

# Form D06

(June 2021)



The **ACT**<sup>®</sup>

2020 | 2021

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In response to your request for Test Information Release materials, this booklet contains the test questions, scoring keys, and conversion tables used in determining your ACT scores. Enclosed with this booklet is a report that lists each of your answers, shows whether your answer was correct, and, if your answer was not correct, gives the correct answer.

## 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.**



## 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

## Here Comes the Sun

It’s winter, and the sun’s rays no longer shine directly on Rjukan, a small town in south-central Norway. While all of Norway has precious few sunlit hours in winter, Rjukan is tucked in a valley between two mountain ridges that completely block sunlight from late September to mid-March. Yet despite the mountains, an oval of afternoon sunlight bathes the market square, thanks to the Solspeil—“sun mirror.”

After moving to Rjukan in 2001, the prolonged winter gloom alarmed artist Martin Andersen. He wondered if mirrors placed on one of the ridges above Rjukan could change the situation.

- Which of the following alternatives to the underlined portion would NOT be acceptable?
  - Rjukan, which is
  - Rjukan;
  - Rjukan—
  - Rjukan:
- NO CHANGE
  - it was the prolonged winter gloom that alarmed artist Martin Andersen.
  - artist Martin Andersen was alarmed by the prolonged winter gloom.
  - the gloom that lasted all winter was alarming for artist Martin Andersen.
- The writer is considering revising the underlined portion to the following:  
redirect sunlight into the town.  
Should the writer make this revision?
  - Yes, because it indicates the materials Andersen hoped to use to build the mirrors.
  - Yes, because it more specifically establishes what Andersen hoped to do.
  - No, because it suggests that Andersen’s idea differed from the ideas mentioned in the following sentence.
  - No, because the original sentence more succinctly establishes what Andersen’s plans were.



He learned that in 1913 local bookkeeper Oscar Kittelsen had proposed erecting mirrors for the same purpose, and instead Sam Eyde, the town's founder, had considered the idea. However, Eyde

did not follow through on construction of the mirrors, and he abandoned the idea.

One hundred years later, Andersen made the mirrors a reality. Three 550-square-foot mirrors were airlifted to the top of a ridge 1,475 feet above Rjukan. Helicopters carried the heavy equipment up the mountain, moreover,

no roads led to the cliffside construction cite. Since a crane would have been too heavy for helicopters to lift,

workers used tools such as thirty-foot wooden tripods to install the mirrors.

The three mirrors team up as a group to create a bright 2,000-square-foot ellipse of light in the town

square. To keep the light on the square, the mirrors adjust every ten seconds, tracking the sun as it crosses the sky.

4. F. NO CHANGE  
G. but  
H. yet  
J. and
5. Which choice provides the most specific reason Eyde could not build the sun mirrors?  
A. NO CHANGE  
B. had come to understand that building the mirrors wasn't feasible,  
C. had realized that the necessary technology didn't exist,  
D. had recognized that the project could not succeed,
6. F. NO CHANGE  
G. reality. When three  
H. reality, three  
J. reality three
7. A. NO CHANGE  
B. mountain because  
C. mountain and  
D. mountain,
8. F. NO CHANGE  
G. lead to the cliffside construction sight.  
H. lead to the cliffside construction cite.  
J. led to the cliffside construction site.
9. A. NO CHANGE  
B. tools, such as thirty-foot, wooden, tripods  
C. tools such as thirty-foot wooden tripods,  
D. tools, such as thirty-foot wooden tripods
10. F. NO CHANGE  
G. help each other out  
H. are synchronized  
J. conspire together
11. If the writer were to delete the underlined portion (adjusting the capitalization as needed), the essay would primarily lose information that:  
A. reveals the size and location of the light reflected by the mirrors.  
B. describes the mechanism that adjusts the mirrors during the day.  
C. clarifies where the mirrors are located in relation to the town.  
D. specifies why the mirrors adjust throughout the day.



They're controlled wirelessly by a company in Germany, and monitored, in Rjukan and on the mountain via webcam.<sup>12</sup> The light rays that reaches the town is between 80 and 100 percent <sup>13</sup> as strong as direct sunlight.

In October 2013, residents rejoiced due to the bright light when the Solspeil first <sup>14</sup> shone a bright beam of sunlight into Rjukan. Locals wore sunglasses and lay on deck chairs to soak up the rays. Said one, "Who'd have thought it? I've stepped out to get a bit of sun."

12. F. NO CHANGE  
G. Germany and, monitored in Rjukan, and  
H. Germany and monitored in Rjukan, and,  
J. Germany and monitored in Rjukan and
13. A. NO CHANGE  
B. reaches the town are  
C. reach the town are  
D. reach the town is
14. F. NO CHANGE  
G. when the Solspeil, controlled remotely,  
H. at the initial time the Solspeil  
J. when the Solspeil

Question 15 asks about the preceding passage as a whole.

15. Suppose the writer's primary purpose had been to describe a technological project that benefited a community. Would this essay accomplish that purpose?
- A. Yes, because it focuses on the international attention Rjukan has experienced since the completion of the Solspeil.  
B. Yes, because it describes the planning and construction of the Solspeil, which brought the sun to Rjukan residents in winter.  
C. No, because it focuses mainly on the history of Rjukan and its founder, Sam Eyde.  
D. No, because it discusses mainly Andersen's artwork, comparing the Solspeil to his work in other cities.

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PASSAGE II

Talking Scop

[1]

[A] *Hwæt!* This Old English term meaning "Hark!" or "Listen!" is perhaps best known as the first word in the medieval epic poem *Beowulf*. The word hints at the importance of oral tradition hundreds of years ago in Anglo-Saxon England. [B] Between the fifth and twelfth centuries, this tradition was upheld by *scops*, professional poets who sang or recited poetry at ceremonies.



[2]

[C] In the Middle Ages, however, the ability to write wasn't common, even among royalty.

Narratives such as the heroic epic *Beowulf* and the mournful poem *The Seafarer* has been passed on  
16

by people being conversant for centuries. [D] The  
17 position of scop required not only great memorization

skills (something that could be honed over time)  
18 but also the ability to compose epic works

at an elevated, consistent level of frequency.  
19 Scops became the keepers of poems,

songs were written, and even the histories  
20 of their people.

[3]

Skilled scops were valued as highly in  
21 Anglo-Saxon society that they were sometimes granted

extra rewards for their talents. There are, generally,  
22

several records of royals giving land to deserving scops.  
23

16. F. NO CHANGE  
G. were  
H. was  
J. is

17. A. NO CHANGE  
B. by folks rattling them off  
C. through spoken word  
D. in chitchat

18. Which choice most effectively indicates why scops needed great memorization skills?  
F. NO CHANGE  
G. (performances could last from several minutes to several days)  
H. (audiences could range from a few to many people)  
J. (better than that of the average person)

19. A. NO CHANGE  
B. regularly as part of their usual routine.  
C. on a regular basis.  
D. a lot.

20. F. NO CHANGE  
G. scops were writers of songs,  
H. they wrote songs,  
J. songs,

21. A. NO CHANGE  
B. for  
C. so  
D. DELETE the underlined portion.

22. F. NO CHANGE  
G. in other words,  
H. nonetheless,  
J. in fact,

23. A. NO CHANGE  
B. scops after the scops proved they were worthy of such a gift.  
C. scops when the royals felt they had earned it.  
D. scops when the scops proved worthy.



Coins or gold rings—these could be quite useful—were

24

common gifts for scop which did well.

25

[4]

To achieve this kind of success, a scop needed to transcend being just an entertainer in a mead hall. 26 While mindful of the expectation that they would glorify their leaders, scop set standards for morality through their celebration of heroes and condemnation of villains. Therefore, a person's reputation could rise or fall by the scop's hand. Additionally, scop preserved and

conveyed through history from one generation to the

27

next. To provide a type of immortality traditionally <sup>28</sup> revered by the Anglo-Saxons. More than a storyteller, the scop was a historian, teacher, and messenger of community values. The scop's call of "Hwæt!" was an invitation to audiences to gather and celebrate their culture.

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

which could be used as status symbols to display one's success—

Given that the information is accurate, should the writer make this revision?

- F. Yes, because the revised phrase more clearly explains why coins and gold rings would be useful to scop.
- G. Yes, because the revised phrase more clearly describes why scop were important to royals.
- H. No, because the revised phrase fails to maintain the paragraph's focus on why scop were highly valued in Anglo-Saxon society.
- J. No, because the revised phrase fails to explain how the gifts were of use to scop.

25. A. NO CHANGE

- B. for whom
- C. whom
- D. who

26. Which of the following true statements, if added here, would create the most effective transition between the first sentence of the paragraph and the information that follows?

- F. A scop would often travel through several communities, performing in various locations.
- G. Sometimes audience members sang along with the scop during performances.
- H. The best scop could keep an audience's attention for long periods.
- J. A scop was also a moral compass for the community.

27. A. NO CHANGE

- B. over
- C. by
- D. DELETE the underlined portion.

28. F. NO CHANGE

- G. next. Thereby providing
- H. next, providing
- J. next. Providing

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

29. The writer wants to add the following sentence to the essay:
- Today, poets are thought of mainly as writers.
- The sentence would most logically be placed at:
- A. Point A in Paragraph 1.  
 B. Point B in Paragraph 1.  
 C. Point C in Paragraph 2.  
 D. Point D in Paragraph 2.
30. Suppose the writer's primary purpose had been to discuss one type of person who was significant in early Anglo-Saxon society. Would this essay accomplish that goal?
- F. Yes, because it describes the role of scop and explains how they safeguarded the history and values of Anglo-Saxon communities.  
 G. Yes, because it discusses early Anglo-Saxon ceremonies and the kinds of people who participated in them.  
 H. No, because it mainly focuses on describing the specific poems and stories that scop recited rather than on Anglo-Saxon communities themselves.  
 J. No, because it instead focuses on the moment in history when the role of the scop began to dwindle.

PASSAGE III

**Logging the Lake**

Last June while I was visiting family in Maine, my uncle Lee invited me, a total city girl, to his “summer office”—a nickname for his <sup>31</sup>boat. He’s a teacher, but in the summer he salvages sunken logs from lakes and sells them. So one <sup>32</sup>morning as we walked to the dock to ready the pontoon, a versatile type of boat that’s essentially a platform atop two hollow metal flotation cylinders.

After a chilly ride across Moosehead Lake, we reached a bay that Uncle Lee had tagged on his GPS. He activated the boat’s sonar, and piloted slowly <sup>33</sup>forward as we watched a monitor. Soon, ghostly images appeared on the screen, showing what <sup>34</sup> looked like a collection of matchsticks on the lake <sup>35</sup>bottom. They weren’t matchsticks, of course, but sunken logs.

31. A. NO CHANGE  
 B. his “summer office” (a nickname)  
 C. his: “summer office,” a nickname  
 D. his “summer office” a nickname
32. F. NO CHANGE  
 G. morning we walked to the dock and readied  
 H. morning, walking to the dock and readying  
 J. morning, walking to the dock to ready
33. A. NO CHANGE  
 B. sonar, and piloted,  
 C. sonar and piloted,  
 D. sonar and piloted
34. F. NO CHANGE  
 G. the images showed  
 H. they showed  
 J. showed
35. Which choice most precisely characterizes the arrangement of “matchsticks” as haphazard?
- A. NO CHANGE  
 B. jumble  
 C. range  
 D. batch





For centuries, Maine loggers sent their harvests to market by floating them down rivers. When the logs reached Moosehead Lake, they were bound together and towed to lakeside sawmills. Each year, some of the logs sank. In the deep water, protected from insects and oxygen,<sup>36</sup> the wood remained well preserved.

On the boat, another monitor displayed and showed the underwater video camera's view:<sup>37</sup> the boat's grapple arm reaching for a log

that Uncle Lee thought<sup>38</sup> was birch. The arm's iron pinchers grasped the log, coaxed it from beneath

another log, and, aided by a winch, they pull<sup>39</sup> it from the depths. When the log surfaced, it looked like

a gunked-up, mega-big<sup>40</sup> telephone pole. As my uncle lashed the log to the boat, he pointed out the axe marks

on the wood. Because it was felled by an axe he explained<sup>41</sup> the tree was probably cut in the mid-nineteenth century.

Add to that when it was cut<sup>42</sup> the age of the tree—easily two hundred years—and we were looking at a birch

that had seen centuries come and centuries go.<sup>43</sup>

36. If the writer were to delete the underlined portion, the essay would primarily lose:
- F. a description of factors that differentiate Moosehead Lake from other lakes.
  - G. an indication of why the submerged logs have remained in good condition.
  - H. a clarification about the quality of the wood in submerged logs.
  - J. an explanation of the underwater decomposition process.
37. A. NO CHANGE  
B. the underwater video camera's view of the grapple arm:  
C. the boat's underwater video camera's view:  
D. the underwater video camera's view:
38. F. NO CHANGE  
G. that, Uncle Lee, thought  
H. that, Uncle Lee thought  
J. that Uncle Lee thought,
39. A. NO CHANGE  
B. pulling  
C. pulled  
D. pull
40. F. NO CHANGE  
G. a repugnantly filthy and prodigiously sized  
H. an excessively proportioned, begrimed  
J. a slimy, hefty
41. A. NO CHANGE  
B. axe, he explained,  
C. axe, he explained  
D. axe he explained,
42. The best placement for the underlined portion would be:
- F. where it is now.
  - G. after the word *age*.
  - H. after the word *tree* (and before the dash).
  - J. after the word *looking*.
43. Which choice puts the age of the tree into perspective by using a specific detail?
- A. NO CHANGE
  - B. may have started life a century before the Declaration of Independence.
  - C. had spent many more years under water than it had on land.
  - D. first sprouted from seed a remarkably long time ago.



By the end of the day, I'd gotten pretty good at  
operating the grapple arm, and we had nine logs tied to

the boat. Uncle Lee said that one day last year he hauled  
out twenty logs, but some days he'd leave the lake without  
finding a single salvageable log.

44. Which choice best illustrates that the narrator felt a moderate degree of proficiency at operating the grapple arm?
- F. NO CHANGE  
G. I'd perfected the skill of  
H. I still struggled with  
J. I'd tried my hand at
45. Which choice most effectively concludes the essay by alluding to both the past and future of the salvaged logs?
- A. NO CHANGE  
B. The kind of wood we'd recovered—old-growth, tight-grained hardwood—wasn't really available from commercial loggers anymore.  
C. Our load of high-quality wood would become beautiful furniture or flooring, complete with an immersing backstory.  
D. With those heavy logs along for the ride, the boat moved a bit sluggishly, but even so we made it home by dinnertime.

#### PASSAGE IV

##### The Meteoric Rise of Meenakshi Wadhwa

Meenakshi Wadhwa was pursuing her PhD; when

a professor asked her, if she wanted to see a meteorite  
from Mars. Wadhwa was struck by how similar the  
rock's chemical makeup was to that of Earth rocks.

Thereafter, the idea that she could learn about the  
composition of distant worlds by studying meteorites  
has driven Wadhwa's career ever since.

After graduating, Wadhwa became the curator of  
the meteorite collection at The Field Museum in Chicago,  
there she conducted research on meteorites, especially  
those from Mars. Wadhwa used a mass spectrometer to  
identify and measure the elements in meteorite samples.

46. F. NO CHANGE  
G. in pursuit of her PhD  
H. was pursuing her PhD  
J. pursuing her PhD
47. A. NO CHANGE  
B. her if she wanted to see a meteorite  
C. her, if she wanted to see a meteorite,  
D. her, if she wanted, to see a meteorite
48. F. NO CHANGE  
G. After that day, the  
H. Since then, the  
J. The
49. A. NO CHANGE  
B. it was there that  
C. where  
D. DELETE the underlined portion.



The mass spectrometer revealed the rocks' age and identified the processes that created them. This

50

information helped Wadhwa better understand the geological history of Mars.

51

In 2006, Wadhwa became the director of the Center for Meteorite Studies at Arizona State University.

With more than 1,800 space rocks, including samples from Mars and the asteroid belt. Making the meteorite collection Wadhwa oversees is the largest at any university.

52

Because meteorites contain material that predates Earth, Wadhwa and her colleagues can learn about the elements that were present when the Sun, planets, and moons formed.

53

Wadhwa's research has shed light on the early history of the solar system. For example, a 2010 study she cowrote found that the solar system is likely 1.9 million years older than the previous estimate. In 2013, Wadhwa and two colleagues discovered evidence that a supernova exploded before the planets formed likely seeded our solar system

54

55

with many essential elements. 56

50. Which choice most strongly indicates that the mass spectrometer did not directly reveal the processes that created meteorites?

- F. NO CHANGE
- G. determined
- H. hinted at
- J. showed

51. A. NO CHANGE  
B. facilitated  
C. assisted  
D. aided

52. F. NO CHANGE  
G. Mars, and the asteroid belt; the  
H. Mars and the asteroid belt. The  
J. Mars and the asteroid belt, the

53. A. NO CHANGE  
B. In fact,  
C. These  
D. The

54. F. NO CHANGE  
G. In other words,  
H. Even so,  
J. Instead,

55. A. NO CHANGE  
B. supernova, which exploded  
C. supernova that exploded  
D. supernova, exploding

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

Wadhwa has twice been to Antarctica to hunt for meteorites.

Should the writer make this addition here?

- F. Yes, because it emphasizes that Wadhwa is passionate about studying meteorites.
- G. Yes, because it further demonstrates the meteorite expertise Wadhwa has developed.
- H. No, because it presents information that is discussed earlier in the essay.
- J. No, because it is only loosely related to the content of the paragraph.

Of the many honors Wadhwa's research has earned her, perhaps the most meaningful one came

57

from astronomers, Carolyn, and Gene Shoemaker.

58

After discovering an asteroid, they asked the International Astronomical Union to name it after

Wadhwa. The asteroid's orbit crosses that of the

Red Planet meaning that one day, as Wadhwa

59

put it, she "just might have an impact on Mars."

60

57. A. NO CHANGE  
 B. herself,  
 C. itself,  
 D. for it,
58. F. NO CHANGE  
 G. astronomers Carolyn,  
 H. astronomers Carolyn  
 J. astronomers; Carolyn
59. A. NO CHANGE  
 B. Planet, meaning that one day,  
 C. Planet, meaning that, one day  
 D. Planet, meaning, that one day
60. F. NO CHANGE  
 G. herself once verbally said,  
 H. said in her own words,  
 J. vocally stated,

#### PASSAGE V

#### The Soul of Stax

[1]

Stax Records of Memphis, Tennessee,

maybe less renowned than Detroit's Motown,

61

but its contributions to 1960s American soul music

has been no less significant. The southern soul coming

62

out of Stax had a grittier, funkier sound than Motown's,  
 blending elements of country, gospel, and rhythm & blues.

63

[A] But beyond genre, it was the people, their methods, and even the building itself (which had once been a movie theater) that made Stax one of the most exceptional recording studios of the era.

61. A. NO CHANGE  
 B. may be less renowned than  
 C. may be less renowned then  
 D. maybe less renowned then
62. F. NO CHANGE  
 G. wasn't any  
 H. were no  
 J. was no
63. A. NO CHANGE  
 B. Stax, infused with  
 C. Stax, which had  
 D. Stax with



[2]

Stax's unlikely founders, siblings Jim Stewart and Estelle Axton, were bankers themselves whom loved

64

music. They knew little about the music industry or soul,

65

but they had open minds and collected collaboration. Their open-door policy allowed unestablished or unconventional

66

artists (often ignored by bigger studios) to make their names at Stax. [B] Booker T. Jones, Carla Thomas, and

67

Otis Redding were just a few of more than thirty artists who recorded hits there.

68

[3]

That conversation included a range of perspectives rarely found at other studios. Despite the pervasive segregation of Memphis in the 1960s, when the Stax staff and house band were fully integrated. The "Stax family" also included people of various ages and economic backgrounds, all were contributing to Stax's unique sound. [C]

70

64. F. NO CHANGE

G. which

H. whom

J. who

65. A. NO CHANGE

B. Although they knew

C. While knowing

D. Knowing

66. F. NO CHANGE

G. summoned

H. convened

J. invited

67. If the writer were to delete the underlined portion, the essay would primarily lose a detail that:

A. helps explain why talented artists would join a fledgling studio run by people with little experience in the industry.

B. suggests why unestablished and unconventional artists were overlooked by the more exclusive studios.

C. indicates that bigger studios felt threatened by having Stax as a competitor.

D. establishes that Stewart and Axton knew little about the music industry.

68. Which choice would provide the most effective transition between this paragraph and the next paragraph?

F. NO CHANGE

G. worked closely with Stewart and Axton to make Stax a successful studio.

H. all became a part of the musical "conversation" happening there.

J. launched their careers at Stax.

69. A. NO CHANGE

B. 1960s, during which

C. 1960s; both

D. 1960s,

70. F. NO CHANGE

G. of this contributed

H. contributing

J. contributed



[4]

Another distinction was one of method. At most studios, performers worked, from previously arranged

<sup>71</sup>

sheet music. For example, Stax musicians spontaneously composed music together, a practice called *head*

<sup>72</sup>

*arranging*. Otis Redding might walk in and sing a

few lyrics to the band. The other musicians would

riff on his idea until a complete song emerged between

<sup>73</sup>

the collaboration. Then, they'd record the song without ever putting the notes on paper.

[5]

Even the building, for instance, helped to create the Stax sound. Recording equipment in the 1960s was

<sup>74</sup>

rudimentary by today's standards. [D] But the former

theater's sloped floor and bass-heavy movie speakers

gave recordings a deep, raw tone so distinctive that

aficionados can often recognize a Stax song within

the first few notes.

71. A. NO CHANGE  
B. studios, performers worked from  
C. studios performers worked, from  
D. studios performers worked from,

72. F. NO CHANGE  
G. In contrast,  
H. Likewise,  
J. Besides,

73. A. NO CHANGE  
B. from  
C. upon  
D. to

74. F. NO CHANGE  
G. building, consequently,  
H. building, however,  
J. building

Question 75 asks about the preceding passage as a whole.

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

In general, recorded music couldn't capture the depth of sound that could be heard at a live performance.

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

- A. Point A in Paragraph 1.  
B. Point B in Paragraph 2.  
C. Point C in Paragraph 3.  
D. Point D in Paragraph 5.

**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.

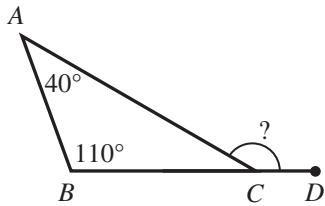
You are permitted to use a calculator on this test. You may use your calculator for any problems you choose,

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. In the figure below,  $C$  is on  $\overline{BD}$ ,  $\angle BAC$  measures  $40^\circ$ , and  $\angle ABC$  measures  $110^\circ$ . What is the measure of  $\angle ACD$ ?

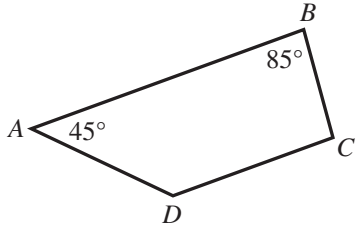


- A.  $110^\circ$   
 B.  $120^\circ$   
 C.  $130^\circ$   
 D.  $140^\circ$   
 E.  $150^\circ$
2. For what value of  $a$  is the equation  $\frac{1}{2}a + 10 = 6$  true?  
 F.  $-32$   
 G.  $-8$   
 H.  $-2$   
 J.  $8$   
 K.  $32$
3. What is the least common denominator of the fractions  $\frac{4}{15}$ ,  $\frac{1}{20}$ , and  $\frac{3}{8}$ ?  
 A.  $24$   
 B.  $120$   
 C.  $300$   
 D.  $480$   
 E.  $2,400$
4.  $|5 - 3| - |1 - 6| = ?$   
 F.  $-7$   
 G.  $-3$   
 H.  $3$   
 J.  $7$   
 K.  $15$

**DO YOUR FIGURING HERE.**



5. In the trapezoid below,  $\overline{AB}$  is parallel to  $\overline{DC}$ . What is the measure of  $\angle C$ ?



**DO YOUR FIGURING HERE.**

- A.  $50^\circ$   
 B.  $95^\circ$   
 C.  $115^\circ$   
 D.  $130^\circ$   
 E.  $135^\circ$
6. Gao earns his regular pay of \$12 per hour for up to 40 hours of work per week. For each hour over 40 hours of work per week, Gao is paid  $1\frac{1}{2}$  times his regular pay. How much does Gao earn in a week in which he works 56 hours?
- F. \$ 672  
 G. \$ 756  
 H. \$ 768  
 J. \$1,008  
 K. \$1,344
7. On the first day of school, Ms. Dubacek gave her third-grade students 6 new spelling words to learn. On each day of school after that, she gave the students 3 new spelling words. How many new spelling words had she given the students by the end of the 21st day of school?
- A. 60  
 B. 63  
 C. 66  
 D. 69  
 E. 72
8. What is the value of the expression  $\frac{8!}{(4!)^2}$  ?  
 (Note:  $3! = 3(2)(1)$  and  $6! = 6(5)(4)(3)(2)(1)$ )
- F. 0  
 G.  $\frac{1}{2}$   
 H. 1  
 J. 70  
 K. 420

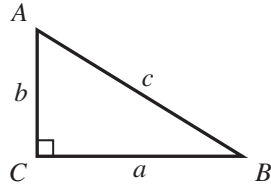
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9. Right triangle  $\triangle ABC$  and its side lengths given in inches are shown below. What is  $\sin B$ ?

- A.  $\frac{a}{b}$   
 B.  $\frac{a}{c}$   
 C.  $\frac{b}{a}$   
 D.  $\frac{b}{c}$   
 E.  $\frac{c}{a}$



DO YOUR FIGURING HERE.

10.  $(6a^3 - 5ac^2 + 12c) - (4c - 3a^3 - 2ac^2)$  is equivalent to:

- F.  $2a^3 - 2ac^2 + 14c$   
 G.  $3a^3 - 7ac^2 + 16c$   
 H.  $9a^3 - 3ac^2 + 8c$   
 J.  $3a^6 - 7a^2c^4 + 16c^2$   
 K.  $9a^6 - 3a^2c^4 + 8c^2$

11. Which of the following  $(x,y)$  pairs is the solution for the system of equations  $x + 2y = 2$  and  $-x + y = 7$ ?

- A.  $(-4,3)$   
 B.  $(-1,1.5)$   
 C.  $(1,0.5)$   
 D.  $(0,1)$   
 E.  $(2,0)$

12. Tim's flight was originally scheduled to depart at 4:51 p.m., but it was delayed 563 minutes. What time did Tim's flight eventually depart?

- F. 1:12 a.m.  
 G. 1:28 a.m.  
 H. 2:14 a.m.  
 J. 10:14 p.m.  
 K. 10:54 p.m.

13. A circle with the equation  $x^2 + y^2 = 144$  is graphed in the standard  $(x,y)$  coordinate plane. At what points does the circle intersect the  $x$ -axis?

- A.  $(-6,0)$  and  $(6,0)$   
 B.  $(-12,0)$  and  $(12,0)$   
 C.  $(-24,0)$  and  $(24,0)$   
 D.  $(-72,0)$  and  $(72,0)$   
 E.  $(-144,0)$  and  $(144,0)$

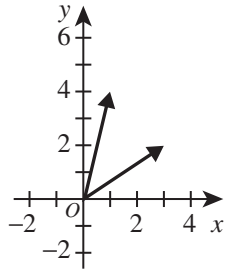
14. Given that  $x^2 - 5x - 36$  factors into 2 binomial factors with integer coefficients, which of the following binomials is 1 of those factors?

- F.  $x - 12$   
 G.  $x - 9$   
 H.  $x - 4$   
 J.  $x + 6$   
 K.  $x + 12$

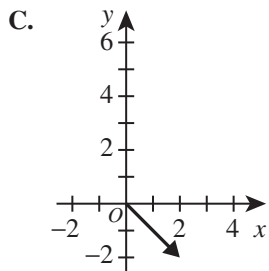
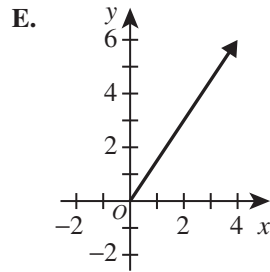
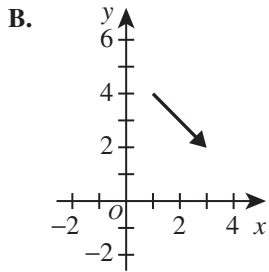
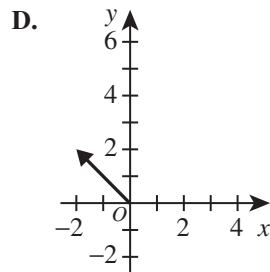
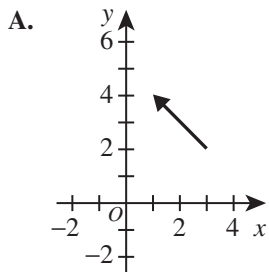


15. Two vectors are shown in the standard  $(x,y)$  coordinate plane below.

DO YOUR FIGURING HERE.



One of the following vectors in the standard  $(x,y)$  coordinate plane is the sum of these 2 vectors. Which one?



16. A square and a rectangle have the same area. The length of the rectangle is 196 centimeters, and the width of the rectangle is 4 centimeters. What is the length, in centimeters, of a side of the square?

- F. 20  
G. 28  
H. 100  
J. 400  
K. 784



17. T-shirts are on sale for  $D$  dollars each, including tax. Valentina has  $N$  dollars with which to purchase T-shirts. After she purchases the *maximum* number she can,  $Q$  T-shirts, she has  $R$  dollars left. For all possible choices of  $D$  and  $N$ , which of the following equations models a correct relationship between  $D$ ,  $N$ ,  $Q$ , and  $R$ , as defined?

- A.  $N = Q + R$
- B.  $N = Q + RD$
- C.  $N = QD + RD$
- D.  $N = QD + R$
- E.  $N = QR + D$

18. At a sandwich shop, customers can order either a meat or a vegetarian sandwich on either white or wheat bread. Out of a total of 50 customers, 20 ordered a sandwich on white bread, 28 ordered a meat sandwich, and 12 ordered a meat sandwich on white bread. The given information is summarized in the table below.

Type of bread	Meat	Vegetarian	Total
White	12	?	20
Wheat	?	?	?
Total	28	?	50

How many customers ordered a vegetarian sandwich on wheat bread?

- F. 2
  - G. 8
  - H. 10
  - J. 14
  - K. 16
19. A team of biologists tagged and released 90 deer in a forest. From the same forest 2 weeks later, the biologists collected a random sample of 30 deer, 5 of which were tagged. Let  $p$  be the proportion of deer in this forest that are tagged. What is  $\hat{p}$ , the sample proportion, for this sample?

- A.  $\frac{1}{24}$
- B.  $\frac{1}{18}$
- C.  $\frac{1}{6}$
- D.  $\frac{1}{5}$
- E.  $\frac{1}{3}$

20.  $\sqrt{2} + \sqrt{8} + \sqrt{18} = ?$

- F.  $2\sqrt{7}$
- G.  $6\sqrt{2}$
- H.  $12\sqrt{2}$
- J.  $14\sqrt{2}$
- K. 14

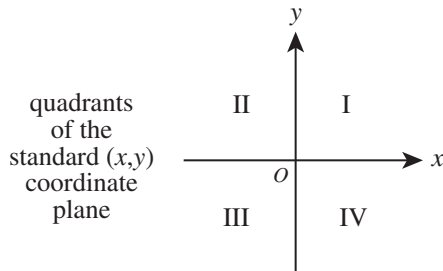
**DO YOUR FIGURING HERE.**



21. Which of the following inequalities is equivalent to  $3 - 2x > 7 - x$ ?

- A.  $x < -\frac{4}{3}$
- B.  $x > -\frac{4}{3}$
- C.  $x < -4$
- D.  $x > -4$
- E.  $x > 6$

22. Let  $a$  be positive and  $b$  be negative. If it can be determined, in which quadrant of the standard  $(x,y)$  coordinate plane is the point  $(-a, b^2)$  located?



- F. I
  - G. II
  - H. III
  - J. IV
  - K. Cannot be determined from the given information
23. The mass of a certain type of bacteria grows exponentially, doubling every 20 minutes. What was the mass, in milligrams, of the bacteria exactly 2 hours after the mass first reached 10 milligrams?
- A. 70
  - B. 200
  - C. 320
  - D. 640
  - E. 4,000
24. One day will be randomly selected from the 7 days in a week. Then 1 month will be randomly selected from the 12 months in a year. What is the probability that the selected day will be Tuesday and the selected month will be January?
- F.  $\frac{1}{84}$
  - G.  $\frac{1}{42}$
  - H.  $\frac{1}{19}$
  - J.  $\frac{2}{19}$
  - K.  $\frac{19}{84}$

**DO YOUR FIGURING HERE.**



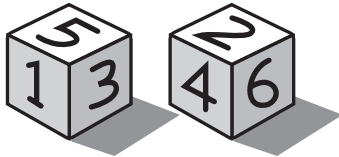
25. The average weight of Juan, Jim, and Malik is exactly 160 pounds. The average weight of Juan, Jim, Malik, and Harry is exactly 150 pounds. How many pounds does Harry weigh?
- A. 100  
B. 120  
C. 130  
D. 155  
E. 190

**DO YOUR FIGURING HERE.**

26. What is the value of the expression  $(\log_6(36))(\log_3(9))$  ?
- F. 2  
G. 3  
H. 4  
J. 5  
K. 18

27. Each of 2 identical number cubes, shown below, has a different integer, 1 through 6, on each face. Consider the sample space determined by rolling these number cubes and adding the 2 integers on the faces that land on top. What is the positive difference between the greatest sum and the least sum in this sample space?

- A. 5  
B. 10  
C. 11  
D. 12  
E. 34



28. What angle measure, in radians, is equal to  $30^\circ$  ?
- F.  $\frac{\pi}{6}$   
G.  $\frac{\pi}{5}$   
H.  $\frac{\pi}{3}$   
J.  $\frac{\pi}{2}$   
K.  $\frac{5\pi}{6}$

29. For one school week, Hannah recorded the following temperatures, in degrees Fahrenheit, so she could investigate the difference between the high and low temperature each day.

<u>Day</u>	<u>Low</u>	<u>High</u>
Monday	$-3^\circ$	$26^\circ$
Tuesday	$-5^\circ$	$32^\circ$
Wednesday	$-7^\circ$	$22^\circ$
Thursday	$3^\circ$	$40^\circ$
Friday	$2^\circ$	$40^\circ$

To the nearest degree, what was the mean of the differences in daily high and low temperatures for these 5 days?

- A.  $28^\circ$   
B.  $29^\circ$   
C.  $30^\circ$   
D.  $32^\circ$   
E.  $34^\circ$



30. A family's budgeted items are expressed as a fraction of their weekly income in the chart below.

**DO YOUR FIGURING HERE.**

Expense	Fraction of income
fixed	$\frac{3}{8}$
food	$\frac{1}{4}$
utilities	$\frac{1}{8}$
transportation	$\frac{1}{12}$
personal	$\frac{1}{16}$
entertainment	$\frac{1}{24}$

What fractional part of their weekly income is left for unbudgeted items?

- F.  $\frac{5}{48}$
- G.  $\frac{1}{48}$
- H.  $\frac{1}{24}$
- J.  $\frac{1}{16}$
- K.  $\frac{1}{8}$
31. What is the 322nd digit after the decimal point in the repeating decimal  $0.\overline{1357}$  ?
- A. 0
- B. 1
- C. 3
- D. 5
- E. 7
32. You and a friend each have a can full of water. You start pouring the water from your can into an empty bucket at a constant rate of 4 ounces per second. While you are still pouring water, 3 seconds after you started, your friend starts pouring the water from her can into the same bucket at a constant rate of 2 ounces per second. How many seconds after you first started pouring the water into the bucket will it contain 24 ounces of water?
- F. 4
- G. 5
- H. 6
- J. 8
- K. 12



33. A package of candy contains pieces each of which is 1 of 6 possible colors: brown, red, green, yellow, orange, and blue. In each package,  $\frac{1}{3}$  of the pieces are brown and the remaining pieces have an even distribution of the other 5 colors. What is the probability that a piece drawn randomly from the package is red?

- A.  $\frac{1}{15}$
- B.  $\frac{2}{15}$
- C.  $\frac{1}{6}$
- D.  $\frac{1}{5}$
- E.  $\frac{2}{3}$

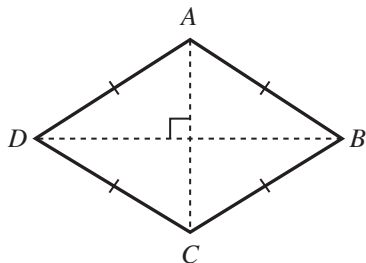
34. Which of the following intervals is the range of the function  $f(x) = -(x - 3)^2 + 4$ ?

- F.  $(-\infty, 3]$
- G.  $(-\infty, 4]$
- H.  $[3, 4]$
- J.  $[3, \infty)$
- K.  $[4, \infty)$

35. Anoki made a scale drawing of his rectangular classroom. The classroom is 7.5 meters by 9.0 meters. In his scale drawing, Anoki made the length of the shorter side of the classroom 9.0 centimeters. What is the length, in centimeters, of the longer side of the classroom in Anoki's scale drawing?

- A. 7.5
- B. 10.5
- C. 10.8
- D. 15.0
- E. 16.5

36. In rhombus  $ABCD$  shown below,  $AC = 5$  feet and  $BD = 6$  feet. What is the area of  $ABCD$ , in square feet?



- F. 5.5
- G. 7.5
- H. 11
- J. 15
- K. 30

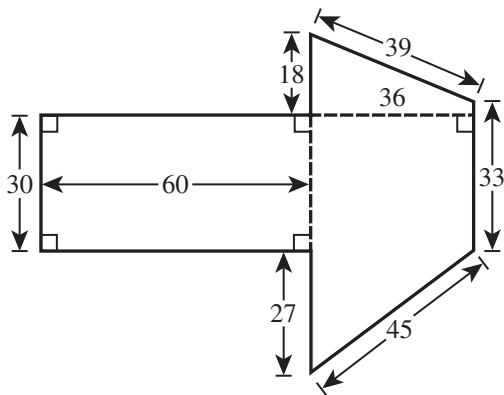
**DO YOUR FIGURING HERE.**



37. One number is 25% of a second number, and the second number is 70% of a third number. The first number is what percent of the third number?
- A. 17.5%
  - B. 42.5%
  - C. 45%
  - D. 87.5%
  - E. 95%

DO YOUR FIGURING HERE.

38. The monthly rent charged for a store at Center Street Mall is \$2 per square foot of floor area. The floor plan of a store at Center Street Mall is shown in the figure below, with right angles as indicated and all distances given in feet. How much monthly rent is charged for this store?



- F. \$1,656
  - G. \$1,872
  - H. \$6,624
  - J. \$7,380
  - K. \$7,488
39. Mrs. Neeson, a science teacher, told her students that 30.0% of their final semester grades will come from their homework averages, and the remaining 70.0% will come from their test averages. She also said that the final exam will count for 20.0% of the test average. What percent of the science final semester grade is the final exam grade?
- A. 6.0%
  - B. 10.5%
  - C. 14.0%
  - D. 20.0%
  - E. 28.6%
40. A rectangle with an area of 30 square inches has length and width, in inches, that are both integers. Which of the following CANNOT be the perimeter, in inches, of the rectangle?
- F. 22
  - G. 26
  - H. 34
  - J. 60
  - K. 62





Use the following information to answer questions 41–43.

DO YOUR FIGURING HERE.

A couple is deciding between 2 condos to purchase. Some information about each condo is given below.

Property details	List price	Area in ft <sup>2</sup>	Price per ft <sup>2</sup>	Annual property tax
Condo X	\$210,000	2,274	\$92	\$3,824
Condo Y	\$189,900	1,726	?	\$3,524

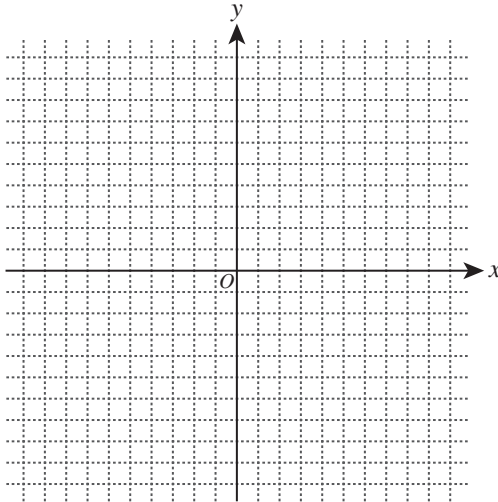
The couple assumes that the market value of either condo will increase exponentially at a rate of 4% per year.

41. What is the positive difference, in dollars, of the 2 list prices?
- A.  $2.01 \times 10^2$   
 B.  $2.01 \times 10^3$   
 C.  $2.01 \times 10^4$   
 D.  $2.10 \times 10^4$   
 E.  $2.10 \times 10^5$
42. The couple will consider the price per square foot of each condo. Let  $x$  and  $y$  be the price per square foot, rounded to the nearest \$1, of Condo X and Condo Y, respectively. One of the following comparisons is true. Which one?
- F.  $x$  is \$ 3 greater than  $y$ .  
 G.  $x$  is \$ 6 less than  $y$ .  
 H.  $x$  is \$ 6 greater than  $y$ .  
 J.  $x$  is \$18 less than  $y$ .  
 K.  $x$  is \$18 greater than  $y$ .
43. The annual property tax for Condo X is 2% of its assessed value. What is the assessed value of Condo X ?
- A. \$ 19,120  
 B. \$ 42,000  
 C. \$186,200  
 D. \$191,200  
 E. \$205,900
- 
44. In the complex plane, consider the segment whose endpoints are the points corresponding to  $-6 + 3i$  and  $2 - 7i$ . The midpoint of this segment corresponds to which of the following complex numbers?
- F.  $-4 - 4i$   
 G.  $-4 + 5i$   
 H.  $-2 - 2i$   
 J.  $-2 + 2i$   
 K.  $4 + 5i$

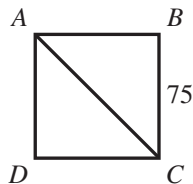


45. In the standard  $(x,y)$  coordinate plane, the 3 lines with equations  $y = \frac{3}{5}x - 3$ ,  $y = -\frac{2}{5}x + 2$ , and  $x = 0$  bound a triangular region. What is the area, in square coordinate units, of that triangular region? (A blank grid has been provided for your use.)

DO YOUR FIGURING HERE.



- A. 2.5  
 B. 5.0  
 C. 7.5  
 D. 12.5  
 E. 62.5
46. In square  $ABCD$  shown below,  $\overline{AC}$  is a diagonal and the length of  $\overline{BC}$  is 75 feet. Which of the following quantities is NOT a rational number?



- F. The perimeter of  $ABCD$ , in feet  
 G. The area of  $ABCD$ , in square feet  
 H. The length of  $\overline{AB}$ , in feet  
 J. The length of  $\overline{AC}$ , in feet  
 K. The measure of  $\angle CAD$ , in degrees
47. The volume of a solid object is equal to the volume of water it displaces when completely submerged in water. A solid object will be placed in a rectangular tank that has a base of 35 cm by 30 cm and is filled with water to a uniform depth of 13 cm. When the object is completely submerged, the new depth of the water in the tank is 15 cm. What is the volume, in cubic centimeters, of the object?
- A. 135  
 B. 525  
 C. 780  
 D. 1,212  
 E. 2,100

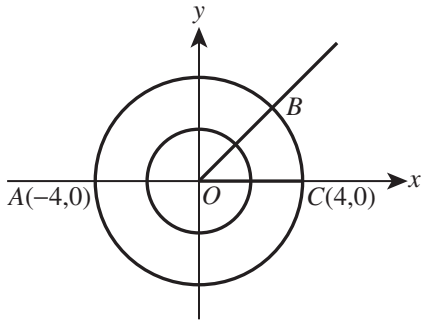
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Use the following information to answer questions 48–51.

DO YOUR FIGURING HERE.

The 2 circles graphed in the standard  $(x,y)$  coordinate plane below are centered at the origin,  $O$ . In coordinate units, the radius of the smaller circle is 2, and the radius of the larger circle is 4. Points  $A(-4,0)$ ,  $B$ , and  $C(4,0)$  are on the larger circle. The measure of  $\angle BOC$  is  $45^\circ$ .



(Note: Both axes have the same scale.)

48. What is the  $x$ -coordinate of  $B$ ?

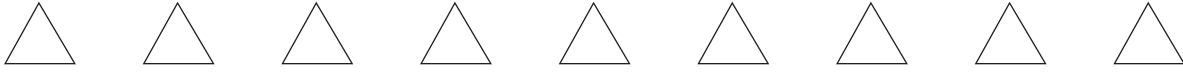
- F.  $\frac{4}{\sqrt{3}}$
- G.  $\frac{4}{\sqrt{2}}$
- H. 4
- J.  $4\sqrt{2}$
- K.  $4\sqrt{3}$

49. A 3rd circle, not shown, is the image resulting from applying the 1st transformation listed below to the *smaller* circle and then applying the 2nd transformation listed below to the result of the 1st transformation.

- 1st: A dilation with center  $O$  and scale factor 2
- 2nd: A translation of 8 coordinate units to the right

The 3rd circle has how many points in common with the *larger* circle?

- A. 0
  - B. 1
  - C. 2
  - D. 4
  - E. Infinitely many
50. What is the area, in square coordinate units, of the region that is outside the smaller circle and inside the larger circle?
- F.  $4\pi$
  - G.  $12\pi$
  - H.  $20\pi$
  - J.  $48\pi$
  - K.  $80\pi$



51. Which of the following is an equation of  $\overleftrightarrow{OB}$  ?

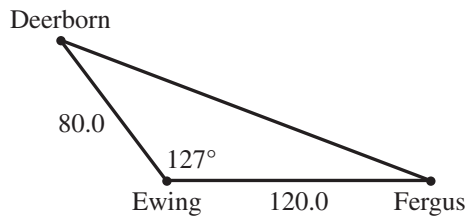
- A.  $y = -4x$
- B.  $y = -x$
- C.  $y = x$
- D.  $y = 2x$
- E.  $y = 4x$

DO YOUR FIGURING HERE.

52. A sequence is given by  $s_1 = 4$  and  $s_{n+1} = 2s_n - 3$  for  $n \geq 1$ . What is  $s_5$  ?

- F. 5
- G. 7
- H. 11
- J. 19
- K. 35

53. In the figure below, the distances between 2 pairs of cities are shown, as well as the angle formed at Ewing, which has a measure of  $127^\circ$ . Which of the following values is closest to the distance, in miles, from Deerborn to Fergus?



(Note:  $\cos 127^\circ \approx -0.6$ ;  $\sin 127^\circ \approx 0.8$ )

- A. 100
- B. 140
- C. 160
- D. 180
- E. 200

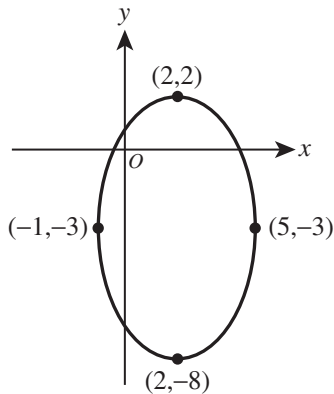
54. Which of the following expressions is equivalent to

$$\frac{1}{x-a} - \frac{1}{x+a} ?$$

- F.  $\frac{2a}{x^2 - a^2}$
- G.  $\frac{a^2}{x^2 - a^2}$
- H.  $\frac{2x}{x^2 - a^2}$
- J.  $\frac{1}{x^2 - a^2}$
- K.  $-\frac{1}{2a}$



55. One of the following equations represents the ellipse shown below in the standard  $(x,y)$  coordinate plane. Which one?



- A.  $\frac{(x-2)^2}{3} + \frac{(y+3)^2}{5} = 1$   
 B.  $\frac{(x+2)^2}{3} + \frac{(y-3)^2}{5} = 1$   
 C.  $\frac{(x+2)^2}{5} + \frac{(y-3)^2}{3} = 1$   
 D.  $\frac{(x-2)^2}{9} + \frac{(y+3)^2}{25} = 1$   
 E.  $\frac{(x+2)^2}{9} + \frac{(y-3)^2}{25} = 1$
56. One of the following equations is that of a parabola with  $x$ -intercepts  $-5$  and  $\frac{3}{4}$  in the standard  $(x,y)$  coordinate plane. Which equation?
- F.  $y = 3x^2 - 11x - 20$   
 G.  $y = 3x^2 + 11x - 20$   
 H.  $y = 4x^2 - 17x - 15$   
 J.  $y = 4x^2 + 17x - 15$   
 K.  $y = 15x^2 - 17x - 4$

57. There are 100 fractions in the following set.

$$\left\{ \frac{1}{4}, \frac{4}{7}, \frac{7}{10}, \frac{10}{13}, \dots, \frac{292}{295}, \frac{295}{298}, \frac{298}{301} \right\}$$

Each fraction after the first is found by adding 3 to the preceding fraction's numerator *and* denominator. What is the product of these 100 fractions?

- A. 1  
 B.  $\frac{1}{3}$   
 C.  $\frac{1}{4}$   
 D.  $\frac{1}{100}$   
 E.  $\frac{1}{301}$

DO YOUR FIGURING HERE.



58. If  $2^x = 7$  and  $2^y = 14$ , then  $x - y = ?$

F. -14  
 G. -7  
 H. -1  
 J. 1  
 K. 49

**DO YOUR FIGURING HERE.**

59. The table indicates the grade (10 or 11) and high school (North or South) of the 270 students enrolled in Algebra II in the Green City School District.

	North	South
Grade 10	47	93
Grade 11	73	57

Suppose 2 of these students will be chosen at random to represent the Algebra II classes at a local STEM (Science, Technology, Engineering, and Mathematics) event. Which of the following expressions gives the probability that both chosen students will be from the same grade and the same high school?

- A.  $\frac{47(46)}{270(269)} + \frac{93(92)}{270(269)} + \frac{73(72)}{270(269)} + \frac{57(56)}{270(269)}$   
 B.  $\frac{1}{4} \left( \frac{47}{270} + \frac{93}{270} + \frac{73}{270} + \frac{57}{270} \right)$   
 C.  $\frac{47(73)}{270(269)} + \frac{93(57)}{270(269)}$   
 D.  $\frac{47(93)}{270(269)} + \frac{73(57)}{270(269)}$   
 E.  $\frac{1}{4} \left( \frac{1}{4} \right)$
60. A certain company has 120 employees, 85 of whom have business degrees. Of the employees with business degrees, 75 are certified public accountants (CPAs). There are 14 employees who are not CPAs and also do not hold a business degree. One employee of the company will be selected at random to be interviewed for a television news program. What is the probability that the selected employee will be a CPA ?

(Note: A business degree is NOT required to be a CPA.)

F.  $\frac{75}{120}$   
 G.  $\frac{85}{120}$   
 H.  $\frac{89}{120}$   
 J.  $\frac{96}{120}$   
 K.  $\frac{99}{120}$

**END OF TEST 2**

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

**DO NOT RETURN TO THE PREVIOUS TEST.**

## READING TEST

35 Minutes—40 Questions

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

## Passage I

**LITERARY NARRATIVE:** This passage, which includes an essay by Angie Cruz, is adapted from the unattributed article “First Addresses, Seared in Memory” (©2006 by The New York Times).

In the full article “First Addresses, Seared in Memory,” several established writers respond to the quotation from *Breakfast at Tiffany’s* by exploring how their first apartments influenced them as writers.

In the introduction to his 1958 novella “Breakfast at Tiffany’s,” no less a luminary than Truman Capote wrote of his first New York apartment, a one-room apartment in a brownstone in the East 70’s:

5 The walls were stucco, and a color rather like tobacco-spit. Everywhere, in the bathroom too, there were prints of Roman ruins freckled brown with age. The single window looked out on a fire escape. Even so, my spirits heightened whenever I felt in my pocket the key to this apartment; with all its gloom, it still was a place of my own, the first, and my books were there, and jars of pencils to sharpen, everything I needed, so I felt, to become the writer I wanted to be.

With housing costs throughout the city more prohibitive than ever, acquiring one’s first New York apartment is a far more daunting task than it was even a decade ago. But there is no question that the experience of one’s first place in the city is a transforming rite of passage. Angie Cruz remembers hers:

15 In 1997, I returned to the city from college upstate to study creative writing at New York University and found a sublet in my old neighborhood, Washington Heights. It was a steal, \$600 a month for an L-shaped one-bedroom in a prewar building at 615 West 164th Street. All the apartments faced the courtyard, and as if watching a stage from a production booth, I saw my relatives and longtime neighbors across the way from my second-floor window.

25 Because I wanted color and to hide the defects on the walls, I painted the bedroom an oceanic blue, the living room the color of a mango, the bathroom a leaf green.

40 The apartment bore signs of its past and wasn’t perfect. The dumbwaiter had been turned into a pantry. The kitchen cabinets didn’t close all the way, and the wooden floors were hidden by beige industrial tiles. Then there were the plumbing ghosts. My toilet flushed randomly, all by itself, and the sink in the kitchen filled up with bubbles when the lady upstairs did her wash.

45 I woke up in the morning with the sunlight, and from my kitchen window I often greeted my grandmother, who lived across the courtyard, her asking me, “Are you still studying up there?”

50 That had been my explanation when she asked me why didn’t I have a job with good benefits. “Estudiando” is the one word that magically answered all the questions from my relatives when I locked myself up and didn’t pick up the phone, even when they saw that my light was on. “We are estudiando,” I said, when my relatives stood at my front door holding plastic containers filled with dinner, and saw a group of women crowded in the living room plotting an event, discussing politics, sharing their writing.

65 Although my apartment was a snug 500 square feet, filled with books, museum posters and my very bad but honest figurative paintings, the rooms seemed to swell in size when other writers needed a place to stay. And so my apartment was often full of people coming and going, crammed with additional desks and beds for short-term stays. There was always a fresh batch of iced tea in the fridge, an answering machine to answer my calls, photographs on my desk of all the people I love.

75 The wooden and ceramic dolls I collected from different parts of the world watched over my laptop. My desk faced the courtyard, a neglected garden overgrown with weeds. In the late afternoon I could see if my sassy grandmother was home from her job at the lamp factory in New Jersey, and when the radio next door wasn’t at full blast, I could hear my aunt, who also lived across the courtyard, yelling after my teenage nephew from her window.

85 There were also moments when it was quiet,  
and the merengue-loving neighbors were  
taking their afternoon siesta. In one of those  
rare quiet moments, I remember having a revela-  
90 tion while staring at a draft of my first novel  
on my desk, that if I had waited to tell my story  
until I had a room of my own, as opposed to a  
place that always brimmed with people, I  
would never have finished that novel.

95 But even more so, without all the family mem-  
bers, who showed up with leftovers and slipped  
\$20 in my hand when I looked tired from long  
nights at freelance jobs teaching, editing and  
even window-designing while “estudiando” for  
100 my master’s degree, I wouldn’t have had the  
confidence that I was right to continue to live  
my life as a writer. It was the spirit of all that  
collective activity inside that apartment with  
elastic walls that gave birth to my first novel.

1. As presented in the passage, Capote’s and Cruz’s attitudes toward the condition of their apartments can best be described as:
  - A. similar; they were both disappointed in their old, shabby apartments.
  - B. similar; the apartments’ defects didn’t keep them from appreciating their apartments.
  - C. different; Capote was disappointed in his apartment’s shabbiness, whereas Cruz felt at home despite her apartment’s defects.
  - D. different; Capote felt at home despite his apartment’s defects, whereas Cruz was disappointed in her apartment’s shabbiness.
2. Details in the passage indicate that, compared to Cruz’s first apartment, Capote’s first apartment:
  - F. was somewhat larger.
  - G. had less natural light.
  - H. was in a different city.
  - J. had a clearer view.
3. The primary writing mode of Cruz’s essay is:
  - A. descriptive; Cruz uses imagery and specific details to portray her surroundings.
  - B. narrative; Cruz recounts the main events of her writing career.
  - C. persuasive; Cruz uses events from her life to argue that family support systems are crucial.
  - D. expository; Cruz explains how to thrive in a flawed apartment.
4. The main idea of the ninth paragraph (lines 62–72) is that Cruz’s apartment was:
  - F. too small and cluttered to hold all the people who wanted to stay there.
  - G. a hospitable, welcoming place despite its clutter and small size.
  - H. decorated with posters and pictures brought by Cruz’s many visitors.
  - J. much like an office building, with people hurriedly coming and going.
5. The main function of the tenth paragraph (lines 73–82) is to:
  - A. analyze the relationship Cruz had with her grandmother.
  - B. explain how world travel and music influenced Cruz’s writing.
  - C. depict the sights and sounds Cruz encountered while at her desk.
  - D. reveal Cruz’s frustration with the cluttered, noisy apartment complex.
6. Which of the following statements best captures Cruz’s revelation as it is presented in lines 86–92?
  - F. For Cruz, a quiet, solitary place to write wasn’t available and may not have been helpful.
  - G. Cruz was opposed to the idea that a room full of people is more inspiring than a quiet one.
  - H. For Cruz, writing came most easily during quiet moments.
  - J. Cruz needed to make the most of the few quiet moments she could find.
7. According to the passage, without her family members, Cruz wouldn’t have:
  - A. obtained a college degree.
  - B. felt confident about her career choice.
  - C. been able to pay rent for her apartment.
  - D. continued her freelance teaching jobs.
8. According to the passage, acquiring an apartment in New York has become more daunting because:
  - F. there are fewer apartments in the city.
  - G. it has become a transforming rite of passage.
  - H. more people are moving to the city.
  - J. apartments have become more expensive.
9. According to Cruz, she returned to the city to:
  - A. be near family.
  - B. find an apartment.
  - C. finish her second novel.
  - D. study creative writing.
10. Based on the passage, Cruz considered the rent she paid for her apartment to be:
  - F. lower than that of similar apartments.
  - G. too high for a one-bedroom in a prewar building.
  - H. more than she had expected to pay.
  - J. less than she had paid in the past.



## Passage II

**SOCIAL SCIENCE:** This passage is adapted from the book *The Disappearing Spoon* by Sam Kean (©2010 by Sam Kean).

*Aluminium* is the British spelling of *aluminum*.

A number of brilliant chemists devoted their careers to aluminium throughout the 1800s, and it's hard to judge whether the element was better or worse off afterward. A Danish chemist and a German chemist simultaneously extracted this metal from the ancient astringent alum around 1825. (Alum is the powder cartoon characters like Sylvester the cat sometimes swallow that makes their mouths pucker.) Because of its luster, mineralogists immediately classified aluminium as a precious metal, like silver or platinum, worth hundreds of dollars an ounce.

Twenty years later, a Frenchman figured out how to scale up these methods for industry, making aluminium available commercially. For a price. It was still more expensive than even gold. That's because, despite being the most common metal in the earth's crust—around 8 percent of it by weight, hundreds of millions of times more common than gold—aluminium never appears in pure, mother lode-al form. It's always bonded to something, usually oxygen. Pure samples were considered miracles. The French once displayed Fort Knox-like aluminium bars next to their crown jewels, and the minor emperor Napoleon III reserved a prized set of aluminium cutlery for special guests at banquets. (Less favored guests used gold knives and forks.) In the United States, government engineers, to show off their country's industrial prowess, capped the Washington Monument with a six-pound pyramid of aluminium in 1884. A historian reports that one ounce of shavings from the pyramid would have paid a day's wages for each of the laborers who erected it.

Aluminium's sixty-year reign as the world's most precious substance was glorious, but soon an American chemist ruined everything. The metal's properties—light, strong, attractive—tantalized manufacturers, and its omnipresence in the earth's crust had the potential to revolutionize metal production. It obsessed people, but no one could figure out an efficient way to separate it from oxygen. At Oberlin College in Ohio, a chemistry professor named Frank Fanning Jewett would regale his students with tales of the aluminium El Dorado that awaited whoever mastered this element. And at least one of his students had the naïveté to take his professor seriously.

In his later years, Professor Jewett bragged to old college chums that “my greatest discovery was the discovery of a man”—Charles Hall. Hall worked with Jewett on separating aluminium throughout his undergraduate years at Oberlin. He failed and failed and failed again, but failed a little more smartly each time. Finally, in 1886, Hall ran an electric current from hand-made batteries (power lines didn't exist) through a liquid with dissolved aluminium compounds. The energy from the current zapped and liberated the pure

metal, which collected in minute silver nuggets on the bottom of the tank. The process was cheap and easy, and it would work just as well in huge vats as on the lab bench. This had been the most sought-after chemical prize since the philosopher's stone, and Hall had found it. The “aluminium boy wonder” was just twenty-three.

Hall's fortune, however, was not made instantly. Chemist Paul Héroult in France stumbled on more or less the same process at the same time. (Today Hall and Héroult share credit for the discovery that crashed the aluminium market.) An Austrian invented another separation method in 1887, and with the competition bearing down on Hall, he quickly founded what became the Aluminium Company of America, or Alcoa, in Pittsburgh. It turned into one of the most successful business ventures in history.

Aluminium production at Alcoa grew at exponential rates. In its first months in 1888, Alcoa eked out 50 pounds of aluminium per day; two decades later, it had to ship 88,000 pounds per day to meet the demand. And while production soared, prices plummeted. Years before Hall was born, one man's breakthrough had dropped aluminium from \$550 per pound to \$18 per pound in seven years. Fifty years later, not even adjusting for inflation, Hall's company drove down the price to 25 cents per pound. And thanks to Hall, aluminium became the utterly blasé metal we all know, the basis for pop cans and ping-pong Little League bats and airplane bodies. (A little anachronistically, it still sits atop the Washington Monument, too.) I suppose it depends on your taste and temperament whether you think aluminium was better off as the world's most precious or most productive metal.

11. The passage can best be described as an:
- evaluation of Hall and his company's effects on the world economy.
  - assessment of major discoveries in chemistry during the nineteenth century.
  - overview of how the perception of aluminum's value changed and Hall's role in that change.
  - argument that aluminium should still be considered a precious metal due to its value to manufacturers.
12. Based on the passage, the author would most likely agree with which of the following statements?
- It is unclear why aluminum was originally classified as being similar to metals like silver and platinum.
  - It is uncertain whether mineralogists or chemists were ultimately more responsible for the widespread use of aluminum.
  - There is no clear evidence for why aluminum's price dropped substantially years before Hall began experimenting with the metal.
  - It is difficult to definitively judge whether aluminum's status was bettered or worsened by the attention it received in the 1800s.

13. In the context of the passage, what does the author most nearly mean when he says that “an American chemist ruined everything” (lines 33–34)?
- A. Hall was the first to discover how to extract pure aluminum from the earth’s crust.
  - B. Hall made aluminum commercially available to manufacturers for a very high price.
  - C. Hall’s work with aluminum quickly stripped it of its status as a rare and precious metal.
  - D. Hall founded his company in the United States long before other countries had the tools to produce aluminum.
14. In the passage, which of the following individuals or groups is presented as believing in Jewett’s “aluminum El Dorado” (line 41)?
- F. Most students at Oberlin
  - G. Manufacturers in France
  - H. Héroult
  - J. Hall
15. The main point of the fourth paragraph (lines 45–60) is that:
- A. Hall failed for years in his experimentation with aluminum.
  - B. Hall found an ideal solution to a confounding scientific problem.
  - C. Jewett’s experiments with electricity led to a major scientific discovery.
  - D. despite its success in the lab, Hall’s breakthrough wasn’t initially practical on an industrial level.
16. The passage indicates that Hall moved quickly to found Alcoa because:
- F. other scientists’ work was rapidly beginning to rival his own.
  - G. he much preferred developing a business to studying chemistry.
  - H. his professors were pressuring him to begin producing aluminum commercially.
  - J. he wanted to distance himself from Héroult, who tried to take credit for Hall’s discovery.
17. The author most likely includes the information about Napoleon III primarily to:
- A. illustrate how commonplace gold had become by the 1880s.
  - B. highlight the extravagant wealth of the French royalty.
  - C. emphasize just how highly esteemed aluminum once was.
  - D. suggest that the nineteenth-century fascination with aluminum was felt primarily by the French.
18. According to the passage, the Washington Monument was capped with a pyramid of aluminum because:
- F. the pyramid’s high cost was meant to symbolize the overall value of the monument to the United States.
  - G. aluminum was a commonly used building material at the time the monument was erected.
  - H. US engineers wanted to outdo the lavish displays of wealth put on by French royalty.
  - J. the US government wanted to flaunt the United States’ industrial might.
19. The passage indicates that before Hall’s discovery, manufacturers were interested in using aluminum in part because of the metal’s:
- A. strength.
  - B. popularity.
  - C. purity.
  - D. cheapness.
20. The author most likely uses the word *stumbled* (line 62) to suggest that:
- F. the mistakes Hall made in his initial experiments were later remedied by Héroult.
  - G. Héroult’s discovery may have been more accidental than intentional.
  - H. the problems Hall faced during his experiments were not experienced by Héroult.
  - J. Héroult was the first to discover an entirely new process for obtaining aluminum.

## Passage III

**HUMANITIES:** Passage A is adapted from the article “Dylan’s Electric Kiss-Off” by Damien Cave et al. (©2004 by Rolling Stone LLC). Passage B is adapted from *American Popular Music: The Rock Years* by Larry Starr and Christopher Waterman (©2006 by Oxford University Press).

## Passage A by Damien Cave et al.

The most notorious live performance in rock & roll lasted about fifteen minutes: three songs played at assaultive volume by a plugged-in blues band fronted by the young poet-king of American folk music, at the sacred annual congress of acoustic purists, the Newport Folk Festival. In that quarter-hour, on the warm Sunday evening of July 25th, 1965, at Freebody Park in Newport, Rhode Island, Bob Dylan, 24—backed by the electric-Chicago charge of the Paul Butterfield Blues Band—declared his independence from the orthodoxy of the folk scene and publicly unveiled his rock & roll heart.

Dylan paid for his daring. Some witnesses claimed that he left the stage in tears—shocked by the shouting and heckling from several members of the Newport audience—before going back out to do penance: two acoustic numbers. Butterfield guitarist Mike Bloomfield said Dylan “looked real shook up.” But Al Kooper, who joined the Butterfield Band that fateful night as guest organist, insists that the catcalls are a myth: “It wasn’t ‘Boo, boo, boo.’ It was ‘More, more, more.’”

When Dylan walked onstage at Newport, dressed in black pants and a green shirt, it was the first time he had appeared in public with an electric guitar since his days with his Minnesota high school combo. A month before Newport, Dylan cut his first Top Five hit, “Like a Rolling Stone,” in New York with a group that included Kooper and Bloomfield. Yet Dylan’s first performance that weekend, at a Newport workshop on Saturday, was a pair of older folk songs.

There is no apparent booing on the surviving soundboard tape of the show. There is yelling. It has been suggested that the audience was complaining about the sound mix. Folk icon Pete Seeger admitted he was so enraged by Dylan’s set he wanted to “chop the microphone cord,” but only because Dylan’s voice was so distorted. (On the tape, Dylan is front, center and biting clear.) The crowd was mostly upset because Dylan, the top attraction at Newport, was on- and off-stage in less time than it took some folkies to sing a ballad. He was so rattled when he returned alone to sing “It’s All Over Now Baby Blue” and “Mr. Tambourine Man,” that he had the wrong harmonica for the latter song. “Does anybody have an E harmonica—an E harmonica, anybody?” Dylan asked the crowd. “Just throw ’em all up.” He got one.

The folk scene never recovered, rock & roll was never the same, and Dylan knew he was responsible.

## Passage B by Larry Starr and Christopher Waterman

50 Why was there such a shock wave produced by the concept of Bob Dylan as a rock ’n’ roll star?

It probably had to do with the differing cultural roles assigned by most people to urban folk music on the one hand and to rock ’n’ roll on the other. Urban folk in the early 1960s was an increasingly topical, political, socially conscious music. Even the singing of traditional folk songs often carried with it a subtext of political identification—with labor, with the poor, with minority groups and other peoples seen as oppressed, with a movement for international peace and understanding—depending on the nature and origins of the particular songs chosen. Thus the words were of paramount importance in urban folk music, and the acoustic guitar accompaniments enabled the words to be heard clearly. Besides, acoustic guitars were easily portable, readily accessible, and presented no elaborate barrier between performers and audiences. It was a relatively simple matter to bring an acoustic guitar along to a political meeting or demonstration, and to set it up and play it there when and if the occasion presented itself, which surely cannot be said of rock ’n’ roll band equipment. And of course rock ’n’ roll was identified as a “fun” music, a music to accompany dancing and other socializing, whose lyric content was by definition light, amusing, sometimes clever, often generic, but virtually never serious.

By the mid-1960s changes within rock ’n’ roll were already in the wind, but Bob Dylan’s electric style and other manifestations of folk rock had the effect of an enormous injection of growth hormones into the pop music scene. Suddenly, it was all right—expected, even—for rock ’n’ roll to be as “adult” as its baby boomer audience was now becoming itself, and rock ’n’ roll abruptly grew up into rock. Pop records on serious subjects, with political and poetical lyrics, sprang up everywhere; before long, this impulse carried over into the making of ambitious concept albums. The later 1960s flowered into a period of intense and remarkable innovation and creativity in pop music.

Questions 21–23 ask about Passage A.

21. In Passage A, the words “sacred” and “purists” (line 5) most nearly serve to characterize the Newport Folk Festival and its attendees as:
- A. drawn to songs containing moral lessons.
  - B. driven to discover unknown musicians.
  - C. devoted to the genre of folk music.
  - D. dedicated to Dylan’s career.

22. The information about Dylan’s guitar in lines 23–26 of Passage A primarily serves to:
- F. outline the development of Dylan’s style of guitar-playing.
  - G. contribute to an account of Dylan’s rise to fame.
  - H. emphasize that Dylan switched instruments throughout his career.
  - J. establish that fans were unaccustomed to Dylan playing electric guitar.

23. According to Passage A, Dylan had the wrong harmonica onstage to sing “Mr. Tambourine Man” because:
- A. he hadn’t planned on playing that song.
  - B. Seeger had tampered with Dylan’s equipment backstage.
  - C. he was flustered by the crowd’s response to his rock ’n’ roll performance.
  - D. he wasn’t used to switching instruments between songs.

Questions 24–27 ask about Passage B.

24. In the context of Passage B, the list between the dashes in lines 58–61 can best be described as examples of people and causes that:
- F. folk music sympathized with.
  - G. traditional folk songs avoided mentioning.
  - H. symbolized folk music’s international popularity.
  - J. constituted folk music’s audience.
25. In line 86, the phrase “this impulse” most specifically refers to the:
- A. shift from political to poetical lyrics in rock ’n’ roll.
  - B. ambitiousness of albums in the later 1960s.
  - C. swift displacement of folk music by rock ’n’ roll.
  - D. increased seriousness of pop music.
26. As it is used in line 66, the word *presented* most nearly means:
- F. unveiled.
  - G. posed.
  - H. imparted.
  - J. depicted.

27. Which of the following statements provides the best paraphrase of lines 77–81?
- A. Innovations within rock ’n’ roll enticed Dylan and others like him to become rock musicians.
  - B. Rock ’n’ roll’s popularity grew as a result of the increasing appeal of electric instruments.
  - C. Dylan’s genre-crossing approach spurred development in rock ’n’ roll.
  - D. Rock ’n’ roll merged with folk music to become a genre called folk rock.

Questions 28–30 ask about both passages.

28. Which of the following statements best captures a main difference in the focus of the two passages?
- F. Passage A focuses on describing the Newport Folk Festival, while Passage B focuses on comparing the popularity of folk music to the popularity of rock ’n’ roll.
  - G. Passage A focuses on analyzing Dylan’s popularity, while Passage B focuses on questioning why Dylan switched from playing folk music to playing rock ’n’ roll.
  - H. Passage A focuses on defending Dylan’s decision to play rock ’n’ roll at the Newport Folk Festival, while Passage B focuses on reflecting on rock ’n’ roll’s increasingly ambitious sophistication in the 1960s.
  - J. Passage A focuses on portraying Dylan’s rock ’n’ roll performance at the Newport Folk Festival, while Passage B focuses on exploring the roles of and changes within folk music and rock ’n’ roll in the 1960s.
29. With which of the following claims would the authors of both passages most likely agree?
- A. Dylan’s conversion from folk musician to rock ’n’ roll musician temporarily stalled his career.
  - B. Dylan’s rock ’n’ roll performance at the Newport Folk Festival marked a pivotal moment in the evolution of rock ’n’ roll.
  - C. The response to Dylan’s rock ’n’ roll performance at the Newport Folk Festival left Dylan confused about the course of his musical development.
  - D. Changes within rock ’n’ roll motivated Dylan to switch from playing folk music to playing rock ’n’ roll.
30. Compared to Passage A, Passage B provides more information about:
- F. the pre-1960s history of rock ’n’ roll.
  - G. lyrics in folk music and rock ’n’ roll.
  - H. Dylan’s public persona.
  - J. Dylan’s background and musical training.



## Passage IV

**NATURAL SCIENCE:** This passage is adapted from the article “The Hearing of the Barn Owl” by Eric I. Knudsen (©1981 by Scientific American, Inc.).

For the barn owl life depends on hearing. A nocturnal hunter, the bird must be able to find field mice solely by the rustling and squeaking sounds they make as they traverse runways in snow or grass. Like predators that hunt on the ground, the barn owl must be able to locate its prey quickly and precisely in the horizontal plane. Since the bird hunts from the air, it must also be able to determine its angle of elevation above the animal it is hunting. The owl has solved this problem very successfully: it can locate sounds in azimuth (the horizontal dimension) and elevation (the vertical dimension) better than any other animal whose hearing has been tested.

What accounts for this acuity? The answer lies in the owl’s ability to utilize subtle differences between the sound in its left ear and that in its right. The ears are generally at slightly different distances from the source of a sound, so that sound waves reach them at slightly different times. The barn owl is particularly sensitive to these minute differences, exploiting them to determine the azimuth of the sound. In addition the sound is perceived as being somewhat louder by the ear that is closer to the source, and this difference offers further clues to horizontal location. For the barn owl the difference in loudness also helps to specify elevation because of an unusual asymmetry in the owl’s ears. The right ear and its opening are directed slightly upward; the left ear and its opening are directed downward. For this reason the right ear is more sensitive to sounds from above and the left ear to sounds from below.

These differences in timing and loudness provide enough information for the bird to accurately locate sounds both horizontally and vertically. To be of service to the owl, however, the information must be organized and interpreted. Much of the processing is accomplished in brain centers near the beginning of the auditory pathway. From these centers nerve impulses travel to a network of neurons in the midbrain that are arranged in the form of a map of space. Each neuron in this network is excited only by sounds from one small region of space. From this structure impulses are relayed to the higher brain centers. The selection of sensory cues and their transformation into a map of space is what enables the barn owl to locate its prey in total darkness with deadly accuracy.

The most visually striking anatomical feature of the barn owl, and the one that plays the most important role in its location of prey, is the face. The skull is relatively narrow and small and the face is large and round, made up primarily of layers of stiff, dense feathers arrayed in tightly packed rows. The feathered structure, called the facial ruff, forms a surface that is a very efficient reflector of high-frequency sounds.

Two troughs run through the ruff from the forehead to the lower jaw, each about two centimeters wide and nine centimeters long. The troughs are similar in shape to the fleshy exterior of the human ear, and they serve the same purpose: to collect high-frequency sounds from a large volume of space and funnel them into the ear canals. The troughs join below the beak. The ear openings themselves are hidden under the preaural flaps: two flaps of skin that project to the side next to the eyes. The entire elaborate facial structure is hidden under a layer of particularly fine feathers that are acoustically transparent.

The barn owl is capable of locating the source of a sound within a range of one to two degrees in both azimuth and elevation; one degree is about the width of a little finger at arm’s length. Surprisingly, until the barn owl was tested, man was the species with the greatest known ability to locate the source of a sound; human beings are about as accurate as the owl in azimuth but are three times worse in elevation.

The sensitivity of the barn owl’s hearing is shown both by its capacity to locate distant sounds and by its ability to orient its talons for the final strike. When the owl swoops down on a mouse, even in a completely dark experimental chamber, it quickly aligns its talons with the body axis of the mouse. This behavior is not accidental. When the mouse turns and runs in a different direction, the owl realigns its talons accordingly. This behavior clearly increases the probability of a successful strike; it also implies that the owl not only identifies the location of the sound source with extreme accuracy but also detects subtle changes in the origin of the sound from which it infers the direction of movement of the prey.

31. The first paragraph most strongly suggests that a barn owl must be able to locate sounds in the vertical dimension mainly because it hunts:
- A. from the air.
  - B. even when it can only partially see the animal it is hunting.
  - C. animals that move quickly.
  - D. while detecting sounds in both its right and left ears.
32. The author uses the expression “the azimuth of the sound” (line 21) most nearly to refer to a sound’s:
- F. fluctuation between high and low frequencies.
  - G. location in the horizontal dimension.
  - H. transformation into a map of space.
  - J. loudness and intensity.

33. As it is used in line 20, the word *exploiting* most nearly means:
- A. imposing upon.
  - B. improving.
  - C. victimizing.
  - D. making use of.
34. Which of the following behaviors of a barn owl does the author provide as the strongest evidence of the bird's ability to detect subtle changes in the origin of a sound?
- F. Locating sound originating from small prey
  - G. Catching prey in complete darkness
  - H. Realigning its talons as a mouse turns and runs
  - J. Swooping down on stationary prey
35. The passage indicates that each neuron in the network of neurons in the barn owl's midbrain is excited only by sounds:
- A. from one particular species of animal.
  - B. from one small region of space.
  - C. falling within one specific frequency.
  - D. falling within one predictable timing pattern.
36. The author's use of the word "deadly" (line 45) most nearly serves to:
- F. hint that the barn owl's method of attack is sometimes harmful to the owl itself.
  - G. imply that the barn owl's prowess as a hunter is both alarming and regrettable.
  - H. reiterate that the barn owl is feared by many animals for its ability to swiftly kill.
  - J. emphasize that the barn owl's means of hunting is both remarkable and lethal.
37. The author directly states that which of the following features of the barn owl is the most visually striking?
- A. Its aerodynamic flight
  - B. Its coloring
  - C. Its face
  - D. Its talons
38. According to the passage, in terms of length and width, a barn owl's troughs are:
- F. wider than they are long.
  - G. longer than they are wide.
  - H. about as wide as they are long.
  - J. variable in terms of their relative length and width.
39. The author most likely refers to the feathers that cover the barn owl's facial structure as being "acoustically transparent" (line 65) to emphasize that the feathers are:
- A. shaped into two flaps that protect the owl's ear openings.
  - B. arranged in several layers that allow sound to be amplified.
  - C. textured and dense enough to block unnecessary sensory stimuli.
  - D. fine enough to allow sound to pass through them unfiltered.
40. Based on the passage, which of the following statements most accurately compares a human's ability to locate the source of a sound in azimuth and elevation to the barn owl's ability to do so?
- F. The barn owl is about as accurate as a human in azimuth but is about three times more accurate in elevation.
  - G. The barn owl is about three times more accurate than a human in both azimuth and elevation.
  - H. The barn owl is about as accurate as a human in both azimuth and elevation.
  - J. The barn owl is about three times more accurate as a human in azimuth but is about as accurate in elevation.

**END OF TEST 3**

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

**DO NOT RETURN TO A PREVIOUS TEST.**



## SCIENCE TEST

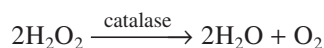
35 Minutes—40 Questions

**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

Hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) decomposes in the presence of the enzyme *catalase*, producing  $\text{H}_2\text{O}$  and oxygen gas ( $\text{O}_2$ ) according to the balanced chemical equation



Students performed 2 experiments to study this decomposition. In each trial of the experiments, Steps 1–3 were performed:

1. A fresh, circular piece of filter paper with a diameter of 6.0 mm was immersed for 2 min in an aqueous catalase solution maintained at a certain pH.
2. The filter paper was removed from the solution. Then a glass rod was used to quickly push the filter paper to the bottom of a beaker containing 500 mL of a freshly prepared aqueous solution having a certain concentration of  $\text{H}_2\text{O}_2$  (see Figure 1).
3. Once the filter paper reached the bottom of the beaker, the glass rod was immediately removed, and gas bubbles from the reaction surrounded the filter paper, causing it to rise to the surface of the solution. The *rising time*, RT (the time required for the filter paper to rise to the surface), was recorded.

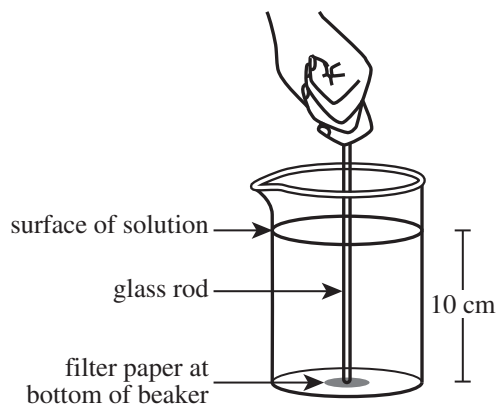


Figure 1

## Experiment 1

In Trials 1–5,  $\text{H}_2\text{O}_2$  solutions that differed in concentration (percent  $\text{H}_2\text{O}_2$  by volume) were tested while the catalase solution was maintained at a pH of 6. The results are shown in Table 1.

Trial	$\text{H}_2\text{O}_2$ concentration (percent by volume)	RT (sec)
1	0.2	27
2	0.3	21
3	0.5	17
4	1.0	13
5	2.0	10

**Experiment 2**

Trials 1–5 were repeated 3 times, except that in each set of trials, a different pH was tested. The results are shown in Table 2.

Trial	pH	H <sub>2</sub> O <sub>2</sub> concentration (percent by volume)	RT (sec)
6	5	0.2	50
7	5	0.3	39
8	5	0.5	31
9	5	1.0	24
10	5	2.0	18
11	7	0.2	19
12	7	0.3	15
13	7	0.5	12
14	7	1.0	9
15	7	2.0	7
16	8	0.2	22
17	8	0.3	17
18	8	0.5	14
19	8	1.0	10
20	8	2.0	8

Figure and tables adapted from K. A. Johnson, "A Simple Method for Demonstrating Enzyme Kinetics Using Catalase from Beef Liver Extract." ©2000 by the Division of Chemical Education, Inc., American Chemical Society.

1. In Experiment 2, which of the following combinations of pH and H<sub>2</sub>O<sub>2</sub> concentration led to the shortest RT ?

	pH	H <sub>2</sub> O <sub>2</sub> concentration
A.	5	0.2%
B.	5	2.0%
C.	7	0.2%
D.	7	2.0%

2. The number of circular pieces of filter paper used in Experiment 2 was:

- F. 5.  
G. 10.  
H. 15.  
J. 20.

3. Suppose that another trial had been performed in Experiment 1 and that the RT for this trial had been 8 sec. The H<sub>2</sub>O<sub>2</sub> concentration for this trial would most likely have been closest to which of the following?

- A. 0.4%  
B. 0.7%  
C. 1.6%  
D. 2.2%

4. Did H<sub>2</sub>O<sub>2</sub> decompose faster in Trial 2 or in Trial 7 ?

- F. Trial 2; the shorter RT corresponded to the faster decomposition.  
G. Trial 2; the longer RT corresponded to the faster decomposition.  
H. Trial 7; the shorter RT corresponded to the faster decomposition.  
J. Trial 7; the longer RT corresponded to the faster decomposition.

5. Consider the gas bubbles that were responsible for causing the filter paper to rise to the surface. The interior of these gas bubbles was most likely primarily occupied by which of the following substances?

- A. H<sub>2</sub>O  
B. Catalase  
C. O<sub>2</sub>  
D. H<sub>2</sub>O<sub>2</sub>

6. Suppose that in each trial of Experiment 1 the volume of the H<sub>2</sub>O<sub>2</sub> solution contained in the beaker in Step 2 had been 400 mL. In Trial 5, the RT would most likely have been closest to which of the following?

- F. 8 sec  
G. 10 sec  
H. 14 sec  
J. 16 sec

7. According to the results of Experiments 1 and 2, what was the range of RT values for the trials done at a neutral pH ?

- A. 7 sec–19 sec  
B. 8 sec–22 sec  
C. 10 sec–27 sec  
D. 18 sec–50 sec



**Passage II**

The number of bacteria that adhere to a surface is affected by the medium in which they are grown. Two studies examined how different media affect the number of bacteria, either *Escherichia coli* or *Salmonella typhimurium*, that adhere to a stainless steel surface.

*Study 1*

In each of 4 trials, Steps 1–8 were performed:

- Five 0.36 cm<sup>2</sup> stainless steel chips were placed into a flask.
- A 125 mL quantity of 10% soy broth (in water) was added to the flask.
- A 15 mL sample of an *E. coli* culture having a cell density of 100,000 cells/mL was added to the flask.
- The flask was incubated at 23°C for 1 hr, 24 hr, 48 hr, or 72 hr.
- The chips were removed from the flask and washed with *Ringer's solution* (an aqueous salt solution).
- The chips were placed in a solution of *euchrysin* (a dye that stains DNA).

7. The chips were washed with pure water.

- The number of *E. coli* attached to each chip was counted, and the average number of cells/cm<sup>2</sup> of chip was determined.

Steps 1–8 were repeated; 4 trials were performed for each of 3 other media: 100% soy broth, skim milk, and 20% meat juice (in water).

The results are shown in Table 1.

Medium	Average number of <i>E. coli</i> cells/cm <sup>2</sup> for an incubation time of:			
	1 hr	24 hr	48 hr	72 hr
10% soy broth	2,300	12,000	49,000	53,000
100% soy broth	4,700	58,000	92,000	61,000
Skim milk	1,100	2,300	780	230
20% meat juice	5,700	51,000	330,000	560,000

*Study 2*

Study 1 was repeated with *S. typhimurium* instead of *E. coli* (see Table 2).

Medium	Average number of <i>S. typhimurium</i> cells/cm <sup>2</sup> for an incubation time of:			
	1 hr	24 hr	48 hr	72 hr
10% soy broth	550,000	95,000	78,000	78,000
100% soy broth	110,000	56,000	32,000	45,000
Skim milk	98,000	540,000	510,000	540,000
20% meat juice	6,500	62,000	91,000	91,000

Tables adapted from Scott K. Hood and Edmund A. Zottola, "Adherence to Stainless Steel by Foodborne Microorganisms During Growth in Model Food Systems." ©1997 by Elsevier Science B. V.



8. If an incubation time of 36 hr had been tested in Study 1, the average number of *E. coli* cells/cm<sup>2</sup> in 10% soy broth would most likely have been:
- F. less than 2,300 cells/cm<sup>2</sup>.
  - G. between 2,300 cells/cm<sup>2</sup> and 12,000 cells/cm<sup>2</sup>.
  - H. between 12,000 cells/cm<sup>2</sup> and 49,000 cells/cm<sup>2</sup>.
  - J. greater than 49,000 cells/cm<sup>2</sup>.
9. Suppose a student wants to use a medium to grow *E. coli* that will *minimize*, as much as possible, the adherence of the *E. coli* to a stainless steel surface over a 72 hr incubation period. Based on the results of Study 1, which of the 4 media tested should the student select?
- A. 10% soy broth
  - B. 100% soy broth
  - C. Skim milk
  - D. 20% meat juice
10. In each trial of the studies, what was the purpose of the euchrysin solution?
- F. To make it possible to see the cells that were attached to each chip
  - G. To remove any cells that were only loosely associated with each chip prior to staining the cells
  - H. To provide a source of nutrients for the cells
  - J. To eliminate any excess dye from the chips after staining the cells
11. According to the results of Studies 1 and 2, for all 4 of the incubation times tested, the average number of *S. typhimurium* cells/cm<sup>2</sup> was greater than the average number of *E. coli* cells/cm<sup>2</sup> for which of the media tested?
- A. 10% soy broth and 100% soy broth only
  - B. 10% soy broth and skim milk only
  - C. 100% soy broth and 20% meat juice only
  - D. Skim milk and 20% meat juice only
12. After the cells attached to a stainless steel chip were stained, any excess dye that remained on the chip needed to be removed prior to analyzing the cells. In the studies, which step was most likely performed to accomplish this task?
- F. Step 4
  - G. Step 5
  - H. Step 6
  - J. Step 7
13. Which of the following statements about the effect of either 10% soy broth or skim milk on the number of *S. typhimurium* that adhere to a stainless steel surface is consistent with the results of Study 2? As the incubation time increases from 1 hr through 72 hr for *S. typhimurium* in:
- A. 10% soy broth, the average number of *S. typhimurium* cells/cm<sup>2</sup> increases and then remains constant.
  - B. 10% soy broth, the average number of *S. typhimurium* cells/cm<sup>2</sup> decreases and then remains constant.
  - C. skim milk, the average number of *S. typhimurium* cells/cm<sup>2</sup> increases only.
  - D. skim milk, the average number of *S. typhimurium* cells/cm<sup>2</sup> decreases only.
14. In the studies, the macromolecule that was stained in the cells was composed of what type of subunit?
- F. Amino acid
  - G. Fatty acid
  - H. Monosaccharide
  - J. Nucleotide



### Passage III

The presence of earthworms in forest soil can affect the amount of phosphorus (P) in the soil. Studies were done in 2 adjacent oak forests: Forest W, an old forest, and Forest Z, a young forest. Both forests had the same type of soil.

Two 100 m<sup>2</sup> plots were selected in each forest: one that had been invaded by earthworms several years before the studies began, and one that had no earthworms (see Table 1).

Forest	Plot	Earthworms
W	1	present
	2	absent
Z	3	present
	4	absent

#### Study 1

Three holes were dug in each plot. In each hole, a 10 cm<sup>3</sup> volume of soil was collected from the wall of the hole at the surface and also at 3 cm, 6 cm, 9 cm, and 12 cm depths. All the soil volumes collected from the holes in a plot were combined into a single sample, and all particles larger than 2 mm in diameter were removed. The sample from each plot was oven dried and then analyzed to determine the *total soil P*, in mg P/cm<sup>3</sup> (see Figure 1).

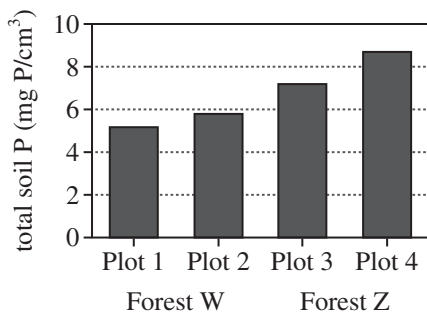


Figure 1

#### Study 2

In each plot, samples of the *soil solution* (aqueous solution present between soil particles) were collected using a pair of *lysimeters* that had been installed 2 years before the studies began. One lysimeter collected a sample of soil solution from a depth of 12 cm (shallow), and the other collected a sample from a depth of 36 cm (deep). For each sample, the concentration of *soluble reactive P* (SRP; one of several different forms of P found in soil solution), in *micrograms* of P per liter (µg P/L), was determined (see Figure 2).

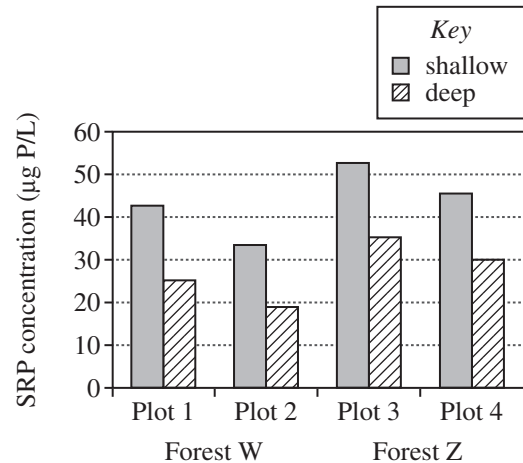


Figure 2

Figures adapted from Esteban R. Suarez et al., "Effects of Exotic Earthworms on Soil Phosphorus Cycling in Two Broadleaf Temperate Forests." ©2003 by Springer-Verlag.

15. In Study 1, why were the soil samples oven dried before being analyzed?
- To increase the soil mass
  - To increase the water content
  - To remove most or all SRP
  - To remove most or all water
16. Which of the following statements gives the most likely reason the lysimeters were installed 2 years before the studies began? The 2-year period allowed time for the:
- holes to be dug in the plots.
  - soil to settle again after being disturbed.
  - SRP concentration to decrease to zero.
  - oak trees to grow to a minimum height.

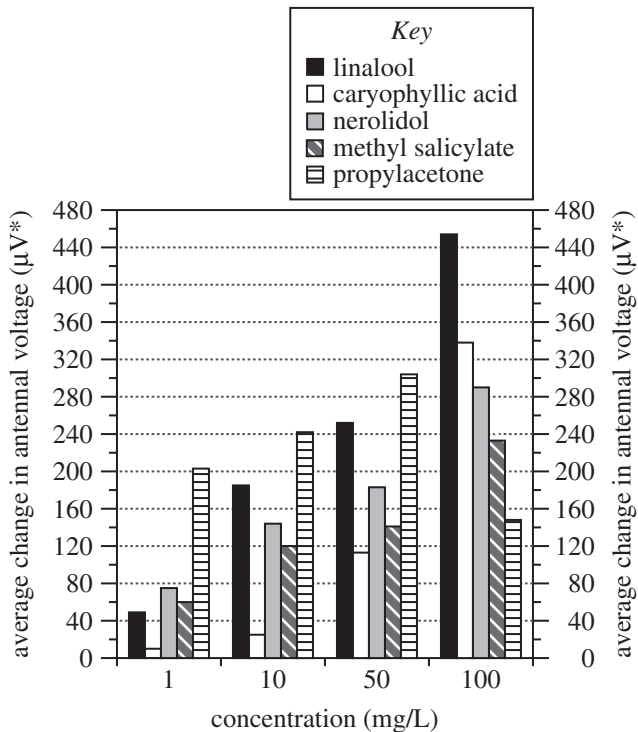


17. Which of the following statements gives the most likely reason that only the top 12 cm of soil was considered in Study 1 ?
- The soil's maximum depth was less than 12 cm.
  - The soil's maximum depth was greater than 12 cm.
  - The earthworms lived only at depths less than 12 cm.
  - The earthworms lived only at depths greater than 12 cm.
18. Which 2 plots should be compared to determine the effect of a forest's age on total soil P in the absence of earthworms?
- Plots 1 and 2
  - Plots 1 and 3
  - Plots 2 and 4
  - Plots 3 and 4
19. In Study 1, all the particles in the samples analyzed for total soil P were:
- smaller than or equal to 2 mm in diameter.
  - between 2 mm and 3 mm in diameter.
  - exactly 3 mm in diameter.
  - larger than 3 mm in diameter.
20. The greatest depth at which soil was collected in Study 1 was how many times as great as the greatest depth at which soil solution samples were collected in Study 2 ?
- $\frac{1}{3}$
  - $\frac{1}{2}$
  - 2
  - 3
21. Consider the results of Study 2 for Forest W. For each of the 2 depths, was the SRP concentration in the plot with earthworms greater than or less than the SRP concentration in the plot without earthworms?
- |    | <u>shallow</u> | <u>deep</u> |
|----|----------------|-------------|
| A. | greater        | greater     |
| B. | greater        | less        |
| C. | less           | greater     |
| D. | less           | less        |



### Passage IV

Certain *odorants* (airborne chemical compounds) can stimulate a change in the electrical activity of the *olfactory neurons* in the antennae of the moth *Manduca sexta*. The change in the electrical activity of an antenna in the presence of an odorant can be detected as an increase in the antenna's voltage relative to its voltage in the absence of odorants. The figure below shows the average change in antennal voltage for adult female *M. sexta* that were exposed to each of 5 odorants at each of 4 concentrations.



\*microvolts;  $1 \mu\text{V} = 1 \times 10^{-6} \text{ V}$

Figure adapted from Kevin C. Daly, Lynnsey A. Carrell, and Esther Mwilaria, "Detection Versus Perception: Physiological and Behavioral Analysis of Olfactory Sensitivity in the Moth (*Manduca sexta*).” ©2007 by the American Psychological Association.

22. As the odorant concentration increased from 1 mg/L through 100 mg/L, the average change in antennal voltage:
- decreased only for all 5 odorants.
  - increased only for all 5 odorants.
  - decreased only for 4 odorants but decreased and then increased for 1 odorant.
  - increased only for 4 odorants but increased and then decreased for 1 odorant.
23. Based on the figure, if adult female *M. sexta* are exposed to 5 mg/L of methyl salicylate, the average change in antennal voltage will most likely be:
- less than 60  $\mu\text{V}$ .
  - between 60  $\mu\text{V}$  and 120  $\mu\text{V}$ .
  - between 120  $\mu\text{V}$  and 185  $\mu\text{V}$ .
  - greater than 185  $\mu\text{V}$ .
24. For which of the following combinations of odorant and concentration was the average change in antennal voltage closest to the average change in antennal voltage for 50 mg/L of nerolidol?
- | odorant               | concentration |
|-----------------------|---------------|
| F. propylacetone      | 1 mg/L        |
| G. linalool           | 10 mg/L       |
| H. caryophylllic acid | 50 mg/L       |
| J. methyl salicylate  | 100 mg/L      |
25. For the *M. sexta* exposed to an odorant concentration of 1 mg/L, what is the order of the 5 odorants, from the odorant that stimulated the least average change in antennal voltage to the odorant that stimulated the greatest average change in antennal voltage?
- Caryophylllic acid, linalool, methyl salicylate, nerolidol, propylacetone
  - Caryophylllic acid, methyl salicylate, nerolidol, linalool, propylacetone
  - Propylacetone, methyl salicylate, nerolidol, caryophylllic acid, linalool
  - Propylacetone, nerolidol, caryophylllic acid, methyl salicylate, linalool



26. According to the passage, certain chemical compounds can stimulate a change in the electrical activity of a specific type of neuron in *M. sexta*. This type of neuron is found in what organ of the human body?
- F. Liver
  - G. Ears
  - H. Heart
  - J. Nose
27. Would the neurons that are referred to in the passage be classified as belonging to the central nervous system or to the peripheral nervous system?
- A. Central; the function of these neurons is to receive and process information from other neurons.
  - B. Central; the function of these neurons is to receive stimuli from the environment and then pass this information to other neurons.
  - C. Peripheral; the function of these neurons is to receive and process information from other neurons.
  - D. Peripheral; the function of these neurons is to receive stimuli from the environment and then pass this information to other neurons.



### Passage V

The orbital energy of a satellite depends on the *central body* (moon or planet) around which the satellite revolves, the altitude of the satellite's orbit, and the satellite's mass. Table 1 lists these characteristics for each of 12 different satellites.

A satellite's *orbital period* is the time required for a satellite to complete 1 revolution around its central body. Figure 1 shows a satellite's orbital period as a function of altitude above the Moon, Mars, and Earth.

Table 1				
Satellite	Central body	Altitude (km)*	Mass (kg) <sup>†</sup>	Orbital energy (MJ) <sup>‡</sup>
1	Moon	400	100	168
2		1,400	100	204
3		2,400	100	223
4		3,400	100	235
5	Earth	1,400	50	1,846
6		1,400	150	5,537
7		1,400	200	7,383
8		1,400	250	9,229
9	Earth	400	100	3,313
10		1,400	100	3,692
11		2,400	100	3,984
12		3,400	100	4,217

\*kilometers  
<sup>†</sup>kilograms  
<sup>‡</sup>megajoules

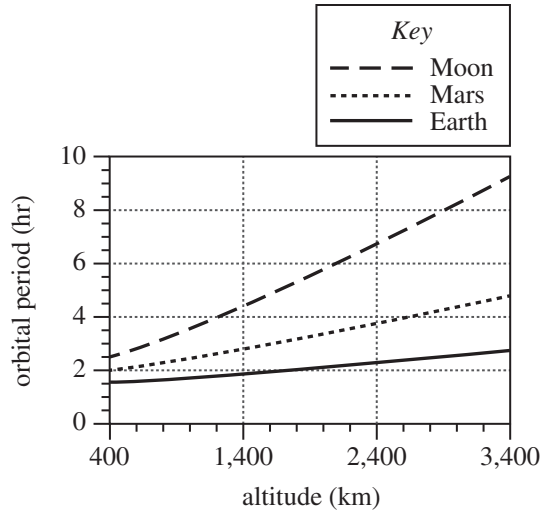
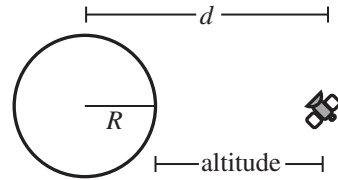


Figure 1



28. Consider a satellite that completes 1 revolution around Mars in exactly 5 hr. Based on Figure 1, the altitude at which this satellite orbits is most likely closest to which of the following?
- F. 3,200 km  
G. 3,600 km  
H. 4,000 km  
J. 4,400 km
29. Consider the hypothesis “For a given central body and a given satellite mass, the greater the altitude of the orbit, the greater the orbital energy.” Which group(s) of satellites listed in Table 1 could be cited as evidence in support of this hypothesis?
- A. Satellites 1–4 only  
B. Satellites 5–8 only  
C. Satellites 1–4 and Satellites 9–12 only  
D. Satellites 5–8 and Satellites 9–12 only
30. Consider 3 satellites: 1 orbiting the Moon, 1 orbiting Earth, and 1 orbiting Mars. Each satellite has the same mass and orbits at the same altitude above its central body. Based on Figure 1, the satellite orbiting which central body most likely completes a revolution in the *least* time?
- F. Moon  
G. Earth  
H. Mars  
J. Cannot be determined from the given information
31. Consider the data for Satellites 5–8. The trend in this data set could be more completely demonstrated if which additional satellite were grouped together with Satellites 5–8 ?
- A. Satellite 2  
B. Satellite 3  
C. Satellite 9  
D. Satellite 10
32. The diagram below (not drawn to scale) shows the radius,  $R$ , of a central body; the *center-to-center distance*,  $d$ , between the central body and a satellite; and the satellite’s altitude.



Given the data in Table 1 regarding Satellites 2 and 10, for which satellite would  $d$  be greater?

- F. Satellite 2, because the altitude for Satellite 2 is greater than the altitude for Satellite 10.  
G. Satellite 2, because  $R$  for the Moon is greater than  $R$  for Earth.  
H. Satellite 10, because the altitude for Satellite 10 is greater than the altitude for Satellite 2.  
J. Satellite 10, because  $R$  for Earth is greater than  $R$  for the Moon.

33. Which of the following questions requires additional information beyond what is available in Table 1 and Figure 1 in order to be answered?
- A. What is the orbital energy of a 100 kg satellite in orbit around Mars at an altitude of 400 km ?  
B. At what altitude does a 100 kg satellite orbit Earth if its orbital energy is 3,984 MJ ?  
C. Approximately how many revolutions does a satellite complete per hour while in orbit around Mars at an altitude of 400 km ?  
D. Approximately how much time is required for a satellite to complete 1 revolution around Earth at an altitude of 400 km ?



**Passage VI**

Each of 3 scientists provided a model of acids and bases.

*Scientist 1*

An acid is an uncharged substance that *dissociates* (breaks apart into 2 or more ions) when dissolved in  $\text{H}_2\text{O}$ , producing 1 or more hydrogen ions ( $\text{H}^+$ ) and a corresponding negative ion. A base is an uncharged substance that dissociates when dissolved in  $\text{H}_2\text{O}$ , producing a metal ion and 1 or more hydroxide ions ( $\text{OH}^-$ ).

An example of an acid is hydrochloric acid ( $\text{HCl}$ ) because, in  $\text{H}_2\text{O}$ , it dissociates into  $\text{H}^+$  and a chloride ion ( $\text{Cl}^-$ ). An example of a base is sodium hydroxide ( $\text{NaOH}$ ) because, in  $\text{H}_2\text{O}$ , it dissociates into a sodium ion ( $\text{Na}^+$ ) and  $\text{OH}^-$ .

*Scientist 2*

An acid is an uncharged or charged substance that donates an  $\text{H}^+$  to another substance (the base) in a chemical reaction, forming a covalent bond. A base is an uncharged or charged substance that accepts an  $\text{H}^+$  from another substance (the acid) in a chemical reaction, forming a covalent bond.

In the reaction of  $\text{HCl}$  with  $\text{H}_2\text{O}$ ,  $\text{HCl}$  is an acid because it donates an  $\text{H}^+$  to the  $\text{H}_2\text{O}$ . A covalent bond forms between the donated  $\text{H}^+$  and the  $\text{H}_2\text{O}$ , producing a hydronium ion ( $\text{H}_3\text{O}^+$ ) and  $\text{Cl}^-$ . In this reaction,  $\text{H}_2\text{O}$  is a base because it accepts the  $\text{H}^+$  from  $\text{HCl}$ .

*Scientist 3*

An acid is an uncharged or charged substance that accepts a pair of electrons from a base (an uncharged or charged substance that donates the pair of electrons) in a chemical reaction. As the electrons are transferred, a new covalent bond forms between the atom in the acid that is accepting the electrons and the atom in the base that is donating the electrons. At the same time, an existing bond within the acid is broken.

In the reaction of  $\text{HCl}$  with  $\text{H}_2\text{O}$ ,  $\text{HCl}$  is an acid because it accepts a pair of electrons from  $\text{H}_2\text{O}$ . A covalent bond forms between the H atom of  $\text{HCl}$  and the O atom of  $\text{H}_2\text{O}$ , and, at the same time, the bond between the H atom and the Cl atom in  $\text{HCl}$  is broken. This produces  $\text{H}_3\text{O}^+$  and  $\text{Cl}^-$ . In this reaction,  $\text{H}_2\text{O}$  is a base because it donates the pair of electrons to the H atom of the  $\text{HCl}$  molecule.

34. All 3 scientists made which of the following statements about  $\text{H}_2\text{O}$  or  $\text{HCl}$ ?

- F.  $\text{H}_2\text{O}$  is an acid.
- G.  $\text{H}_2\text{O}$  is a base.
- H.  $\text{HCl}$  is an acid.
- J.  $\text{HCl}$  is a base.

35. Scientist 2's description of an acid differs from that of Scientist 3 in which of the following ways? According to Scientist 2, an acid:

- A. accepts a pair of electrons, whereas according to Scientist 3, an acid donates an  $\text{H}^+$ .
- B. donates a pair of electrons, whereas according to Scientist 3, an acid accepts an  $\text{H}^+$ .
- C. accepts an  $\text{H}^+$ , whereas according to Scientist 3, an acid donates a pair of electrons.
- D. donates an  $\text{H}^+$ , whereas according to Scientist 3, an acid accepts a pair of electrons.

36. Consider the statement "All bases contain hydroxide ions." Which of the scientists would be likely to agree with the statement?

- F. Scientist 1 only
- G. Scientist 3 only
- H. Scientists 1 and 2 only
- J. Scientists 2 and 3 only

37. Consider the statement "In any chemical reaction where a substance acts as an acid, there must also be a substance that acts as a base." Which of Scientists 2 and 3, if either, would be likely to agree with this statement?

- A. Scientist 2 only
- B. Scientist 3 only
- C. Both Scientist 2 and Scientist 3
- D. Neither Scientist 2 nor Scientist 3

38. The chemical formula of hypochlorous acid is  $\text{HOCl}$ . Scientist 1 would likely assert that  $\text{HOCl}$  is an acid, and explain that assertion by stating that, in  $\text{H}_2\text{O}$ ,  $\text{HOCl}$  dissociates into:

- F.  $\text{H}^-$  and  $\text{ClO}^+$ .
- G.  $\text{H}^+$  and  $\text{ClO}^-$ .
- H.  $\text{OH}^-$  and  $\text{Cl}^+$ .
- J.  $\text{OH}^+$  and  $\text{Cl}^-$ .

**4****4**

39. Based on Scientist 3's model, which of these can *never* act as a base in a reaction: an individual atom of H or an individual atom of O? An atom of:

- A. H, because it has less than 2 electrons.
- B. H, because it has more than 2 electrons.
- C. O, because it has less than 2 electrons.
- D. O, because it has more than 2 electrons.

40. Consider Scientist 2's model. The *conjugate base* of an acid can be defined as the part of the acid that remains after the acid has donated the  $H^+$  in a reaction. What substance is the conjugate base in the reaction described by Scientist 2?

- F.  $H_2O$
- G.  $H_3O^+$
- H. HCl
- J.  $Cl^-$

**END OF TEST 4**

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

### Scoring Keys for Form D06

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

### Test 1: English—Scoring Key

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

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

**\*Reporting Categories**

**POW** = Production of Writing

**KLA** = Knowledge of Language

**CSE** = Conventions of Standard English

Number Correct (Raw Score) for:	
Production of Writing (POW)	___ (22)
Knowledge of Language (KLA)	___ (12)
Conventions of Standard English (CSE)	___ (41)
Total Number Correct for English Test (POW + KLA + CSE)	___ (75)

**Test 2: Mathematics—Scoring Key**

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

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

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

**\*Reporting Categories**

**PHM** = Preparing for Higher Math

N = Number & Quantity

A = Algebra

F = Functions

G = Geometry

S = Statistics & Probability

**IES** = Integrating Essential Skills

**MDL** = Modeling

Number Correct (Raw Score) for:	
Preparing for Higher Math (PHM) (N + A + F + G + S)	_____ (35)
Integrating Essential Skills (IES)	_____ (25)
Total Number Correct for Mathematics Test (PHM + IES)	_____ (60)
Modeling (MDL) (Not included in total number correct for mathematics test raw score)	_____ (22)

### Test 3: Reading—Scoring Key

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

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

**\*Reporting Categories**

**KID** = Key Ideas & Details

**CS** = Craft & Structure

**IKI** = Integration of Knowledge & Ideas

Number Correct (Raw Score) for:	
Key Ideas & Details (KID)	___ (23)
Craft & Structure (CS)	___ (12)
Integration of Knowledge & Ideas (IKI)	___ (5)
Total Number Correct for Reading Test (KID + CS + IKI)	___ (40)

### Test 4: Science—Scoring Key

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

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

**\*Reporting Categories**

**IOD** = Interpretation of Data

**SIN** = Scientific Investigation

**EMI** = Evaluation of Models,  
Inferences & Experimental Results

Number Correct (Raw Score) for:	
Interpretation of Data (IOD)	___ (18)
Scientific Investigation (SIN)	___ (11)
Evaluation of Models, Inferences & Experimental Results (EMI)	___ (11)
Total Number Correct for Science Test (IOD + SIN + EMI)	___ (40)

## 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 D06	Your Scale Score
English	_____
Mathematics	_____
Reading	_____
Science	_____
<b>Sum of scores</b> <span style="float: right;">_____</span>	
<b>Composite score (sum ÷ 4)</b> <span style="float: right;">_____</span>	

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

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