

# Form 72E

(December 2015)



The **ACT**<sup>®</sup>

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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.

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## ENGLISH TEST

45 Minutes—75 Questions

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

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

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

### PASSAGE I

#### The Ants Go Marching

[1]

Ants' search for food can require traveling as far as one hundred meters away from their nests (the rough equivalent of a human walking fifteen miles). 1 Yet no matter how winding a path ants might have taken to find

food. They are able to navigate back to their starting point with remarkable precision.

[2]

To test their scientific hypothesis, a team of research biologists studied ants in the Tunisian desert. [A]

1. If the writer were to delete the parenthetical information in the preceding sentence, the essay would primarily lose:
  - A. an approximation of the distance that humans typically travel on a daily basis to obtain food.
  - B. a detail that puts the distance ants travel on a scale readers might better be able to imagine.
  - C. an estimation of the distance that ants travel in order to find food.
  - D. a correlation that indicates a similarity between humans and ants.
2. **F. NO CHANGE**
  - G. food, they
  - H. food; they
  - J. food they
3. Which choice most clearly introduces the research question central to the essay?
  - A. NO CHANGE
  - B. To discover how certain animals navigate their way over long distances,
  - C. To determine how ants accomplish this navigational task,
  - D. To answer this question,



The scientists will place food a short distance from the

ants' home and then tracked the ants' paths to the food.

[3]

The team's first experiment involving relocating the ants after they'd found the food. [B] By moving the ants to a new location, the scientists changed the direction the ants would need to walk in order to return to their nest. When the ants headed away from their nest, walking in the direction they would have gone if they hadn't been moved, scientists concluded that ants rely on an internal navigation system rather than external markers.

[4]

They also tested what they referred to as "the pedometer hypothesis." [C] The scientists tied tiny stilts made out of pig hair to some ants' legs. With the extended legs, which were made of pig hair, the ants

moved a greater distance with each step. Marching far

past their nest on the way home, the researchers determined that ants count their steps.

[5]

Plenty of questions remained. For instance, why were the ants' paths back to their nests more direct than the ants' routes to the food? The scientists suspected that the ants, in addition to having an exoskeleton, were constantly maintaining a sense of their location in relation to their nest. [D] Because the routes home were so direct, the ants must have been making adjustments all along.

4. F. NO CHANGE  
G. have placed  
H. placed  
J. place
5. A. NO CHANGE  
B. the paths that were taken by the ants as they went  
C. the ants' paths that the ants took  
D. DELETE the underlined portion.
6. F. NO CHANGE  
G. involved that they relocated  
H. involving them relocating  
J. involved relocating
7. A. NO CHANGE  
B. referred, to as  
C. referred to, as  
D. referred to as,
8. F. NO CHANGE  
G. legs that had been extended by attaching pig hair,  
H. extensions made of pig hair attached to their legs,  
J. the extended legs,
9. A. NO CHANGE  
B. So when the ants marched  
C. So as they marched  
D. By marching
10. F. NO CHANGE  
G. passed there  
H. passed their  
J. past there
11. Which choice reiterates information most relevant to the essay at this point?  
A. NO CHANGE  
B. being social insects of the Formicidae family,  
C. counting their steps,  
D. forming colonies,



Were they using the sun's position in the sky as a

12

marker of time and location. Perhaps? Even with these uncertainties, the research team was confident it was on the path to figuring out how ants are able to navigate relatively long distances.

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

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

The desert was the ideal place to study ants: the homogenous terrain lacked visual landmarks, and the constant wind destroyed any tracks or scent cues.

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

- F. A in Paragraph 2.
- G. B in Paragraph 3.
- H. C in Paragraph 4.
- J. D in Paragraph 5.

- 12. F. NO CHANGE
- G. sun's position in the sky,
- H. suns position in the sky,
- J. suns position in the sky
- 13. A. NO CHANGE
- B. location? Perhaps.
- C. location; perhaps?
- D. location. Perhaps.

15. Suppose the writer's primary purpose had been to briefly summarize some scientific research that investigates one particular skill of an animal or insect. Would this essay accomplish that purpose?
- A. Yes, because it outlines some experiments conducted by a team researching navigation techniques of ants.
  - B. Yes, because it summarizes the navigational methods of a number of animals that have to travel long distances.
  - C. No, because it instead summarizes the methods that ants use to locate food in the harsh conditions of the Tunisian desert.
  - D. No, because it acknowledges that the team researching ants' navigation techniques still had unanswered questions.

PASSAGE II

**Maria Telkes: The Sun Queen**

[1]

About fifteen miles west of Boston, a

16

1949 photo captured the image of two women in overcoats talking as they stood in front of a

house in Dover, Massachusetts. [17] The house,

heated from the sun when it was out and shining,

18

was the first of its kind. [A]

- 16. Assuming that the capitalization and punctuation would be adjusted as needed, the best placement for the underlined portion would be:
  - F. where it is now.
  - G. after the word *photo*.
  - H. after the word *women*.
  - J. after the word *Massachusetts*.
- 17. Which of the following true statements, if added here, would provide the best introduction for the essay?
  - A. The coats they wore indicated that the weather that day was not very warm.
  - B. The two women, Dr. Maria Telkes and Eleanor Raymond, had designed it.
  - C. It was difficult to tell from the picture what time of day it was.
  - D. One woman had lighter hair than the other woman.
- 18. F. NO CHANGE
- G. totally heated just from sunlight and that warmth,
- H. using the sun's heat to heat the house,
- J. heated only by the sun,



[2]

Ten years earlier—before the sun first warmed it's<sup>19</sup> chilly Dover home—Telkes had been studying how to use the sun's energy to produce clean drinking water from salt water. Telkes had been working with the Massachusetts Institute of Technology before World War II began, and her reputation as a chemical engineer<sup>20</sup> got the US government's attention. The US military hired Telkes to design a water filtration system that could easily

be used by sailors, stranded<sup>21</sup> at sea. Her solar still, which removed the salt through vaporization instead of boiling,

produced countless gallons of drinkable water and saved<sup>22</sup> many lives.

[3]

After the war, Telkes went back to work at MIT on a much larger project, a home heating system powered only by sunlight. [B] Then, in 1948, she began work with Eleanor Raymond, an architect, who was designing a home for a sculptor named Amelia Peabody.

Together, Telkes and Raymond,<sup>23</sup> blended form

with function, and the end result<sup>24</sup> home dazzled architects and scientists alike.

[4]

[C] Its design improved on top of<sup>25</sup>

traditional solar-heating systems.<sup>26</sup> By transferring heat from the air (instead of from rocks or water).

19. A. NO CHANGE  
B. that's  
C. that  
D. its

20. Given that all the choices are accurate, which one provides the most relevant information at this point in the essay?  
F. NO CHANGE  
G. eventually she would develop other inventions for private use.  
H. she hoped to solve global hunger problems through inventions like a solar oven.  
J. she had been interested since high school in how the sun's energy could be used.

21. A. NO CHANGE  
B. by, sailors, stranded  
C. by sailors stranded,  
D. by sailors stranded

22. F. NO CHANGE  
G. having saved  
H. and saving  
J. saving

23. A. NO CHANGE  
B. Together, Telkes, and Raymond  
C. Together, Telkes and Raymond  
D. Together Telkes and Raymond,

24. F. NO CHANGE  
G. resulting  
H. results  
J. result

25. A. NO CHANGE  
B. above  
C. upon  
D. over

26. F. NO CHANGE  
G. systems and by  
H. systems; by  
J. systems by



The heat activated a chemical compound trapped between—an exterior glass wall and a series of metal walls, which served as the heating elements.

This system could withstand winter months and, during hot summers, work in reverse by drawing in

and transferring the heat from inside to outside.

[5]

[D] The successes of her solar still and solar house did not mark the end of Telkes's career. She continued to find practical, innovative, and cost-effective ways to use the sun's energy.

27. A. NO CHANGE  
B. between, an exterior glass wall  
C. between an exterior glass wall,  
D. between an exterior glass wall
28. Which choice most strongly emphasizes the difficult conditions the heating system could withstand?  
F. NO CHANGE  
G. the bitter cold of a Massachusetts winter  
H. some chilly temperatures  
J. the cold season
29. A. NO CHANGE  
B. the interior to the exterior, or the inside to the  
C. the interior, or inside, to the exterior, or  
D. the interior inside to the exterior

Question 30 asks about the preceding passage as a whole.

30. The writer is considering adding the following sentence to the essay:  
The Peabody home became known as the solar house.  
If the writer were to add this sentence, it would most logically be placed at Point:  
F. A in Paragraph 1.  
G. B in Paragraph 3.  
H. C in Paragraph 4.  
J. D in Paragraph 5.

PASSAGE III

From Theater to Film

Hindi cinema, which is the Hindi-language film

industry based in Mumbai, India. It's unique aesthetic derives from Parsi theater troupes in Mumbai in the late 1800s. An ethnic group possessing a diversity of skills in business and the arts, the Parsis used this expertise to produce elaborate theatrical productions.

31. A. NO CHANGE  
B. cinema who's  
C. cinema is  
D. cinema
32. F. NO CHANGE  
G. Hindi cinema's  
H. Their  
J. Your



These productions appealed to broad audiences

by drawing upon ancient Indian epic literature and  
<sup>33</sup>  
 drama as well as incorporating dance, spectacle,

and song. 34

Hoping to emulate the success of the Parsis,

they adopted Parsi theatrical methods. Hindi cinema's  
<sup>35</sup>  
 first feature film, *Raja Harishchandra* (1913), was

based upon an ancient Indian epic poem. Hindi filmmakers  
<sup>36</sup>  
 continued this epic tradition in subsequent films exploring  
 social and economic conditions in India. The 1957 film

*Mother India*, for example, portrays a families struggles  
<sup>37</sup>  
 against poverty through several generations.

*Mother India*, like many Hindi films since sound rose  
<sup>38</sup>

in movies, also did not use synchronous sound—  
<sup>39</sup>  
actors dubbed their lines after filming was complete.

33. A. NO CHANGE  
 B. arriving at the traditions of  
 C. throughout  
 D. calling out
34. At this point, the writer is considering adding the following true statement:  
 In the 1800s, the city of Mumbai was known as a center of commerce and industry.  
 Should the writer make this addition here?
- F. Yes, because it describes why the Parsis chose to integrate song and dance elements into their theatrical productions.  
 G. Yes, because it explains how the Parsis appealed to the diverse population then living in Mumbai.  
 H. No, because those facts about Mumbai have no place in a discussion of how Parsi theater influenced Hindi cinema.  
 J. No, because it indicates that Parsi theatrical productions were not successful.
35. A. NO CHANGE  
 B. Parsi theatrical methods were adopted by early Hindi filmmakers.  
 C. early Hindi filmmakers adopted Parsi theatrical methods.  
 D. the methods of Parsi theater were adopted.
36. F. NO CHANGE  
 G. based on an ancient, Indian, epic,  
 H. based by an ancient Indian epic  
 J. base on an ancient, Indian epic
37. A. NO CHANGE  
 B. family's  
 C. families'  
 D. family
38. F. NO CHANGE  
 G. sound put an appearance  
 H. the advent of sound  
 J. sound gave rise
39. Which choice most effectively introduces the subject of the paragraph and leads into the next sentence of the essay?
- A. NO CHANGE  
 B. incorporated the Parsi theater's tradition of elaborate song and dance.  
 C. was epic in length, lasting nearly three hours and included an intermission.  
 D. portrayed protagonists faced with difficult social and economic issues.



Complex musical numbers are a defining characteristic of  
40

most Hindi films. This serves as interludes designed to  
41

entertain the audience rather than to advance the plot. 42

Often featuring multiple settings or romanticized backdrops, musical numbers in Hindi cinema emphasize spectacle. One number in the 1951 film *Awara* was shot on thirteen different sets. Two love songs in the 1981 film *Silsila*, set at large in India, was shot among tulips in  
43

Holland. In regarding the Parsi tradition of using spectacle  
44  
to appeal to a broad audience, many Hindi films today incorporate elements from Indian folk music, classical music, and modern pop, often within a single song.

Hindi cinema is now one of the largest film industries in the world, enduring criticism by some for its use of  
45  
outdated technology. Modern Hindi filmmakers continue to apply the conventions of Parsi theater by remaining faithful to Indian traditions while appealing to a wide range of audiences.

- 40. F. NO CHANGE  
G. being a defining characteristic of  
H. is defining characteristics with  
J. is a defining characteristic of
- 41. A. NO CHANGE  
B. These numbers serve  
C. These then serve  
D. Those serve
- 42. If the writer were to delete the preceding sentence, the paragraph would primarily lose:  
F. a description of the musical components that make up typical song and dance numbers in Hindi films.  
G. a definition of the term *interlude* and its multiple functions within Hindi films.  
H. an analysis of the effectiveness of musical numbers in Hindi films.  
J. an explanation of the main function of musical numbers in Hindi films.
- 43. A. NO CHANGE  
B. largely for the part in India, were  
C. for the large part in India, was  
D. largely in India, were
- 44. F. NO CHANGE  
G. In the account of  
H. During  
J. True to
- 45. Which choice most effectively emphasizes the prolific nature of Hindi cinema today?  
A. NO CHANGE  
B. world, releasing more than 150 new films per year.  
C. world and has its own, unique traditions.  
D. world and is based out of Mumbai, India.



## PASSAGE IV

## The Construction of a Graphic Novel

[1]

The story begins at my cluttered wooden desk, where I write in whatever space I can clear among the haphazard stacks of sketchbooks, photos, and comics. I jot down notes about characters and plots, collecting recurring images and themes as I go. Eventually, a story line I can imagine as a graphic novel emerges. I keep scribbling until I've written a full first draft. When I was younger, I preferred stories about superheroes in space. 46 I approach that draft one chapter at a time and carve out

the plot, taking away text until only the barest framework 47

had been left. 48

[2]

Once the story is solid, I swivel my chair around and face the gleaming, white, surface of my tilted, drawing table. 49 [A] I map out a storyboard, limiting myself to five or six sentences per page. The sentences are accompanied by a series of: thumbnails, small panels that I use to 50

experiment with the sequence of images. Because 51 graphic novels demand such economy of language, I often deviate from a strictly chronological narrative.

46. The writer is considering deleting the preceding sentence. Should the sentence be kept or deleted?
- F. Kept, because it illustrates the kinds of topics the narrator enjoys writing about.
- G. Kept, because it demonstrates that the narrator has loved writing and drawing from an early age.
- H. Deleted, because it doesn't identify any of the superheroes.
- J. Deleted, because it interrupts the paragraph's focus on the narrator's writing process.
47. Which choice best maintains the carving imagery introduced earlier in the sentence?
- A. NO CHANGE
- B. whittling away at
- C. eliminating
- D. removing
48. F. NO CHANGE
- G. would have been
- H. was
- J. is
49. A. NO CHANGE
- B. gleaming, white, surface of my tilted
- C. gleaming white surface of my tilted,
- D. gleaming white surface of my tilted
50. F. NO CHANGE
- G. of thumbnails—
- H. of: thumbnails—
- J. of thumbnails
51. A. NO CHANGE
- B. The reason is that because
- C. The reason being that
- D. The reason because



[B] Devoting even a single panel to a flashback of an event in a character's past can reveal a motivation that might have taken a whole page of words to explain.

52

[3]

53 A circular panel that features a close-up of a character's shocked face, for example, emphasizes the

emotion; it creates an entirely different effect than a rectangle containing a wide view of a character in a crowd.

54

[C] I work in pencil at this stage, constantly making adjustments to get each image just right I tilt the angle of one character's torso to suggest her distrust of the woman sitting next to her. I sharpen the lines of a character's tightened jaw to give away the anger behind his seemingly polite reply. [D] Each visual detail is as vital to the narrative as any word.

[4]

[1] Over weeks and months, that stack becomes heavy, its weight a satisfying affirmation of my progress.

57

[2] When I'm ready to fully commit the story to the paper, I uncap a pen and then ink every penciled line. [3] The finished pages pile up steadily. 58

52. F. NO CHANGE  
G. have took  
H. of taken  
J. of took

53. Which of the following statements would create the most effective transition from the preceding paragraph to this one?
- A. I enjoy drawing and writing equally; for this reason, the graphic novel is my favorite form of storytelling.  
B. The thumbnails become my guide as I then divide blank pages into panels of different shapes and sizes.  
C. In my art classes, I learned many techniques to improve my drawing skills.  
D. When I'm ready, I move on to the next step: mapping out a storyboard.

54. F. NO CHANGE  
G. affect, than  
H. effect then  
J. affect then

55. A. NO CHANGE  
B. right, for example,  
C. right:  
D. right,

56. F. NO CHANGE  
G. some characters'  
H. the characters'  
J. characters'

57. A. NO CHANGE  
B. it's weight is  
C. its weight is  
D. it's weight

58. Which of the following sequences of sentences makes Paragraph 4 most logical?
- F. NO CHANGE  
G. 1, 3, 2  
H. 2, 3, 1  
J. 3, 2, 1

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

59. The writer is considering adding the following sentence to the essay:
- I smudge a lamppost to make rain.
- If the writer were to add this sentence, it would most logically be placed at Point:
- A. A in Paragraph 2.  
 B. B in Paragraph 2.  
 C. C in Paragraph 3.  
 D. D in Paragraph 3.
60. Suppose the writer's primary purpose had been to analyze various artistic styles of graphic novels. Would this essay accomplish that purpose?
- F. Yes, because it explains in detail how the narrator comes up with new ideas for graphic novels.  
 G. Yes, because it explores some of the narrator's artistic influences.  
 H. No, because it describes instead the narrator's general process for creating a graphic novel.  
 J. No, because it summarizes rather than analyzes various artistic styles of graphic novels.

PASSAGE V

**That High Lonesome Sound**

[1]

Bill Monroe gets most of the credit for popularizing the hybrid genre of music known as bluegrass. [A] A high-energy country music that emerged in the 1940s, Monroe wanted to feature  
61

acoustic stringed instruments, such as: the  
62  
 fiddle, banjo, mandolin, guitar, and upright bass.

High-pitched, harmonized vocals given the music  
63  
 what Monroe called "that high lonesome sound."

While few dispute Monroe's critical role in the formation of this now-classic American genre of music, Monroe was always quick to acknowledge his musical

influences, which included music he had heard on the radio  
64  
and in church; musicians he had met; and a talented uncle.  
64

61. A. NO CHANGE  
 B. the bands consisted of  
 C. bluegrass features  
 D. Monroe featured
62. F. NO CHANGE  
 G. instruments, such as  
 H. instruments: such as,  
 J. instruments such as,
63. A. NO CHANGE  
 B. had gave  
 C. gives  
 D. give
64. Which choice best introduces the essay's main focus and sets up a clear organizational pattern for the essay?
- F. NO CHANGE  
 G. influences: his uncle Pen and a blues musician named Arnold Schultz.  
 H. influences for the lasting impression they had made on Monroe and others.  
 J. influences.

[2]

Monroe was raised in rural Kentucky with a large family. [B] His uncle Pen taught him and his eight siblings to play a variety of instruments. [C] The family performed the music of their Scottish and Irish ancestors—folk songs and ballads that settlers had brought to the Appalachian region during the eighteenth century. Monroe became skilled at playing mandolin and guitar and being a skilled

66

fiddle player. Eventually, he was often providing

67

accompaniment for Uncle Pen at local dances. 68

[3]

Arnold Schultz was an African American traveling musician who taught Monroe how to play the blues. “I’m a farmer with a mandolin and a high tenor voice,” Monroe modestly insisted.

69

65. A. NO CHANGE  
 B. ancestors, of which  
 C. ancestors whose  
 D. ancestors
66. F. NO CHANGE  
 G. a skilled mandolin player and guitar player, and he also became skilled at being a  
 H. skilled at playing mandolin, guitar, and  
 J. a skilled mandolin, guitar, and
67. Which choice creates the most logical and specific transition to the rest of the sentence?  
 A. NO CHANGE  
 B. In the later years of his childhood,  
 C. By the time he was twelve,  
 D. Someday, however,
68. Which of the following true statements best concludes this paragraph and prepares the reader for the subject of the next paragraph?  
 F. It was at one of these dances that Monroe encountered his next musical influence.  
 G. They were a popular duo, hired regularly to provide music for local square dances.  
 H. Most often, Uncle Pen played fiddle, and Monroe played mandolin or guitar.  
 J. Their music was fast-paced and lively, perfect for energetic country dancing.
69. Given that all the quotations are accurate, which one most directly elaborates on the information in the preceding sentence?  
 A. NO CHANGE  
 B. “Bluegrass has brought more people together . . .” claimed Monroe, “than any music in the world. You meet people at festivals and renew acquaintances year after year.”  
 C. “It’s plain music that tells a story,” Monroe said about bluegrass. “It’s played from my heart to your heart, and it will touch you.”  
 D. Monroe said that when he heard Schultz’s music, “I tried to keep in my mind a little of it. . . . I wanted some blues in my music.”



Schultz's bluesy, syncopated style can be heard in bluegrass music's use of polyrhythms 70. These jazzlike

polyrhythms are one of Monroe's clearest deviation in 71

style from the old-time folk music he'd grew up playing.  
The music Monroe had played with his family was

primarily Scottish and Irish folk music. 73

[4]

Unfortunately, Schultz never recorded his music, so he wasn't well known to the public. Monroe, however, spoke of Schultz's influence frequently with gratitude and respect. [D] Monroe also later honored his uncle

Pen: in a song, "When the caller hollered do-si-do / You 74  
knew Uncle Pen was ready to go." The influences of both men, Pen and Schultz, live on in bluegrass music.

70. At this point, the writer is considering making the following addition to the sentence:

—the sounding of two or more independent rhythms at the same time

Should the writer make this addition here?

- F. Yes, because it defines a technical musical term that is likely to be unfamiliar to many readers.
- G. Yes, because it provides an example of a polyrhythm.
- H. No, because the paragraph doesn't explain why Monroe chose to use polyrhythms in his music.
- J. No, because it adds unrelated details that interrupt the progression of ideas in the paragraph.

71. A. NO CHANGE  
B. most clearer deviations  
C. clearest deviations  
D. clear deviation

72. F. NO CHANGE  
G. he had grow  
H. he'd grown  
J. he grown

73. The writer is considering deleting the preceding sentence. Should the sentence be kept or deleted?

- A. Kept, because it provides a useful detail about the music Monroe had played with his family.
- B. Kept, because it defines the term "old-time folk music," used earlier in the paragraph.
- C. Deleted, because it blurs the paragraph's focus on Monroe's uncle.
- D. Deleted, because it repeats information given earlier in the essay.

74. F. NO CHANGE  
G. Pen in a song:  
H. Pen, in a song,  
J. Pen, in a song

Question 75 asks about the preceding passage as a whole.

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

Meanwhile, Monroe's mother sang, and his father danced.

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

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

**END OF TEST 1**

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

## MATHEMATICS TEST

60 Minutes—60 Questions

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

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

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

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

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

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

1. A cookie recipe that yields 24 cookies requires  $1\frac{3}{4}$  cups of butter. When the ingredients in this recipe are increased proportionally, how many cups of butter are required for the recipe to yield 72 cookies?

- A.  $2\frac{5}{8}$
- B. 3
- C.  $3\frac{1}{2}$
- D.  $5\frac{1}{4}$
- E.  $10\frac{1}{2}$

2. The age, in years, of each of the first 6 presidents of the United States at his first inauguration was 57, 61, 57, 57, 58, and 57, respectively. Which of the following values is closest to the mean age, in years, of the first 6 presidents at their respective first inaugurations?

- F. 57
- G. 57.5
- H. 57.8
- J. 58.7
- K. 59

3. The temperature  $F$  in degrees Fahrenheit is related to the temperature  $K$  in kelvins by the equation  $F = 1.8K - 459.67$ . Which of the following temperatures, in kelvins, is closest to 120 degrees Fahrenheit?

- A. 322
- B. 461
- C. 526
- D. 580
- E. 676

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**DO YOUR FIGURING HERE.**



4. For nonzero values of  $x$  and  $y$ , which of the following expressions is equivalent to  $-\frac{18x^3y^2}{3xy}$ ?

F.  $-6x^2y$   
 G.  $-6x^3y^2$   
 H.  $-6x^4y^3$   
 J.  $-15x^2y$   
 K.  $-21x^2y$

**DO YOUR FIGURING HERE.**

5. If  $\sqrt{a} = b$  and  $b = 9$ ,  $a = ?$

A. 3  
 B. 18  
 C. 81  
 D.  $\frac{9}{2}$   
 E.  $\frac{81}{4}$

6. Damon and 4 of his coworkers are having lunch. Each of the 5 people will pay for his or her own lunch, but they agree to divide the tip equally among themselves. The total for the 5 lunches is \$80.00, and the group will add a tip of 15% of the total. Each person's portion of the tip will be how much?

F. \$1.50  
 G. \$2.40  
 H. \$3.00  
 J. \$5.00  
 K. \$5.33

7. The number 0.000 000 000 087 3 is equivalent to which of the following expressions?

A.  $8.73 \times 10^{-13}$   
 B.  $8.73 \times 10^{-11}$   
 C.  $8.73 \times 10^{-10}$   
 D.  $8.73 \times 10^{11}$   
 E.  $8.73 \times 10^{13}$

8. The circular spinner dial for a new board game is divided into 6 congruent sectors. What is the arc measure, in degrees, of each sector?

F.  $30^\circ$   
 G.  $36^\circ$   
 H.  $45^\circ$   
 J.  $60^\circ$   
 K.  $72^\circ$

DO YOUR FIGURING HERE.

9. When  $5\frac{4}{9}$  is written as an improper fraction in lowest terms, the numerator of the fraction is:

- A. 20
- B. 29
- C. 36
- D. 45
- E. 49

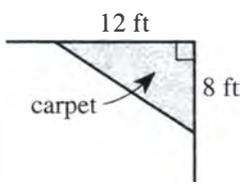
10.  $2\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} + 3\begin{bmatrix} 2 & 1 \\ -1 & -2 \end{bmatrix} = ?$

- F.  $\begin{bmatrix} 8 & 3 \\ 2 & 2 \end{bmatrix}$
- G.  $\begin{bmatrix} 8 & 7 \\ 3 & 2 \end{bmatrix}$
- H.  $\begin{bmatrix} 8 & 8 \\ 7 & 7 \end{bmatrix}$
- J.  $\begin{bmatrix} 9 & 5 \\ 8 & 8 \end{bmatrix}$
- K.  $\begin{bmatrix} 15 & 15 \\ 10 & 10 \end{bmatrix}$

11. The speed of one motorcycle exceeds 4 times the speed of another motorcycle by 24 mph. The speed of the slower motorcycle is  $g$  mph. Which of the following expressions represents the speed of the faster motorcycle, in miles per hour?

- A.  $g + 6$
- B.  $g + 24$
- C.  $g - 24$
- D.  $4g + 24$
- E.  $4g - 24$

12. In the Coaltown High School cafeteria, the student council is laying a triangular carpet in a corner that is designated to be a lounge. The carpet is a right triangle with the 2 shorter sides having lengths of 12 feet and 8 feet, as shown in the figure below. What is the area, in square feet, of the carpet?



- F. 10
- G. 20
- H. 40
- J. 48
- K. 96



13. Students studying motion observed a cart rolling at a constant rate along a straight line. The table below gives the distance,  $d$  feet, the cart was from a reference point at 1-second intervals from  $t = 0$  seconds to  $t = 5$  seconds.

$t$	0	1	2	3	4	5
$d$	12	17	22	27	32	37

Which of the following equations represents this relationship between  $d$  and  $t$ ?

- A.  $d = t + 12$   
 B.  $d = 5t + 7$   
 C.  $d = 5t + 12$   
 D.  $d = 12t + 5$   
 E.  $d = 29t$
14. Rajeev went on a delivery trip that began and ended at his truck terminal. He used all of the time during the trip driving, unloading, or resting. Rajeev began his trip on Tuesday at 7:00 a.m. when he left the terminal. During his driving time, he drove 1,200 miles at an average speed of 50 miles per hour. His driving time was twice as long as his unloading time, and his resting time was 30 hours. When did Rajeev end his delivery trip?
- F. Wednesday at 7:00 a.m.  
 G. Wednesday at 7:00 p.m.  
 H. Friday at 1:00 a.m.  
 J. Saturday at 1:00 a.m.  
 K. Saturday at 1:00 p.m.
15. For the equation  $3x + 15y = 9$ , which of the following expressions represents  $x$  in terms of  $y$ ?
- A.  $-15y + 3$   
 B.  $-6y$   
 C.  $-5y + 3$   
 D.  $-5y + 9$   
 E.  $-2y$
16. The perimeter of a parallelogram is 80 inches, and the length of 1 side is 16 inches. If it can be determined, what are the lengths, in inches, of the other 3 sides?
- F. 16, 16, 16  
 G. 16, 16, 32  
 H. 16, 24, 24  
 J. 16, 32, 32  
 K. Cannot be determined from the given information

DO YOUR FIGURING HERE.

DO YOUR FIGURING HERE.

Use the following information to answer questions 17–19.

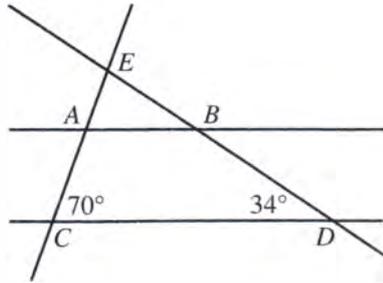
The Tully family and the Quan family ate dinner together at Eugenio’s Pasta Restaurant. An *order of pasta* comes in 1 of 2 sizes, large or small, and consists of 1 of 6 types of pasta and 1 of 5 types of sauce. The table below gives the number of large and small orders of pasta bought by each family, and the price each family paid for their orders of pasta (without tax and tip).

Family	Number of orders		Price
	large	small	
Tully	6	4	\$26.00
Quan	2	4	\$14.00

17. The price is the same for each order of a given size. What is the price of a large order of pasta?
- A. \$1.50
  - B. \$2.00
  - C. \$2.50
  - D. \$3.00
  - E. \$5.00
18. How many different possible orders of pasta can a person get?
- F. 2
  - G. 10
  - H. 12
  - J. 30
  - K. 60
19. The Tully family also bought 5 salads priced at \$2.00 per salad and 12 breadsticks priced at \$1.50 for an order of 3 breadsticks. What was the total price of the pasta, salads, and breadsticks the Tully family bought, without tax and tip?
- A. \$29.50
  - B. \$30.00
  - C. \$42.00
  - D. \$43.00
  - E. \$54.00



20. In the figure below, parallel lines  $\overleftrightarrow{AB}$  and  $\overleftrightarrow{CD}$  are cut by transversals  $\overleftrightarrow{AC}$  and  $\overleftrightarrow{BD}$  that intersect at  $E$ . Two angle measures are given. What is the measure of  $\angle ABD$ ?

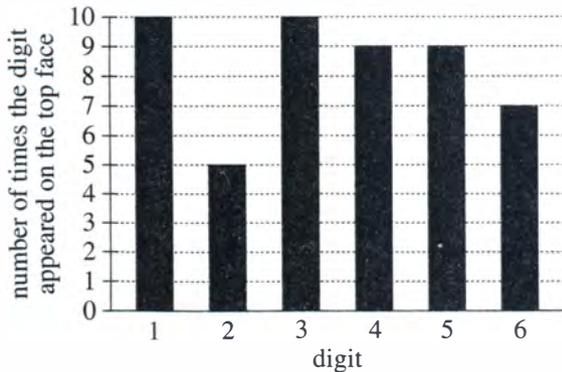


- F.  $110^\circ$
- G.  $112^\circ$
- H.  $138^\circ$
- J.  $144^\circ$
- K.  $146^\circ$

21. The total cost,  $c$  dollars, for Main Street Orchestra to perform a concert at Milly's Auditorium is determined by  $c = r + 20m$ , where  $r$  is the rental fee, in dollars, of the auditorium and  $m$  is the number of orchestra members playing. The Friday night rental fee for Milly's Auditorium is \$500. There will be 30 orchestra members playing in Friday night's concert. For the total price of exactly 200 tickets to equal the total cost of performing the concert, what should be the price of each ticket?

- A. \$2.60
- B. \$2.65
- C. \$3.00
- D. \$4.50
- E. \$5.50

22. An experiment consisted of rolling a 6-sided cube with the digits 1 through 6 on its faces, 1 digit per face. The cube was rolled 50 times, and after each roll, the number appearing on the top face was recorded. The number of times each digit was recorded is represented in the bar graph shown below. In what percent of the total number of rolls did a 5 appear on the top face of the cube?



- F. 2%
- G. 4%
- H. 9%
- J.  $16\frac{2}{3}\%$
- K. 18%

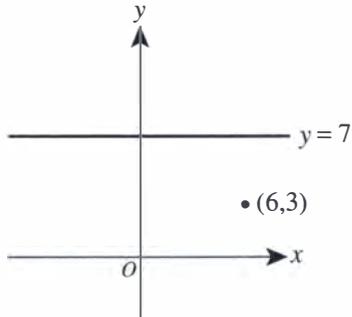
DO YOUR FIGURING HERE.

DO YOUR FIGURING HERE.

23. The length of a rectangle is 12 feet longer than the rectangle's width. The area of the rectangle is 140 square feet. The width of the rectangle,  $w$  feet, is the positive solution to which of the following equations?
- A.  $w^2 = 140$
  - B.  $w(w + 12) = 140$
  - C.  $w(w - 12) = 140$
  - D.  $2w + 2(w + 12) = 140$
  - E.  $2w + 2(w - 12) = 140$

24. What is the length, in coordinate units, of the line segment with endpoints  $(-8,4)$  and  $(4,9)$  in the standard  $(x,y)$  coordinate plane?
- F.  $\sqrt{41}$
  - G.  $\sqrt{119}$
  - H.  $\sqrt{169}$
  - J.  $\sqrt{185}$
  - K.  $\sqrt{313}$

25. The point  $(6,3)$  and the line  $y = 7$  are graphed in the standard  $(x,y)$  coordinate plane below. After the point has been reflected across the line, what are the coordinates of the point's image?



- A.  $(-6, 11)$
  - B.  $(2, 11)$
  - C.  $(6, -11)$
  - D.  $(6, -3)$
  - E.  $(6, 11)$
26. The diameter of a circle is 6 feet. What is the area, in square feet, of the circle?
- F.  $3\pi$
  - G.  $6\pi$
  - H.  $9\pi$
  - J.  $36\pi$
  - K.  $144\pi$
27. In a chemistry course, a student scored 99 on one test, 98 on another test, and 88 on each of the other tests. The student's test average for the course, where each test is weighted equally, is exactly 91. What is the *total number* of tests that the student has taken in the course?
- A. 3
  - B. 4
  - C. 5
  - D. 7
  - E. 12



28. A cash prize will be given to the winning group of the talent show at Aspen High School. The winning group will receive a cash prize that, when divided equally among the students in that group, gives each student in the group a whole-dollar share of the prize. Considering that a group of 2, 3, 4, or 5 students could win the show, what is the least possible amount that the cash prize can be?

F. \$ 12  
 G. \$ 15  
 H. \$ 30  
 J. \$ 60  
 K. \$120

DO YOUR FIGURING HERE.

29. Which of the following expressions is a factor of the polynomial  $x^2 - x - 72$  ?

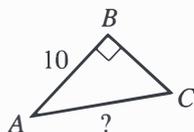
A.  $x - 9$   
 B.  $x - 8$   
 C.  $x + 2$   
 D.  $x + 9$   
 E.  $x + 36$

30. Javier will have a pool installed in his backyard. The interior of the pool is a right circular cylinder with a uniform depth of 5 feet and a radius of 8 feet. The maximum volume of water that can be in the pool is 75% of the volume of the pool. Which of the following values is closest to the maximum number of cubic feet of water that can be in the pool?

F.  $0.75\pi(8^2)(5)$   
 G.  $0.75\pi(5^2)(8)$   
 H.  $0.75[5(8)]^2$   
 J.  $(8^2)(5)\pi - 75$   
 K.  $(5^2)(8)\pi - 75$

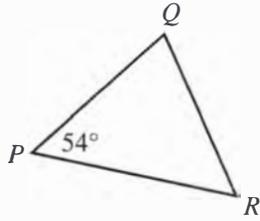
31. In  $\triangle ABC$  shown below,  $\sin C = \frac{4}{5}$  and the length of  $\overline{AB}$  is 10 inches. What is the length, in inches, of  $\overline{AC}$  ?

A. 3  
 B.  $\sqrt{41}$   
 C. 8  
 D. 9  
 E.  $\frac{25}{2}$



32. In isosceles triangle  $\triangle PQR$  shown below,  $\overline{PQ} \cong \overline{QR}$  and the measure of  $\angle P$  is  $54^\circ$ . If it can be determined, what is the measure of  $\angle Q$ ?

DO YOUR FIGURING HERE.

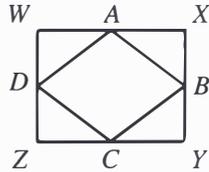


- F.  $36^\circ$
  - G.  $54^\circ$
  - H.  $72^\circ$
  - J.  $81^\circ$
  - K. Cannot be determined from the given information
33. A function is defined by  $g(a) = -2a + 7$ , and its domain is the set of integers from 1 through 30, inclusive. For how many values of  $a$  is  $g(a)$  negative?
- A. 26
  - B. 27
  - C. 28
  - D. 29
  - E. 30
34. Given that  $n$  is a positive integer and  $b$  is 3 times  $n$ , what is the least common denominator, in terms of  $n$ , for the addition of  $\frac{1}{b}$  and  $\frac{1}{n}$ ?
- F.  $(n + 3)n$
  - G.  $(n + 3)$
  - H.  $\frac{1}{3}n$
  - J.  $3n$
  - K.  $3n^2$
35. Nichelle has 84 solid-colored disks that are either red, blue, or green. She lines them up on the floor and finds that there are 24 more red disks than green and 15 more green disks than blue. How many red disks does she have?
- A. 10
  - B. 15
  - C. 25
  - D. 41
  - E. 49
36. The measures of 4 interior angles of a pentagon are  $70^\circ$ ,  $100^\circ$ ,  $110^\circ$ , and  $135^\circ$ , respectively. What is the measure of the 5th interior angle?
- F.  $35^\circ$
  - G.  $55^\circ$
  - H.  $83^\circ$
  - J.  $108^\circ$
  - K.  $125^\circ$



37. The midpoints of the sides of rectangle  $WXYZ$  are the vertices of rhombus  $ABCD$ . The dimensions of rectangle  $WXYZ$  are 6 cm by 8 cm. What is the perimeter, in centimeters, of rhombus  $ABCD$ ?

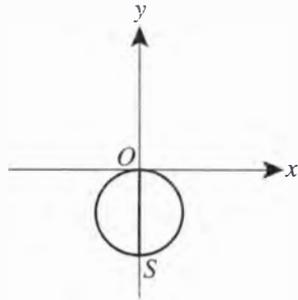
- A. 20  
B. 25  
C. 28  
D. 40  
E. 48



DO YOUR FIGURING HERE.

38. In the standard  $(x,y)$  coordinate plane below, a circle has a radius of  $r$  coordinate units and passes through the origin,  $O$ . The circle has diameter  $\overline{OS}$ , where  $S$  lies on the negative  $y$ -axis. In terms of  $r$ , what are the coordinates of  $S$ ?

- F.  $(0, -2\pi r)$   
G.  $(0, -2r)$   
H.  $(0, -r)$   
J.  $(0, -0.5r)$   
K.  $(0, r)$



39. Let  $k$  be a constant of proportionality and let  $w$ ,  $x$ ,  $y$ , and  $z$  be positive real number variables. In which of the following equations does  $x$  vary directly with  $y$ , directly with the square of  $w$ , and inversely with  $z$ ?

- A.  $x = \frac{kw^2}{yz}$   
B.  $x = \frac{kw^2y}{z}$   
C.  $x = \frac{ky}{w^2z}$   
D.  $x = \frac{kz}{w^2y}$   
E.  $x = kw^2yz$

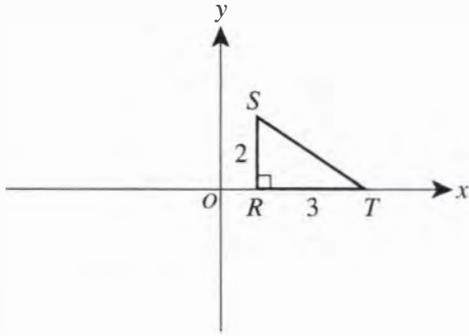
40. What is the set of real solutions for  $|x|^2 - |x| - 2 = 0$ ?

- F.  $\{2\}$   
G.  $\{-2, 2\}$   
H.  $\{-1, 2\}$   
J.  $\{1, 2\}$   
K.  $\{-2, -1, 1, 2\}$

Use the following information to answer questions 41–44.

DO YOUR FIGURING HERE.

In the standard  $(x,y)$  coordinate plane below,  $R$  is located at  $(1,0)$ ,  $S$  is located at  $(1,2)$ , and  $T$  is located at  $(4,0)$  to form right triangle  $\triangle RST$ . The given lengths are in coordinate units.



41. What is the slope of  $\overline{ST}$  ?
- A.  $-\frac{3}{2}$
  - B.  $-\frac{2}{3}$
  - C.  $\frac{1}{2}$
  - D.  $\frac{2}{3}$
  - E.  $\frac{3}{2}$
42. What is the midpoint of  $\overline{ST}$  ?
- F.  $(2, 1)$
  - G.  $(2, \frac{3}{2})$
  - H.  $(\frac{5}{2}, 1)$
  - J.  $(3, \frac{1}{2})$
  - K.  $(3, \frac{3}{2})$
43. Which of the following expressions gives the measure of  $\angle STR$  ?
- A.  $\cos^{-1}(\frac{2}{3})$
  - B.  $\sin^{-1}(\frac{2}{3})$
  - C.  $\sin^{-1}(\frac{3}{2})$
  - D.  $\tan^{-1}(\frac{2}{3})$
  - E.  $\tan^{-1}(\frac{3}{2})$



44. Right triangle  $\triangle RST$  will be rotated about the  $x$ -axis to form a right circular cone. How long, in coordinate units, is the radius of the cone's base?

F. 2  
 G. 3  
 H. 4  
 J. 6  
 K. 9

DO YOUR FIGURING HERE.

45. A cube has a total surface area of 216 square centimeters. Which of the following expressions gives the area, in square centimeters, of a single face of the cube?

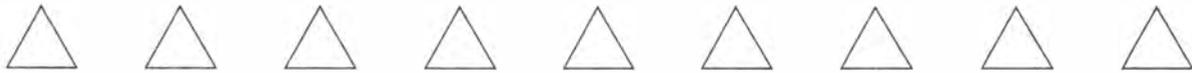
A.  $\sqrt{216}$   
 B.  $\sqrt[3]{216}$   
 C.  $\frac{216}{6} \cdot \frac{216}{6}$   
 D.  $\frac{216}{6}$   
 E.  $\frac{216}{4}$

46. When graphed in the standard  $(x,y)$  coordinate plane, the lines  $x = -3$  and  $y = x - 5$  intersect at what point?

F. ( 2, 2)  
 G. ( 2, -5)  
 H. (-3, 2)  
 J. (-3, -5)  
 K. (-3, -8)

47. In the standard  $(x,y)$  coordinate plane, which of the following lines is perpendicular to the line  $3y = 4x + 2$ ?

A.  $y = -\frac{4}{3}x - 2$   
 B.  $y = -\frac{3}{4}x + 6$   
 C.  $y = \frac{3}{4}x - 2$   
 D.  $y = \frac{4}{3}x + 1$   
 E.  $4y = 3x + 5$

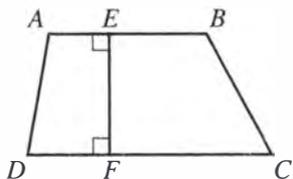


48. For every negative real value of  $x$ , all of the following statements are true EXCEPT:

**DO YOUR FIGURING HERE.**

- F.  $|x| > 0$
- G.  $2x < 0$
- H.  $x^5 < 0$
- J.  $x - x^2 < 0$
- K.  $|x| - x = 0$

49. In trapezoid  $ABCD$  illustrated below,  $\overline{AB}$  is 8 units long,  $\overline{CD}$  is 12 units long, and  $\overline{EF}$  is 6 units long. Also,  $\angle AEF$  and  $\angle DFE$  are right angles. What is the area of  $ABCD$ , in square units?

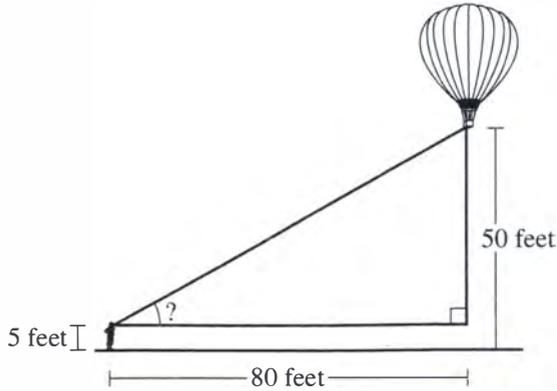


- A. 60
  - B. 72
  - C. 84
  - D. 120
  - E. 288
50. Let  $a$  be a prime number greater than 10,000 and let  $x = \sqrt{a}$ . Which of the following expressions represents a rational number?
- F.  $\frac{x}{2}$
  - G.  $\sqrt{x}$
  - H.  $2x$
  - J.  $x^2$
  - K.  $x + 2$

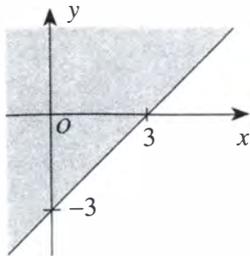


51. Melanie is standing 80 feet from the launch site of a hot-air balloon when the balloon lifts off from the ground and rises vertically. Melanie's horizontal line of sight is 5 feet above the ground. When the bottom of the balloon is 50 feet above the ground, as shown below, which of the following expressions gives the angle that Melanie's horizontal line of sight makes with her line of sight to the bottom of the balloon?

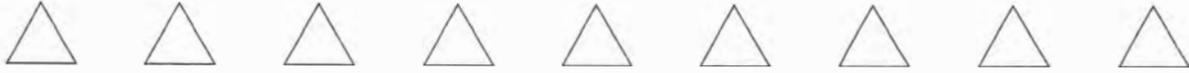
DO YOUR FIGURING HERE.



- A.  $\tan^{-1}\left(\frac{45}{80}\right)$   
 B.  $\tan^{-1}\left(\frac{50}{75}\right)$   
 C.  $\tan^{-1}\left(\frac{75}{50}\right)$   
 D.  $\tan^{-1}\left(\frac{80}{45}\right)$   
 E.  $\tan^{-1}\left(\frac{80}{50}\right)$
52. One of the following inequalities is graphed below in the standard  $(x,y)$  coordinate plane. Which one?



- F.  $y \leq x - 3$   
 G.  $y \geq x - 3$   
 H.  $y \geq x + 3$   
 J.  $y \leq 3x - 3$   
 K.  $y \geq 3x - 3$

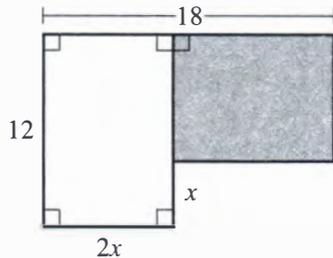


53. A box contains 6 identically sized, solid-colored balls. One ball is green, 2 are yellow, and 3 are red. A ball is drawn at random and returned to the box, then a second ball is drawn at random. What is the probability that the first ball is red and the second ball is green?

- A.  $\frac{1}{12}$   
 B.  $\frac{1}{10}$   
 C.  $\frac{1}{3}$   
 D.  $\frac{2}{3}$   
 E.  $\frac{7}{10}$

DO YOUR FIGURING HERE.

54. The dimensions shown below are in feet. What is the area, in square feet, of the shaded rectangle?



- F.  $2x^2$   
 G.  $2x^2 - 48x + 216$   
 H.  $2x^2 - 42x + 216$   
 J.  $216 - 2x^2$   
 K.  $216 - 3x$

55. The graph of  $y = \sin x$  in the standard  $(x,y)$  coordinate plane is reflected over the  $x$ -axis, shifted up  $a$  units, and then shifted left  $0.5\pi$  units. Which of the following equations represents the graph after the 3 transformations?

- A.  $y = a - \sin(x - 0.5\pi)$   
 B.  $y = a - \sin(x + 0.5\pi)$   
 C.  $y = a + \sin(x - 0.5\pi)$   
 D.  $y = 0.5\pi - \sin(x + a)$   
 E.  $y = 0.5\pi + \sin(x - a)$

56. For all positive real numbers  $x$ , which of the following

expressions is equivalent to  $\frac{\left(\frac{x^{24}}{x^6}\right)}{\left(\frac{1}{x^2}\right)}$ ?

- F.  $x^2$   
 G.  $x^8$   
 H.  $x^{12}$   
 J.  $x^{16}$   
 K.  $x^{20}$

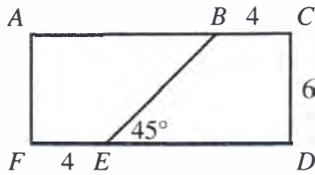


57. Two numbers have a product of  $-48$  and a sum of  $0$ .  
What is the lesser of the 2 numbers?

A.  $-4\sqrt{3}$   
 B.  $-3\sqrt{2}$   
 C.  $-2\sqrt{3}$   
 D.  $0$   
 E.  $3$

**DO YOUR FIGURING HERE.**

58. As shown below,  $\overline{BE}$  divides rectangle  $ACDF$  into 2 congruent trapezoids. The measure of  $\angle BED$  is  $45^\circ$ . The lengths of  $\overline{BC}$ ,  $\overline{CD}$ , and  $\overline{EF}$  are given in feet. What is the area, in square feet, of rectangle  $ACDF$ ?



F.  $10$   
 G.  $14$   
 H.  $60$   
 J.  $72$   
 K.  $84$

59. What is  $\frac{1}{3}\%$  of  $\frac{6}{7}$ ?

A.  $\frac{1}{350}$   
 B.  $\frac{9}{350}$   
 C.  $\frac{99}{3,500}$   
 D.  $\frac{1}{35}$   
 E.  $\frac{2}{7}$

60. For what real value of  $x$ , if any, is  $\log_{(x+3)}(x^2+3) = 2$  true?

F.  $-2$   
 G.  $-1$   
 H.  $0$   
 J.  $1$   
 K. There is no such value of  $x$ .

**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

**PROSE FICTION:** This passage is adapted from the novel *Homecoming: A Novel* by Bernhard Schlink (©2006 by Bernhard Schlink).

Once the supper table was cleared, the dishes washed, and the flowers in the garden watered, my grandparents would set to work on the *Novels for Your Reading Pleasure and Entertainment* series. They worked at the dining table, pulling the ceiling lamp down and reading and editing the manuscripts, the page proofs, and the bound galleys. Sometimes they did some writing as well: they insisted that each volume conclude with a brief didactic essay, and when none was forthcoming they supplied it themselves. They wrote about the importance of toothbrushing, the battle against snoring, the principles of beekeeping, the history of the postal system. They also rewrote passages in the novels when they found them awkward, unbelievable, or immodest or when they felt they could make a better point. The publisher gave them a free hand.

When I was old enough to stay up after the blackbird had finished its song, I was allowed to sit with them. The light of the lamp just above the table, the dark of the room surrounding it—I loved it. I would read or learn a poem or write a letter to my mother or an entry in my summer diary. Whenever I interrupted my grandparents to ask a question, I got a friendly answer. I was afraid though to ask too many: I could sense their concentration. The remarks they exchanged were sparse, and my questions sounded garrulous. So I read, wrote, and studied in silence. From time to time I lifted my head cautiously, so as not to be noticed, and observed them: Grandfather, his dark eyes now riveted on the work before him, now gazing out, lost, into the distance, and Grandmother, who did everything with a light touch, reading with a smile and making corrections with a quick and easy hand. Yet the work must have been much harder on her than on him: while he cared only for history books and had a neutral, objective relationship to the novels they dealt with, she loved literature, fiction as well as verse, and had a sure feeling for it; she must have suffered from having to spend so much time on such banal texts.

I was not allowed to read them. If I grew curious when they talked about one or another novel, I was told in no uncertain terms I was not to read it: there was a

better novel or a better novella on the subject by Conrad Ferdinand Meyer or Gottfried Keller or another classic Swiss writer. Grandmother would then get up and bring me the better book.

When they gave me the extra copies of the bound galleys to take home as scrap paper, they made a point of reminding me not to read them. They would not have given them to me at all had paper not been so expensive at the time and my mother's income so low. Everything I did not have to hand in to the teacher I wrote on the back of the bound galleys: Latin, Greek, and English vocabulary words, first drafts of compositions, plot summaries, descriptions of famous paintings, world capitals, rivers and mountains, important dates, and notes to classmates a few desks away. I liked the thick pads of thick paper, and because I was a good boy I refrained from reading the printed sides of the pages for years.

During the first few summers my grandparents found the life I was leading with them too isolated, and tried to bring me into contact with children my own age. They knew their neighbors and by talking to a number of families arranged for me to be invited to birthday parties, outings, and visits to the local swimming pool. Since it took a lot of doing and they did it out of love, I did not dare resist, but I was always happy when the event was over and I could return to them. Friendships might have grown out of these contacts had we seen one another more often, but the Swiss children's summer holidays began soon after I arrived, and they would disperse, returning only shortly before my departure.

So I spent my summer holidays without playmates my own age; I spent them taking the same walks to the lake and hikes through a ravine, around a pond, and up a hill with a view of the lake and the Alps; I spent them going on the same excursions to the Rapperswil fortress, Ufenau Island, the cathedral, the museums. These hikes and excursions were as much a part of the summer as harvesting apples, berries, lettuce, and vegetables, hoeing beds, weeding, snipping wilted flowers, trimming hedges, mowing grass, tending the compost, keeping the watering can filled, and doing the watering. Just as these operations recurred naturally, so the recurrence of the other activities struck me as natural. The never-changing evenings at the table under the lamp thus belonged to the natural rhythm of summer.

1. It can most reasonably be inferred from the passage that the narrator felt that the summers with his grandparents were:
  - A. stifflingly quiet.
  - B. frustratingly busy.
  - C. highly energizing.
  - D. enjoyably routine.
  
2. It can most reasonably be inferred that the narrator's grandparents believed the *Novels for Your Reading Pleasure and Entertainment* series consisted of texts that:
  - F. were essential leisure reading for educated people.
  - G. were mediocre in quality.
  - H. should have been taught in classrooms.
  - J. used sophisticated language.
  
3. Details in the passage most strongly suggest that during the school year, the narrator lived with:
  - A. his grandparents only.
  - B. his mother but not his grandparents.
  - C. his grandparents and mother in the same house.
  - D. other students at a private boarding school.
  
4. The passage characterizes the narrator's grandparents' work on the *Novels for Your Reading Pleasure and Entertainment* series as:
  - F. writing the novels and most of the essays.
  - G. editing the novels and writing each of the essays.
  - H. editing the novels and essays in addition to writing an occasional essay.
  - J. reading the novels in order to write essays that analyzed them.
  
5. The narrator speculates that while his grandmother worked with the *Novels for Your Reading Pleasure and Entertainment* series, her feelings about the texts contrasted with:
  - A. her written comments on the galleys.
  - B. her passions about working in the garden.
  - C. the smile that she wore on her face.
  - D. the comments about the series that she directed to the narrator's grandfather.
  
6. The narrator's reaction to his grandparents' arrangements for him to spend time with other families can best be described as:
  - F. annoyance, because he disliked the neighbors' children.
  - G. relief, because he found the time with his grandparents to be isolating.
  - H. happiness, because he struggled with making friends on his own.
  - J. acceptance, because he felt he owed his grandparents for their efforts.
  
7. As it is used in line 10, the word *forthcoming* most nearly means:
  - A. provided.
  - B. willing.
  - C. candid.
  - D. likeable.
  
8. Which of the following statements best captures how the narrator portrays his grandparents' attitudes toward literature?
  - F. His grandfather felt indifferent about literature, while his grandmother had an emotional connection to it.
  - G. His grandfather was passionate about reading literature, while his grandmother preferred to edit and write it.
  - H. Both of his grandparents believed that literature should be read in school under the guidance of a teacher.
  - J. Both of his grandparents wanted to write their own literature because they considered most novels flawed.
  
9. The main point of the third paragraph (lines 40–46) is that the narrator's grandmother:
  - A. limited her own reading to classic books by Swiss authors.
  - B. insisted that the narrator read books other than the ones included in the *Novels for Your Reading Pleasure and Entertainment* series.
  - C. turned toward books by Swiss authors as sources for her essays.
  - D. referenced as many Swiss authors as possible in her work on the *Novels for Your Reading Pleasure and Entertainment* series.
  
10. The narrator indicates that he read the texts on the bound galleys:
  - F. after his grandparents went to bed at night.
  - G. whenever his grandparents asked him to help them edit.
  - H. once the books were published.
  - J. when he was years older.

## Passage II

**SOCIAL SCIENCE:** Passage A is adapted from the article “The Other Humans: Neanderthals Revealed” by Stephen S. Hall (©2008 by The National Geographic Society). Passage B is adapted from the editorial “Fossils for All” by the editors of the journal *Scientific American* (©2009 by Scientific American, Inc.).

## Passage A by Stephen S. Hall

One of the longest and most heated controversies in human evolution rages around the genetic relationship between Neanderthals and their European successors. Did the modern humans sweeping out of Africa beginning some 60,000 years ago completely replace the Neanderthals, or did they interbreed with them? In 1997 the latter hypothesis was dealt a powerful blow by geneticist Svante Pääbo—then at the University of Munich—who used an arm bone from the original Neanderthal man to deliver it. Pääbo and his colleagues were able to extract a tiny 378-letter snippet of mitochondrial DNA (a kind of short genetic appendix to the main text in each cell) from the 40,000-year-old specimen. When they read out the letters of the code, they found that the specimen’s DNA differed from living humans to a degree suggesting that the Neanderthal and modern human lineages had begun to diverge long before the modern human migration out of Africa. Thus the two represent separate geographic and evolutionary branches splitting from a common ancestor. If there was any interbreeding when they encountered each other later, it was too rare to leave a trace of Neanderthal mitochondrial DNA in the cells of living people.

Pääbo’s genetic bombshell seemed to confirm that Neanderthals were a separate species.

However, “During this time of the biological transition,” says Erik Trinkaus, a paleoanthropologist at Washington University in St. Louis, “the basic behavior [of the two groups] is pretty much the same, and any differences are likely to have been subtle.” Trinkaus believes they indeed may have mated occasionally. He sees evidence of admixture between Neanderthals and modern humans in certain fossils, such as a 24,500-year-old skeleton of a child discovered at the Portuguese site of Lagar Velho, and a 32,000-year-old skull from a cave called Muierii in Romania.

Katerina Harvati, a researcher at the Max Planck Institute in Leipzig, has used detailed 3-D measurements of Neanderthal and early modern human fossils to predict exactly what hybrids between the two would have looked like. None of the fossils examined so far matches her predictions.

The disagreement between Trinkaus and Harvati is hardly the first time that two respected paleoanthropologists have looked at the same set of bones and come up with mutually contradictory interpretations. Pondering—and debating—the meaning of fossil anatomy will always play a role in understanding Neanderthals.

Passage B by the editors of *Scientific American*

In June of 2009 the famed Lucy fossil arrived in New York City. The 3.2-million-year-old partial skeleton of *Australopithecus afarensis* could attract hundreds of thousands of visitors over the course of her four-month engagement—part of a six-year tour.

Before this tour, Lucy had never been on public display outside of Ethiopia. One might expect scholars of human evolution to be delighted by the opportunity to share the discipline’s crown jewel with so many members of the science-interested public. But news reports announcing her New York debut included the same objections that aired when she first landed in the U.S.: namely, that the bones could sustain damage and that the tour takes a key specimen out of scientific circulation for too long. Indeed, some major museums turned the exhibit away in part for those reasons.

The objections reflect a larger problem of possessiveness in the field of human origins. Indeed, fossil hunters often block other scientists from studying their treasures, fearing assessments that could scoop or disagree with their own. In so doing, they are taking the science out of paleoanthropology.

Critics of such secrecy commonly point to the case of *Ardipithecus ramidus*, a 4.4-million-year-old human ancestor discovered by Tim White of the University of California, Berkeley. Fifteen years after White announced the first fossils of *A. ramidus* and touted the importance of this species for understanding human origins, access to the specimens remains highly restricted.

White, for his part, has said that he published only an initial report and that normal practice is to limit access until publication of a full assessment. And he has noted that the condition of a key specimen—a badly crushed skeleton—has slowed the release of the team’s detailed report.

The scientists who unearth the remnants of humanity’s past deserve first crack at describing and analyzing them. But there should be clear limits on this period of exclusivity. Otherwise, the self-correcting aspect of science is impeded: outside researchers can neither reproduce the discovery team’s findings nor test new hypotheses.

Questions 11–13 ask about Passage A.

11. The main function of the question in lines 4–6 is to:
- reveal the date when Neanderthals and early modern humans became separate species, according to Hall.
  - outline a debate that likely has been resolved through the findings of Trinkaus.
  - suggest the reasons early modern humans eventually replaced Neanderthals.
  - present what Hall believes is one of the most heated controversies in the field of human evolution.

12. As it is used in line 25, the term *genetic bombshell* most nearly refers to Pääbo and his team's:
- F. innovative method of studying the mitochondrial DNA of Neanderthals.
  - G. finding that DNA from a Neanderthal specimen differs significantly from the DNA of living humans.
  - H. suggestion that there is only a trace of Neanderthal mitochondrial DNA in living humans.
  - J. discovery that given many samples, Neanderthal DNA sometimes resembles the DNA of living humans.
13. Harvati is described as using 3-D measurements of Neanderthal and early modern human fossils primarily to:
- A. avoid having to use actual fossil specimens for her research, since they are often unavailable.
  - B. predict what a fossil specimen that is a hybrid of the two beings would look like.
  - C. determine whether the skeleton found in Lagar Velho is of a Neanderthal or an early modern human.
  - D. create sketches of Neanderthals and early modern humans for other researchers to use.

Questions 14–17 ask about Passage B.

14. Passage B indicates that, in terms of age, the Lucy fossil is:
- F. the oldest fossil of a human ancestor that has been found as of 2009.
  - G. the oldest fossil of a human ancestor that has been found with the skull intact as of 2009.
  - H. not as old as the fossils that have been found of *A. ramidus*.
  - J. not as old as fossil remnants of a human ancestor that have been found in Romania.
15. Based on Passage B, which of the following is a reason some major museums declined to be part of the tour of the Lucy exhibit?
- A. Frustration with scientists' possessiveness of the Lucy fossil in the past
  - B. Reluctance to share Lucy with the scientific community
  - C. Anticipation of large crowds to see Lucy that would be difficult to manage in museum spaces
  - D. Conviction that Lucy is more valuable being studied by scientists than being displayed on tour
16. As is it used in lines 87–88, the term *period of exclusivity* most nearly refers to the:
- F. week when a scientist has to decide whether to keep a major fossil find private permanently.
  - G. first month after a fossil find, after which the discovery team is expected to file a report.
  - H. length of time a scientist may restrict access to new fossil specimens.
  - J. duration of time a scientist is allowed to study fossil specimens unearthed by other scientists.
17. The main purpose of the fifth paragraph of Passage B (lines 79–84) is to:
- A. describe the condition of the first fossils of *A. ramidus*.
  - B. present what White has offered as justification for his actions.
  - C. provide a second example of possessiveness in the field of human origins.
  - D. outline paleoanthropologists' typical procedure for reporting on a major finding.

Questions 18–20 ask about both passages.

18. Which statement provides the most accurate comparison of the tone of each passage?
- F. Hall is sentimental and fanciful, whereas the editors of *Scientific American* are cynical.
  - G. Hall is objective, whereas the editors of *Scientific American* are critical and concerned.
  - H. Hall is disappointed and angry, whereas the editors of *Scientific American* are forgiving.
  - J. Hall is sarcastic, whereas the editors of *Scientific American* are reflective and patient.
19. The authors of both passages would most likely agree that the discussion of human origins would best be furthered through scientists' willingness to:
- A. share fossils of human ancestors and debate their meanings and significance with other experts.
  - B. memorize the oldest research on Neanderthals and early modern humans.
  - C. explore new technologies for creating 3-D measurements of the bones of *A. afarensis*.
  - D. encourage the general public to attend showings of fossils of human ancestors.
20. Compared to Passage A's discussion of the fossil of the original Neanderthal man, Passage B's discussion of the Lucy fossil can best be described as:
- F. more focused on outlining the details of the structure and measurements of the fossil.
  - G. more focused on providing a survey of the work of scientists who have studied the fossil.
  - H. less focused on describing the fossil's direct role in educating the public about paleoanthropology.
  - J. less focused on explaining the fossil's direct role in research relating to human origins and genetics.

## Passage III

**HUMANITIES:** This passage is adapted from the article “New Note: Esperanza Spalding’s Music” by John Colapinto (©2010 by Condé Nast).

In 2008, the prodigiously gifted bassist, singer, and composer Esperanza Spalding released her major-label debut, *Esperanza*, which she recorded as a twenty-three-year-old instructor at the Berklee College of Music, in Boston. While the music was indisputably jazz, it suggested an almost bewildering array of influences—fusion, funk, soul, rhythm and blues, Brazilian samba and Cuban *son*, pop balladry, chanted vocalese—with lyrics sung in Spalding’s three languages: English, Portuguese, and Spanish. An ebullient mash-up of sounds, styles, and tongues, the record seemed like something new—jazz for the iPod age—and it rose quickly to No. 3 on the *Billboard* jazz chart, and stayed on the chart for sixty-two weeks. The freshness and the excitement of her approach have led, inevitably, to her being called the “new hope for jazz.”

Spalding, born in 1984 in Portland, Oregon, to a single mother of African American, Asian, Native American, and Hispanic heritage, belongs to a growing movement of young musicians who have taken a less traditional approach to the music. For years, young jazz musicians adopted a near slavish devotion to sounding like players from jazz’s golden age (anywhere between the nineteen-twenties and the arrival of the Beatles in America, in 1964), rejecting the pop, rock, and fusion experimentation that came in the nineteen-seventies and eighties. The members of the Young Lions movement, with Wynton Marsalis the most visible among them, fetishized staunchly noncommercial “pure” jazz.

Attendance at jazz concerts has been declining for years; a hit jazz album today might sell forty thousand copies worldwide. *Esperanza* has so far sold more than a hundred thousand. This is, in part, because Spalding hews closer to dance rhythms than many of her contemporaries do. (Jazz has become increasingly complicated, piling on odd meters and abstruse melodies.) It is also because she sings; for audiences put off by the cerebral rigors of instrumental improvisation, her pliant alto voice gives them something to hang on to. But her original songs sacrifice none of the melodic sophistication and harmonic interest of jazz; and she is as technically adept, and as serious a student of the music’s history, as the most dutiful of the Young Lions.

Spalding is passionate about bringing fresh influences, voices, and idioms to the music, to prevent jazz from becoming merely “a museum piece,” as she put it. In the course of a year, she plays a hundred and fifty concert dates around the world. In 2009, she played at the Nobel Peace Prize ceremony, in Oslo, Norway. The schedule sharply limits the time she has for writing new material and practicing. She moved to Texas last fall in part because it offers seclusion for working and writing.

In mid-January, Spalding spent a few days in a state-of-the-art recording facility in New Jersey, overseeing the recording of the string arrangements for her new album, *Chamber Music Society*. Present at the sessions was Gil Goldstein, a jazz accordion player and Grammy-winning arranger and producer. Hired as an arranger for the project, Goldstein had tweaked Spalding’s string parts for the number “Apple Blossom.” Although the two had worked smoothly through most of the session, Spalding balked at the changes to the song.

“Your string parts are too busy,” Spalding told him, as they sat on a sofa in the studio’s control room.

“Busy?” Goldstein echoed, laughing. “No way!”

“It’s so delicate—I don’t want it to get too dense.”

Spalding insisted on reverting to her earlier, simpler arrangement. Goldstein assented, then went into the soundproofed studio and began conducting the trio of violin, cello, and viola. But Spalding was not hearing what she wanted. She took the baton from Goldstein, who surrendered it without complaint. (He later told me that he likes it when a musician knows what he or she wants, and that it makes for a better recording.) She put on headphones and, following the sheet music spread out in front of her on the conductor’s podium, guided the musicians through the session. At one point, she demanded a retake when she wanted the violinist to play a certain note with an upward bow motion, rather than a downstroke. Later, she asked the violinist to play a series of notes by plucking the strings. She was unsatisfied with the sound.

“Maybe make that plucking more like bells—*ting*, *ting*, *ting*,” she said.

The violinist mimicked the motion she had mimed at the podium and brought out a bell-like sound.

“Yes!” Spalding said.

21. In general, the author presents Spalding as:

- A. an accomplished, versatile musician who is taking jazz in an exciting new direction.
- B. a young and inspiring musician whose explorations in jazz may one day propel her out of her current obscurity.
- C. an overlooked but potentially influential musician who is discouraged by the decline of jazz.
- D. a creative person who stays within the limits of one musical genre, achieving spectacular results as a result of her focused efforts.

22. Lines 53–56 mark a shift in the passage from:
- F. a discussion of the impact Spalding has had on others to a discussion of the impact others have had on her.
  - G. an overview of Spalding’s career, philosophy, and experience to a description of an event that supports the claims made in the overview.
  - H. a description of Spalding as a performer to a description of her as a student.
  - J. a description of events in Spalding’s recent past to a description of a defining moment early in her career.
23. It is reasonable to infer that the sheet music referred to in line 76 was composed by:
- A. one of Spalding’s teachers at Berklee.
  - B. Spalding.
  - C. Marsalis.
  - D. one of Spalding’s protégés.
24. As presented in lines 68–88, Spalding’s manner of working with musicians can best be described as:
- F. repetitive, contradictory, and impatient.
  - G. mild mannered, imaginative, and accepting.
  - H. humorous, self-effacing, and energetic.
  - J. persistent, precise, and ultimately affirming.
25. According to the passage, how well has Spalding’s first major-label jazz recording fared in the marketplace?
- A. Its sales have more than doubled those of a standard hit jazz album of the time.
  - B. It has drawn some attention in the United States but made a huge splash in Europe.
  - C. Its poor sales have contributed to Spalding’s decision to develop a jazz style that better reflects her passion.
  - D. Its sales were slow at first but picked up rapidly after Goldstein began promoting Spalding.
26. The passage states that which of the following approaches to jazz sets Spalding apart from many of her contemporaries?
- F. She looks to Marsalis as her mentor at a time when her jazz contemporaries look to Goldstein.
  - G. She considers studying jazz history to be a liability.
  - H. She prefers composing over performing.
  - J. She incorporates dance rhythms in her work.
27. As it is used in line 37, the expression *put off* most nearly means:
- A. postponed.
  - B. repelled.
  - C. released.
  - D. misplaced.
28. As it is used in line 46, the phrase “a museum piece” is intended as a form of:
- F. praise.
  - G. encouragement.
  - H. criticism.
  - J. inquiry.
29. According to the passage, how many concert dates does Spalding perform a year?
- A. A handful
  - B. Between twenty and fifty
  - C. Between fifty-one and one hundred
  - D. One hundred and fifty
30. What was the source of Spalding’s irritation during the recording session described in the passage?
- F. Goldstein had complicated a section of Spalding’s “Apple Blossom” that Spalding wanted to keep simple.
  - G. Goldstein had dropped the string section from the musical score of *Chamber Music Society*.
  - H. The musicians had misunderstood which part of Spalding’s score was left open for improvisation.
  - J. Goldstein had wanted to feature strings in a section of “Apple Blossom” that Spalding had written for bells.

## Passage IV

**NATURAL SCIENCE:** This passage is adapted from the article “Silence of the Pikas” by Wendee Holtcamp (©2010 by Wendee Holtcamp).

Pikas, a diminutive alpine-dwelling rabbit relative, are unique among alpine mammals in that they gather up vegetation throughout summer—including flowers, grasses, leaves, evergreen needles, and even pine cones—and live off the hay pile throughout winter, rather than hibernating or moving downslope. But increasingly warm temperatures may drive them to the brink: the high-energy mammals can overheat and die at temperatures as mild as 25 degrees Celsius if they can’t regulate their body temperature by moving into the cooler microclimate under the talus. And since they already live near the tops of mountains, when a particular talus field’s microclimate becomes inhospitable, they simply have nowhere to go.

Sometimes called cony, mouse hare, rock rabbit, or whistling hare, the pika has a narrow niche. They live only in talus fields, and these must lie adjacent to alpine meadows or other vegetation so they have access to plants for food and hay farming. The talus rock fields must have boulders of a certain size; scree, a similar habitat with smaller rocks, won’t do. Rocks provide safe haven from pikas’ main predator, weasels. But perhaps more important, the interstices between the rocks provide both a cool, moist microclimate where pikas cool down during hot summer days and also the perfect sanctuary in which to settle during the long winter’s night. They don’t huddle together like many other mammals, as far as scientists can tell, but remain fiercely territorial and solitary throughout the winter, guarding their hay piles with their lives. As a snowpack settles over the land, it insulates the Earth and maintains a certain underground temperature at which pikas can survive, just below freezing. With warming temperatures reducing snowpack in many mountainous areas, in a strange twist of fate, global warming can cause pikas to freeze.

Biologists have dubbed mountaintop habitat patches “sky islands” because the valleys in between are as uninhabitable as the sea for nonmobile alpine species. This creates an ideal scenario to test the predictions of one of ecology’s key theories: island biogeography. Individual pikas have a relatively limited distance they can disperse, around two kilometers, so they can’t just shift from one mountain to another. At the population level, they’re stuck on a particular mountain range. In the 1990s, biologist Erik Beever and colleagues surveyed pikas throughout the hydrographic Great Basin—a heart-shaped 500,000 square kilometer intermontane plateau dotted with 314 mountain ranges, incorporating parts of California, Nevada, Utah, Oregon, Idaho and Arizona—and were unable to find pikas in 6 of 25 mountain ranges that they had occupied in the late 20th century. Was the cause of pika extirpations (disappearances) climatic, anthropogenic, or biogeographical?

Island biogeography theory says that “species are predicted to remain on large islands and islands that are not very isolated from mainland [habitat],” explains Beever, who did much of his work while a graduate student under Mary Peacock, at the University of Nevada–Reno. He and colleagues found pika populations persisted in mountain ranges with more talus habitat available—supporting one prediction of island biogeography theory—but pikas were not more likely to persist at sites closer to the Rocky Mountain or Sierra Nevada “mainland” ranges.

“Here isolation doesn’t have anything to do with whether they’re lost or not,” Beever says. Not only that, “the sheer size of a mountain range in this case isn’t very predictive of patterns of loss. [And] if we count the amount of habitat, that’s less important than these climatic influences.” Ultimately, the factors most strongly associated with pika disappearance were climatic; specifically, warmer and drier sites, which tended to be lower down the mountains. In another study published in *Ecological Applications*, Beever, University of Colorado researcher Chris Ray, and other colleagues revealed that acute cold stress and chronic heat stress (in other words, cold snaps and overall hotter summers) affect pika more than individual very hot days.

“The problem with global warming is that if [pikas] lose [their] snowpack, which provides insulation in winter, they freeze to death, and if the ambient air temperature heats up too much in summer, then they [overheat]. That’s the challenge,” Peacock says, who has studied pika population genetics. “They’re already at the top of the mountain. If you heat it up substantially, there’s no place for them to go.”

31. The primary purpose of the passage is to discuss the:
- methods scientists use to track the numbers of pikas in several regions.
  - role pika social behavior plays in their ability to adapt to changing conditions.
  - causes of pika disappearances and scientists’ proposed solutions to the disappearances.
  - habitat and conditions in which pikas flourish and the causes of their disappearances.
32. In lines 53–55, the author poses a question about the cause of pika disappearances that she:
- answers in the paragraphs that follow.
  - uses to emphasize the extent of pika disappearances.
  - asks to highlight flaws in Beever’s research.
  - poses to establish the three main results of pika disappearances.

33. According to the passage, one of Beever's findings that supports island biogeography theory is:
- A. pika populations thrived in most of the mountain ranges that pikas had occupied in the twentieth century.
  - B. pika populations endured in mountain ranges with more talus habitat available.
  - C. the size of a mountain range correlated with the size of a pika population.
  - D. isolated pika populations were more likely to survive in varied habitats.
34. According to the passage, the study published in *Ecological Applications* indicates that a pika population is most stressed by a summer with:
- F. a higher than average amount of rainfall.
  - G. several individual very hot days.
  - H. overall hotter temperatures.
  - J. slightly cooler temperatures.
35. It can most reasonably be inferred from the passage that one reason pikas easily overheat is that they:
- A. become overwhelmed by a thick snowpack.
  - B. are a high-energy mammal.
  - C. huddle together in interstices.
  - D. insulate themselves inside hay piles.
36. The passage indicates that compared to a talus field, scree habitats have:
- F. more food.
  - G. fewer predators.
  - H. smaller rocks.
  - J. better access to interstices.
37. The passage indicates that the perfect sanctuary for a pika on a long winter night is located:
- A. on a hay pile near an alpine talus field.
  - B. in an alpine meadow near a talus field.
  - C. on the top of a mountain adjacent to a talus field.
  - D. in the interstices between rocks in an alpine talus field.
38. In the passage, the behavior of pikas during winter is characterized in part as:
- F. fiercely territorial.
  - G. relatively relaxed.
  - H. predatory.
  - J. social.
39. The passage states that biologists dub mountaintop habitat patches "sky islands" because:
- A. any species that survive on mountaintops are completely cut off from the rest of the mountain.
  - B. the mountaintops' altitude makes them a haven for most species.
  - C. the valleys between mountaintops are as uninhabitable as the sea would be for nonmobile alpine species.
  - D. like the sea, mountaintops are only habitable to mobile species.
40. It can most reasonably be inferred from the passage that as compared to pika populations on the top of a mountain, those at lower mountain elevations are more likely to:
- F. disappear.
  - G. thrive.
  - H. remain unchanged.
  - J. migrate to another mountain range.

**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**

X-ray spectroscopy is a way of analyzing a mineral's composition. When an electron beam is directed onto a mineral, each element in the mineral emits characteristic X-rays having a narrow range of energies. The *intensity* of all X-rays emitted by the elements is measured. The greater the *maximum* intensity of the X-rays emitted by an element, the greater the relative concentration of the element in the mineral.

Figures 1 and 2 show X-ray spectroscopy results for Mineral 1 and Mineral 2, respectively, under identical conditions. Energy is given in kiloelectron volts (keV); intensity is given in counts per second (sec).

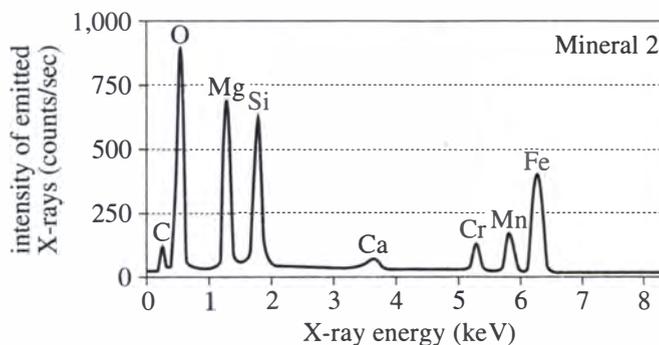


Figure 2

- Which of the following elements emitted X-rays that had the same maximum intensity in both minerals?
  - A. Ca
  - B. Cr
  - C. Fe
  - D. Si
- According to Figure 2 and additional information provided, what is the order of C, Ca, Mn, and Fe, from the element with the lowest relative concentration in Mineral 2 to the element with the highest relative concentration in Mineral 2?
  - F. Ca, Mn, C, Fe
  - G. Ca, C, Mn, Fe
  - H. Fe, Mn, C, Ca
  - J. Fe, C, Ca, Mn

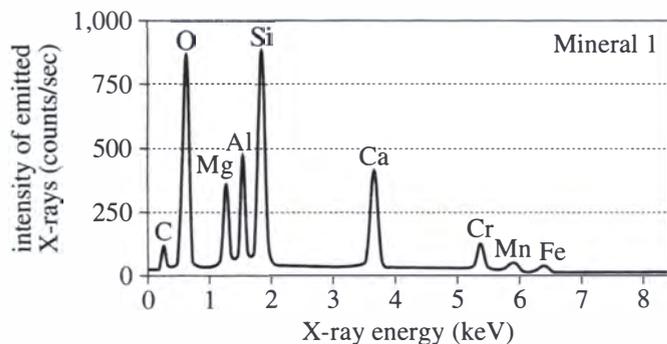


Figure 1



3. The energy of the most intense X-rays emitted by an element is directly related to the element's atomic number. The atomic numbers of several of the elements are shown in the table below.

Element	Atomic number
Si	14
Ca	20
Cr	24

If an element with an atomic number of 22 had been present in Mineral 1, the energy of the most intense X-rays emitted by this element would most likely have been:

- A. less than 3.5 keV.
- B. between 3.5 keV and 5.5 keV.
- C. between 5.5 keV and 7.5 keV.
- D. greater than 7.5 keV.

4. According to Figure 1, the maximum intensity of the X-rays emitted by the Mg in Mineral 1 is less than half the maximum intensity of the X-rays emitted by which of the following other elements in Mineral 1?

- F. Al
- G. Ca
- H. Cr
- J. Si

5. Suppose that another mineral, Mineral 3, has the chemical formula  $\text{MnSiO}_3$ . Based on Figures 1 and 2, X-ray spectroscopy of this mineral would produce 3 maximum intensity peaks closest to which of the following energies?

- A. 0.5 keV, 1.9 keV, and 5.9 keV
- B. 0.5 keV, 3.7 keV, and 5.9 keV
- C. 1.9 keV, 3.7 keV, and 5.3 keV
- D. 1.9 keV, 5.3 keV, and 6.3 keV

**Passage II**

In red blood cells (RBCs), the protein *hemoglobin* (Hb) carries oxygen. Each Hb molecule contains 4 globin polypeptides—a pair of P-type globins and a pair of Q-type globins. The possible combinations of the P-type globin and the Q-type globin for the 3 variants of human Hb are shown in Table 1. For each combination, the notation is of the form (P-type)<sub>2</sub>(Q-type)<sub>2</sub>.

Table 1		
Human Hb variant		
Hb1	Hb2	Hb3
$\zeta_2\varepsilon_2$ $\zeta_2\gamma_2$ $\alpha_2\varepsilon_2$	$\alpha_2\gamma_2$	$\alpha_2\beta_2$ $\alpha_2\delta_2$
Note: $\zeta$ , $\varepsilon$ , $\gamma$ , $\alpha$ , $\beta$ , and $\delta$ are 6 different globin polypeptides. Each of them is either a P-type globin or a Q-type globin. For example, in each molecule of Hb2, $\alpha_2$ is the P-type globin pair and $\gamma_2$ is the Q-type globin pair.		

Figure 1 shows the sites of RBC production during early human development (gestation through 48 weeks after birth). The figure also shows, over that time period, what percent of the total number of globin polypeptides produced are  $\zeta$ ,  $\varepsilon$ ,  $\gamma$ ,  $\alpha$ ,  $\beta$ , or  $\delta$  globin polypeptides.

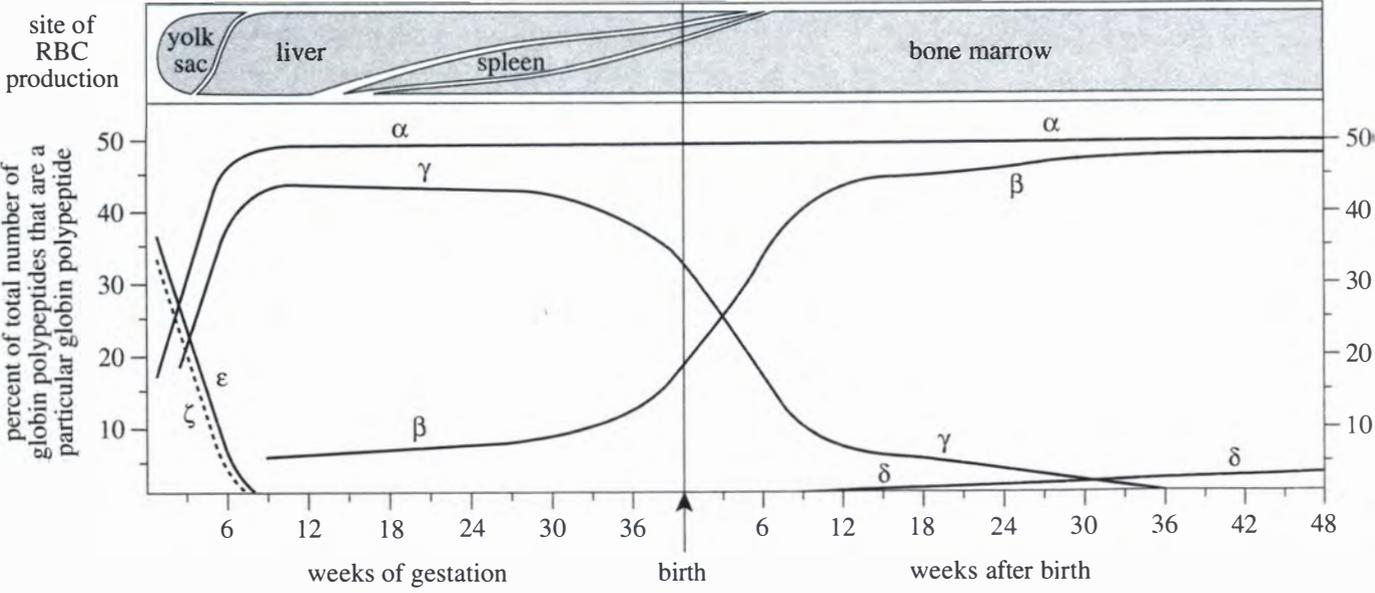


Figure 1

Table and figure adapted from Robert L. Nussbaum, Roderick R. McInnes, and Huntington F. Willard, *Thompson & Thompson Genetics in Medicine*, 6th edition. ©2004 by Elsevier.



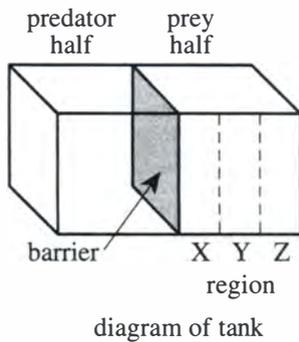
6. According to Figure 1,  $\zeta$  globin is found in RBCs that are produced at which 2 sites in the human body?
- F. Yolk sac and liver  
G. Liver and spleen  
H. Liver and bone marrow  
J. Spleen and bone marrow
7. According to Figure 1, approximately what percent of the total number of globin polypeptides produced in the RBCs of a human at birth are  $\alpha$  globins?
- A. 13%  
B. 21%  
C. 30%  
D. 50%
8. The percent of any particular globin polypeptide produced in the RBCs of a human does not change significantly after the first 48 weeks of age. Based on this information and the information provided in the passage, the most abundant Hb variant in a healthy 2-year-old child would most likely have what globin polypeptide combination?
- F.  $\alpha_2\beta_2$   
G.  $\alpha_2\delta_2$   
H.  $\alpha_2\gamma_2$   
J.  $\alpha_2\varepsilon_2$
9. According to the information given, which Hb variant, Hb2 or Hb3, is more abundant in RBCs from 12 weeks to 24 weeks of gestation?
- A. Hb2, because the percent of  $\beta$  globin produced is greater than the percent of  $\gamma$  globin produced.  
B. Hb2, because the percent of  $\gamma$  globin produced is greater than the percent of  $\beta$  globin produced.  
C. Hb3, because the percent of  $\beta$  globin produced is greater than the percent of  $\gamma$  globin produced.  
D. Hb3, because the percent of  $\gamma$  globin produced is greater than the percent of  $\beta$  globin produced.
10. Based on Table 1, how many different P-type globins and how many different Q-type globins, respectively, are found among the 3 human Hb variants?
- |    | <u>P-type globins</u> | <u>Q-type globins</u> |
|----|-----------------------|-----------------------|
| F. | 1                     | 3                     |
| G. | 2                     | 4                     |
| H. | 2                     | 5                     |
| J. | 4                     | 6                     |

**Passage III**

Prey can use visual cues and/or chemical cues to identify predators. Students conducted 2 experiments to determine if visual cues and/or chemical cues affected how guppies (a prey fish) responded to cichlids (a guppy predator).

*Experiment 1*

Four identical tanks (Tanks 1–4) were filled with water. A barrier was placed in each tank to divide each tank into 2 equal halves, the predator half and the prey half. The type of barrier was different for each tank (see Table 1). Three regions (Regions X–Z), each 10 cm wide, were designated in the prey half of each tank (see diagram).



Tank	Barrier	Cue(s) transmitted through the barrier
1	opaque without perforations	none
2	transparent without perforations	visual only
3	opaque with perforations	chemical only
4	transparent with perforations	visual and chemical

A guppy was added to the prey half of each tank, and a cichlid was added to the predator half of each tank. The guppy in each tank was observed every 15 sec for the next 5 min, and the region in which the guppy was located at the time of each observation was recorded. Then, the percent of observations recorded for each region was determined (see Figure 1).

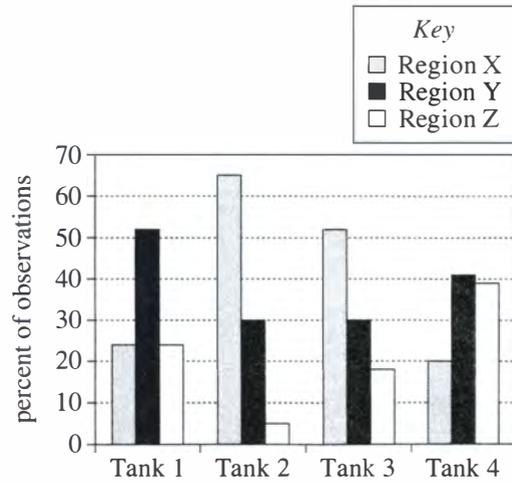


Figure 1

*Experiment 2*

Tanks 1–4 were emptied. Then, Experiment 1 was repeated in every respect but the following: 4 guppies were added to the prey half of each tank, and the location of each of the guppies was recorded at the time of each observation (see Figure 2).

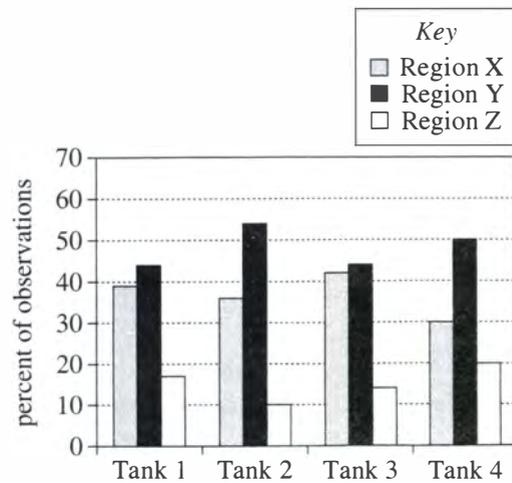


Figure 2

Figures 1 and 2 adapted from Jason Jones et al., "Senses & Sensibility: Predator-Prey Experiments Reveal How Fish Perceive & Respond to Threats." ©2008 by the American Biology Teacher.



11. In Experiment 1, in which of the tanks was the guppy able to see the cichlid?
- A. Tank 1 only
  - B. Tanks 2 and 4 only
  - C. Tanks 3 and 4 only
  - D. Tanks 2, 3, and 4 only
12. Experiment 1 differed from Experiment 2 in which of the following ways?
- F. More cichlids were observed in Experiment 1 than in Experiment 2.
  - G. More cichlids were observed in Experiment 2 than in Experiment 1.
  - H. More guppies were observed in Experiment 1 than in Experiment 2.
  - J. More guppies were observed in Experiment 2 than in Experiment 1.
13. A student hypothesized that when no cues were transmitted through the barrier, the percent of observations in Region Y would be the same regardless of the number of guppies in the tank. Are the results of Experiments 1 and 2 consistent with this hypothesis?
- A. Yes; the percent of observations in Region Y was the same for Tank 1 in Experiment 1 and Tank 1 in Experiment 2.
  - B. Yes; the percent of observations in Region Y was the same for Tank 1 in Experiment 1 and Tank 3 in Experiment 2.
  - C. No; the percent of observations in Region Y was not the same for Tank 1 in Experiment 1 and Tank 1 in Experiment 2.
  - D. No; the percent of observations in Region Y was not the same for Tank 1 in Experiment 1 and Tank 3 in Experiment 2.
14. Consider the results of Experiment 2 for the tank with the barrier through which both visual cues and chemical cues were transmitted. What is the order of the regions of the tank, from the region with the largest percent of observations to the region with the smallest percent of observations?
- F. Region Y, Region X, Region Z
  - G. Region Y, Region Z, Region X
  - H. Region Z, Region X, Region Y
  - J. Region Z, Region Y, Region X
15. A student hypothesized that any guppy receiving visual cues would stay as far away from a predator as possible. Are the results of Experiment 1 consistent with this hypothesis?
- A. Yes; in Experiment 1, neither the guppy in Tank 2 nor the guppy in Tank 4 was observed in Region X.
  - B. Yes; in Experiment 1, neither the guppy in Tank 1 nor the guppy in Tank 3 was observed in Region Z.
  - C. No; in Experiment 1, both the guppy in Tank 2 and the guppy in Tank 4 were observed in Region X.
  - D. No; in Experiment 1, both the guppy in Tank 1 and the guppy in Tank 3 were observed in Region Z.
16. The students conducting the experiments made which of the following assumptions about chemical cues?
- F. Chemical cues were not produced by the cichlids when a barrier was present.
  - G. Chemical cues were not produced by the cichlids when a barrier was absent.
  - H. Chemical cues could diffuse through the barriers without perforations.
  - J. Chemical cues could not diffuse through the barriers without perforations.

**Passage IV**

Using the equipment shown in Figure 1, a group of students performed 3 experiments involving pendulums in motion. Each pendulum consisted of a bob of mass  $M$  suspended from a rigid support by a string of length  $L$ .

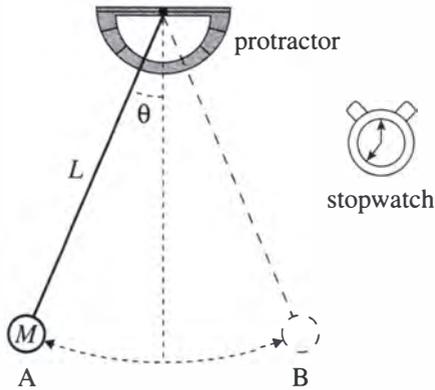


Figure 1

At the start of each trial, the students displaced the bob to a selected angle,  $\theta$ , measured from the vertical, using a protractor fastened to the support. The students then released the bob from rest, allowing it to swing back and forth. They used a stopwatch to measure the *period*,  $T$ , of the pendulum, defined as the time required for the bob to complete 1 *full swing* (from Point A to Point B and back to Point A).

Before each experiment, the students derived an equation, based on the laws of physics, to predict  $T$  for each trial of that experiment. Then, after obtaining their measurements, the students graphed their predicted  $T$  data and their measured  $T$  data.

**Experiment 1**

A pendulum with  $M = 100$  g and  $L = 100$  cm was released from rest at various values of  $\theta$ , in degrees. The pendulum was timed for 10 full swings and the measured time was then divided by 10 to obtain a measured average  $T$ , in seconds (sec), for each  $\theta$  (see Figure 2).

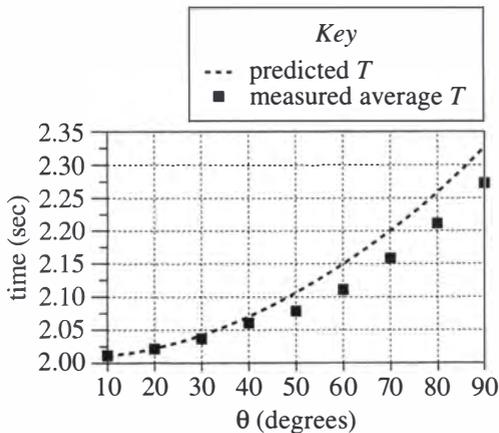


Figure 2

**Experiment 2**

Pendulums with  $M = 100$  g but various values of  $L$  were released from rest at  $\theta = 10^\circ$ . The measured average  $T$  for each pendulum was obtained as in Experiment 1 (see Figure 3).

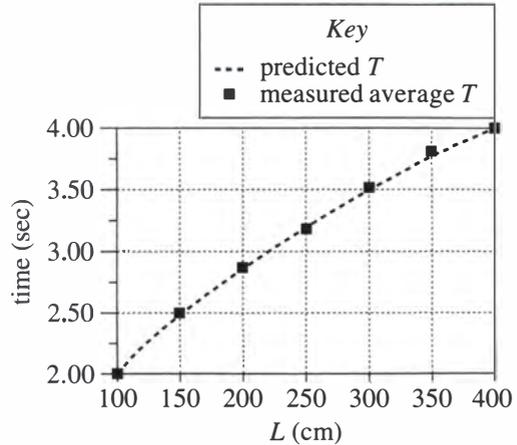


Figure 3

**Experiment 3**

Pendulums with  $L = 100$  cm but various values of  $M$  were released from rest at  $\theta = 10^\circ$ . The measured average  $T$  for each pendulum was obtained as in Experiment 1 (see Figure 4).

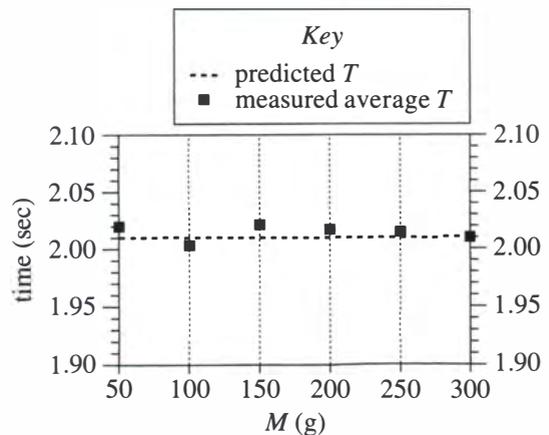


Figure 4

17. In Experiment 1, the gravitational potential energy of the pendulum bob was greatest when the bob was released from which selected value of  $\theta$ ?

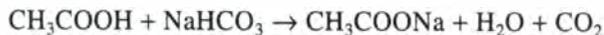
- A.  $10^\circ$
- B.  $30^\circ$
- C.  $70^\circ$
- D.  $90^\circ$



18. Suppose a trial had been performed in Experiment 2 using a pendulum with  $L = 175$  cm. The measured average  $T$  for this pendulum would most likely have been between:
- F. 1.50 sec and 2.00 sec.
  - G. 2.00 sec and 2.50 sec.
  - H. 2.50 sec and 3.00 sec.
  - J. 3.00 sec and 3.50 sec.
19. According to the results of Experiment 1, for  $\theta = 70^\circ$ , the measured average  $T$  was how many seconds less than, or how many seconds greater than, the predicted  $T$ ?
- A. 0.04 sec less
  - B. 2.16 sec less
  - C. 0.04 sec greater
  - D. 2.16 sec greater
20. How did the procedure followed in Experiment 1 differ from the procedure followed in Experiment 2? In Experiment 1:
- F.  $\theta$  was varied while  $M$  and  $L$  were held constant, but in Experiment 2,  $L$  was varied while  $M$  and  $\theta$  were held constant.
  - G.  $\theta$  was varied while  $M$  and  $L$  were held constant, but in Experiment 2,  $M$  was varied while  $L$  and  $\theta$  were held constant.
  - H.  $L$  was varied while  $\theta$  and  $M$  were held constant, but in Experiment 2,  $\theta$  was varied while  $L$  and  $M$  were held constant.
  - J.  $L$  was varied while  $\theta$  and  $M$  were held constant, but in Experiment 2,  $M$  was varied while  $L$  and  $\theta$  were held constant.
21. Based on the results of Experiments 1 and 2, which of the following changes in  $\theta$  or in  $L$  would most likely yield the greatest change in the measured average  $T$  for a pendulum with  $M = 100$  g?
- A. Increasing  $\theta$  from  $10^\circ$  to  $70^\circ$
  - B. Increasing  $\theta$  from  $20^\circ$  to  $90^\circ$
  - C. Increasing  $L$  from 100 cm to 200 cm
  - D. Increasing  $L$  from 200 cm to 250 cm
22. Suppose Experiment 3 had been repeated, except that each pendulum had a string length of 200 cm. Based on the results of Experiments 2 and 3, the graph of predicted  $T$  versus  $M$  for the pendulums would most likely have been a:
- F. straight horizontal line crossing both vertical axes at approximately 2.01 sec.
  - G. straight horizontal line crossing both vertical axes at approximately 2.85 sec.
  - H. curve crossing the left vertical axis at approximately 2.01 sec, increasing as  $M$  increases.
  - J. curve crossing the left vertical axis at approximately 2.85 sec, increasing as  $M$  increases.

### Passage V

When *vinegar* (a solution of acetic acid,  $\text{CH}_3\text{COOH}$ , in  $\text{H}_2\text{O}$ ) is mixed with *baking soda* (sodium bicarbonate,  $\text{NaHCO}_3$ ), the following reaction occurs:



A teacher constructed the apparatus shown in Figure 1 for a demonstration. First, 30 mL of vinegar was poured into a bottle. Then, 5 g of baking soda was placed in a balloon. The balloon was affixed to the top of the bottle with wire to form an airtight seal.

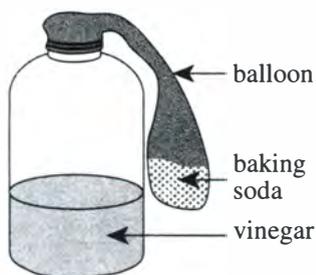


Figure 1

The apparatus was placed on a balance, and the mass reading was 68.7 g. The balloon was then lifted up so that all the baking soda fell into the bottle. As bubbles formed in the bottle, the balloon inflated and the mass reading on the balance steadily *decreased*. When the reaction was finished, the mass reading was 68.1 g (see Figure 2).

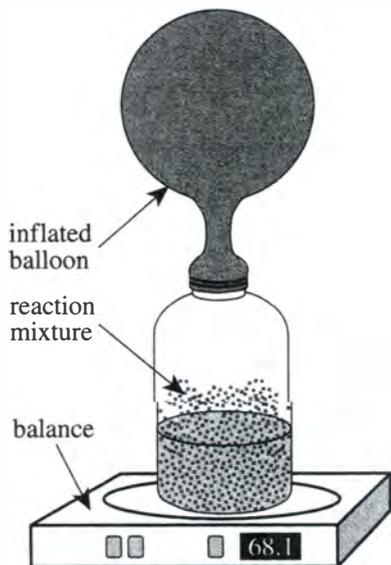


Figure 2

The teacher asked 3 students to explain what occurred in the demonstration. The students agreed that the balloon inflated because bubbles of  $\text{CO}_2$  formed and then exited the reaction mixture. They disagreed about why the mass reading on the balance decreased.

#### Student 1

No gas exited the apparatus because it was airtight. Gases, however, have no mass, so as  $\text{CO}_2$  was produced, the mass of the apparatus decreased.

#### Student 2

Gases have mass, so the mass of the apparatus should not have changed. A balloon, however, will deflate over time because there are tiny pores in its surface. Due to the rapid pressure increase in the apparatus, a measurable mass of  $\text{CO}_2$  exited through the pores in the quickly expanding balloon, which caused the mass of the apparatus to decrease.

#### Student 3

Gases have mass, and although there are tiny pores in a balloon's surface, there was not enough time for a measurable mass of gases to have exited the balloon. The air exerted an upward *buoyant force* on the apparatus that was equal to the weight of the volume of air that was displaced by the apparatus. As the balloon inflated, the volume of the apparatus increased, causing it to displace a greater volume of air. Thus, the buoyant force increased, which caused the mass reading on the balance to decrease. The actual mass of the apparatus did not measurably change.

23. The explanation given by which student, if any, is *inconsistent* with the law of conservation of mass?

- A. Student 1
- B. Student 2
- C. Student 3
- D. None of the students

24. Suppose that while the balloon was inflating, a probe located near the balloon had detected a significant increase in the concentration of  $\text{CO}_2$  in the air surrounding the balloon. Which of the students gave an explanation that would be supported by this finding?

- F. Student 1 only
- G. Student 2 only
- H. Students 1 and 2 only
- J. Students 1, 2, and 3

25. As the balloon inflated, did the mass of acetic acid in the bottle increase or decrease?

- A. Increase, because acetic acid was being consumed.
- B. Increase, because acetic acid was being produced.
- C. Decrease, because acetic acid was being consumed.
- D. Decrease, because acetic acid was being produced.



26. When empty, a particular balloon has a mass of 2.0 g. After the balloon is completely inflated with  $\text{CO}_2$  and sealed, the mass of the inflated balloon and its contents is 3.0 g. The mass 24 hr later is still 3.0 g. These observations are most consistent with the explanation given by which, if any, student?
- F. Student 1
  - G. Student 2
  - H. Student 3
  - J. The observations are equally consistent with the explanations given by all 3 students.
27. Based on Student 3's explanation, the mass of air that was displaced by the inflated balloon was approximately:
- A. 0.6 g.
  - B. 5.0 g.
  - C. 68.1 g.
  - D. 68.7 g.
28. Suppose that the apparatus had been fitted with a rigid, airtight cap instead of the balloon, and that the baking soda had been contained in a chamber below the cap. If the baking soda in the chamber had been released by remote control into the vinegar, which of the students would have been likely to predict that the mass reading on the balance would *decrease* ?
- F. Student 1 only
  - G. Students 1 and 3 only
  - H. Students 2 and 3 only
  - J. Students 1, 2, and 3
29. Which of the students would agree that the actual mass of the apparatus decreased by more than 0.1 g during the demonstration?
- A. Student 1 only
  - B. Student 2 only
  - C. Students 1 and 2 only
  - D. Students 2 and 3 only

Passage VI

A *parallel-plate capacitor* (PPC) stores electric charge on 2 separated plates when a voltage is applied across the plates. Figure 1 shows a PPC before (left) and after (right) it was filled with a *dielectric* (insulating material). The capacitance of an empty PPC,  $C_0$ , is the amount of charge stored per unit of applied voltage. The capacitance of a filled PPC,  $C_x$ , equals  $C_0$  multiplied by the *dielectric constant*,  $\kappa$ , of the filling material. Table 1 gives  $\kappa$  for 12 materials. Table 2 gives the *dielectric strength*,  $S$  (the maximum electric field strength at which a dielectric remains an insulator), for 7 of the materials.

Material	$S$ (kV/mm*)
Oxygen	2.97
Nitrogen	3.23
Air	3.13
Silicone oil	15.0
H <sub>2</sub> O	67.5
Paper	28.7
SrTiO <sub>3</sub>	8.0

\*kilovolts per millimeter of material thickness

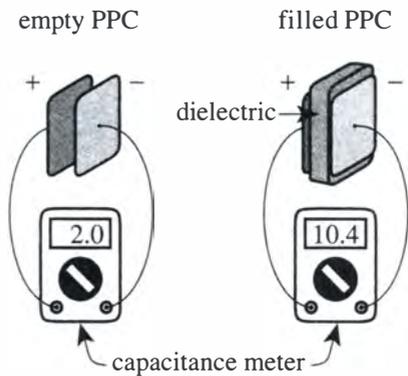
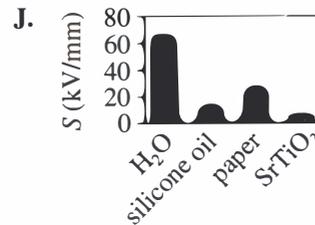
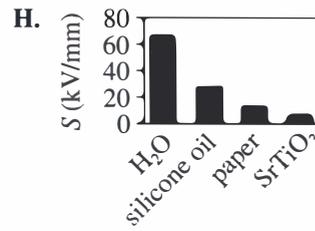
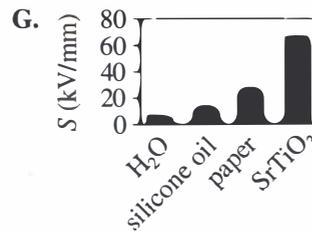
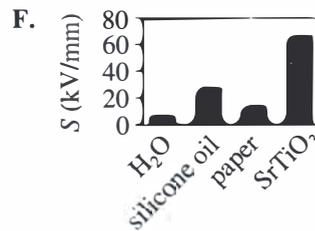


Figure 1

Material		$\kappa$
Gases	oxygen	1.00048
	nitrogen	1.00052
	air	1.00053
	CO <sub>2</sub>	1.00092
Liquids	silicone oil	2.5
	ethanol	25.3
	glycerol	46.5
	H <sub>2</sub> O	80.1
Solids	polystyrene	2.6
	paper	3.7
	Pyrex glass	5.2
	SrTiO <sub>3</sub> *	332.1

\*strontium titanate

30. Based on Table 2, which of the following graphs best represents  $S$  for H<sub>2</sub>O, silicone oil, paper, and SrTiO<sub>3</sub> ?





31. For many substances,  $\kappa$  depends on temperature. The table below gives  $\kappa$  for  $\text{H}_2\text{O}$  at several temperatures.

Temperature (°C)	$\kappa$
0.0	87.9
30.0	76.6
60.0	66.7
90.0	58.1

The  $\kappa$  for  $\text{H}_2\text{O}$  given in Table 1 was most likely measured at a temperature closest to which of the following?

- A. 20°C  
 B. 40°C  
 C. 80°C  
 D. 100°C
32. Based on Table 1, the dielectric that fills the PPC shown in Figure 1 is most likely which material?
- F. Polystyrene  
 G. Paper  
 H. Pyrex glass  
 J.  $\text{SrTiO}_3$

33. Based on Table 2, when exposed to an electric field of 3.00 kV/mm, which of the gases listed below remain(s) an insulator?

- I. Oxygen  
 II. Nitrogen  
 III. Air

- A. I only  
 B. III only  
 C. I and II only  
 D. II and III only
34. Lightning strikes can occur when air between the ground and the base of a storm cloud is exposed to an electric field stronger than  $S$  for air. Suppose a certain storm cloud's base is 300 m above the ground. Based on Table 2, approximately what minimum voltage would be present between the storm cloud's base and the ground immediately before a bolt of lightning from this storm cloud strikes the ground?
- F. 300,000 mm  $\times$  3.13 kV/mm  
 G. 300,000 m  $\times$  3.13 kV/mm  
 H.  $\frac{300 \text{ mm}}{3.13 \text{ kV/mm}}$   
 J.  $\frac{300 \text{ m}}{3.13 \text{ kV/mm}}$

**Passage VII**

In a particular *estuary* (an inlet where ocean water and river water mix), the sediment contains the radioactive isotopes lead-210 ( $^{210}\text{Pb}$ ) and cesium-137 ( $^{137}\text{Cs}$ ). The isotopes are components of particles that fall from the air into the estuary. Unlike  $^{210}\text{Pb}$ ,  $^{137}\text{Cs}$  is produced only by human activities. It has been detectable in the estuary sediment since 1954, the year it was first found in Earth's atmosphere. In 2003, 2 studies examined  $^{210}\text{Pb}$  and  $^{137}\text{Cs}$  concentrations in the estuary sediment.

At each of 2 sites (Site 1 and Site 2), 4 cylindrical vertical cores of the sediment, each 5.0 cm in diameter and 40 cm in length, were collected. Each core's sediment was sampled at the top and then every 2 cm down the core's length. The Site 1 samples from the same depth in each core were combined, and the Site 2 samples from the same depth in each core were combined.

**Study 1**

A portion of each combined sample was analyzed to determine the  $^{210}\text{Pb}$  concentration in *becquerels* per kilogram of sediment (Bq/kg). (One becquerel is equivalent to 1 nuclear decay per second.) The results are shown in Figure 1.

**Study 2**

Another portion of each combined sample was analyzed to determine the  $^{137}\text{Cs}$  concentration (see Figure 2). The  $^{137}\text{Cs}$  data indicated the total thickness of sediment that had been deposited at each site from 1954 to 2003. Then, the average sediment accumulation rate over that period was calculated for each site. The Site 1 rate was 0.41 cm/yr; the Site 2 rate was 0.37 cm/yr.

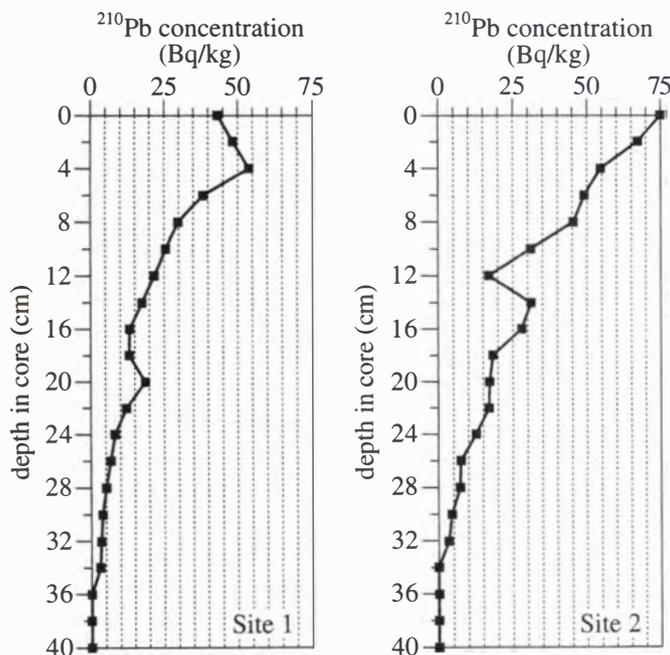


Figure 1

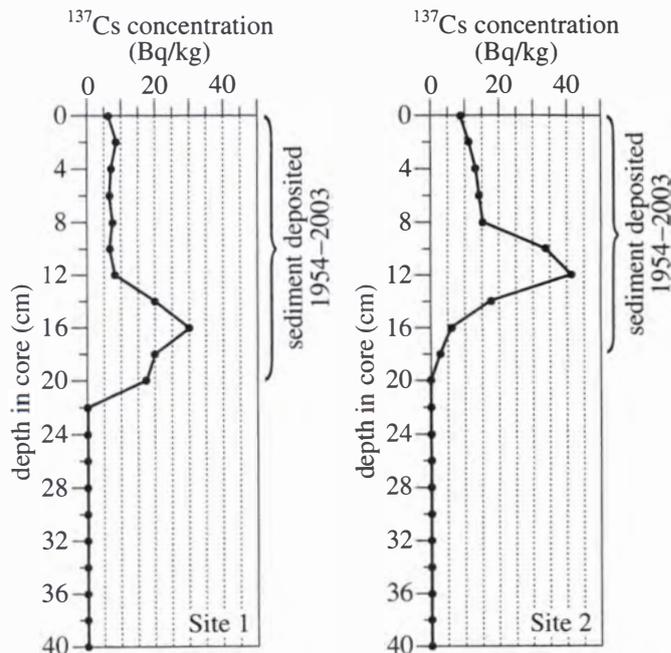


Figure 2

Figures adapted from M. C. Freitas et al., "Anthropogenic Influence in the Sado Estuary (Portugal): A Geochemical Approach." ©2008 by Journal of Iberian Geology.

35. According to the results of Study 1, at Site 1, what was the maximum concentration of  $^{210}\text{Pb}$  in a combined sediment sample and from what depth was that sample?

	$^{210}\text{Pb}$ concentration (Bq/kg)	depth in core (cm)
A.	54	0
B.	54	4
C.	75	0
D.	75	4



36. At the average sediment accumulation rate calculated for Site 1 in Study 2, the time it would take to accumulate a 40 cm thickness of sediment would be closest to which of the following?
- F. 40 yr
  - G. 100 yr
  - H. 400 yr
  - J. 1,000 yr
37. Suppose equal masses of the combined sediment samples from a depth of 8 cm at Site 1 and of the combined sediment samples from a depth of 8 cm at Site 2 had been thoroughly mixed and then analyzed for  $^{210}\text{Pb}$ . Based on the results of Study 1, the  $^{210}\text{Pb}$  concentration would most likely have been:
- A. less than 30 Bq/kg.
  - B. between 30 Bq/kg and 45 Bq/kg.
  - C. between 45 Bq/kg and 60 Bq/kg.
  - D. greater than 60 Bq/kg.
38. According to the results of Study 1, at Site 2, the concentration of  $^{210}\text{Pb}$  in the sample of surface sediment was how many times as great as the concentration of  $^{210}\text{Pb}$  in the sample from a depth of 10 cm ?
- F. Less than 0.5
  - G. 0.5
  - H. 2.0
  - J. More than 2.0
39. Based on the information provided, why was no  $^{137}\text{Cs}$  present in the Site 1 and Site 2 sediments at a depth of 30 cm ?
- A. All the  $^{137}\text{Cs}$  in the sediments had decayed.
  - B. All the  $^{137}\text{Cs}$  in the sediments had reacted with other elements.
  - C. The sediments at that depth were deposited before 1954.
  - D. The sediments at that depth were deposited after 1954.
40. In Study 2, the average sediment accumulation rate for Site 2 was calculated using which of the following expressions?
- F.  $18 \text{ cm} \div 49 \text{ yr}$
  - G.  $49 \text{ yr} \div 18 \text{ cm}$
  - H.  $40 \text{ cm} \div 49 \text{ yr}$
  - J.  $49 \text{ yr} \div 40 \text{ cm}$

**END OF TEST 4**

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

## 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 72E	Your Scale Score
English	_____
Mathematics	_____
Reading	_____
Science	_____
<b>Sum of scores</b> _____	
<b>Composite score (sum ÷ 4)</b> _____	

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	74-75	60	40	39-40	36
35	72-73	59	39	38	35
34	70-71	58	38	37	34
33	68-69	57	37	36	33
32	67	56	35-36	35	32
31	65-66	54-55	34	34	31
30	64	53	32-33	33	30
29	62-63	51-52	31	32	29
28	60-61	48-50	30	31	28
27	58-59	45-47	29	30	27
26	56-57	43-44	28	29	26
25	54-55	41-42	27	27-28	25
24	51-53	38-40	26	25-26	24
23	48-50	36-37	24-25	24	23
22	45-47	34-35	23	22-23	22
21	42-44	32-33	21-22	21	21
20	39-41	31	20	19-20	20
19	37-38	29-30	18-19	17-18	19
18	35-36	26-28	17	16	18
17	34	22-25	16	15	17
16	31-33	17-21	15	13-14	16
15	28-30	13-16	13-14	12	15
14	25-27	11-12	12	11	14
13	23-24	9-10	11	10	13
12	22	7-8	9-10	9	12
11	19-21	6	8	8	11
10	17-18	5	7	7	10
9	15-16	4	6	6	9
8	13-14	3	5	5	8
7	10-12	—	4	4	7
6	8-9	2	—	3	6
5	6-7	—	3	2	5
4	5	1	2	—	4
3	3-4	—	—	1	3
2	2	—	1	—	2
1	0-1	0	0	0	1

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

For each of the seven subscore areas, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale subscores. For each of the seven subscore areas, locate and circle either the 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 subscore that corresponds to that raw score. As you determine your scale subscores, enter them in the blanks provided on the right. The highest possible scale subscore is 18. The lowest possible scale subscore is 1.

If you left a test completely blank and marked no items, do not list any scale subscores for that test.

### ACT Test 72E

### Your Scale Subscore

#### English

Usage/Mechanics \_\_\_\_\_

Rhetorical Skills \_\_\_\_\_

#### Mathematics

Pre-Algebra/Elementary Algebra \_\_\_\_\_

Intermed. Algebra/Coord. Geometry \_\_\_\_\_

Plane Geometry/Trigonometry \_\_\_\_\_

#### Reading

Social Studies/Sciences \_\_\_\_\_

Arts/Literature \_\_\_\_\_

53

Scale Subscore	Raw Scores							Scale Subscore
	Test 1 English		Test 2 Mathematics			Test 3 Reading		
	Usage/Mechanics	Rhetorical Skills	Pre-Algebra/Elem. Algebra	Inter. Algebra/Coord. Geometry	Plane Geometry/Trigonometry	Social Studies/Sciences	Arts/Literature	
18	37-40	35	23-28	18-20	18	20	20	18
17	34-36	34	22	—	—	18-19	19	17
16	33	32-33	21	17	17	16-17	18	16
15	31-32	29-31	20	15-16	15-16	15	17	15
14	30	27-28	19	14	13-14	13-14	16	14
13	28-29	25-26	18	12-13	12	12	14-15	13
12	26-27	22-24	16-17	10-11	11	11	13	12
11	24-25	20-21	15	9	9-10	10	12	11
10	21-23	18-19	14	7-8	7-8	9	11	10
9	19-20	16-17	12-13	6	6	8	10	9
8	17-18	13-15	10-11	5	4-5	6-7	8-9	8
7	15-16	11-12	8-9	4	3	5	7	7
6	13-14	10	6-7	3	—	4	6	6
5	11-12	8-9	4-5	2	2	3	4-5	5
4	9-10	6-7	3	—	—	2	3	4
3	6-8	4-5	2	1	1	—	2	3
2	4-5	2-3	1	—	—	1	1	2
1	0-3	0-1	0	0	0	0	0	1

## 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.**



**Form 22N**  
**ACT® Writing Test Prompt**  
**(December 2015)**

**Tech-Free Time**

People today are almost never free from their electronic devices. They constantly monitor their phones, exchange texts and photos, mind their social media pages, work on their laptops and tablets, watch videos, play online games, and engage in countless other plugged-in pursuits. But a growing number of people are beginning to question this practice. They believe that an overdependence on electronic devices is harmful to their health, their relationships, and perhaps their humanity. Accordingly, they adopt and recommend deliberate “tech-free time” during which they avoid the use of the technologies so prevalent in the world around them. Given the predominance of digital technologies in our daily lives, it is worth considering whether some self-imposed tech-free time might have value.

*Read and carefully consider these perspectives. Each suggests a particular way of thinking about the value of tech-free time.*

**Perspective One**

Being connected to technology is what defines us as modern people. There’s no point in pretending that we do not depend on and enjoy our digital world.

**Perspective Two**

Some tech-free time is essential for restoring us to our true selves. Our devices keep us from experiencing and appreciating the real world around us.

**Perspective Three**

Most people can’t stay away from their digital devices even if they want to. Either their livelihoods or family relationships depend on being constantly connected, or else they’re simply addicted to their devices and can’t break free.

**Essay Task**

Write a unified, coherent essay in which you evaluate multiple perspectives on the value of tech-free time. In your essay, be sure to:

- analyze and evaluate the perspectives given
- state and develop your own perspective on the issue
- explain the relationship between your perspective and those given

Your perspective may be in full agreement with any of the others, in partial agreement, or wholly different. Whatever the case, support your ideas with logical reasoning and detailed, persuasive examples.

## Writing Test Scores Overview

Two trained readers scored your essay on a scale of 1–6 in each of the four writing domains: Ideas and Analysis, Development and Support, Organization, and Language Use and Conventions. The ACT Writing Test Scoring Rubric provided below presents the standards by which your essay was evaluated.

Each domain score represents the sum of the two readers' scores. Your writing score is calculated from your domain

scores and is reported on a scale of 1–36. Your domain scores do not necessarily add up to your reported writing score.

Because each domain receives its own score, the four scores will not necessarily be identical. For example, you may find that your essay exhibited stronger skill in organization than in the development of ideas.

## The ACT Writing Test Scoring Rubric

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

## The ACT Writing Test Scoring Rubric

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

## How Your Writing Score Was Calculated

1. Locate the 1st Rater and 2nd Rater scores (1–6) on the enclosed Test Information Release report and enter them in the first two columns below. Add the Rater scores and enter in the Domain Score column to the right.

	1st Rater	+	2nd Rater	=	Domain Score
Ideas and Analysis	_____	+	_____	=	_____
Development and Support	_____	+	_____	=	_____
Organization	_____	+	_____	=	_____
Language Use and Conventions	_____	+	_____	=	_____

2. Enter the sum of the Domain Scores here \_\_\_\_\_. This is your raw score (value between 8 and 48).
3. Use the table below to find the scaled Writing Subject Score that corresponds to your raw score.

Scale Score	Raw Score
	Writing
36	48
35	—
34	—
33	47
32	46
31	45
30	44
29	42-43
28	41
27	40
26	39
25	38
24	36-37
23	33-35
22	32
21	31
20	29-30
19	28
18	27
17	25-26
16	24
15	23
14	22
13	21
12	19-20
11	18
10	17
9	16
8	15
7	14
6	13
5	12
4	11
3	10
2	—
1	8-9



01/20/16

ACT ASSESSMENT TEST INFORMATION RELEASE REPORT  
TEST DATE = 12/15 TEST FORM = 72E TEST CENTER =

ITEM NUMBER	1	1111111112	2222222223	3333333334	4444444445	5555555556	6666666667	77777
NUMBER	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	12345
<b>ENGLISH</b>								
CORRECT ANSWER	BGCHAJAJBF	CFBFAJBJCF	DFCGCJDGAH	CGAHCFBHBF	BJDJBJBJDG	AFBFCFAHDH	CGDGAJCFDF	CHDGC
YOUR ANSWER	+++++	+++++	+++J+++H++	+++++F++	+++F+++++	+++++F	+++J+++++	+++++
SUBSCORE	RURURURUU	RUURRURUR	UUUUUUURR	UURRUUURU	RRURRRRUU	UURUUUURR	UUURURRRR	UURUR
<b>MATHEMATICS</b>								
CORRECT ANSWER	DHAFCGBJEG	DJCHCHDKCK	EKBHEHDJAF	EHBJEKAGBG	BHDFDKBJAJ	AGAHBKAKAG		
YOUR ANSWER	+++++F	+++++F	+++++F	+++++F	+++G+++F++	++B+D++++		
SUBSCORE	AAAGAAATAG	ATGAATGAAT	AAAGGTAAAT	TTGGATTGGA	GGTTTGATA	TGATTGGTAG		
<b>READING</b>								
CORRECT ANSWER	DGBHCJAFBJ	DGBHDHBJAJ	AGBJAJBHDF	DFBHBHDFCF				
YOUR ANSWER	+++D+++CH	+++++JC+++	CH+++++AJ	C+CFDGC+BH				
SUBSCORE	LLLLLLLLLL	SSSSSSSSSS	LLLLLLLLLL	SSSSSSSSSS				
<b>SCIENCE</b>								
CORRECT ANSWER	BGBJAFDFBG	BJCFCJDHAF	CGAGCHAF CJ	AHDFBGBJCF				
YOUR ANSWER	+++++F	+++++F	+F++A+DJ++	++AG+F+HD+				

1st Row: Correct responses to the items on the ACT tests.

2nd Row: Your Responses:

- A plus (+) indicates your response was correct.
- A letter (A through K) is the response you chose, if your answer was incorrect.
- A dash (-) indicates you omitted the item.
- An asterisk (\*) indicates you gridded more than one response.

3rd Row: If the test includes subscores, one of the letters below indicates the category to which each item belongs:

- English: U = Usage/Mechanics  
R = Rhetorical Skills
- Math: A = Pre-Algebra/Elementary Algebra  
G = Intermediate Algebra/Coordinate Geometry  
T = Plane Geometry/Trigonometry
- Reading: S = Social Studies/Sciences  
L = Arts/Language

WITH WRITING TEST FORM: 22N

IDEAS AND ANALYSIS:	1st RATER: 04	2nd RATER: 03
DEVELOPMENT AND SUPPORT:	1st RATER: 04	2nd RATER: 03
ORGANIZATION:	1st RATER: 04	2nd RATER: 03
LANGUAGE USE AND CONVENTIONS:	1st RATER: 04	2nd RATER: 03

