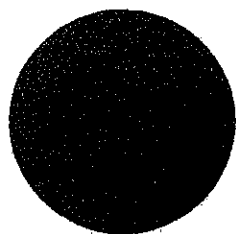


**Form 74H**  
(December 2016)



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## ENGLISH TEST

45 Minutes—75 Questions

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

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

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

### PASSAGE 1

#### From Word-Cross to a Crossword Craze

In the early 1900s, the "Fun" section of the *New York World* <sup>1</sup> a Sunday supplement that presented puzzles to entertain the newspaper's readers.

One day, in 1913 the section's editor Arthur Wynne, <sup>2</sup> was asked by his superior to create a new puzzle.

Inspired by a game called "Magic Squares" from <sup>3</sup>

his childhood, Wynne drew <sup>4</sup> up a variation that used a diamond-shaped grid with numbered squares in rows and columns. The puzzle was to be filled in with the answers to clues that corresponded to the numbered squares. He named his new creation a "word-cross."

After the puzzle's debut in December, <sup>5</sup> Requests from readers came pouring in for more word-crosses. Some readers even submitted puzzles of their own.

1. A. NO CHANGE  
B. *World* was  
C. *World*;  
D. *World*,
2. F. NO CHANGE  
G. One day in 1913, the section's editor, Arthur Wynne,  
H. One day, in 1913 the section's editor, Arthur Wynne,  
J. One day in 1913 the section's editor Arthur Wynne
3. A. NO CHANGE  
B. He was getting inspiration from  
C. He found inspiration from  
D. He became inspired by
4. F. NO CHANGE  
G. down  
H. over  
J. to
5. A. NO CHANGE  
B. December—requests  
C. December, requests  
D. December; requests

Wynne began including a word-cross in his section every week. Usually one he wrote himself but sometimes a reader's submission. Eventually the puzzles became known as "crosswords."

By 1915, reader submissions arrived in such great numbers that, Martha Petherbridge, Wynne's secretary, began assisting Wynne in managing and editing the puzzles. Crossword devotees would complain if there was even a small formatting flaw or factual error in

the puzzles, so Petherbridge checked carefully for typographical and content errors prior to printing. She also established firm rules for crossword layouts, including the introduction of square-shaped grids.

By the 1920s, the craze for crosswords went far beyond the *World's* "Fun" supplement. Songwriters released tunes with crossword-related lyrics. Fashionable women wore crossword-decorated dresses. In line, fans of crosswords in crowds waited at the New York Public Library to use dictionaries to search for puzzle answers. And a fledgling publishing company became an immediate success when in 1924 it released a smash hit: the first book-length collection of crossword puzzles.

6. F. NO CHANGE  
G. week and usually  
H. week—usually  
J. week; usually

7. A. NO CHANGE  
B. that Martha Petherbridge, Wynne's secretary,  
C. that, Martha Petherbridge, Wynne's secretary  
D. that Martha Petherbridge Wynne's secretary

8. If the writer were to delete the underlined portion, the paragraph would primarily lose:  
F. an indication of the importance of the newspaper to Arthur Wynne.  
G. specific details that help the reader understand how seriously crossword enthusiasts took the puzzles.  
H. an explanation of why the author is interested in crossword puzzles.  
J. an indication of readers' frustration with the work of Martha Petherbridge.

9. A. NO CHANGE  
B. prior to printing checked for typographical and content errors carefully.  
C. carefully, checked for errors, prior to printing, both typographical and content.  
D. checked, prior to printing, typographical and content errors, carefully.

10. F. NO CHANGE  
G. In line waited fans of crosswords in crowds  
H. Fans of crosswords in crowds waited in line  
J. Crowds of crossword fans waited in line

11. A. NO CHANGE  
B. themselves  
C. them  
D. one

12. F. NO CHANGE  
G. hit; the  
H. hit the  
J. hit. The

Though the 1920s was the time and age when  
crosswords were at the peak of the public's obsession<sup>13</sup>

with crosswords, the puzzles and their cryptic clues<sup>14</sup>  
continue to captivate audiences.<sup>14</sup>

13. A. NO CHANGE  
B. signified that crosswords had reached the top peak  
C. indicated and signaled the peak  
D. marked the height
14. Given that all the choices are true, which one provides the most effective and logical conclusion to this essay?  
E. NO CHANGE  
G. publication of the *New York World* finally ceased in 1931.  
H. puzzles today often use clues that depend on puns and wordplay.  
J. these puzzles are published across the world and in many languages.

Question 15 asks about the preceding passage as a whole.

15. Suppose the writer's primary purpose had been to inform the reader about the origin of the modern crossword puzzle. Would this essay accomplish that purpose?  
A. Yes, because the essay tells how Arthur Wynne became a world-famous crossword writer and inspired many crossword fads.  
B. Yes, because the essay describes both the inspiration for and the development of the crossword puzzle.  
C. No, because the essay instead instructs the reader on the best ways to create crossword puzzles.  
D. No, because the essay instead focuses on Martha Petherbridge's career specifically.

PASSAGE II

A Siletz Speaker

[1]

"Ghaa-yalh," Bud Lane says to his young granddaughter. [A] He's using a phrase from the language of his ancestors, words so old that they were spoken

thousands of years before Europeans arrived in North America. [16] His goal is to teach her Coastal Athabaskan, a nearly extinct language spoken fluently by only a few members of the Confederated Tribes of Siletz

Indians, given that it is the language of their ancestors.

17

[2]

Alfred (Bud) Lane III didn't grow up along the coast of Oregon, which is where the Siletz Reservation is located. He was born in 1957 in Guam, where his father was stationed in the military. As a young adult, Lane moved to the land of his ancestors to learn everything he could about Siletz culture. The Confederated Tribes of the Grande Ronde created Oregon's first language-immersion program to successfully teach the tribes' preschoolers to speak their native language, Chinuk Wawa. [19] He learned fragments of the Coastal Athabaskan language,

as in small pieces of the language, but he longed to converse in it. [B]

20

16. At this point, the writer is considering adding the following true statement:

"Come here," Lane is saying to the toddler.

Should the writer make this addition here?

- F. Yes, because it helps explain why *ghaa-yalh* is one of the easiest Coastal Athabaskan phrases to translate into English.
  - G. Yes, because it provides a translation of the Coastal Athabaskan phrase quoted earlier, a phrase unfamiliar to most readers.
  - H. No, because it provides information that's not relevant to the paragraph's focus on describing Lane's granddaughter.
  - J. No, because the essay later suggests that the phrase Lane speaks to his granddaughter has several meanings in Coastal Athabaskan.
17. A. NO CHANGE  
B. Indians, even though it was spoken thousands of years before the arrival of Europeans to North America.  
C. Indians. The little girl is his granddaughter.  
D. Indians.

18. E. NO CHANGE

- G. since he did not grow up on the coast of Oregon or near the Siletz Reservation.
- H. considering it was the place to do so.
- J. as the purpose of his move.

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

- A. Kept, because it provides information about Chinuk Wawa, the language of the Confederated Tribes of the Grande Ronde.
- B. Kept, because it suggests that the Confederated Tribes of Siletz Indians will be successful in teaching their children Coastal Athabaskan.
- C. Deleted, because it doesn't provide information that's relevant to this paragraph's focus on Lane's background.
- D. Deleted, because it doesn't state which member of the Confederated Tribes of the Grande Ronde led the tribes' language-immersion program.

20. Which choice provides the most specific examples of the types of fragments of the Coastal Athabaskan language that Lane learned?

- F. NO CHANGE
- G. such as a few everyday phrases and lyrics to songs.
- H. enough for him to be able to speak it a little.
- J. something new here and there.

[3]

Lane convinced Nellie Orton, a tribal elder who knew<sup>21</sup> the language well but never spoke it in public, to be his teacher. [22] He produced language CDs and created an

online Coastal Athabaskan "talking dictionary," of words that had previously existed only in the few speakers' heads. [C]

[4]

In 2003, the tribal council asked Lane<sup>24</sup> whether he

were to have started<sup>25</sup> language classes in the community.

Still,<sup>26</sup> he soon resigned from his job at the local paper mill and began teaching at the Siletz Valley Charter School. [D] With financial help from a grant awarded to the tribe in 2008, with these funds<sup>27</sup> Lane organized a small staff to develop a formal language curriculum, including instructional materials accessible not only to schoolchildren but to all tribal members.

21. A. NO CHANGE  
B. whom  
C. she  
D. DELETE the underlined portion.
22. Which of the following true statements, if added here, would provide the most logical link to the information about Lane's work that follows in the next sentence?  
F. More than half of the Pacific Northwest's approximately thirty indigenous languages are already extinct, and without direct preservation efforts, more will be lost.  
G. For the next thirty years, Lane recorded elders' speech and studied the Coastal Athabaskan language, becoming one of the tribe's most fluent speakers.  
H. Working with other tribal members, Lane helped design a cedar-plank dance house along the Siletz River.  
J. Lane also worked closely with two other tribal elders, Loren Bommelyn and Gladys Bolton.
23. A. NO CHANGE  
B. online Coastal Athabaskan, "talking dictionary"  
C. online Coastal Athabaskan "talking dictionary"  
D. online, Coastal Athabaskan "talking dictionary,"

24. F. NO CHANGE  
G. council, asked Lane,  
H. council, asked Lane,  
J. council asked Lane,
25. A. NO CHANGE  
B. would start  
C. started  
D. starts
26. F. NO CHANGE  
G. In the same manner, he  
H. Nevertheless, he  
J. He
27. A. NO CHANGE  
B. this is how  
C. and then  
D. DELETE the underlined portion.

[5]

For Lane, a unique knowledge is embedded in the traditions of his forebears, including medical knowledge.

Language, he believes, is the life force of a culture, a

source of stories, poetry, history, and art. "Language maintains our view of yuhl—the world," he says.

28. Given that all the choices are accurate, which one most effectively leads readers into Lane's message in the concluding sentences of the essay?

F. NO CHANGE

G. and his granddaughter is one of the youngest members of the Tututni tribe.

H. several of whom are still living.

J. particularly in their language.

29. A. NO CHANGE

B. including history,

C. the history there,

D. with history,

Question 30 asks about the preceding passage as a whole.

30. The writer is considering adding the following true statement to the essay:

The dictionary is bilingual and includes both a written English translation of each word and a sound file of the word spoken in both English and Coastal Athabaskan, often by Lane himself.

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

F. Point A in Paragraph 1.

G. Point B in Paragraph 2.

H. Point C in Paragraph 3.

J. Point D in Paragraph 4.

PASSAGE III

The Fulton Fish Market

[1]

Walking in Manhattan just south of the Brooklyn

Bridge, feeling as if I've been transported back in time.

The streets at the South Street Seaport are paved

with cobblestones. [A] Bobbing up and down

in the East River are several, well-preserved,

nineteenth-century multimasted schooners.

31. A. NO CHANGE

B. a feeling that is like

C. I feel as if

D. as though

32. F. NO CHANGE

G. several, well-preserved, nineteenth-century,

H. several, well-preserved nineteenth-century,

J. several well-preserved nineteenth-century

The most potent link to the seaport's past, however, is the fishy smell coming from the East River. 33

[2]

From 1822 to 2005, the Fulton Fish Market served as a vital link between the fishing industry and the New York City fish trade and was considered the most important wholesale fish market on the East Coast. [B] The market would open as early as 3:00 a.m. on weekday mornings, this is when fishing-boat crews would bring their fresh

<sup>34</sup>

catch in to the East River. The distributors, in turn, would

<sup>35</sup>

sell the fish to buyers whom purchased seafood for local restaurants and stores.

<sup>36</sup>

[3]

[1] As I approached, I could hear a clamor of voices as hundreds of fishmongers and buyers haggled over prices. [2] Rows upon rows of carts and wooden bins packed with ice and seafood was crammed into the building. [3] I remember the first time I visited the market. [4] Anyone new to the market would be overwhelmed by the variety of seafood alone with live blue crabs, half-ton

<sup>38</sup>

swordfish, twenty-pound tuna fillets, fresh octopus.

<sup>39</sup>

[5] Dodging forklifts, I made my way past bins of ice lined

with fish laid side by side. head to tail, head to tail. 40

33. Which of the following true statements, if added here, would both introduce the main topic of the essay and provide the best transition to the next paragraph?

- A. The other major river in New York City is the Hudson River, but I don't find myself walking near the Hudson very often.
- B. It is a pungent reminder of the fish market that operated here on Fulton Street for nearly two centuries.
- C. Personally, I don't mind the fishy smell; it reminds me of a once forgotten time.
- D. The East River separates the island of Manhattan from Brooklyn and Queens.

34. F. NO CHANGE

G. on such mornings

H. which is when

J. DELETE the underlined portion.

35. Given that all the choices are accurate, which one is most relevant at this point in the paragraph?

A. NO CHANGE

B. to sell to wholesale distributors.

C. after spending time at sea.

D. for payday.

36. F. NO CHANGE

G. those buyers which

H. the buyers whose

J. buyers who

37. A. NO CHANGE

B. has been

C. were

D. DELETE the underlined portion.

38. F. NO CHANGE

G. alone, there were

H. alone:

J. alone;

39. Which choice best maintains the descriptive pattern established in the list of seafood?

A. NO CHANGE

B. some other slightly more exotic species.

C. something that I think was octopus.

D. etc.

40. For the sake of logic and cohesion, Sentence 3 should be placed:

F. where it is now.

G. before Sentence 1.

H. after Sentence 1.

J. after Sentence 4.



[4]

Today, because of my passing by<sup>41</sup> the building that once was the Fulton Fish Market, I listen to the excited voices of tourists who have come to visit the nearby Seaport Museum and shop at the Seaport Mall. [C] The area is still busy, so<sup>42</sup> the market itself moved in 2005 to the Bronx, where it now operates as the New Fulton Fish Market Cooperative. [D] It's easy to imagine, likewise,<sup>43</sup> the market still echoing around me here on Fulton Street. All I have to do is close my eyes and take a deep breath.

41. A. NO CHANGE  
B. being that I pass  
C. while in passing  
D. as I pass

42. F. NO CHANGE  
G. because  
H. but  
J. or

43. A. NO CHANGE  
B. as a matter of fact,  
C. in other words,  
D. though,

Questions 44 and 45 ask about the preceding passage as a whole.

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

In 1924, for example, the market sold 384 million pounds of fish—25 percent of all seafood sold in the United States.

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

- F. Point A in Paragraph 1.  
G. Point B in Paragraph 2.  
H. Point C in Paragraph 4.  
J. Point D in Paragraph 4.

45. Suppose the writer's primary purpose had been to give an overview of a historic site by blending facts with personal experiences. Would this essay accomplish that purpose?

- A. Yes, because it outlines the history of the original Fulton Fish Market and describes the central role the narrator played in that history.  
B. Yes, because it provides information about the original Fulton Fish Market through the narrator's memories of the market.  
C. No, because it focuses primarily on the narrator's impression of the Fulton Fish Market site as it exists today.  
D. No, because it focuses on the narrator's research into how the original Fulton Fish Market operated.

PASSAGE IV

Surf's Up

[1]

Snails from the family Janthinidae spend most of their lives upside down, "surfing" the ocean's surface under a cluster of air bubbles<sup>46</sup> they create themselves.

46. F. NO CHANGE  
G. an airy arrangement that almost looks something like a bunch of grapes  
H. a self-made clump of air bubbles  
J. a bunch

These "bubble-rafting snails" (janthinids) drift for miles, moving up and down, feeding on jellyfish and other floating prey. [A] They use mucus to create a small raft of tiny air bubbles, permanently attached to the bottom of

their bodies, which makes them float in that way. In 2011, University of Michigan graduate student Celia Churchill published a paper that explains how the bubble rafters' incredible way of life evolved.

[2]

Churchill and her team began their research by analyzing and comparing the DNA of several snail families determining the ancestral lineage of bubble-rafting snails.

[B] Churchill, who found in her surprise that bubble rafters

are most genetically similar to wentletraps, a snail in the family Epitoniidae. [C] Wentletraps live on the ocean floor,

they are creatures that feed on coral and sea anemones, and rarely, if ever, come up to the water's surface. These snails use mucus to bind their eggs together into long

strands or egg masses that trail behind them as they glide

across the ocean floor. Churchill asserts that is the genetic precursor to bubble rafts.

47. The writer wants to emphasize that janthinids move by drifting passively under the surface of the water. Given that all the choices are true, which one best accomplishes that goal?

- A. NO CHANGE
- B. their bubbles peeking through the water's surface.
- C. wherever the water and wind take them,
- D. often in groups that travel together,

48. F. NO CHANGE  
G. float, so therefore they feed on prey that also float like they do.  
H. like jellyfish and other buoyant prey they feed on.  
J. buoyant.

49. A. NO CHANGE  
B. as a determination of  
C. as determining  
D. to determine

50. F. NO CHANGE  
G. Churchill, who was surprised to find  
H. Churchill was surprised to find  
J. Churchill found in her surprise

51. A. NO CHANGE  
B. comparing  
C. the same  
D. alike

52. F. NO CHANGE  
G. these snails, like most in the family Epitoniidae, feed  
H. they feed  
J. feeding

53. Which choice both is punctuated correctly and makes most clear that "egg masses" is the term for the long strands of eggs that wentletraps bind together with mucus?

- A. NO CHANGE
- B. strands (with egg masses)
- C. strands, or egg masses,
- D. strands; egg masses

54. F. NO CHANGE  
G. these egg masses are  
H. which are  
J. it is

[3]

According to the biologist, air often gets trapped in the egg masses of female wentletraps, forming small air bubbles. At one point, a wentletrap must have created enough bubbles to cause her to float to the ocean's surface.

Given the abundance of jellyfish and other foods on the surface, creating air bubbles and floating—became a

55

survival advantage.

56

[4]

Churchill argues that though the ability to make

57

bubbles on purpose didn't evolve quickly, while certain

58

lineages of wentletraps did develop this habit. [D]

These exceptional snails gave rise to the handful of

bubble-rafting snail species known today. Churchill,

in explaining how a few bottom-feeding wentletraps

became janthinids skimming the ocean's surface, has

answered the question of how some snails became surfers.

59

55. A. NO CHANGE

B. surface creating air bubbles—

C. surface, creating air bubbles—

D. surface creating air bubbles

56. F. NO CHANGE

G. benefit for the fulfillment of what a wentletrap needs to survive.

H. beneficiary element in terms of staying alive.

J. means to the end that is nourishment.

57. A. NO CHANGE

B. progression through time that led to making

C. leap for science of making

D. gifted talent to make

58. F. NO CHANGE

G. however

H. whereas

J. DELETE the underlined portion.

59. A. NO CHANGE

B. offered an unknown about snails and surfing in her provided explanation.

C. given an answer to a question relating biologically to surfing snails.

D. done something about snails that can surf.

Question 60 asks about the preceding passage as a whole.

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

Eventually, snails evolved that would use mucus to build small rafts of air bubbles on which they could float to the surface of the ocean to feed.

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

F. Point A in Paragraph 1.

G. Point B in Paragraph 2.

H. Point C in Paragraph 2.

J. Point D in Paragraph 4.

PASSAGE V

Paris: Where Apiary Meets Opera House

In the 1980s, during time off from a backstage job in the world of Paris opera, Jean Paucton took a beekeeping course at the famous Luxembourg Gardens.

Shortly thereafter, the prop expert ordered some. A <sup>61</sup>hive—securely packed, sealed, and humming with

life—arrived at Paucton's workplace, the Palais Garnier is <sup>62</sup>a preeminent opera house in the city's historic district.

[1] Paucton's plans to establish the hive to his home in <sup>63</sup>the countryside fell through, and he found himself looking for a place to temporarily store his purchase. [2] Up on the roof, an opera house fireman suggested (who was raising <sup>64</sup>trout in the huge cistern below the Palais Garnier).

[3] Paucton's bees have been cared for ever since, high <sup>65</sup>above elaborate productions of *Carmen*, *La Bohème*, and *Così Fan Tutte*. [4] Now in his late seventies, the beekeeper has expanded his project to five hives. [5] The annual harvest has grown to more than one thousand pounds of honey, which he bottles, labels by hand, and sells in nearby specialty shops. 66

For all its charm, Paucton's story has an <sup>67</sup>increasingly serious dimension. Since the mid-1990s, <sup>68</sup>

however, bee populations worldwide have declined <sup>69</sup>

61. A. NO CHANGE  
B. some of his very own.  
C. some bees.  
D. his own.

62. E. NO CHANGE  
G. Garnier is considered  
H. Garnier serves as  
J. Garnier,

63. A. NO CHANGE  
B. transport  
C. land  
D. settle

64. E. NO CHANGE  
G. an opera house fireman made the suggestion  
H. suggested an opera house fireman  
J. was an opera house fireman's suggestion

65. Which choice best emphasizes that Paucton's bees lead healthy lives at their opera house location?  
A. NO CHANGE  
B. thriving  
C. present  
D. noted

66. For the sake of logic and cohesion, Sentence 4 should be placed:  
E. where it is now.  
G. before Sentence 1.  
H. after Sentence 1.  
J. after Sentence 2.

67. A. NO CHANGE  
B. its'  
C. it's  
D. DELETE the underlined portion.

68. E. NO CHANGE  
G. dimensionality about which to consider.  
H. dimension, as relates to importance.  
J. dimensionality of itself.

69. A. NO CHANGE  
B. nevertheless,  
C. furthermore,  
D. DELETE the underlined portion.

dramatically. Hundreds of thousands of hives have been  
<sup>70</sup> disappearing every year. Pesticides, pollution, parasites,  
and disease imperil the insects, which rank among the top  
pollinators on Earth. Countless crops—apples, cucumbers,  
almonds, avocados, broccoli, to name a few—<sup>71</sup>simply won't  
<sup>71</sup> grow as well without bees to pollinate them.

Surprisingly, bees in urban areas, where there are  
fewer pesticides and a far greater variety of flowering  
plants and trees, are faring better—by far—then their  
<sup>72</sup>

country cousins. While the disorder, widely known as  
<sup>73</sup> “colony collapse,” defies a simple explanation, experts

and amateurs, urban beekeepers among them,  
<sup>74</sup> joined the effort to reestablish the health of all bees.

The ramifications for the agriculture industry and for the  
general health of the planet are grander than the grandest  
opera staged at the Palais Garnier.

70. Which of the following alternatives to the underlined portion would NOT be acceptable?

- F. dramatically. More specifically, hundreds
- G. dramatically. In fact, hundreds
- H. dramatically, hundreds
- J. dramatically; hundreds

71. If the writer were to delete the underlined portion, the essay would primarily lose details that:

- A. create unnecessary confusion for readers who think of bees as pests.
- B. establish the difference between Paucton's bees and bees in the countryside outside Paris.
- C. elaborate on a key point being made about bees' central role in world agriculture.
- D. suggest why more beekeepers than ever are turning their hobbies into professions.

72. F. NO CHANGE  
G. than their  
H. than its  
J. then

73. A. NO CHANGE  
B. disorder widely,  
C. disorder, widely,  
D. disorder widely

74. F. NO CHANGE  
G. them who  
H. them, who  
J. them

Question 75 asks about the preceding passage as a whole.

75. Suppose the writer's primary purpose had been to bring attention to a pressing environmental issue that was solved through human ingenuity and perseverance. Would this essay accomplish that purpose?

- A. Yes, because the essay establishes that Paucton has persevered over many decades to reverse the decimating trend of “colony collapse.”
- B. Yes, because the essay proves that urban beekeepers and their country cousins have rescued bees from the effects of “colony collapse.”
- C. No, because the essay does not claim that “colony collapse” is a pressing issue in the global sense, but rather a concern limited to beekeepers.
- D. No, because the essay indicates that the problem of “colony collapse” has not yet been solved, though many are involved in seeking a solution.

END OF TEST 1

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



# MATHEMATICS TEST

60 Minutes—60 Questions

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

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

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

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

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

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

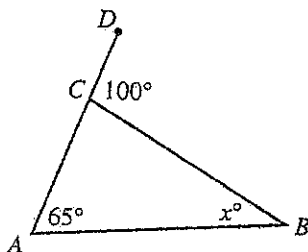
1. The 32-member French Club is meeting to choose a student government representative. The members decide that the representative, who will be chosen at random, CANNOT be any of the 5 officers of the club. What is the probability that Luis, who is a member of the club but NOT an officer, will be chosen?

- A. 0
- B.  $\frac{1}{32}$
- C.  $\frac{1}{27}$
- D.  $\frac{6}{32}$
- E.  $\frac{1}{5}$

2. The statement  $\triangle ABC \cong \triangle DEF$  is true. Which of the following statements *must* be true?

- F.  $\overline{AB} \cong \overline{DF}$
- G.  $\overline{AC} \cong \overline{EF}$
- H.  $\overline{BC} \cong \overline{DF}$
- J.  $\angle A \cong \angle F$
- K.  $\angle C \cong \angle F$

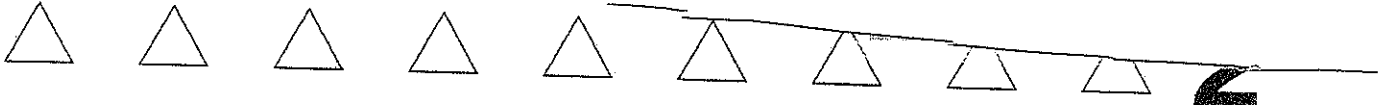
3. In the figure below,  $C$  lies on  $\overline{AD}$ , the measure of  $\angle BAC$  is  $65^\circ$ , the measure of  $\angle BCD$  is  $100^\circ$ , and the measure of  $\angle ABC$  is  $x^\circ$ .



What is the value of  $x$ ?

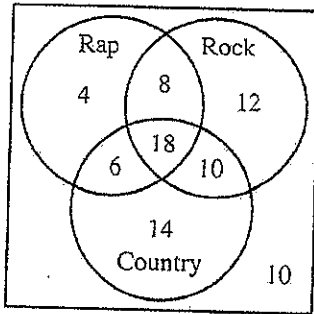
- A. 15
- B. 25
- C. 35
- D. 65
- E. 80

**DO YOUR FIGURING HERE.**



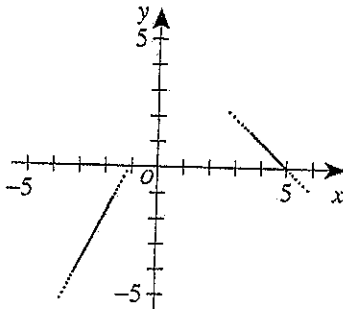
4. A group of students was surveyed about what types of music each had listened to during the previous week. Students could choose 1, 2, or 3 types of music (Rap, Rock, or Country), or they could respond "none of these music types." Only 10 students responded with "none of these music types," and 18 students responded that they had listened to all 3 types. In the figure below, the 8 regions show the numbers of responses in each category.

DO YOUR FIGURING HERE.



One region had exactly 8 responses. What type(s) of music did those 8 students respond they had listened to during the previous week?

- F. Rap only  
 G. Country and Rock only  
 H. Country and Rap only  
 J. Rap and Rock only  
 K. All 3 types of music
5. What is the value of  $2|2 - 9| - 3(4 + 2)$  ?
- A. -32  
 B. -26  
 C. -15  
 D. -5  
 E. -4
6. Portions of the graphs represented by the functions  $-2x + y = 2$  and  $x + y = 5$  are shown in the standard  $(x, y)$  coordinate plane below. Although only a portion of each graph is shown, the domain of each function is all real numbers. If it can be determined, at what point do the graphs intersect?



- F.  $(-1, 5)$   
 G.  $(1, 4)$   
 H.  $(2, 5)$   
 J.  $(4, 1)$   
 K. Cannot be determined from the given information

**2**

7. On a map,  $\frac{1}{2}$  inch represents 10 actual miles. Two towns that are  $4\frac{1}{2}$  inches apart on this map are how many actual miles apart?

- A. 10
- B. 20
- C.  $22\frac{1}{2}$
- D. 45
- E. 90

8. The cost of a long-distance call to a certain city is \$1.05 for the first minute and \$0.15 for each additional minute or part thereof. What is the cost of a 15-minute call to this city?

- F. \$1.20
- G. \$2.25
- H. \$3.15
- J. \$3.30
- K. \$3.45

9. Property valued at \$56,000 is assessed at  $\frac{3}{4}$  of its value. If the yearly tax is calculated as \$3 per \$100 of assessed value, what is the yearly tax on this property?

- A. \$ 420
- B. \$1,120
- C. \$1,260
- D. \$1,680
- E. \$2,240

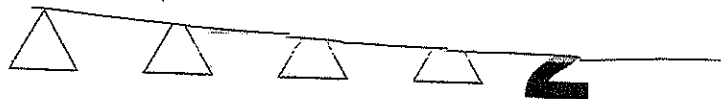
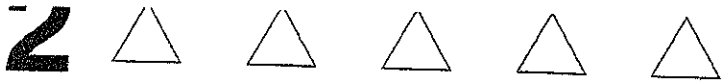
10. Tammy will draft 1 player at random from a list of 20 players for her fantasy football team. Each player in the list plays only 1 position. The number of players who play a particular position is given in the table below. What is the probability that the player Tammy drafts will be a kicker or a receiver?

Position	Number of players
Kicker	4
Linebacker	2
Quarterback	6
Receiver	8

- F.  $\frac{2}{25}$
- G.  $\frac{1}{5}$
- H.  $\frac{2}{5}$
- J.  $\frac{1}{2}$
- K.  $\frac{3}{5}$

**DO YOUR FIGURING HERE.**





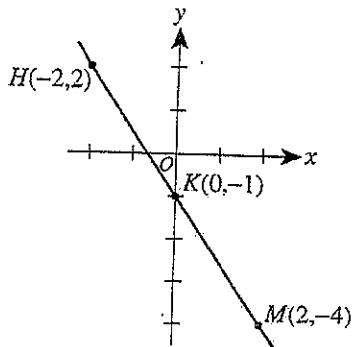
DO YOUR FIGURING HERE.

11. Ben is saving money to buy a TV that costs \$495, including tax. Ben opens a savings account with a deposit of \$75 and deposits \$65 at the end of each month. What is the minimum number of months Ben will need to make deposits until he has enough money in his account to buy the TV?

- A. 5
- B. 6
- C. 7
- D. 8
- E. 9

12. What is the slope of  $\overleftrightarrow{HM}$ , shown in the standard  $(x,y)$  coordinate plane below?

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

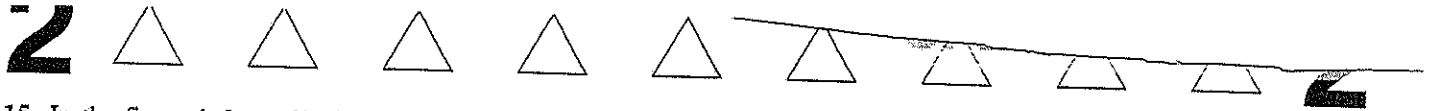


13. The polynomial  $45x^2 + 26x - 8$  is equivalent to the product of  $(5x + 4)$  and which of the following binomials?

- A.  $9x - 4$
- B.  $9x - 2$
- C.  $9x + 4$
- D.  $40x - 12$
- E.  $40x - 2$

14. Given that  $\sin^2 x = \frac{4}{13}$ , what is  $\cos^2 x$ ?

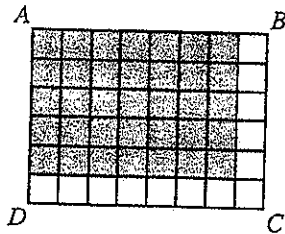
- F.  $\frac{4}{9}$
- G.  $\frac{9}{4}$
- H.  $\frac{9}{13}$
- J.  $\frac{13}{9}$
- K.  $\frac{13}{4}$



15. In the figure below, all of the small squares are equal in area, and the area of rectangle  $ABCD$  is 1 square unit. Which of the following expressions represents the area, in square units, of the shaded region?

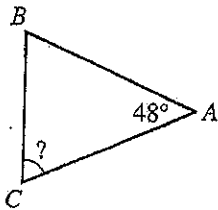
DO YOUR FIGURING HERE.

- A.  $\frac{1}{8} \cdot \frac{1}{6}$   
 B.  $\frac{1}{8} \cdot \frac{5}{6}$   
 C.  $\frac{1}{8} \cdot \frac{7}{8}$   
 D.  $\frac{7}{8} \cdot \frac{1}{6}$   
 E.  $\frac{7}{8} \cdot \frac{5}{6}$



16. In  $\triangle ABC$  shown below, the measure of  $\angle A$  is  $48^\circ$ , and  $\overline{AB} \cong \overline{AC}$ . What is the measure of  $\angle C$ ?

- F.  $42^\circ$   
 G.  $48^\circ$   
 H.  $52^\circ$   
 J.  $66^\circ$   
 K.  $72^\circ$



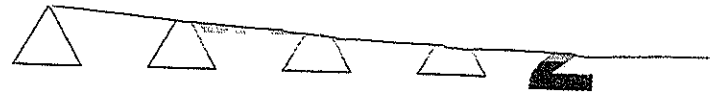
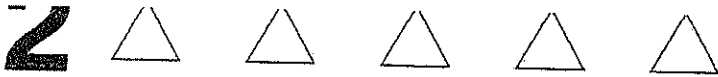
17. The first 5 terms of a sequence are given in the table below. The sequence is defined by setting  $a_1 = 9$  and  $a_n = a_{n-1} + (n-1)^2$  for  $n \geq 2$ . What is the sixth term,  $a_6$ , of this sequence?

$a_1$	$a_2$	$a_3$	$a_4$	$a_5$	$a_6$
9	10	14	23	39	?

- A. 62  
 B. 64  
 C. 76  
 D. 78  
 E. 95

18. In the standard  $(x,y)$  coordinate plane, the line represented by which of the following equations goes through  $(0,7)$  and is parallel to the line represented by  $y = -2x - 4$ ?

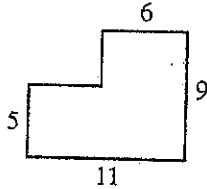
- F.  $y = -2x - 7$   
 G.  $y = -2x + 7$   
 H.  $y = \frac{1}{2}x - 7$   
 J.  $y = \frac{1}{2}x + 7$   
 K.  $y = 7x - 4$



DO YOUR FIGURING HERE.

19. A scale drawing of Corinne's bedroom floor is shown below. All given dimensions are in feet, and all intersecting line segments shown are perpendicular. Corinne wants to completely cover the floor with square hardwood tiles. Each tile has a side length of 1 foot, and no tiles will be cut. How many tiles will Corinne need to cover the floor?

- A. 63
- B. 69
- C. 74
- D. 79
- E. 84



20. A survey about 3 issues affecting Bluff City Park was given to 60 residents. The results of the survey are shown below.

Issue	Yes	No
Curfew	48	12
Skateboard use	26	34
Children under 14 accompanied by a person at least 14 years old	38	22

Assume that the results in the table accurately predict the response ratios for the town's 1,200 residents. How many of the 1,200 residents would respond No on the curfew issue?

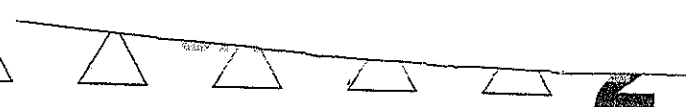
- F. 240
- G. 300
- H. 600
- J. 680
- K. 960

21. In the standard  $(x,y)$  coordinate plane, the graph of the line  $3x - 4y = d$  passes through the point  $(-5,6)$ . What is the value of  $d$ ?

- A. -39
- B. -9
- C. 2
- D. 9
- E. 38

22. Given  $u$  and  $v$  such that  $(a^2)^u = a^{12}$  and  $(a^v)^2 = a^8$  for all positive  $a$ , what is  $a^{u+v}$ ?

- F.  $a^5$
- G.  $a^{10}$
- H.  $a^{16}$
- J.  $a^{20}$
- K.  $a^{24}$



DO YOUR FIGURING HERE.

23. In the standard  $(x,y)$  coordinate plane, a translation maps a point  $(x,y)$  to its image  $(x-5, y+3)$ . To what image does this translation map  $(-3,-2)$ ?

- A.  $(-8,-5)$
- B.  $(-8, 1)$
- C.  $(-2, 1)$
- D.  $(2,-5)$
- E.  $(2, 1)$

24. Given  $x = \frac{4a+b}{3}$ , which of the following expressions is equivalent to  $b$ ?

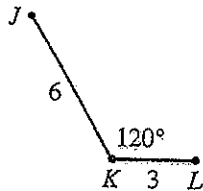
- F.  $3x - 4a$
- G.  $3x + 4a$
- H.  $x - \frac{4a}{3}$
- J.  $\frac{x}{3} - 4a$
- K.  $\frac{x-4a}{3}$

25. Matt purchased a 60-foot-long roll of chain-link fence. He used the entire roll of fence to construct a rectangular pen for his dog. Given that the pen is 12 feet wide, what is its length, in feet?

- A. 5
- B. 18
- C. 24
- D. 36
- E. 48

26. Angle  $\angle JKL$  is shown below with the given lengths in coordinate units. What is the measure of  $\angle JKL$  in radians?

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



27. A rectangle is  $3\sqrt{5}$  meters wide and  $5\sqrt{5}$  meters long. What is the area, in square meters, of the rectangle?

- A. 75
- B.  $16\sqrt{5}$
- C.  $15\sqrt{5}$
- D.  $8\sqrt{10}$
- E.  $8\sqrt{5}$

DO YOUR FIGURING HERE.

28. Which of the following operations will produce the largest result when substituted for the blank in the expression  $11 \text{ --- } \left(-\frac{1}{83}\right)$ ?

- F. Averaged with
- G. Divided by
- H. Minus
- J. Plus
- K. Multiplied by

29. In Westville on Tuesday, the high temperature was  $30^{\circ}\text{C}$  and the low temperature was  $20^{\circ}\text{C}$ . What was the difference between the high and low temperatures, in degrees *Fahrenheit*?

(Note: The relationship between the temperature  $c$ , in degrees Celsius, and the temperature  $f$ , in degrees Fahrenheit, is given by  $c = \frac{5}{9}(f - 32)$ .)

- A.  $5\frac{2}{9}^{\circ}\text{F}$
- B.  $10^{\circ}\text{F}$
- C.  $12\frac{2}{9}^{\circ}\text{F}$
- D.  $18^{\circ}\text{F}$
- E.  $46^{\circ}\text{F}$

30. A committee will be selected from a group of 12 women and 18 men. The committee will consist of 5 women and 5 men. Which of the following expressions gives the number of different committees that could be selected from these 30 people?

- F.  ${}_{30}P_{10}$
- G.  $({}_{12}P_5)({}_{18}P_5)$
- H.  ${}_{30}C_{10}$
- J.  $({}_{30}C_5)({}_{30}C_5)$
- K.  $({}_{12}C_5)({}_{18}C_5)$

31. Which of the following expressions is equal to

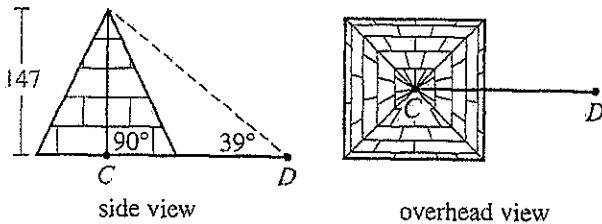
$$\frac{3}{4 - \sqrt{5}} ?$$

- A.  $\frac{3}{11}$
- B.  $\frac{3}{7}$
- C.  $\frac{12 - 3\sqrt{5}}{21}$
- D.  $\frac{12 + \sqrt{15}}{11}$
- E.  $\frac{12 + 3\sqrt{3}}{11}$

Use the following information to answer questions 32–34.

DO YOUR FIGURING HERE.

When it was constructed 4,500 years ago, the Great Pyramid in Egypt had a height of 147 meters and contained roughly 2.3 million stone blocks. It is estimated that 5.5 million tons of limestone, 8,000 tons of granite, and 500,000 tons of mortar were used in its construction. In the side view shown below, an ancient observer found the angle of elevation at  $D$  to the top of the pyramid to be  $39^\circ$ . The diagonals of the pyramid's square base, shown below, intersect at  $C$ .



32. When written in scientific notation, which of the following expressions is equal to the number of blocks used to construct the pyramid?
- F.  $2.3 \times 10^6$
  - G.  $7.8 \times 10^6$
  - H.  $8.3 \times 10^6$
  - J.  $23 \times 10^5$
  - K.  $78 \times 10^5$
33. The perimeter of the pyramid's base was 920 meters when construction was completed. At that time, which of the following values is closest to the length, in meters, of each diagonal of the base?
- A. 30
  - B. 40
  - C. 230
  - D. 320
  - E. 650
34. Which of the following expressions is equal to the length, in meters, of  $\overline{DC}$ ?
- F.  $147 \sin 39^\circ$
  - G.  $147 \tan 39^\circ$
  - H.  $\frac{147}{\cos 39^\circ}$
  - J.  $\frac{147}{\sin 39^\circ}$
  - K.  $\frac{147}{\tan 39^\circ}$

35. In  $\triangle ABC$ ,  $AB = 6$  cm,  $AC = 12$  cm,  $m\angle A = 60^\circ$ , and  $\overline{AC}$  is the longest side. Which of the following statements about the measures of the angles in  $\triangle ABC$  must be true?

(Note:  $m\angle X$  denotes the measure of angle  $X$ .)

- A.  $m\angle A = m\angle B = m\angle C$
- B.  $m\angle B > m\angle A > m\angle C$
- C.  $m\angle B = m\angle C > m\angle A$
- D.  $m\angle B > m\angle C = m\angle A$
- E.  $m\angle C > m\angle A > m\angle B$

DO YOUR FIGURING HERE.

36. Erika is landscaping her front yard. The yard, which is level, has the shape of a rectangle that is 60 feet wide by 80 feet long. To cover the yard with a layer of topsoil having a uniform depth of 4 inches ( $\frac{1}{3}$  foot), Erika needs to use how many cubic feet of topsoil?

- F. 1,600
- G. 1,920
- H. 4,800
- J. 14,400
- K. 19,200

37. Suzanne and Chad are going to bake and deliver cookies to college students during final exam week. They estimate it will cost \$4 for the ingredients to make each batch of cookies and \$50 to buy the mixer, bowls, and other utensils they will need. They decide to sell the cookies for \$5 per batch. Assume they have no other expenses. Which of the following equations represents the profit,  $P$  dollars, they will make on  $b$  batches of cookies?

- A.  $P = 49b$
- B.  $P = 54b - 5$
- C.  $P = 55b - 4$
- D.  $P = -b + 50$
- E.  $P = b - 50$

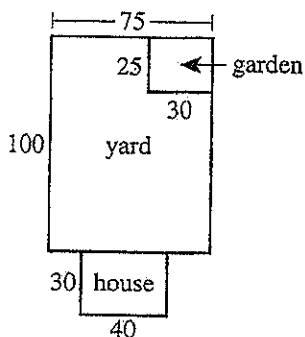
38. The sum of the measures of  $\angle A$  and  $\angle B$  is  $90^\circ$ . The sum of the measures of  $\angle A$  and  $\angle C$  is  $180^\circ$ . The sum of the measures of  $\angle B$  and  $\angle D$  is  $180^\circ$ . What is the sum of the measures of  $\angle C$  and  $\angle D$ ?

- F.  $45^\circ$
- G.  $90^\circ$
- H.  $180^\circ$
- J.  $270^\circ$
- K.  $360^\circ$

Use the following information to answer questions 39–41.

DO YOUR FIGURING HERE.

The figure below shows the top view of the Santana family's house and yard. The Santanas' rectangular house is 40 feet wide and 30 feet long, and their rectangular yard is 75 feet wide and 100 feet long. The Santanas have a rectangular garden in the back corner of their yard that is 30 feet wide and 25 feet long. The garden currently contains 48 flower bulbs: 10 tulip bulbs, 18 daffodil bulbs, and 20 crocus bulbs.



39. The yard will be enclosed by a fence and the back side of the house. The fence will begin at one back corner of the house and will end at the other. What is the minimum number of feet of fencing needed to enclose the yard?
- A. 215  
B. 275  
C. 310  
D. 315  
E. 350
40. The area of the garden is what percent of the area of the yard?
- F. 9%  
G. 10%  
H. 11%  
J. 25%  
K. 40%
41. Beginning next year, Mr. Santana will increase the number of bulbs in the garden each year so that the numbers form a geometric sequence. In 3 years, there will be 162 bulbs in the garden. By what factor will the number of bulbs be multiplied each year?
- A. 1.125  
B. 1.5  
C. 3.375  
D. 4.85  
E. 38



DO YOUR FIGURING HERE.

42. Suspended from the ceiling is a weight on a large spring that is oscillating up and down. The distance,  $d$  inches, between the location of the center of the mass of the weight after  $t$  seconds and the weight's equilibrium location at  $t = 0$  is modeled by the function  $d = 5 \sin(4\pi t)$ . What is the amplitude of the function?

- F.  $\frac{1}{2}$
- G. 2
- H. 4
- J. 5
- K. 10

43. Given that  $i^2 = -1$  and that  $k$  is a positive integer, what is the value of  $i^{(4k+2)}$ ?

- A.  $-i$
- B.  $-1$
- C. 0
- D. 1
- E.  $i$

44. Ling asked 11 people how many text messages each of them sent last week. Each of the 11 responses was in one of the intervals given in the table below. Which interval contains the median of the data?

Number of text messages sent	Number of responses
31-40	1
41-50	2
51-60	2
61-70	3
71-80	3

- F. 31-40
- G. 41-50
- H. 51-60
- J. 61-70
- K. 71-80

45. For all real numbers  $a$ ,  $b$ , and  $c$ , which of the following expressions is equal to  $|a - b - c|$ ?

- A.  $|a + b + c|$
- B.  $|a + b - c|$
- C.  $|a - b + c|$
- D.  $|-a + b + c|$
- E.  $|-a - b - c|$

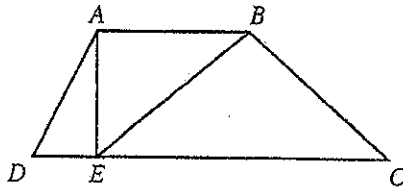


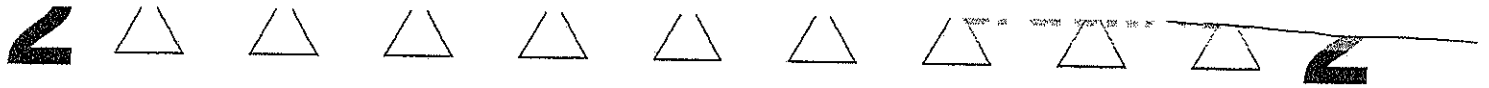
46. Given  $g(x) = \frac{x+1}{x^2}$ , which of the following expressions is equal to  $g(x-1)$  for all  $x$  in its domain?

DO YOUR FIGURING HERE.

- F.  $\frac{x}{x^2 - 2x + 1}$
- G.  $\frac{x}{x^2 - 1}$
- H.  $\frac{x}{2x - 2}$
- J.  $\frac{x+1}{x-1}$
- K.  $\frac{-x^2 + x + 1}{x^2}$
47. A circle with radius 10 cm is divided into 3 congruent arcs. What is the length, in centimeters, of each of the 3 arcs?
- A.  $\frac{10\pi}{3}$
- B.  $\frac{20\pi}{3}$
- C.  $10\pi$
- D.  $\frac{40\pi}{3}$
- E.  $20\pi$
48. Consider all positive integers that are multiples of 20 and that are less than or equal to 300. What fraction of those integers are multiples of 15?
- F.  $\frac{1}{3}$
- G.  $\frac{1}{5}$
- H.  $\frac{1}{15}$
- J.  $\frac{7}{15}$
- K.  $\frac{8}{15}$
49. In the figure below,  $ABCD$  is a trapezoid with  $\overline{AE}$  perpendicular to  $\overline{AB}$ ;  $\overline{AE}$  is 10 units long; and  $\overline{DC}$  is 28 units long. If the area of right triangle  $\triangle EBA$  is 60 square units, what is the area, in square units, of trapezoid  $ABCD$ ?

- A. 140
- B. 170
- C. 180
- D. 200
- E. 240





50. The fraction  $\frac{2}{7}$  is equivalent to  $0.\overline{285714}$ . What is the digit in the 1,001st decimal place of  $0.\overline{285714}$  ?

**DO YOUR FIGURING HERE.**

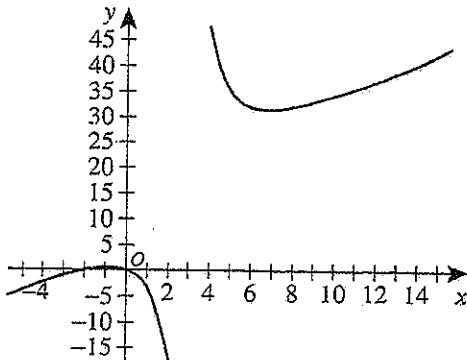
(Note: The digit in the 4th decimal place of  $0.\overline{285714}$  is 7.)

- F. 1
- G. 2
- H. 4
- J. 5
- K. 7

51. The 3 lines with equations  $y = 4$ ,  $x = -3$ , and  $y = x$ , respectively, bound a unique triangular region in the standard  $(x,y)$  coordinate plane. Which of the following descriptions is the best classification of this triangle?

- A. Equilateral
- B. Acute isosceles
- C. Right isosceles
- D. Acute scalene
- E. Right scalene

52. At what point in the standard  $(x,y)$  coordinate plane do the asymptotes of the function  $y = \frac{2x(x+2)}{x-3}$ , graphed below, intersect?



- F.  $(-\frac{7}{3}, 3)$
- G.  $(\frac{7}{3}, 10)$
- H.  $(3, 10)$
- J.  $(3, 16)$
- K.  $(3, 31)$

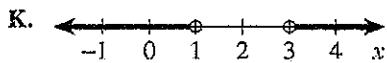
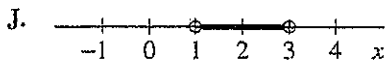
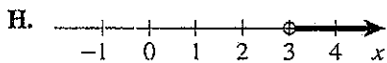
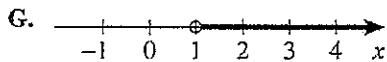
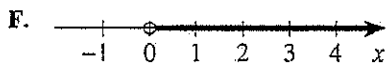


DO YOUR FIGURING HERE.

53. The employees at a hotel reservation center assign an 8-digit confirmation number (CN) to each customer making a reservation. The first digit in each CN is 8. The other 7 digits can be any digit 0 through 9, and digits may repeat. How many possible 8-digit CNs are there?

- A.  $8^7$
- B.  $9^7$
- C.  $10^7$
- D.  $8^8$
- E.  $10^8$

54. Which of the following number line graphs represents all values in the domain of the function  $y = \log_{10}(x^2 - 4x + 3)$ ?



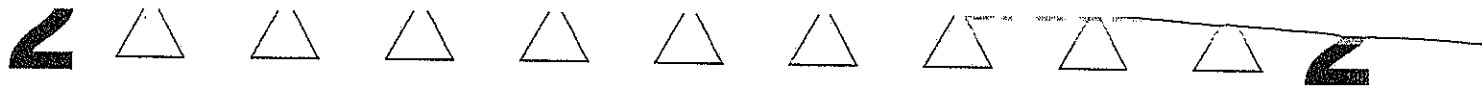
55. What is the determinant of the matrix shown below?

$$\begin{vmatrix} 8 & 3 \\ -5 & -2 \end{vmatrix}$$

- A. 34
- B. 4
- C. -1
- D. -25
- E. -31

56. At Wafer Technologies, identification codes each consist of the following sequence: 1 digit, 4 letters, 1 digit. For any 1 code, the digits (0-9) may be the same, but the letters, each from the English alphabet, must all be different. Which of the following expressions gives the probability that a randomly selected identification code contains the word MATH, spelled correctly?

- F.  $\frac{10^2}{10^2(26^4)}$
- G.  $\frac{10^2}{10^2(26)(25)(24)(23)}$
- H.  $\frac{10^2}{10(9)(26)(25)(24)(23)}$
- J.  $\frac{10^2(4)(3)(2)(1)}{10^2(26^4)}$
- K.  $\frac{10^2(4)(3)(2)(1)}{10(26)(25)(24)(23)}$



57. What is the distance, in coordinate units, between  $2 + 6i$  and  $-4 + 3i$  in the complex plane?

**DO YOUR FIGURING HERE.**

- A. 7
- B. 9
- C.  $\sqrt{13}$
- D.  $\sqrt{45}$
- E.  $\sqrt{85}$

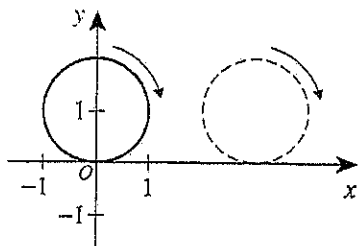
58. What is the minimum value of  $f(x) = |-(x - h)^2 + k| - q$  for each set of positive real numbers,  $h$ ,  $k$ , and  $q$ ?

- F.  $-q$
- G.  $-k$
- H.  $k$
- J.  $-k - q$
- K.  $k - q$

59. Which of the following data sets has the greatest standard deviation?

- A. 1, 1, 1, 10, 10, 10
- B. 1, 2, 3, 4, 5, 6
- C. 2, 6, 6, 10, 10, 12
- D. 5, 5, 5, 5, 5, 5
- E. 5, 6, 7, 8, 9, 10

60. The circle with equation  $x^2 + (y - 1)^2 = 1$  is graphed in the standard  $(x, y)$  coordinate plane below. Suppose the circle rolls along the positive  $x$ -axis for 2 rotations and then stops. Which of the following is an equation of the circle in its new position?



- F.  $(x + 2)^2 + (y - 1)^2 = 1$
- G.  $(x + 2\pi)^2 + (y - 1)^2 = 1$
- H.  $(x + 4\pi)^2 + (y - 1)^2 = 1$
- J.  $(x - 2\pi)^2 + (y - 1)^2 = 1$
- K.  $(x - 4\pi)^2 + (y - 1)^2 = 1$

**END OF TEST 2**

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

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

## READING TEST

35 Minutes—40 Questions

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

### Passage I

**LITERARY NARRATIVE:** Passage A is adapted from an essay by Marita Golden. Passage B is adapted from an essay by Larry L. King. Both essays are from the book *Three Minutes or Less: Life Lessons from America's Greatest Writers* (©2000 by The PEN/Faulkner Foundation).

#### Passage A by Marita Golden

Writers are always headed or looking for home. Home is the first sentence, questing into the craggy terrain of imagination. Home is the final sentence, polished, perfected, nailed down. I am an American writer, and so my sense of place is fluid, ever shifting. The spaciousness of this land reigns and pushes against the borders of self-censorship and hesitation. I have claimed at one point or other everyplace as my home.

Like their creator, my fictional characters reject the notion of life lived on automatic pilot. The most important people in my books see life as a flame, something that when lived properly bristles and squirms, even as it glows. In the autobiography *Migrations of the Heart*, the heroine, who just happened to be me, came of age in Washington, D.C., and began the process of becoming an adult person everywhere else. If you sell your first piece of writing in Manhattan, give birth to your only child in Lagos, experience Paris in the spring with someone you love, and return to Washington after thirteen years of self-imposed exile to write the Washington novel nobody else had (and you thought you never would), tickets, visas, *lingua franca* will all become irrelevant. When all places fingerprint the soul, which grasp is judged to be the strongest? In my novel *A Woman's Place*, one woman leaves America to join a liberation struggle in Africa. In *Long Distance Life*, Naomi Johnson flees 1930s North Carolina and comes up south to Washington, D.C., to find and make her way. Thirty years later her daughter returns to that complex, unpredictable geography and is sculpted like some unexpected work of art by the civil-rights movement.

I am a Washington writer, who keeps one bag in the closet packed, just in case. I am an American, who knows the true color of the nation's culture and its heart, a stubborn, wrenching, rainbow. I am Africa's yearning stepchild, unforgotten, misunderstood, necessary. Writers are always headed or looking for home. The best of us embrace and rename it when we get there.

#### Passage B by Larry L. King

If you live long enough, and I have, your sense of place or your place becomes illusionary. In a changing world, our special places are not exempt. The rural Texas where I grew up in the 1930s and 1940s simply does not exist anymore. It exists only in memory or on pages or stages where a few of us have attempted to lock it in against the ravages of time. And it is, of course, a losing battle. Attempting to rhyme my work of an earlier Texas, with the realities of today's urban-tangle Texas, I sometimes feel that I am writing about pharaohs.

My friend Larry McMurtry a few years ago stirred up a Texas tornado with an essay in which he charged that Texas writers stubbornly insist on writing of old Texas, the Texas of myth and legend, while shirking our responsibilities to write of the complexities of modern Texas. Hardly had the anguished cries of the wounded faded away on the Texas wind, until Mr. McMurtry himself delivered a novel called *Lonesome Dove*. A cracking good yarn, if a bit long on cowboy myths and frontier legends. And decidedly short of skyscraper observations or solutions to urban riddles. But not only did Larry McMurtry have a perfect right to change his mind, I'm delighted that he did.

I spent my formative years in Texas, my first seventeen years, before random relocation arranged by the U.S. Army. Uncle Sam sent me to Queens. I must admit, Queens failed to grow on me. But from it I discovered Manhattan, which did grow on me, and I vowed to return to Manhattan. And one day did. But before that, in 1954, at the age of twenty-five, I came to Washington, D.C., to work in Congress.

New York and Washington offered themselves as measuring sticks against the only world I had previously known. They permitted me to look at my natural habitat with fresh eyes and even spurred me to leave my native place. I have now tarried here in what I call the misty East for almost forty years. This has sometimes led to a confusion of place. I strangely feel like a Texan in New York and Washington, but when I return home to Texas, I feel like a New Yorker or a Washingtonian. So if my native place has been guilty of change, then so have I. Yet when I set out to write there is little of ambivalence. The story speaks patterns, and values that pop out are from an earlier time and of my original

85 place. I fancy myself a guide to the recent past. In an age when the past seems not much value, I think that is not a bad function for the writer.

Questions 1–3 ask about Passage A.

1. According to Passage A, for the author of the passage, being an American writer means that her sense of place is:
  - A. deeply personal.
  - B. constantly shifting.
  - C. tied to her family.
  - D. somewhat irrelevant.
2. Which of the following statements regarding the passage author's Washington novel is best supported by Passage A?
  - A. She wrote the novel about people she met while traveling.
  - G. She could not finish writing it.
  - H. She patterned it after other novels about Washington, DC.
  - J. She thought that she would never write it.
3. Based on how she presents herself in the third paragraph (lines 32–39), the author of Passage A can best be described as someone who:
  - A. overcame many obstacles before achieving success.
  - B. embraces the various elements of her identity.
  - C. gets inspiration from people and everyday things.
  - D. found a place to live that suits her personality.

Questions 4–7 ask about Passage B.

4. The "losing battle" in line 47 of Passage B most nearly refers to the passage author's efforts to:
  - F. inspire a new generation of Texas authors to write about their home state.
  - G. understand the lives of those who lived in 1930s and 1940s rural Texas.
  - H. preserve 1930s and 1940s rural Texas through his writing.
  - J. find new ways to write about his childhood.
5. In the context of Passage B, when the passage author states, "I sometimes feel that I am writing about pharaohs" (lines 49–50), he most nearly means that he feels as if he is writing about:
  - A. a well-known subject.
  - B. an influential time period.
  - C. powerful tyrants.
  - D. the distant past.

6. Based on Passage B, McMurtry's comment that Texas authors write about old Texas too much was received with what can best be described as:
  - F. ambivalence; several writers had already written books that followed McMurtry's suggestion.
  - G. indignation; most writers thought McMurtry was a hypocrite because of *Lonesome Dove*.
  - H. displeasure; many writers openly disagreed with McMurtry's suggestion.
  - J. surprise; many writers didn't know that McMurtry cared about Texas literature.
7. As it is used in line 85, the word *fancy* most nearly means:
  - A. consider.
  - B. theorize.
  - C. enjoy.
  - D. favor.

Questions 8–10 ask about both passages.

8. It can reasonably be inferred from the passages that, regarding its effect on their lives, both passage authors would agree that leaving their native places:
  - F. led to their deciding to move away permanently.
  - G. influenced them to write about visiting new places.
  - H. changed their perspectives about home.
  - J. showed them the value of family.
9. The passages most strongly indicate that in their various moves, both passage authors have:
  - A. resided in Washington, DC.
  - B. written novels while living in New York City.
  - C. relocated because of the military.
  - D. lived in places outside of the United States.
10. Which of the following statements best compares the concluding lines of the passages?
  - F. Both passages end with the authors describing how they see their roles as writers.
  - G. Both passages end with the authors emphasizing the importance that history has for writers.
  - H. The author of Passage A describes her characters, whereas the author of Passage B emphasizes the value of home.
  - J. The author of Passage A describes her approach to starting new books, whereas the author of Passage B explains why his sense of place is illusionary.

Passage II

**SOCIAL SCIENCE:** This passage is adapted from the article "Management Secrets of the Grateful Dead" by Joshua Green (©2010 by The Atlantic Monthly Group).

Since the 1970s, the Grateful Dead has invited academic examination. Musicologists showed interest, although the band's sprawling repertoire and tendency to improvise posed a significant challenge. Engineers studied the band's sophisticated sound system, radical at the time but widely emulated today. Other disciplines have also found relevant elements of the band's history and cultural impact to be worth examining.

Oddly enough, the Dead's influence on the business world may turn out to be a significant part of its legacy. Without intending to—while intending, in fact, to do just the opposite—the band pioneered ideas and practices that were subsequently embraced by corporate America. One was to focus intensely on its most loyal fans. It established a telephone hotline to alert them to its touring schedule ahead of any public announcement, reserved for them some of the best seats in the house, and capped the price of tickets, which the band distributed through its own mail-order house. If you lived in New York and wanted to see a show in Seattle, you didn't have to travel there to get tickets—and you could get really good tickets, without even camping out. "The Dead were masters of creating and delivering superior customer value," Barry Barnes, a business professor at Nova Southeastern University, in Florida, told me. Treating customers well may sound like common sense. But it represented a break from the top-down ethos of many organizations in the 1960s and 1970s. Only in the 1980s, faced with competition from Japan, did American CEOs and management theorists widely adopt a customer-first orientation.

As Barnes and other scholars note, the musicians who constituted the Dead were anything but naïve about their business. They incorporated early on, and established a board of directors (with a rotating CEO position) consisting of the band, road crew, and other members of the Dead organization. They founded a profitable merchandising division and, peace and love notwithstanding, did not hesitate to sue those who violated their copyrights. But they weren't greedy, and they adapted well. They famously permitted fans to tape their shows, ceding a major revenue source in potential record sales. According to Barnes, the decision was not entirely selfless: it reflected a shrewd assessment that tape sharing would widen their audience, a ban would be unenforceable, and anyone inclined to tape a show would probably spend money elsewhere, such as on merchandise or tickets. The Dead became one of the most profitable bands of all time.

It's precisely this flexibility that Barnes believes holds the greatest lesson for business—he calls it "strategic improvisation." It isn't hard to spot a few of its recent applications. Giving something away and earning money on the periphery is becoming the blue-

print for more and more companies doing business on the Internet. Today, everybody is *intensely* interested in understanding how communities form across distances, because that's what happens online.

Much of the talk about "Internet business models" presupposes that they are blindingly new and different. But the connection between the Internet and the Dead's business model was made years ago by the band's lyricist, John Perry Barlow, who became an Internet guru. In 1994, Barlow posited that in the information economy, "the best way to raise demand for your product is to give it away." As Barlow explained to me: "What people today are beginning to realize is what became obvious to us back then—the important correlation is the one between familiarity and value, not scarcity and value. Adam Smith taught that the scarcer you make something, the more valuable it becomes. In the physical world, that works beautifully. But we couldn't regulate [taping at] our shows, and you can't online. The Internet doesn't behave that way. But here's the thing: if I give my song away to 20 people, and they give it to 20 people, pretty soon everybody knows me, and my value as a creator is dramatically enhanced. That was the value proposition with the Dead." The Dead thrived for decades, in good times and bad. In a recession, Barnes says, strategic improvisation is more important than ever. "If you're going to survive an economic downturn, you better be able to turn on a dime," he says. "The Dead were exemplars." It can be only a matter of time until *Management Secrets of the Grateful Dead* or some similar title is flying off the shelves of airport bookstores everywhere.

11. One main idea of the passage is that the Grateful Dead:
  - A. used an innovative, recession-proof approach to business that other companies have learned from.
  - B. wouldn't have become financially successful if they hadn't used the Internet for marketing.
  - C. displayed a talent for songwriting that few other bands have matched.
  - D. organized the band in a way that mimicked the structure of Japanese companies.
12. The passage most strongly implies that one way Grateful Dead fans are similar to some Internet users is that the fans:
  - F. were willing to pay more for quality merchandise.
  - G. displayed a lack of generosity toward strangers.
  - H. formed communities across distances.
  - J. had diverse musical tastes.



13. The author includes quotations from Barnes and Barlow most likely in order to:
- A. illustrate that business leaders have implemented the Grateful Dead's methods.
  - B. provide expert support for the idea that the Grateful Dead used savvy business practices.
  - C. suggest that scholars find the band's history more instructive than that of other bands.
  - D. verify that the Grateful Dead were extremely naïve about running a business.
14. The passage indicates that one component of the Grateful Dead's business model was that the band:
- F. increased its fan base by giving away tickets and merchandise at performances.
  - G. discovered that a fan given something for free would buy other merchandise.
  - H. appointed one member as CEO to streamline decision making.
  - J. resisted significant change because being consistent produced financial stability.
15. What connection does Barlow make between the Grateful Dead's business model and Smith's teachings?
- A. By delaying the release of its music, the Grateful Dead illustrated Smith's teaching that scarcity decreases profits.
  - B. By successfully marketing its music on the Internet, the Grateful Dead disproved Smith's teaching that new markets should be entered cautiously.
  - C. By running its own company, the Grateful Dead exemplified Smith's teaching that controlling the image of a brand adds value.
  - D. By choosing to allow fans to share copies of its songs, the Grateful Dead acted counter to Smith's teaching that scarcity increases value.
16. The main point of the first paragraph is that various scholars have studied the Grateful Dead because:
- F. few bands have produced such an extensive catalog of music.
  - G. the band's fans found ways to make the band relevant to their own careers.
  - H. the band displayed rare qualities in a number of different areas.
  - J. the band's traditional approach to music made its members attractive subjects.
17. As it is used in line 5, the word *radical* most nearly means:
- A. dangerous.
  - B. revolutionary.
  - C. characteristic.
  - D. awesome.
18. Which of the following questions is directly answered by the passage?
- F. What aspect of the Grateful Dead's music most appeals to fans?
  - G. How did the Grateful Dead maintain contact with its fans?
  - H. Which businesses decided to ignore the Grateful Dead's strategies?
  - J. Why haven't more economists studied the Grateful Dead's success?
19. The passage indicates that the Grateful Dead "were masters of creating and delivering superior customer value" (lines 23–24) in part because they:
- A. reserved some of the best seats for loyal fans and capped the price of tickets.
  - B. copied methods displayed by successful Japanese corporations.
  - C. disguised but still used the top-down organizational strategy of many firms.
  - D. provided travel assistance for fans to see shows far from home.
20. According to the passage, American CEOs revised their approach to customers in the 1980s in response to:
- F. shareholder desire for reorganization.
  - G. incorporation by smaller, faster businesses.
  - H. demand for better value from customers.
  - J. increased competition from Japan.

### Passage III

**HUMANITIES:** This passage is adapted from the article "Out of Rembrandt's Shadow" by Matthew Gurewitsch (©2009 by Smithsonian Institution).

Telescopes trained on the night sky, astronomers observe the phenomenon of the binary star, which appears to be a single star but consists in fact of two, orbiting a common center of gravity. Sometimes, one star in the pair can so outshine the other that its companion may be detected only by the way its movement periodically alters the brightness of the greater one.

The binary stars we recognize in the firmament of art tend to be of equal brilliance: Raphael and Michelangelo, van Gogh and Gauguin, Picasso and Matisse. But the special case of an "invisible" companion is not unknown. Consider Jan Lievens, born in Leiden in western Holland on October 24, 1607, just 15 months after the birth of Rembrandt van Rijn, another Leiden native.

While the two were alive, admirers spoke of them in the same breath, and the comparisons were not always in Rembrandt's favor. After their deaths, Lievens dropped out of sight—for centuries. Though the artists took quite different paths, their biographies show many parallels. Both served apprenticeships in Amsterdam with the same master, returned to that city later in life and died there in their 60s. They knew each other, may have shared a studio in Leiden early on, definitely shared models and indeed modeled for each other. They painted on panels cut from the same oak tree, which suggests they made joint purchases of art supplies from the same vendor. They later showed the same unusual predilection for drawing on paper imported from the Far East.

The work the two produced in their early 20s in Leiden was not always easy to tell apart, and as time went on, many a superior Lievens was misattributed to Rembrandt. Quality aside, there are many reasons why one artist's star shines while another's fades. It mattered that Rembrandt spent virtually his entire career in one place, cultivating a single, highly personal style, whereas Lievens moved around, absorbing many different influences. Equally important, Rembrandt lent himself to the role of the lonely genius, a figure dear to the Romantics, whose preferences would shape the tastes of generations to come.

While Lievens' name will be new to many, his work may not be. The sumptuous biblical spectacular *The Feast of Esther*, for instance, was last sold, in 1952, as an early Rembrandt, and was long identified as such in 20th-century textbooks. It is one of more than 130 works featured in the current tour of the international retrospective "Jan Lievens: A Dutch Master Rediscovered."

The artworks, in so many genres, are hardly the works of an also-ran. "We've always seen Lievens

through the bright light of Rembrandt, as a pale reflection," says Arthur K. Wheelock Jr., curator of northern Baroque paintings at the National Gallery. "This show lets you embrace Lievens from beginning to end, to understand that this man has his own trajectory and that he wasn't always in the gravity pull of Rembrandt." Wheelock has been particularly struck by the muscularity and boldness of Lievens, which is in marked contrast to most Dutch painting of the time. "The approach is much rougher, much more aggressive," he says. "Lievens was not a shy guy with paint. He manipulates it, he scratches it. He gives it a really physical presence."

Lievens painted *The Feast of Esther* around 1625, about the time Rembrandt returned to Leiden. It is approximately four and a half by five and a half feet, with figures shown three-quarter length, close to the picture plane. (At that time, Rembrandt favored smaller formats.) At the luminous center of the composition, a pale Queen Esther points an accusing finger at Haman, the royal counselor. Her husband, the Persian King Ahasuerus, shares her light, his craggy face set off by a snowy turban and a mantle of gold brocade. Seen from behind, in shadowy profile, Haman is silhouetted against shimmering white drapery, his right hand flying up in dismay.

Silks, satins and brocades, elegant plumes and gemstones—details like these give Lievens ample scope to show off his flashy handling of his medium. Not for him the fastidious, enamel-smooth surfaces of the Leiden *Fijnschilders*—"fine painters," in whose meticulously rendered oils every brush stroke disappeared. Lievens reveled in the thickness of the paint and the way it could be shaped and scratched and swirled with a brush, even with the sharp end of a handle. This tactile quality is one of Rembrandt's hallmarks as well; there are now those who think he picked it up from Lievens.

21. The main purpose of the passage is to:
- A. argue that Lievens's artworks are superior to Rembrandt's and deserve to be shown in their own retrospective.
  - B. bring Lievens out of obscurity by discussing him as both a peer of Rembrandt and an artist in his own right.
  - C. criticize the art world's belated recognition of Rembrandt and Lievens as an artistic pair.
  - D. illustrate the profound differences between Lievens's artistic training and Rembrandt's.
22. In the passage, both the author and Wheelock describe the effect that Rembrandt's popularity had on Lievens by:
- E. analyzing biographical similarities between the two artists.
  - F. comparing Lievens's early work to his later work.
  - G. personifying Lievens's painting style.
  - H. using astronomy metaphors.

23. In the context of the passage, the main purpose of the first paragraph is to introduce:
- A. a scientific phenomenon that mirrors the relationship between Rembrandt and Lievens.
  - B. an exceptional painting by Lievens that was attributed to Rembrandt.
  - C. the innovative culture in which Rembrandt and Lievens lived.
  - D. a historical event that inspired both Rembrandt and Lievens.
24. The passage most nearly suggests that, in contrast to Rembrandt and Lievens, other artists who are considered members of artistic pairs have tended to:
- F. build their reputations by staying in just one city.
  - G. be underappreciated during their lifetimes.
  - H. achieve equal recognition in the art world.
  - J. have few biographical similarities.
25. In the context of the passage, the description of the subjects featured in the painting *The Feast of Esther* (lines 72–79) mainly serves to:
- A. provide an analogy for the tense relationship between Rembrandt and Lievens.
  - B. demonstrate how Lievens's art reflected Dutch political dynamics.
  - C. illustrate Lievens's bold painting style and attention to detail.
  - D. exemplify techniques common to Dutch painting of the time.
26. The passage indicates that Lievens's recognition in the art community declined most significantly at which of the following times?
- F. When Lievens returned to Amsterdam.
  - G. While Lievens was painting *The Feast of Esther*.
  - H. When Rembrandt returned to Leiden.
  - J. After Rembrandt and Lievens died.
27. The passage most strongly suggests that Lievens might have attained more recognition if he had painted:
- A. in collaboration with other artists.
  - B. more historical subjects.
  - C. in one specific style.
  - D. in smaller formats.
28. The passage indicates that Rembrandt appealed to the Romantics because:
- F. he fit their ideal of the lonely and brilliant artist.
  - G. he traveled widely and absorbed many influences.
  - H. his artwork featured scenes of courtship and love.
  - J. his artwork shaped the tastes of later generations.
29. The fact that *The Feast of Esther* was misidentified as an early Rembrandt painting is most directly used in the passage to support the author's claim that Lievens's work:
- A. is considered by modern art critics to be inferior to Rembrandt's.
  - B. peaked in quality during Lievens's early adulthood.
  - C. may be familiar to some even though Lievens's name is not.
  - D. can be difficult for art exhibitors to obtain.
30. The last sentence of the passage most nearly serves to:
- F. summarize the passage's arguments about why Lievens did not achieve lasting fame.
  - G. suggest that Lievens may have influenced Rembrandt artistically.
  - H. argue that Lievens and Rembrandt collaborated while they were in Leiden.
  - J. outline a controversy regarding the authenticity of some Rembrandt paintings.

Passage IV

**NATURAL SCIENCE:** This passage is adapted from the article "Call of the Leviathan" by Eric Wagner (©2011 by Smithsonian Institution).

In 1839, in the first scientific treatise on the sperm whale, Thomas Beale, a surgeon aboard a whaler, wrote that it was "one of the most noiseless of marine animals." While they do not sing elaborate songs, like humpbacks or belugas, in fact they are not silent. Whalers in the 1800s spoke of hearing loud knocking, almost like hammering on a ship's hull, whenever sperm whales were present. Only in 1957 did two scientists from the Woods Hole Oceanographic Institution confirm the sailors' observations. Aboard a research vessel, the *Atlantis*, they approached five sperm whales, shut off the ship's motors and listened with an underwater receiver. At first, they assumed the "muffled, smashing noise" they heard came from somewhere on the ship. Then they determined the sounds were coming from the whales.

Biologists now believe that the sperm whale's massive head functions like a powerful telegraph machine, emitting pulses of sound in distinct patterns. At the front of the head are the spermaceti organ, a cavity that contains the bulk of the whale's spermaceti, and a mass of oil-saturated fatty tissue. Two long nasal passages branch away from the bony nares of the skull, twining around the spermaceti organ and the fatty tissue. The left nasal passage runs directly to the blowhole at the top of the whale's head. But the other twists and turns, flattens and broadens, forming a number of air-filled sacs capable of reflecting sound. Near the front of the head sit a pair of clappers called "monkey lips."

Sound generation is a complex process. To make its clicking sounds, a whale forces air through the right nasal passage to the monkey lips, which clap shut. The resulting *click!* bounces off one air-filled sac and travels back through the spermaceti organ to another sac nestled against the skull. From there, the click is sent forward, through the fatty tissue, and amplified out into the watery world. Sperm whales may be able to manipulate the shape of both the spermaceti organ and the fatty tissue, possibly allowing them to aim their clicks.

Biologist Dr. Hal Whitehead has identified four patterns of clicks. The most common clicks are used for long-range sonar. So-called "creaks" sound like a squeaky door and are used at close range when prey capture is imminent. "Slow clicks" are made only by large males, but no one knows precisely what they signify. ("Probably something to do with mating," Whitehead guesses.) Finally, "codas" are distinct patterns of clicks most often heard when whales are socializing.

Codas are of particular interest. Whitehead has found that different groups of sperm whales, called vocal clans, consistently use different sets; the reper-

toire of codas the clan uses is its dialect. Vocal clans can be huge—thousands of individuals spread out over thousands of miles of ocean. Clan members are not necessarily related. Rather, many smaller, durable matrilineal units make up clans, and different clans have their own specific ways of behaving.

A recent study in *Animal Behaviour* took the specialization of codas a step further. Not only do clans use different codas, the authors argued, but the codas differ slightly among individuals. They could be, in effect, unique identifiers: names.

Whitehead cautions that a full understanding of codas is still a long way off. Even so, he believes the differences represent cultural variants among the clans. "Think of culture as information that is transmitted socially between groups," he says. "You can make predictions about where it will arise: in complex societies, richly modulated, among individuals that form self-contained communities." That sounds to him a lot like sperm whale society.

But most of a sperm whale's clicking, if not most of its life, is devoted to one thing: finding food. And in the Sea of Cortez, the focus of its attention is *Dosidicus gigas*, the jumbo squid.

The most celebrated natural antagonism between sperm whales and squid almost certainly involves the jumbo squid's larger cousin, the giant squid, a species that grows to 65 feet long. The relationship between sperm whales and squid is pretty dramatic. A single sperm whale can eat more than one ton of squid per day. They do eat giant squid on occasion, but most of what whales pursue is relatively small and over-matched. With their clicks, sperm whales can detect a squid less than a foot long more than a mile away, and schools of squid from even farther away. But the way that sperm whales find squid was until recently a puzzle.

31. The main purpose of the passage is to:
- A. describe how sperm whales use clicks to hunt their prey.
  - B. evaluate historical theories regarding sperm whale clicks.
  - C. provide details about the antagonism between sperm whales and squid.
  - D. explain how sperm whales generate and use clicks.
32. In the eighth paragraph (lines 74–77), the passage begins to focus on the relationship between:
- F. squid and their prey.
  - G. sperm whales and sonar.
  - H. sperm whales and codas.
  - J. squid and sperm whales.

33. The main purpose of the second paragraph (lines 17–30) is to:
- A. compare sperm whales to telegraph machines.
  - B. explain the function of the spermaceti organ.
  - C. outline how scientists came to understand the anatomy of the sperm whale.
  - D. describe the sperm whale anatomy involved in creating sound.
34. It can reasonably be inferred from the passage that codas are of particular interest because scientists don't yet fully understand:
- F. how codas help sperm whales hunt.
  - G. how codas function in sperm whale socialization.
  - H. why codas are emitted only by male whales.
  - J. why codas are so difficult to detect.
35. As it is presented in the passage, the study that appeared in *Animal Behaviour* concluded that sperm whale vocal clans:
- A. each use a distinct dialect, and individuals within each clan have unique codas.
  - B. can adopt the codas of other clans, but individuals within each clan maintain unique dialects.
  - C. each use many dialects, and individuals within each clan develop complex codas.
  - D. can adopt the codas of other clans, but individuals within each clan retain unique identifiers.
36. The passage indicates that compared to the sounds beluga whales and humpback whales make, the sounds sperm whales make are:
- F. more complex and varied.
  - G. more frequent and melodic.
  - H. less elaborate and songlike.
  - J. less enigmatic and repetitive.
37. According to the passage, who confirmed the observation that sperm whales make loud knocking noises?
- A. Beale
  - B. Nineteenth-century whalers
  - C. Woods Hole scientists
  - D. Whitehead
38. As it is used in line 25, the word *runs* most nearly means:
- F. acts.
  - G. hastens.
  - H. operates.
  - J. leads.
39. Based on the passage, the notion that slow clicks are related to sperm whale mating behavior is best described as a:
- A. fact that is supported by several scientific studies.
  - B. fact that whalers discovered in the 1800s.
  - C. reasoned judgment from an expert in biology.
  - D. reasoned judgment from the passage author.
40. Which of the following statements about the mystery of how sperm whales locate squid is best supported by the passage?
- F. The mystery was solved in the 1800s.
  - G. The mystery was solved recently.
  - H. The mystery is likely to be solved in the near future.
  - J. The mystery is likely to remain unsolved until better technology is invented.

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

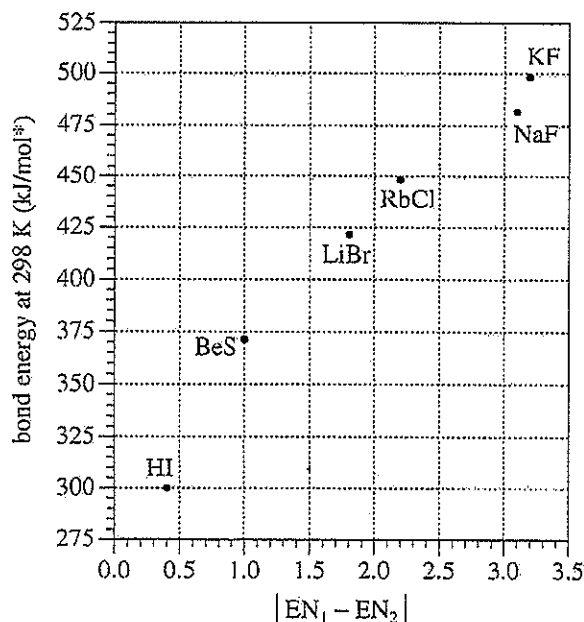
Figure 1 is a simplified periodic table that gives the atomic number, symbol, name, and electronegativity (EN) of 21 elements. Rows of elements are called *periods*. Columns of elements are called *groups*.

Period	Group						
	1A	2A	3A	4A	5A	6A	7A
1	1 H hydrogen 2.1						
2	3 Li lithium 1.0	4 Be beryllium 1.5	5 B boron 2.0	6 C carbon 2.5	7 N nitrogen 3.0	8 O oxygen 3.5	9 F fluorine 4.0
3	11 Na sodium 0.9	12 Mg magnesium 1.2	13 Al aluminum 1.5	14 Si silicon 1.8	15 P phosphorus 2.1	16 S sulfur 2.5	17 Cl chlorine 3.0
4	19 K potassium 0.8	20 Ca calcium 1.0					35 Br bromine 2.8
5	37 Rb rubidium 0.8	38 Sr strontium 1.0					53 I iodine 2.5

Figure 1

Figure 1 adapted from Nivaldo J. Tro, *Chemistry: A Molecular Approach*, 2nd ed. ©2011 by Pearson Education, Inc.

The greater the EN of an element, the more strongly an atom of that element attracts electrons to itself in a chemical bond. The greater the absolute value of the difference between the ENs of 2 elements,  $|EN_1 - EN_2|$ , the more polar is the bond between atoms of the elements. Figure 2 gives, for each of 6 compounds,  $|EN_1 - EN_2|$  and the bond energy at 298 K (the energy needed to break all the bonds in 1 mole of a compound at 298 K).



\*kilojoules per mole;  
1 mole =  $6 \times 10^{23}$  molecules or formula units

Figure 2

Figure 2 adapted from James G. Speight, *Lange's Handbook of Chemistry*, 16th ed. ©2005 by McGraw-Hill, Inc.

- According to Figure 1, the element in Period 2 that is also a member of Group 3A has an EN of:
  - 1.2.
  - 2.0.
  - 2.5.
  - 3.0.
- According to Figure 1, all 3 elements in which of the following lists belong to the same period?
  - H, Li, Na
  - Cl, Br, I
  - Mg, P, S
  - S, N, Br
- The atomic number of an element is the number of protons in the nucleus of an atom of that element. According to Figure 1, the nucleus of an atom of which of the following elements contains more protons than does an atom of sulfur?
  - Fluorine
  - Oxygen
  - Phosphorus
  - Potassium
- Among the 6 compounds represented in Figure 2, as  $|EN_1 - EN_2|$  increases, the bond energy at 298 K:
  - decreases only.
  - increases only.
  - remains the same.
  - varies, but with no general trend.
- Consider  $|EN_1 - EN_2|$  in Figure 2 for BeS. Based on Figure 1, is the bond in HBr less polar or more polar than the bond in BeS?
  - Less polar;  $|EN_1 - EN_2|$  for HBr is less than  $|EN_1 - EN_2|$  for BeS.
  - Less polar;  $|EN_1 - EN_2|$  for HBr is greater than  $|EN_1 - EN_2|$  for BeS.
  - More polar;  $|EN_1 - EN_2|$  for HBr is less than  $|EN_1 - EN_2|$  for BeS.
  - More polar;  $|EN_1 - EN_2|$  for HBr is greater than  $|EN_1 - EN_2|$  for BeS.
- Consider a sample composed of  $3 \times 10^{23}$  molecules of HI. Based on Figure 2, at 298 K, would the amount of energy required to break all the bonds in this sample be greater than 300 kJ or less than 300 kJ?
  - Greater, because the sample contains more than 1 mole of HI.
  - Greater, because the sample contains less than 1 mole of HI.
  - Less, because the sample contains more than 1 mole of HI.
  - Less, because the sample contains less than 1 mole of HI.

**Passage II**

*Triticum aestivum* wheat plants grown in a particular soil are affected by salt (NaCl) in the soil, overwatering of the soil, or both. A study examined the effects.

The following 5 steps were performed:

1. Forty identical pots were divided equally into 4 groups (Groups 1–4).
2. Five kilograms (kg) of the soil was put into each Group 1 pot and each Group 3 pot. A mixture of 4.98 kg of the soil and 20 g of NaCl was put into each Group 2 pot and each Group 4 pot.
3. Ten wheat seeds were planted in each pot and watered daily until all the seeds sprouted. Then 7 of the 10 seedlings were removed from each pot.
4. Over the next 4 months, all the pots received the same amount of sunlight and the same amounts of nutrients daily. Each Group 1 pot and each Group 2 pot received 500 mL of water daily. Each Group 3 pot and each Group 4 pot received 500 mL of water daily, except for 3 consecutive weeks during the third month. Over that 3-week period, each Group 3 pot and each Group 4 pot was overwatered by keeping the water level 1 cm above the top of the soil.

Table 1 describes the differences among the groups.

Group	NaCl mixed with soil?	Plants overwatered?
1	no	no
2	yes	no
3	no	yes
4	yes	yes

5. At 4 months, 2 averages were calculated for the plants in each group of pots: the average plant mass (roots included), in g per plant, and the average *grain yield* (mass of grain produced), in g of grain per plant.

The average plant mass results are shown in Figure 1, and the average grain yield results are shown in Figure 2.

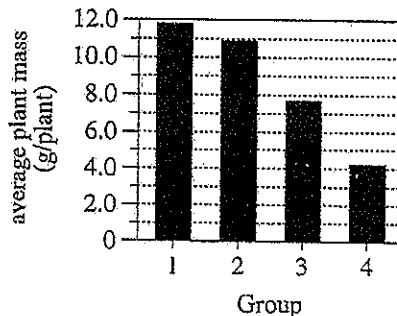


Figure 1

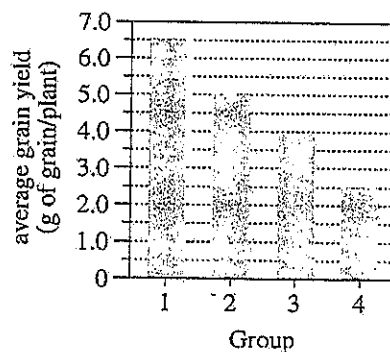


Figure 2

Figures adapted from Muhammad Saqib, Javaid Akhtar, and Riaz Hussain Qureshi, "Pot Study of Wheat Growth in Saline and Waterlogged Compacted Soil: [Part] I. Grain Yield and Yield Components." ©2004 by Elsevier B. V.





7. Assume that wheat plants with a greater mass also have a greater height. Based on Figure 1, the average height of the wheat plants in which group of pots was greatest?
- Group 1
  - Group 2
  - Group 3
  - Group 4
8. What is the most likely reason that 7 seedlings were removed from each pot in Step 3?
- To prevent the plants from producing grain
  - To avoid overcrowding as the plants grew
  - To reduce the amount of NaCl in the soil
  - To decrease the total mass of the pot's contents
9. According to Table 1, the Group 1 pots differed from the Group 3 pots with respect to which of the following factors?
- Mass of soil put into a pot
  - Number of wheat seeds planted in a pot
  - Total amount of nutrients received by a pot
  - Total amount of water received by a pot
10. According to the results of the study, for the Group 3 pots, what was the average plant mass in g/plant, and what was the average grain yield in g of grain/plant?
- |    | <u>average plant mass</u> | <u>average grain yield</u> |
|----|---------------------------|----------------------------|
| F. | 3.9                       | 4.2                        |
| G. | 3.9                       | 7.8                        |
| H. | 7.8                       | 3.9                        |
| J. | 7.8                       | 4.2                        |
11. Based on Figure 2, did NaCl alone or did overwatering alone cause a greater decrease in the average grain yield?
- NaCl; the average grain yield was less for the Group 2 pots than for the Group 3 pots.
  - NaCl; the average grain yield was less for the Group 3 pots than for the Group 2 pots.
  - Overwatering; the average grain yield was less for the Group 2 pots than for the Group 3 pots.
  - Overwatering; the average grain yield was less for the Group 3 pots than for the Group 2 pots.
12. According to Figure 2, at 4 months, the plants in the Group 4 pots had produced, on average, 2.5 g of grain per plant. To calculate the total mass of grain produced, on average, by the plants in a *single* Group 4 pot, should 2.5 g be multiplied by 3 or by 10?
- Three, because at 4 months, there were three Group 4 pots.
  - Three, because at 4 months, there were 3 plants in each Group 4 pot.
  - Ten, because at 4 months, there were ten Group 4 pots.
  - Ten, because at 4 months, there were 10 plants in each Group 4 pot.
13. The researchers who performed the study most likely compared the results shown in Figure 1 for the Group 1 pots and the Group 2 pots to answer which of the following questions?
- What effect did NaCl alone have on average plant mass?
  - What effect did NaCl alone have on average grain yield?
  - What effect did overwatering alone have on average plant mass?
  - What effect did overwatering alone have on average grain yield?

**Passage III**

Both bats and birds have wings used for flight. Two students present opposing views about whether the presence of the wings is an indication that bats and birds are more closely related to each other than either is to other vertebrates without wings, such as humans. Included in each student's presentation is a *cladogram*, a diagram that shows the evolutionary history of several species. A cladogram organizes species into clades based on descent from a common ancestor. A *clade* is a set of related species and their *most recent common ancestor* (MRCA).

*Student 1*

Although both have wings, bats and birds are not more closely related to each other than either is to other vertebrates without wings. Although the wings of bats and birds evolved in response to similar selective forces, they evolved independently of one another, as shown in Figure 1. The wings of birds evolved at Point A, whereas the wings of bats evolved at Point B.

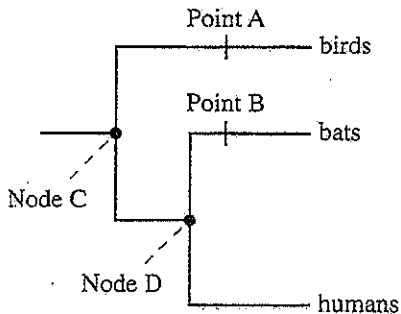


Figure 1

A bat can move individual wing bones, much like the fingers can be moved in a human hand. The bones in a bird wing are fused and inflexible. Thus, the bone structure of a bat wing is more similar to the bone structure of a human hand than to the bone structure of a bird wing. Furthermore, the fact that both bats and humans share mammalian characteristics provides additional evidence that bats are more closely related to humans than to birds.

*Student 2*

Their both having wings is a good indication that bats and birds are more closely related to each other than either is to other vertebrates without wings. The MRCA of all vertebrates with wings must have had wings. As shown in Figure 2, the MRCA of bats and birds, represented at Node Z, evolved to give rise to all winged vertebrates.

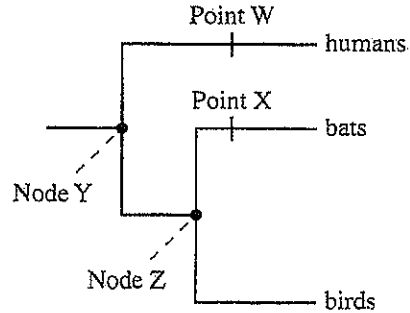


Figure 2

Evidence that the bone structure of a bat wing is similar to that of a human hand does not indicate that bats and humans are closely related because bats, birds, and humans all have a similar forelimb bone structure. Humans and bats are both mammals, but the mammalian characteristics of humans and of bats evolved at Points W and X, respectively.

14. Student 2's cladogram indicates that which of the vertebrates listed below belong to the clade that originates at Node Z?
- I. Humans
  - II. Bats
  - III. Birds
- F. I only
  - G. I and II only
  - H. II and III only
  - J. I, II, and III



15. Consider the statement "Bats have a small claw that sticks out of the wing and functions like a human thumb, allowing the bat to hang onto and climb on trees." This statement supports the view of which student?

- A. Student 1, because Student 1 claims that any descendant of an ancestor with forelimbs will have a nonfunctional structure that resembles a human thumb.
- B. Student 1, because Student 1 claims that the similarity of bone structure between a bat wing and a human hand provides evidence that bats and humans are closely related.
- C. Student 2, because Student 2 claims that any descendant of an ancestor with forelimbs will have a nonfunctional structure that resembles a human thumb.
- D. Student 2, because Student 2 claims that the similarity of bone structure between a bat wing and a human hand provides evidence that bats and humans are closely related.

16. In Student 1's cladogram, is the MRCA of bats and humans represented at Node C or at Node D?

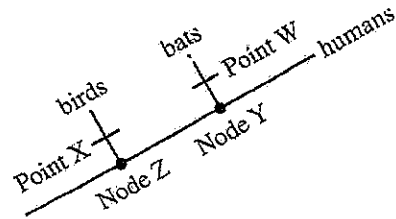
- F. Node C, because the clade that begins with the ancestor represented at Node C includes bats and humans, as well as birds, as descendants.
- G. Node C, because the clade that begins with the ancestor represented at Node C includes bats and humans, but not birds, as descendants.
- H. Node D, because the clade that begins with the ancestor represented at Node D includes bats and humans, as well as birds, as descendants.
- J. Node D, because the clade that begins with the ancestor represented at Node D includes bats and humans, but not birds, as descendants.

17. Which of the students, if either, present(s) a cladogram that is consistent with the statement "Birds and humans, but not bats, share a common ancestor that had forelimbs"?

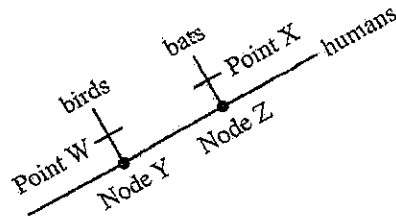
- A. Student 1 only
- B. Student 2 only
- C. Both Student 1 and Student 2
- D. Neither Student 1 nor Student 2

18. Which of the following cladograms is consistent with the cladogram constructed by Student 2?

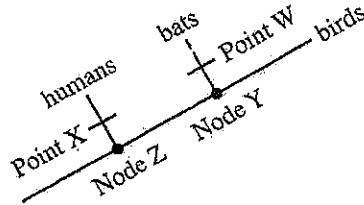
F.



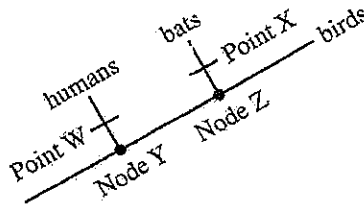
G.



H.



J.



19. Which of the students, if either, would be likely to claim that the MRCA of bats and birds did *not* have wings?

- A. Student 1 only
- B. Student 2 only
- C. Both Student 1 and Student 2
- D. Neither Student 1 nor Student 2

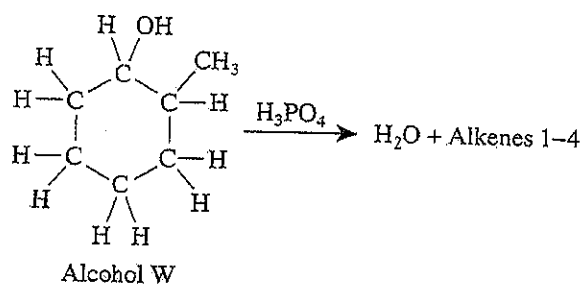
20. Student 2 implies that which of the following morphological traits evolved at Points W and X?

- F. Wings for flight
- G. Forelimbs
- H. Hands
- J. Mammary glands

## Passage IV

Alcohols are carbon compounds containing a hydroxyl (OH) group. Alkenes are carbon compounds containing at least 1 carbon-carbon double bond (C=C).

Dehydration (removal of H<sub>2</sub>O) of Alcohol W in the presence of phosphoric acid (H<sub>3</sub>PO<sub>4</sub>) produces H<sub>2</sub>O and a mixture of 4 alkenes (Alkenes 1-4) that each contain only 1 C=C bond:



Dehydration of each of 3 other alcohols (Alcohols X, Y, and Z) produces H<sub>2</sub>O and 2 or more of Alkenes 1-4. Students studied the dehydration of each of these 4 alcohols, which are all liquids at 25°C.

### Experiment

In each of 4 trials, the students performed Steps 1-5:

1. A 2.30 g sample of Alcohol W, X, Y, or Z was placed in a flask.
2. A 0.5 mL portion of H<sub>3</sub>PO<sub>4</sub> was added to the flask, and an apparatus for *distillation* (evaporation of one or more components of a liquid mixture in one vessel and condensation of the vapors in another vessel) was assembled (see Figure 1).
3. The contents of the flask were boiled at 1 atmosphere (atm) of pressure in a heated sand bath. All the components of the product mixture that distilled before the vapor temperature reached 115°C were collected in a test tube that was cooled in ice water.
4. Two mL of saturated salt solution was added to the test tube. The test tube was covered and shaken, and its contents were allowed to settle into 2 layers.
5. The percent composition of the top layer (the mixture of alkene products only) was determined (see Table 1).

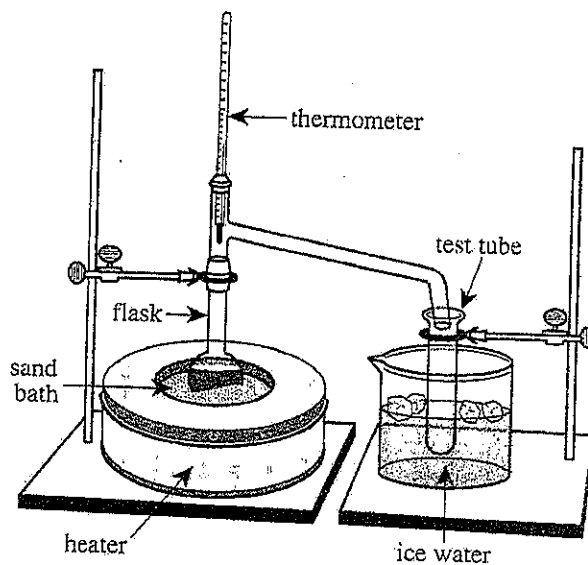
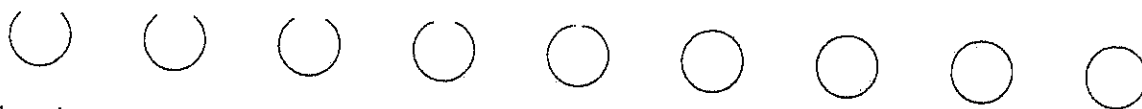


Figure 1

Trial	Alcohol	Percent composition of the mixture of alkene products:			
		Alkene 1	Alkene 2	Alkene 3	Alkene 4
1	W	6	67	18	9
2	X	2	98	0	0
3	Y	0	15	31	54
4	Z	0	9	12	79



21. Based on the results of the experiment, the mixture of alkene products resulting from the dehydration of which of the alcohols contained the greatest percent of Alkene 3?
- Alcohol W
  - Alcohol X
  - Alcohol Y
  - Alcohol Z
22. Trials 1 and 4 differed with respect to which of the following?
- The number of alkenes produced
  - The number of alcohols dehydrated
  - The mass of alcohol placed in the flask
  - The volume of  $H_3PO_4$  placed in the flask
23. What was the most likely purpose of the sand bath shown in Figure 1?
- To partially cool the test tube
  - To evenly distribute heat to the flask
  - To provide sand as a reactant in the dehydration reaction
  - To provide sand as a surface onto which the vapors would condense
24. What is the most likely reason that, upon the completion of Step 4, the mixture of alkene products was the top layer in the test tube?
- The density of the mixture of alkene products was greater than the density of the saturated salt solution.
  - The density of the mixture of alkene products was less than the density of the saturated salt solution.
  - The volume of the mixture of alkene products was greater than the volume of the saturated salt solution.
  - The volume of the mixture of alkene products was less than the volume of the saturated salt solution.
25. When the students dehydrated a different alcohol, Alcohol R, the alkene products that were produced were the same as those resulting from the dehydration of Alcohol W. Based on the results of the experiment, the alkene products resulting from the dehydration of Alcohol R were:
- Alkenes 1 and 2 only.
  - Alkenes 1, 2, and 3 only.
  - Alkenes 2, 3, and 4 only.
  - Alkenes 1, 2, 3, and 4.
26. Which of the following statements gives the most likely reason that the test tube was cooled in ice water, as shown in Figure 1? The test tube was most likely cooled in ice water to more readily:
- condense the liquid produced.
  - condense the vapor produced.
  - evaporate the liquid produced.
  - evaporate the vapor produced.
27. One of the students predicted that in Step 3,  $H_2O$  would be one of the substances collected in the test tube. Based on the boiling point of  $H_2O$  at 1 atm of pressure and the description of Step 3, was the student's prediction correct?
- Yes, because the boiling point of  $H_2O$  is greater than  $115^\circ C$ .
  - Yes, because the boiling point of  $H_2O$  is less than  $115^\circ C$ .
  - No, because the boiling point of  $H_2O$  is greater than  $115^\circ C$ .
  - No, because the boiling point of  $H_2O$  is less than  $115^\circ C$ .

**Passage V**

The processing of sulfur-rich *ore* (rock containing valuable metals) from mines produces liquid waste, which is often stored in a pond. Some of the liquid in the pond seeps down to the groundwater table, where it contaminates the groundwater beneath with sulfate ( $\text{SO}_4^{2-}$ ). A barrier called a *reactive wall* can be installed in the ground near the pond to lessen  $\text{SO}_4^{2-}$  contamination. As polluted water flows through the wall,  $\text{SO}_4^{2-}$  is removed from the water (see Figure 1). The material that forms the wall—the *reactive material* (RM)—is composed of one or more organic substances.

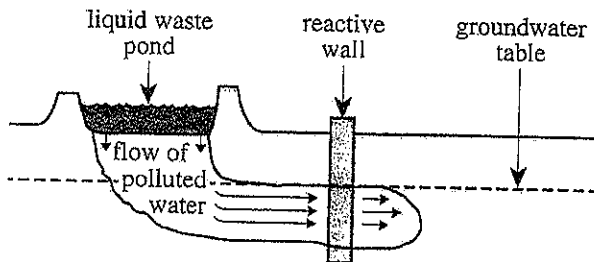


Figure 1

A study evaluated the effectiveness of several reactive materials.

*Study*

Six reactive materials (RMs 1–6) were prepared from samples of 4 organic substances—sewage sludge, leaf mulch, sheep manure, and sawdust—that had been completely dried. Table 1 shows the composition of each RM.

RM	Percent dry mass of substance in material			
	sewage sludge	leaf mulch	sheep manure	sawdust
1	100	0	0	0
2	0	100	0	0
3	0	10	65	25
4	20	10	20	50
5	0	60	0	40
6	15	60	0	25

The following procedures were performed for each RM: First, a 500 mL volume of the RM was placed in a 1 L flask. Next, 500 mL of a simulated liquid mine waste with an  $\text{SO}_4^{2-}$  concentration of 3,600 mg/L was added to the flask. The flask opening was then covered with an airtight cap. Every 5 days, a 10 mL sample of the liquid in the flask was collected through a seal in the cap. Each sample was analyzed for  $\text{SO}_4^{2-}$ . Once a sample was found to have an  $\text{SO}_4^{2-}$  concentration of zero, no additional samples were collected from the flask.

Figure 2 shows the results for each RM.

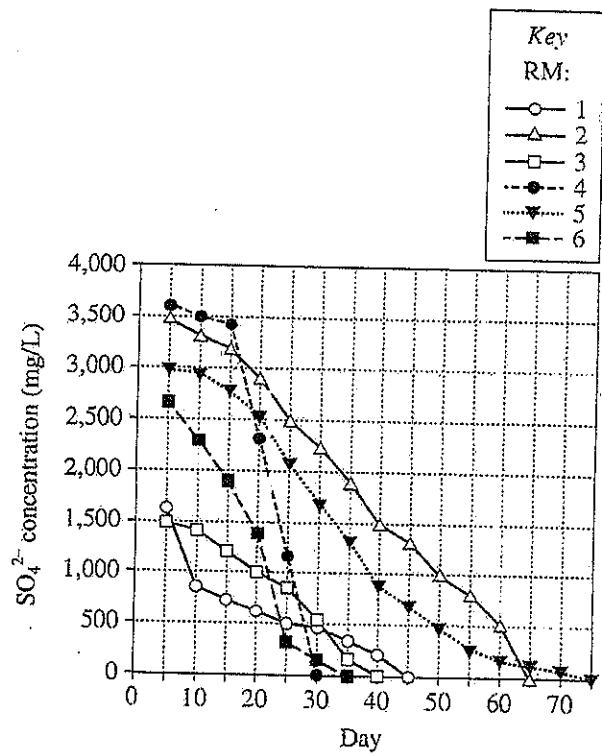


Figure 2

Table and figures adapted from K. R. Waybrant, D. W. Blowes, and C. J. Ptacek, "Selection of Reactive Mixtures for Use in Permeable Reactive Walls for Treatment of Mine Drainage." ©1998 by the American Chemical Society.

28. The movement of liquid waste from a storage pond to the groundwater table is an example of which of the following processes?
- F. Infiltration  
G. Evaporation  
H. Condensation  
J. Weathering
29. If a sample of the liquid in the flask containing RM 1 had been collected on Day 22, the  $\text{SO}_4^{2-}$  concentration of that sample would most likely have been closest to which of the following?
- A. 350 mg/L  
B. 550 mg/L  
C. 750 mg/L  
D. 950 mg/L
30. Over the 75 days that samples were collected, how many samples were collected from the flask containing RM 3, and how many samples were collected from the flask containing RM 6?
- |    | RM 3 | RM 6 |
|----|------|------|
| F. | 8    | 7    |
| G. | 8    | 8    |
| H. | 10   | 10   |
| J. | 10   | 15   |
31. Consider the reactive materials for which the percent dry mass of leaf mulch was greater than 50%. Did each of those reactive materials remove all the  $\text{SO}_4^{2-}$  from the liquid mine waste in their flasks in less than 50 days?
- A. Yes, it took only 30 days for RM 2, RM 5, and RM 6 to remove all the  $\text{SO}_4^{2-}$  from the waste in their flasks.  
B. Yes, it took only 45 days for RM 3, RM 4, and RM 5 to remove all the  $\text{SO}_4^{2-}$  from the waste in their flasks.  
C. No, it took more than 60 days for RM 2 and RM 5 to remove all the  $\text{SO}_4^{2-}$  from the waste in their flasks.  
D. No, it took more than 60 days for RM 5 and RM 6 to remove all the  $\text{SO}_4^{2-}$  from the waste in their flasks.
32. Suppose an environmental engineer wants to ensure that a reactive wall as depicted in Figure 1 will remove as much  $\text{SO}_4^{2-}$  from the polluted water as possible. Based on Figure 1, would the engineer more likely achieve this goal by increasing the thickness of the wall or the height of the wall?
- F. The thickness, because the polluted water will flow horizontally through the wall.  
G. The thickness, because the polluted water will flow vertically through the wall.  
H. The height, because the polluted water will flow horizontally through the wall.  
J. The height, because the polluted water will flow vertically through the wall.
33. Consider the concentration of  $\text{SO}_4^{2-}$  in the liquid mine waste that was added to the flask containing RM 4 on Day 0. Also consider the concentration of  $\text{SO}_4^{2-}$  in the sample collected from that flask on Day 25. The concentration on Day 25 was approximately what fraction of the concentration on Day 0?
- A.  $\frac{1}{10}$   
B.  $\frac{1}{4}$   
C.  $\frac{1}{3}$   
D.  $\frac{1}{2}$
34. Suppose that a reactive material with a composition of 50 percent by dry mass of the sewage sludge and 50 percent by dry mass of the leaf mulch had been tested in the study. The  $\text{SO}_4^{2-}$  concentration of the sample collected on Day 5 from the flask containing that reactive material would most likely have been:
- F. less than 500 mg/L.  
G. between 500 mg/L and 1,500 mg/L.  
H. between 1,500 mg/L and 3,500 mg/L.  
J. greater than 3,500 mg/L.

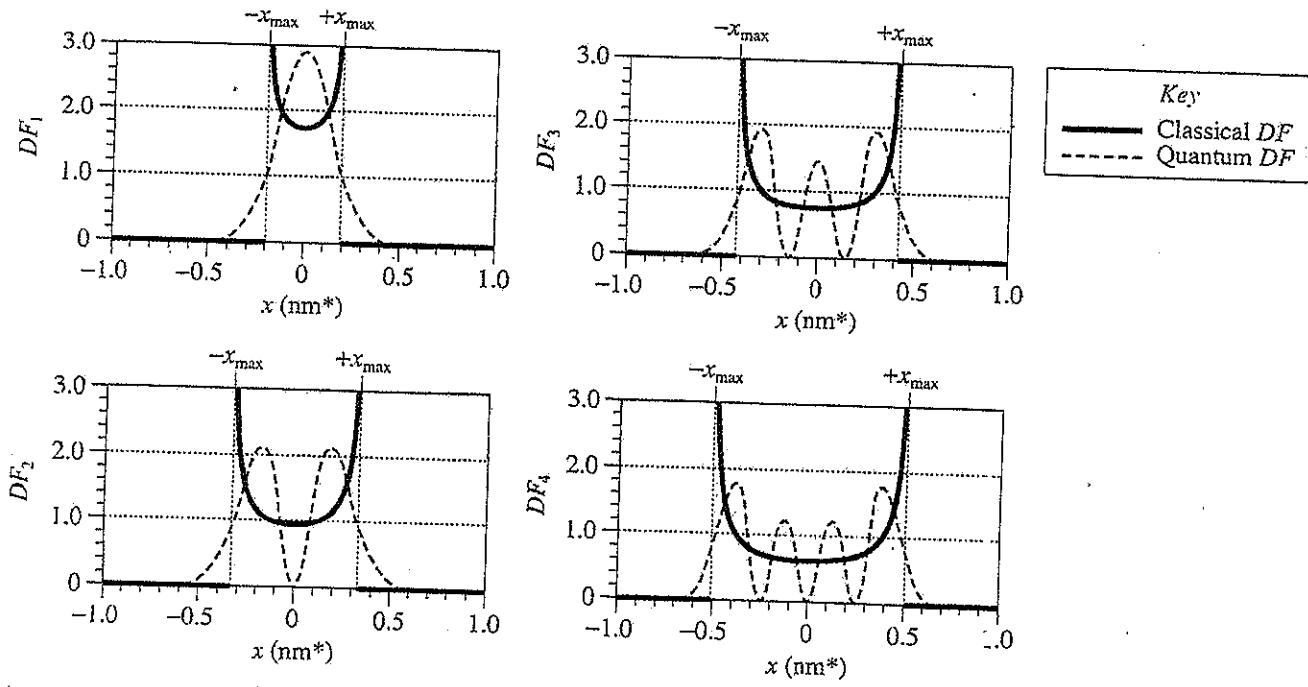
Passage VI

Consider an electron that is constrained to move along the  $x$ -axis. The probability of finding the electron at any given location,  $x$ , along the axis is obtained from a distribution function,  $DF$ , which is related to the electron's energy. The greater the value of  $DF$  at a given  $x$ , the greater the probability of finding the electron at that  $x$ . Classical theory and quantum theory can be used to derive 2 forms of  $DF$ : a classical form and a quantum form.

Table 1 lists the electron energy corresponding to each of 4  $DF$ s. Figure 1 shows the classical and quantum forms of each  $DF$ .

Table 1	
$DF$	Corresponding electron energy (eV*)
$DF_1$	1
$DF_2$	3
$DF_3$	5
$DF_4$	7

\*electron volts

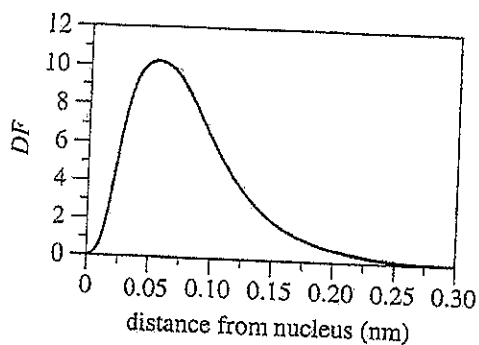


\*nanometer;  $1 \text{ nm} = 10^{-9} \text{ m}$

Figure 1

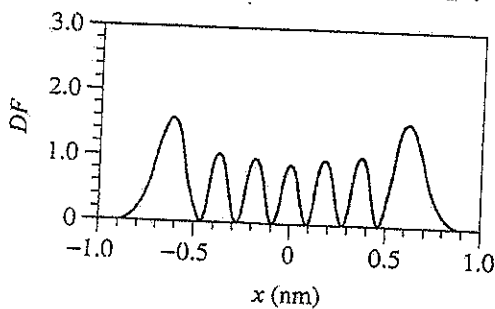


35. The figure below shows the Quantum  $DF$  for an electron bound within a hydrogen atom.



At approximately what distance from the nucleus is this electron most likely to be found?

- A. 0 nm  
 B. 0.05 nm  
 C. 0.15 nm  
 D. 0.30 nm
36. The figure below most likely shows which  $DF$ ?



- F. Classical  $DF_7$   
 G. Classical  $DF_8$   
 H. Quantum  $DF_7$   
 J. Quantum  $DF_8$

37. Based on Table 1 and Figure 1, at which electron energy are *both* the value of Classical  $DF$  and the value of Quantum  $DF$  greater than zero at every  $x$  between the locations  $-x_{\max}$  and  $+x_{\max}$ ?

- A. 1 eV  
 B. 3 eV  
 C. 5 eV  
 D. 7 eV

38. What is the approximate maximum value of Quantum  $DF_4$ , and at what approximate locations does Quantum  $DF_4$  have this value?

	maximum value	locations
F.	1.3	$x = \pm 0.1$ nm
G.	1.3	$x = \pm 0.4$ nm
H.	1.8	$x = \pm 0.1$ nm
J.	1.8	$x = \pm 0.4$ nm

39. Each Quantum  $DF$  represents a unique physical state of the electron. The electron may make a transition from one state to another by either absorbing or emitting energy. Based on Table 1, if the electron were initially in the state represented by  $DF_3$  and then made a transition to the state represented by  $DF_1$ , would the electron more likely absorb energy or emit energy, and how much? The electron would:

- A. absorb 4 eV.  
 B. absorb 6 eV.  
 C. emit 4 eV.  
 D. emit 6 eV.

40. At locations between  $-x_{\max}$  and  $+x_{\max}$ , the value of Classical  $DF$  is inversely proportional to the electron's speed. Based on Table 1 and Figure 1, at which of the following locations is a 5 eV electron most likely moving fastest?

- F.  $x = -0.3$  nm  
 G.  $x = 0$  nm  
 H.  $x = 0.2$  nm  
 J.  $x = 0.4$  nm

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.