Millikan clearly explains in his notebooks.
39. The passage author references Lewontin and Goodstein in the sixth paragraph (lines 34–38) primarily in order to:
- A. identify two leading arguments about Millikan's methodology.
  - B. explain how a scientist's background might influence his or her opinion of Millikan's findings.
  - C. emphasize that current experiments on the electron contradict Millikan's findings.
  - D. highlight the difficulty Millikan's contemporaries had in replicating Millikan's experiments.
40. As it is used in line 39, the phrase *hangs on* most nearly means:
- F. continues.
  - G. depends on.
  - H. sticks with.
  - J. blames on.

**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

Table 1 lists the name, chemical formula, *molecular mass* (the mass of 1 molecule in atomic mass units, amu), and BP (the boiling point at 1 atmosphere of pressure) of various compounds. The first compound listed is composed of the elements carbon (C) and hydrogen (H). Each of the other compounds is composed of C, H, and either fluorine (F), chlorine (Cl), bromine (Br), or iodine (I). The elements F, Cl, Br, and I belong to the *halogen family*.

Table 1			
Name	Chemical formula	Molecular mass (amu)	BP (°C)
Methane	CH <sub>4</sub>	16	-162
Fluoromethane	CH <sub>3</sub> F	34	-78
Difluoromethane	CH <sub>2</sub> F <sub>2</sub>	52	-52
Trifluoromethane	CHF <sub>3</sub>	70	-82
Chloromethane	CH <sub>3</sub> Cl	51	-24
Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	85	40
Trichloromethane	CHCl <sub>3</sub>	119	61
Bromomethane	CH <sub>3</sub> Br	95	4
Dibromomethane	CH <sub>2</sub> Br <sub>2</sub>	174	97
Tribromomethane	CHBr <sub>3</sub>	253	149
Iodomethane	CH <sub>3</sub> I	142	42
Diiodomethane	CH <sub>2</sub> I <sub>2</sub>	268	182
Triiodomethane	CHI <sub>3</sub>	394	218

Table 1 adapted from W. M. Haynes, ed., *CRC Handbook of Chemistry and Physics on CD-ROM*, Version 2011. ©2011 by CRC Press, LLC.

Figure 1 shows a plot of BP versus molecular mass for 3 groups of compounds (Groups 1–3). Each compound in each group is composed of C and 1 or more halogens.

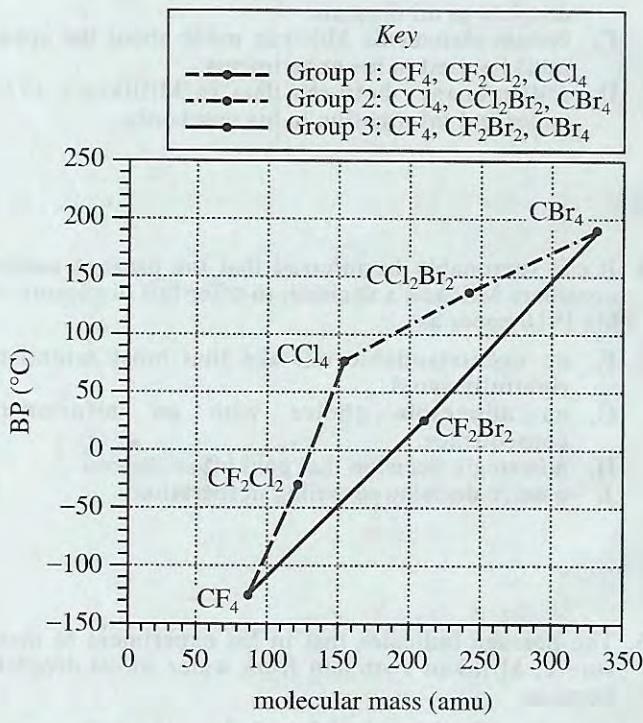


Figure 1

Figure 1 adapted from Michael Laing, "Boiling Points of the Family of Small Molecules, CH<sub>w</sub>F<sub>x</sub>Cl<sub>y</sub>Br<sub>z</sub>: How Are They Related to Molecular Mass?" ©2001 by Division of Chemical Education, Inc., American Chemical Society.

TEST OF END OF UNIT TEST  
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TEST NUMBER TO A PAPER TEST

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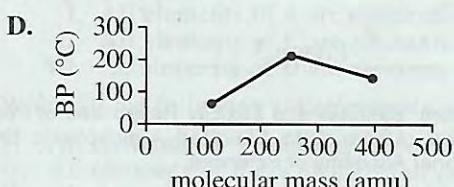
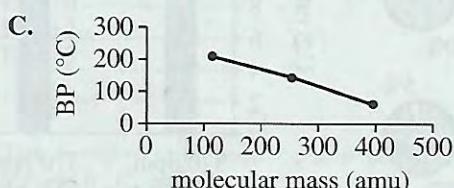
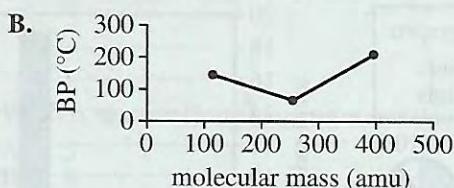
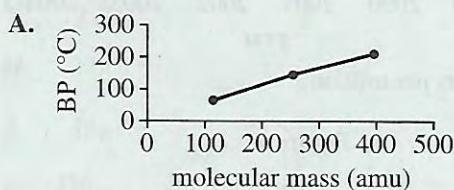
1. The compound represented in Figure 1 that has a BP of  $-30^{\circ}\text{C}$  has a molecular mass of about:

- A. 90 amu.
- B. 120 amu.
- C. 150 amu.
- D. 210 amu.

2. According to Figure 1, of the following compounds, which one has the highest BP?

- F.  $\text{CF}_4$
- G.  $\text{CF}_2\text{Cl}_2$
- H.  $\text{CF}_2\text{Br}_2$
- J.  $\text{CCl}_4$

3. According to Table 1, the relationship between molecular mass and BP among the compounds  $\text{CHCl}_3$ ,  $\text{CHBr}_3$ , and  $\text{CHI}_3$  is best represented by which of the following graphs?



4. At 1 atmosphere of pressure, the temperature at which  $\text{CH}_2\text{I}_2$  boils is how much greater than the temperature at which  $\text{CH}_4$  boils?

- F.  $162^{\circ}\text{C}$
- G.  $268^{\circ}\text{C}$
- H.  $344^{\circ}\text{C}$
- J.  $430^{\circ}\text{C}$

5. According to Table 1 and Figure 1, the molecular mass of  $\text{CF}_4$  is closest to the molecular mass of which of the following compounds?

- A. Dichloromethane
- B. Trichloromethane
- C. Iodomethane
- D. Dibromomethane

6. The *atomic mass* (the mass of 1 atom, in amu) of C is 12 amu. Based on the molecular mass of  $\text{CBr}_4$  shown in Figure 1, the atomic mass of Br is closest to which of the following?

- F. 20 amu
- G. 35 amu
- H. 80 amu
- J. 127 amu

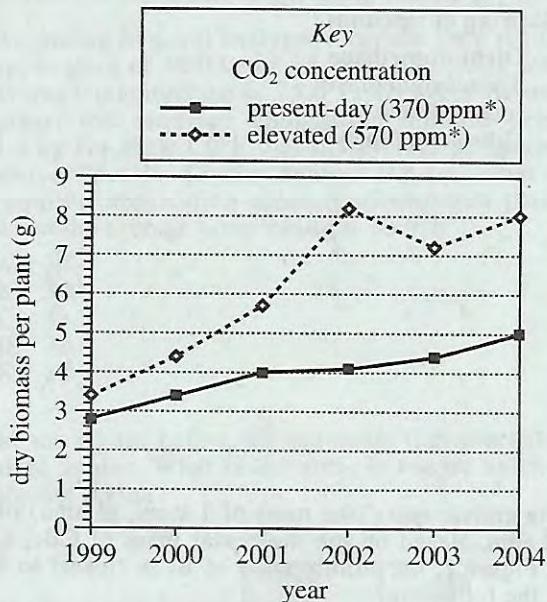


## Passage II

*Urushiol*s are the oils in poison ivy that cause allergic reactions in humans. The higher the *U:S ratio*—the ratio of unsaturated (*U*) urushiol to saturated (*S*) urushiol—the more severe the reaction.

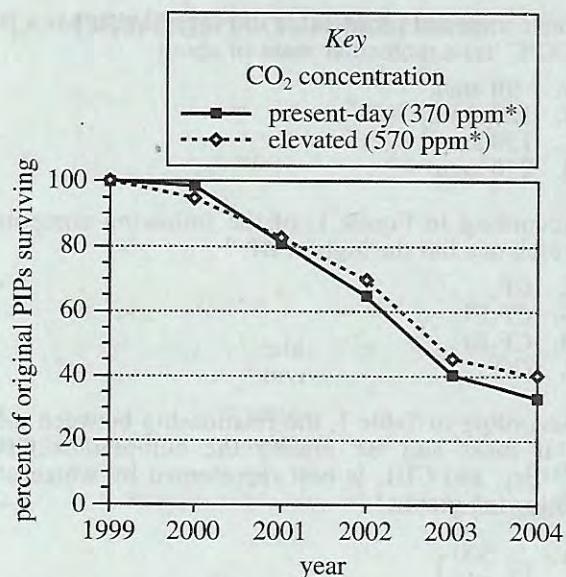
From 1999 to 2004, poison ivy plants (PIPs) were grown in 2 identical outdoor plots under identical conditions except for the atmospheric CO<sub>2</sub> concentration.

Figure 1 shows, for each plot, the yearly dry biomass per plant. Figure 2 shows the yearly percent of original PIPs surviving in each plot. Figure 3 shows, for each plot in 2004, the percent of *U* urushiol per plant, the percent of *S* urushiol per plant, and the *U:S ratio* per plant.



\*ppm = parts per million

Figure 1



\*ppm = parts per million

Figure 2

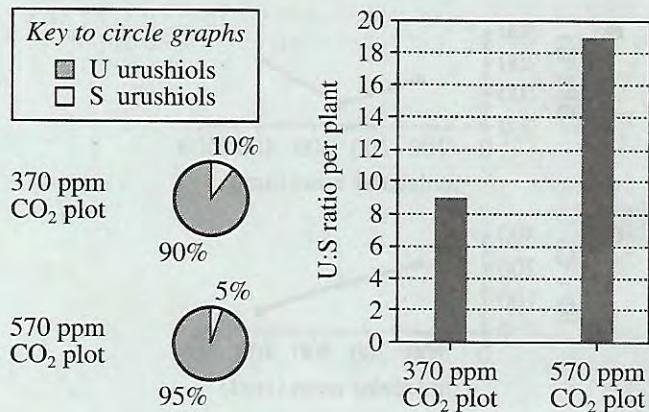


Figure 3

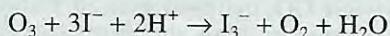
Figures adapted from “Biomass and Toxicity Responses of Poison Ivy (*Toxicodendron radicans*) to Elevated Atmospheric CO<sub>2</sub>.” ©2006 by the National Academy of Sciences.

7. According to Figure 3, for the present-day CO<sub>2</sub> concentration plot, the percent of U urushiols per plant in 2004 was:
- A. 10%.
  - B. 20%.
  - C. 50%.
  - D. 90%.
8. According to Figure 2, which plot had the higher percent of original PIPs surviving at the end of the study?
- F. The present-day CO<sub>2</sub> plot, by a difference of 1%
  - G. The present-day CO<sub>2</sub> plot, by a difference of 7%
  - H. The elevated CO<sub>2</sub> plot, by a difference of 1%
  - J. The elevated CO<sub>2</sub> plot, by a difference of 7%
9. Based on the passage, which of the factors listed below was(were) the same for the 2 plots?
- I. Atmospheric CO<sub>2</sub> concentration in each plot
  - II. Soil type in each plot
  - III. Amount of water applied to each plot
- A. I only
  - B. I and II only
  - C. II and III only
  - D. I, II, and III
10. According to Figure 1, from 1999 to 2004, how did the dry biomasses per plant for the 2 plots compare? The dry biomass per plant grown in a CO<sub>2</sub> concentration of 370 ppm was:
- F. always the same as the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
  - G. always greater than the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
  - H. always less than the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
  - J. in some years greater than, but in other years less than, the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
11. Based on Figure 2, what percent of PIPs grown in the plot with a CO<sub>2</sub> concentration of 370 ppm had *died* by the year 2003?
- A. 40%
  - B. 45%
  - C. 55%
  - D. 60%
12. According to Figure 3, which plot produced a higher percent of S urushiols per plant?
- F. The present-day CO<sub>2</sub> concentration plot; 10% of the urushiols produced per plant were saturated.
  - G. The present-day CO<sub>2</sub> concentration plot; 90% of the urushiols produced per plant were saturated.
  - H. The elevated CO<sub>2</sub> concentration plot; 5% of the urushiols produced per plant were saturated.
  - J. The elevated CO<sub>2</sub> concentration plot; 95% of the urushiols produced per plant were saturated.



### Passage III

When the ozone ( $O_3$ ) in air is mixed with an acidic solution of iodide ion ( $I^-$ ), the  $O_3$  reacts to form triiodide ion ( $I_3^-$ ),  $O_2$ , and  $H_2O$ .



Students performed an experiment to determine the concentration of  $O_3$  in samples of air. Figure 1 shows the relationship between the concentration of  $I_3^-$ , in  $\mu\text{mol/L}$ , and the concentration of  $O_3$ , in parts per billion (ppb), under the conditions of the experiment.

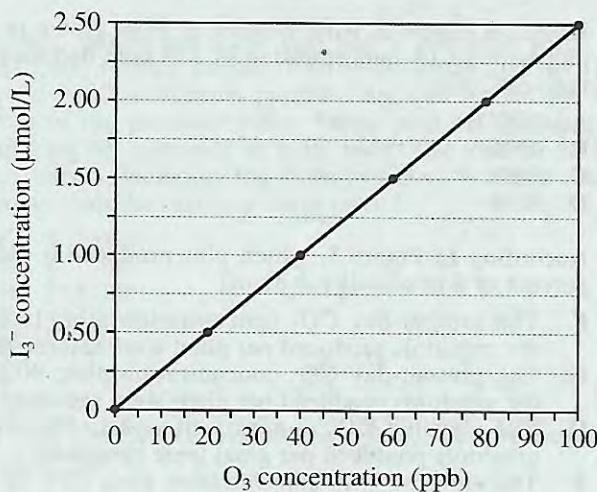


Figure 1

### Experiment

At each of 4 outdoor sites, the students assembled the apparatus shown in Figure 2. First, they attached a long piece of tubing to a stand so that one end of the tubing was 1.5 m above the ground. Then, they placed the other end of the tubing into one hole of a 2-holed stopper. Next, they placed one end of a shorter piece of tubing into the second hole of the 2-holed stopper and attached the other end of the shorter tubing to a vacuum pump.

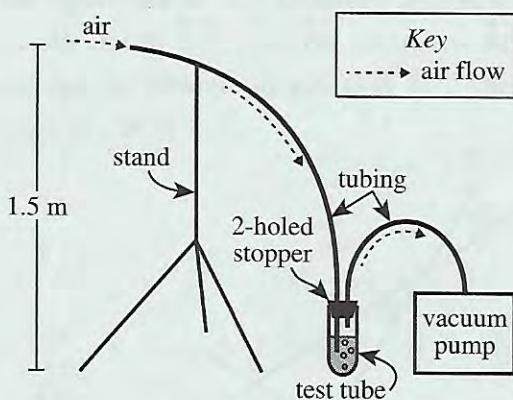


Figure 2

At each site, the students performed the following 2 steps every half hour from 12:30 p.m. to 5:30 p.m. on a particular day:

1. A 10.0 mL volume of an aqueous acidic solution having a 10 mg/mL concentration of  $I^-$  was placed into a clean, empty test tube that was then sealed with the 2-holed stopper.
2. The vacuum pump was turned on for 25 min to collect an air sample. Then, the pump was turned off and the concentration of  $I_3^-$ , in micromoles/liter ( $\mu\text{mol/L}$ ), in the solution was measured.

The results are shown in Figure 3.

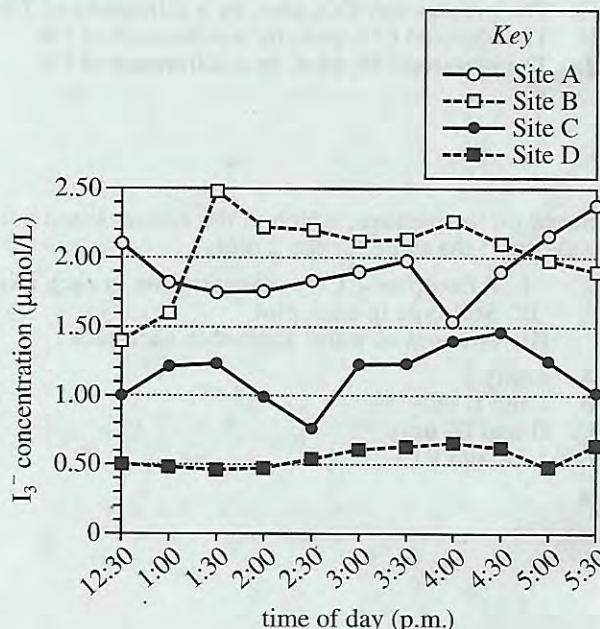


Figure 3

Figures adapted from J. V. Seeley et al., "A Simple Method for Measuring Ground-Level Ozone in the Atmosphere." ©2005 by the Division of Chemical Education, Inc., American Chemical Society.

13. Based on Figures 1 and 3, the air sample collected at which of the following combinations of time and location had the *lowest*  $O_3$  concentration?

	time	location
A.	2:30 p.m.	Site B
B.	2:30 p.m.	Site C
C.	4:00 p.m.	Site B
D.	4:00 p.m.	Site C

14. Consider the air samples that were collected at the 4 sites at 2:00 p.m. Based on Figures 1 and 3, what is the order of those samples from lowest  $O_3$  concentration to highest  $O_3$  concentration?
- F. Site A, Site B, Site C, Site D  
G. Site C, Site B, Site A, Site D  
H. Site D, Site C, Site A, Site B  
J. Site D, Site A, Site C, Site B
15. Based on Figures 1 and 3, which site had the highest overall average  $O_3$  concentration across all the air samples?
- A. Site A  
B. Site B  
C. Site C  
D. Site D
16. Based on Figures 1 and 3, the  $O_3$  concentration at 5:00 p.m. at Site B was approximately how many times as great as the  $O_3$  concentration at 2:00 p.m. at Site C?
- F. 0.5  
G. 2  
H. 3  
J. 4
17. At Site A, was the  $O_3$  concentration highest at 4:00 p.m. or at 5:30 p.m.?
- A. 4:00 p.m.; the  $I_3^-$  concentration was highest at 4:00 p.m., and the higher the  $I_3^-$  concentration, the higher the  $O_3$  concentration.  
B. 4:00 p.m.; the  $I_3^-$  concentration was lowest at 4:00 p.m., and the lower the  $I_3^-$  concentration, the higher the  $O_3$  concentration.  
C. 5:30 p.m.; the  $I_3^-$  concentration was highest at 5:30 p.m., and the higher the  $I_3^-$  concentration, the higher the  $O_3$  concentration.  
D. 5:30 p.m.; the  $I_3^-$  concentration was lowest at 5:30 p.m., and the lower the  $I_3^-$  concentration, the higher the  $O_3$  concentration.
18. When a vacuum pump was operating during Step 2, it drew air through the solution in the test tube. Assuming that the pump drew air at a rate of 200 mL/min, how many milliliters of air were drawn through the solution in the test tube each time Step 2 was performed?
- F. 200 mL  
G. 550 mL  
H. 2,500 mL  
J. 5,000 mL
19. Suppose that the actual  $O_3$  concentration at 12:30 p.m. at Site C was 43 ppb. Based on Figures 1 and 3, which of the following expressions would give the percent error for the value of the  $O_3$  concentration that was determined at 12:30 p.m. at Site C?
- A.  $\frac{|40 \text{ ppb} - 43 \text{ ppb}|}{43 \text{ ppb}} \times 100\%$   
B.  $\frac{|40 \text{ ppb} - 43 \text{ ppb}|}{40 \text{ ppb}} \times 100\%$   
C.  $\frac{|100 \text{ ppb} - 43 \text{ ppb}|}{43 \text{ ppb}} \times 100\%$   
D.  $\frac{|100 \text{ ppb} - 43 \text{ ppb}|}{40 \text{ ppb}} \times 100\%$



#### Passage IV

When waves of laser light pass through a narrow slit and onto a screen, they form a pattern of light and dark bands on the screen, as shown in Figure 1.

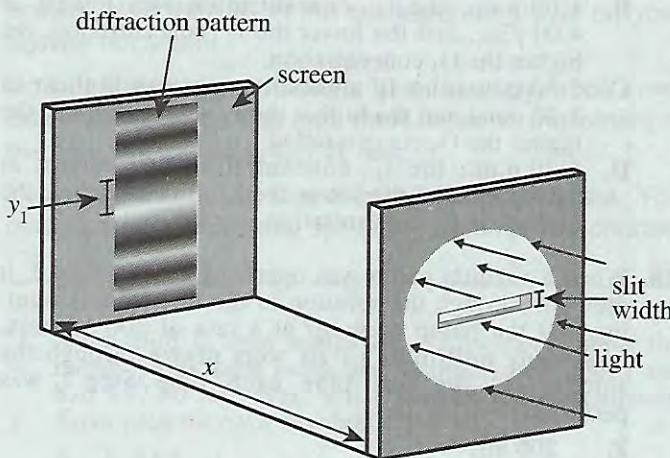


Figure 1

Figure 1 adapted from Francis Sears and Mark Zemanski, *College Physics*. ©1960 by Addison Wesley Publishing Co., Inc.

This phenomenon is called *diffraction*, and the pattern is called a *diffraction pattern*.

In each of the following studies of diffraction, students directed laser light through a slit, forming a diffraction pattern on a screen. They measured  $y_1$ , the distance from the center of the brightest band in the pattern to the center of one of the 2 adjacent dark bands. In each study,  $x$  was the distance between the slit and the screen.

#### Study 1

In Trials 1–4, the slit width was varied, the wavelength of the laser light was fixed, and  $x$  was 6.00 m. The results are shown in Table 1.

Table 1		
Trial	Slit width (mm)	$y_1$ (mm)
1	0.12	30.0
2	0.24	15.0
3	0.36	10.0
4	0.48	7.5

#### Study 2

In Trials 5–8, the slit width was 0.24 mm, the wavelength (color) of the laser light was varied, and  $x$  was 6.00 m. The results are shown in Table 2.

Table 2		
Trial	Wavelength (nm)	$y_1$ (mm)
5	400 (violet)	10.0
6	500 (green)	12.5
7	600 (yellow)	15.0
8	700 (red)	17.5

#### Study 3

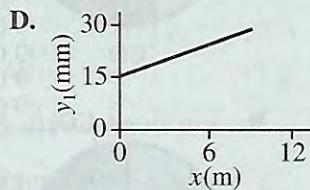
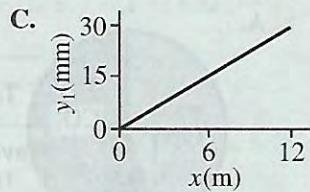
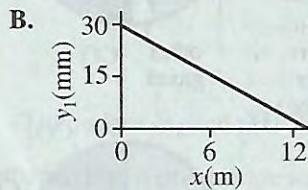
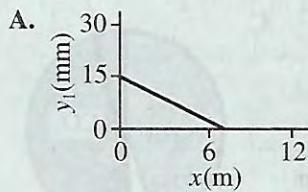
In Trials 9–12, the slit width was 0.24 mm, the wavelength was the same as in Study 1, and  $x$  was varied. The results are shown in Table 3.

Table 3		
Trial	$x$ (m)	$y_1$ (mm)
9	3.00	7.5
10	6.00	15.0
11	9.00	22.5
12	12.00	30.0

20. In Study 2,  $y_1$  would most likely have been less than 10.0 mm if the students had used a laser emitting light having which of the following wavelengths?

- F. 300 nm
- G. 500 nm
- H. 700 nm
- J. 900 nm

21. For fixed values of wavelength and slit width, which of the following graphs best represents the relationship between  $y_1$  and  $x$ ?



22. Suppose that the procedure performed in Trial 2 was repeated, except that  $x$  was 9.00 m. Based on the results of Studies 1 and 3, would  $y_1$  more likely have been greater than 15.0 mm or less than 15.0 mm?

- F. Greater, because  $y_1$  increased as  $x$  increased.
- G. Greater, because  $y_1$  increased as  $x$  decreased.
- H. Less, because  $y_1$  decreased as  $x$  increased.
- J. Less, because  $y_1$  decreased as  $x$  decreased.

23. During the 3 studies, the students did NOT examine the relationship between  $y_1$  and the:

- A. width of the slit.
- B. wavelength of laser light.
- C. distance between the slit and the screen.
- D. distance between the slit and the laser.

24. As the wavelength of light increases, the energy of a photon (particle of light) decreases. In which of the following trials of Study 2 was the energy of a photon greatest?

- F. Trial 5
- G. Trial 6
- H. Trial 7
- J. Trial 8

25. For fixed values of wavelength and  $x$ , when the slit width was doubled, the distance from the center of the brightest band in the pattern to the center of one of the 2 adjacent dark bands:

- A. was doubled.
- B. was halved.
- C. remained unchanged.
- D. varied with no general trend.

26. What is the result of Trial 7 expressed in meters (m)?

- F. 0.00150 m
- G. 0.0150 m
- H. 0.150 m
- J. 1.50 m



### Passage V

Unlike most volcanoes, *hot spot volcanoes* (HSVs) develop far from tectonic plate boundaries. Two scientists discuss the origin and properties of HSVs.

#### Scientist 1

In the mantle beneath an HSV, at depths between 200 km and 400 km, hot magma rises toward Earth's surface in one large column called a *mantle plume*. The ascending magma causes earthquakes and creates networks of large fractures in crustal rocks. Propagation of these fracture networks enables magma to reach the surface more easily, which is why the frequency of eruptions at an HSV typically increases over time. Magma that does not breach Earth's surface will cool and eventually sink back down into the mantle.

HSVs erupt iron-rich lavas that are chemically similar to mantle rocks. Olivine and pyroxenes are the most abundant minerals in mantle rocks and in the lavas erupted at HSVs. The lavas at HSVs also retain a lot of water from the mantle. By weight, water vapor accounts for 75% of the total gas output at HSVs, while CO<sub>2</sub> accounts for only 10%–15%. All other gases combined never account for more than 10%–15% of the total gas output. Kilauea Caldera, in Hawaii, erupts this way.

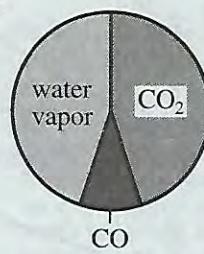
#### Scientist 2

In certain places near the top of the mantle, at depths of less than 100 km, a high concentration of dissolved CO<sub>2</sub> allows mantle rocks to melt at lower temperatures than they normally would. This is how the magma that fuels an HSV forms. The magma then rises toward Earth's surface in small isolated bodies that melt through the entire thickness of the crust, sometimes causing small fractures (less than 1 km long) in crustal rocks. Each eruption at an HSV depletes some of the excess CO<sub>2</sub>, which is why eruption frequency at an HSV will typically slow down over time.

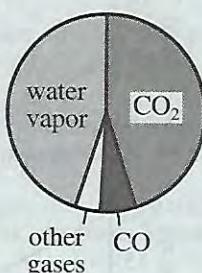
HSVs erupt lavas in which feldspar is the most abundant mineral. These aluminum-rich lavas contain much less water than most mantle rocks. By weight, CO<sub>2</sub> and water vapor each account for 45% of the total gas output at HSVs. Carbon monoxide (CO) accounts for 6% of the total gas output, and all other gases combined account for only 4%. Mt. Erebus, in Antarctica, erupts this way.

27. Which of the following pie charts is most consistent with Scientist 2's description of the total gas output at HSVs?

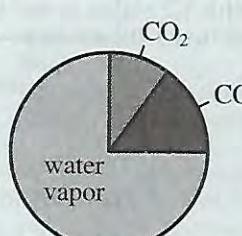
A.



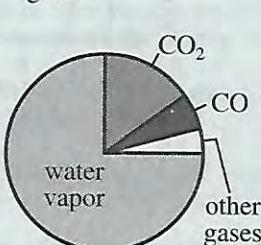
C.



B.



D.



28. Which of the scientists, if either, state(s) that ascending magma causes earthquakes?

F. Scientist 1 only

G. Scientist 2 only

H. Both Scientist 1 and Scientist 2

J. Neither Scientist 1 nor Scientist 2

29. *Basalt* is a volcanic rock that contains abundant iron and is less than 10% feldspar by volume. In contrast, the volcanic rock *phonolite* is mostly feldspar by volume. Based on the passage, which of these 2 types of rock would each scientist more likely expect to see at an HSV?

Scientist 1

- A. basalt  
B. basalt  
C. phonolite  
D. phonolite

Scientist 2

- basalt  
phonolite  
basalt  
phonolite

30. Suppose it were discovered that older HSVs erupt more frequently than younger HSVs. This discovery would better support the viewpoint of which scientist?
- F. Scientist 1; Scientist 1 claims that eruption frequency decreases over time.
  - G. Scientist 1; Scientist 1 claims that eruption frequency increases over time.
  - H. Scientist 2; Scientist 2 claims that eruption frequency decreases over time.
  - J. Scientist 2; Scientist 2 claims that eruption frequency increases over time.
31. The *lithosphere* is a zone of Earth's interior that extends from the surface to a maximum depth of approximately 200 km. Which of the scientists, if either, discuss(es) a process that may extend *beneath* the lithosphere?
- A. Scientist 1 only
  - B. Scientist 2 only
  - C. Both Scientist 1 and Scientist 2
  - D. Neither Scientist 1 nor Scientist 2
32. Suppose that another scientist claims that most mantle rocks contain water. Which of the scientists, if either, would be likely to agree with this claim?
- F. Scientist 1 only
  - G. Scientist 2 only
  - H. Both Scientist 1 and Scientist 2
  - J. Neither Scientist 1 nor Scientist 2
33. A material that lowers the melting point of rocks is called a *flux*. The melting of rocks due to the presence of a flux is called *flux melting*. Flux melting is a feature of which scientist's discussion, and based on that scientist's discussion, what material is acting as the flux?
- A. Scientist 1; iron
  - B. Scientist 2; iron
  - C. Scientist 1; CO<sub>2</sub>
  - D. Scientist 2; CO<sub>2</sub>



## Passage VI

Gene expression in eukaryotes is controlled by *regulatory DNA sequences* (RSs). RSs determine whether, for a particular type of cell, the expression of a gene is turned on or turned off.

Figure 1 shows the coding region of Gene X and shows 3 RSs (RS1–RS3) that are thought to be associated with Gene X. Figure 1 also shows the known expression pattern of Gene X across 6 types of mammalian cells (cell types A–F).

Scientists did 2 experiments to study how RS1, RS2, and RS3 control the expression of Gene X in each of cell types A–F. In each experiment, they prepared *GFP reporter genes*. GFP is a protein that emits green light when viewed with a certain microscope. Reporter genes are DNA molecules that contain RSs of interest and the coding region for an easily detectable protein.

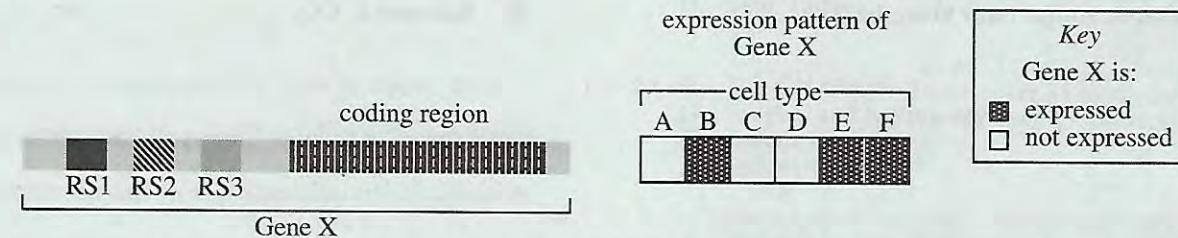


Figure 1

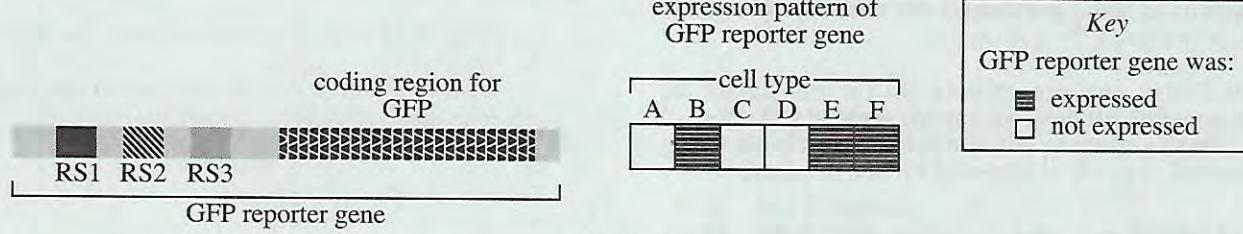


Figure 2

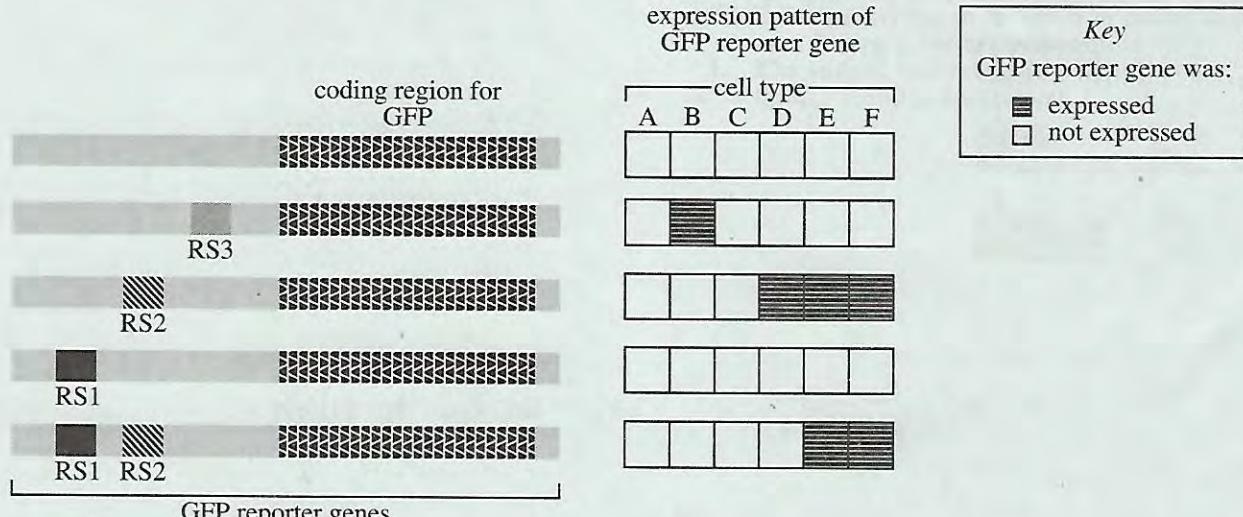


Figure 3

Figures adapted from Bruce Alberts et al., *Molecular Biology of the Cell*, 5th ed. ©2008 by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.

34. Based on the results of Experiment 2, RS2 turns on the expression of the GFP reporter gene in which of the cell types?
- F. Cell type B only  
 G. Cell types E and F only  
 H. Cell types A, B, and C only  
 J. Cell types D, E, and F only
35. According to the results of Experiments 1 and 2, when the cells were viewed with the microscope, green light was NEVER observed for which of the cell types?
- A. Cell type A only  
 B. Cell type C only  
 C. Cell types A and C only  
 D. Cell types A, C, and D only
36. The gene that codes for the enzyme  $\beta$ -galactosidase is a common reporter gene. Consider the combination of RSs in the reporter gene shown below.



Which of the following patterns of  $\beta$ -galactosidase enzymatic activity would most likely result from transfected the cells of cell types A–F with the above reporter gene?

	enzymatic activity of $\beta$ -galactosidase in					
	cell type:					
	A	B	C	D	E	F
F.						■
G.				■		
H.	■				■	
J.		■			■	

*Key*

- has enzymatic activity
- does not have enzymatic activity

37. Based on the results of Experiment 2, the expression of the GFP reporter genes in cell type F was turned on by which of the 3 RSs?
- A. RS1 only  
 B. RS2 only  
 C. RS3 only  
 D. RS1 and RS2 only
38. What is the most likely reason that reporter genes were used in Experiments 1 and 2?
- F. The protein product of Gene X could be more easily observed than could the protein product of the reporter genes.  
 G. The protein product of the reporter genes could be more easily observed than could the protein product of Gene X.  
 H. RS1–RS3 cannot control the expression of Gene X in the cell types studied.  
 J. RS1–RS3 cannot control the expression of the reporter genes in the cell types studied.
39. Consider the expression pattern of the GFP reporter gene in Experiment 2 that contained only RS1 and RS2. What is the most likely reason that the GFP reporter gene was NOT expressed in cell type D? In cell type D, gene expression was turned:
- A. on by RS1.  
 B. on by RS2.  
 C. off by RS1.  
 D. off by RS2.
40. Do the results of Experiments 1 and 2 indicate that the expression of Gene X is controlled by each of RS1–RS3?
- F. No; only 1 of the 3 RSs appeared to affect the expression of the GFP reporter gene in all of the cell types.  
 G. No; only 2 of the 3 RSs appeared to affect the expression of the GFP reporter gene in all of the cell types.  
 H. Yes; each of the 3 RSs appeared to affect the expression of the GFP reporter gene in all of the cell types.  
 J. Yes; each of the 3 RSs appeared to affect the expression of the GFP reporter gene in at least 1, but not all, of the cell types.

**END OF TEST 4**

**STOP! DO NOT RETURN TO ANY OTHER TEST.**

## Scoring Keys for Form A11

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

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

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

#### \*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)

## Test 2: Mathematics—Scoring Key

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

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

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)

(30)

### Test 3: Reading—Scoring Key

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

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

(11)

Integration of Knowledge & Ideas (IKI)

(6)

Total Number Correct for Reading Test

(KID + CS + IKI) (40)

### Test 4: Science—Scoring Key

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

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

(9)

Evaluation of Models, Inferences &  
Experimental Results (EMI)

(13)

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

(40)

## ACT Resource Links

**ACT Online Practice Tests:** <https://www.crackab.com/act/>

※ ACT English Practice Tests:

<https://www.crackab.com/act/english/>

※ ACT Math Practice Tests:

<https://www.crackab.com/act/math/>

※ ACT Reading Practice Tests:

<https://www.crackab.com/act/reading/>

※ ACT Science Practice Tests:

<https://www.crackab.com/act/science/>

**ACT Grammar:** <https://www.crackab.com/act/grammar/>

**ACT Real Past Papers Download:**

<https://www.crackab.com/act-downloads/>

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**Digital SAT & New SAT Practice Tests:**

<https://www.cracksat.net>

**Real SAT Tests Download:**

<http://www.cracksat.net/sat-downloads/>

**AP Exams Practice Tests:**

<https://www.crackap.com>

<https://www.apstudy.net>

## Explanation of Procedures Used to Obtain Scale Scores from Raw Scores

On each of the four 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 off 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 A11	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.

Scale Score	Raw Scores				Scale Score
	Test 1 English	Test 2 Mathematics	Test 3 Reading	Test 4 Science	
36	73-75	59-60	40	39-40	36
35	71-72	57-58	38-39	38	35
34	69-70	56	37	37	34
33	68	54-55	36	36	33
32	67	53	35	35	32
31	66	52	34	34	31
30	65	50-51	33	33	30
29	64	48-49	32	32	29
28	63	45-47	31	31	28
27	61-62	42-44	30	30	27
26	60	39-41	29	29	26
25	57-59	36-38	28	27-28	25
24	55-56	34-35	27	25-26	24
23	52-54	32-33	26	24	23
22	49-51	30-31	24-25	22-23	22
21	46-48	29	23	20-21	21
20	43-45	27-28	21-22	19	20
19	41-42	24-26	20	17-18	19
18	40	22-23	19	16	18
17	37-39	19-21	17-18	14-15	17
16	34-36	15-18	16	13	16
15	30-33	12-14	14-15	12	15
14	27-29	9-11	13	10-11	14
13	25-26	7-8	11-12	9	13
12	23-24	6	9-10	8	12
11	20-22	5	8	7	11
10	17-19	4	7	6	10
9	14-16	3	6	5	9
8	12-13	—	5	4	8
7	10-11	2	4	—	7
6	8-9	—	—	3	6
5	6-7	—	3	2	5
4	5	1	2	—	4
3	3-4	—	—	1	3
2	2	—	—	—	2
1	0-1	0	0	0	1

# ACT® Test Information Release Answer Document Copy Order Form 2017–2018

(June 9, 2018)

**Now that you have received the List Report,** you may request a photocopy of your answer document for a \$22 fee. If you took the writing test, you will also receive a copy of your written essay.

To order this optional service now, complete the order form below. Your order **must be postmarked by September 10, 2018**. A copy of your answer document will be mailed approximately 3 weeks after ACT receives your order form.

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Name (as given when ACT test was taken)

Date of Birth

Street Address

City

State/Province

ZIP/Postal Code

ACT ID (from score report)

(      )

Telephone Number

Location of test center where ACT test was taken

LEGAL SIGNATURE of person whose test information is requested

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## 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 each test 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.

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

**DO NOT OPEN THIS BOOKLET  
UNTIL TOLD TO DO SO.**



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