

Form E26

(June 2022)



The **ACT**[®]

2021 | 2022

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

ENGLISH TEST

45 Minutes—75 Questions

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

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

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

PASSAGE I

Dragon and Snow

Yueming zipped up her warmest coat for the walk home from school and pushed through the double doors. No new snow had fallen since the weekend, when back-to-back snowy blizzards¹ had turned Philadelphia into a place she did not recognize, the view out her apartment window at the time more amazing with each passing hour. The New Year’s festivities, fifteen days of it,² were half over and still her family had not arrived from China, delayed by the storms.

The cold air snapped³ Yueming out of an afternoon daze. At the corner of Tenth and Winter, someone had cleared the snow in front of the mural, one of the several that were part of Yueming’s daily commute. This one *The History of Chinatown*,⁴ looked especially bright today, the sun’s reflection off the snow, working⁵ some magic with the colors.

1. A. NO CHANGE
B. blizzards of snowfall
C. blizzards of snow
D. blizzards
2. F. NO CHANGE
G. such,
H. them,
J. this,
3. Which choice best suggests that the effect of the cold air on Yueming was immediate?
A. NO CHANGE
B. pulled
C. lured
D. drew
4. F. NO CHANGE
G. one: *The History of Chinatown*,
H. one, *The History of Chinatown*,
J. one *The History of Chinatown*
5. A. NO CHANGE
B. snow was working,
C. snow working,
D. snow working



There, in paint, Chinese immigrants worked
their jobs, one bent over a clothes iron,
others caught up in railroad construction, and
a giant figure on the horizon, his gaze locked on
the passerby. In the lower left-hand corner, a child
no bigger than Wei tugged at a kite in a schoolyard.
As many times as she had seen them, these figures
still caught Yueming off guard, incongruous as
they were—motionless—with the rush of

Philadelphia's urban city traffic heading
for the Vine Street Expressway.

Mother and Wei would come
tomorrow after this visit, their next one

would be for Yueming's graduation. [A] Having to

tell them soon, tomorrow, over her decision to stay,
that she would not be coming home to China. [B] She

would remain instead in this world, familiar and
new. [C] Suddenly, laughter turned the corner in her

direction. It belonged to a small group of young men,
each carrying a piece of a giant dragon. [D] She would

see the toothy, quaking creature in all its festive entirety
the following evening with her family. But now, Yueming
hesitated under the arch that opened into Chinatown. As

6. Which choice indicates there is another, specific type of work depicted in the mural?
- F. NO CHANGE
G. gripping it with an enormous hand,
H. in the center of the image,
J. others hard at work,
7. A. NO CHANGE
B. off guard, incongruous,
C. off guard incongruous,
D. off guard incongruous
8. F. NO CHANGE
G. the city of Philadelphia's urban
H. in-town vehicular car
J. DELETE the underlined portion.
9. A. NO CHANGE
B. tomorrow. After this visit, their
C. tomorrow, after this visit, their
D. tomorrow. Their
10. F. NO CHANGE
G. Yueming had to
H. Her having to
J. To
11. A. NO CHANGE
B. with
C. of
D. in
12. Which choice connects Yueming in a figurative way to the mural described in the essay?
- F. NO CHANGE
G. paint herself instead into
H. not leave
J. take
13. A. NO CHANGE
B. direction, which belonged
C. direction that belonged
D. direction belonging
14. F. NO CHANGE
G. its'
H. its
J. DELETE the underlined portion.

the traffic light changed and changed again, she watched
the distance grow between herself and the undone dragon,
color bobbing on a cityscape of snow. [15]

15. The writer wants to divide this paragraph into two in order to separate the statement indicating Yueming's plans for herself from the details about her immediate surroundings. The best place to begin the new paragraph would be at:
- A. Point A.
 - B. Point B.
 - C. Point C.
 - D. Point D.

PASSAGE II

The following paragraphs may or may not be in the most logical order. Each paragraph is numbered in brackets, and question 30 will ask you to choose where Paragraph 3 should most logically be placed.

Aquatic Explorer AQUA2

[1]

Marine dives offer scientists invaluable chances to study sea life firsthand. [16] Yet the limited time divers may remain underwater—often no more than

two hours—has led scientists to call for robots able

17

to help conduct observations in an assistive capacity.

18

Complex functions like detecting chemicals and mapping

topography, and these have already been implemented in

19

robots with wide success. The bigger challenge is teaching a robot to swim.

16. If the writer were to delete the words “invaluable” and “firsthand” from the preceding sentence, the sentence would primarily lose:
- F. a description of the kinds of sea life that are sought out by scientists on marine dives.
 - G. a tone of appreciation for the difficulties scientists often encounter during a marine dive.
 - H. an indication of one benefit of marine dives and how significant it is to scientists.
 - J. a suggestion that most marine dives are conducted by scientists.
17. A. NO CHANGE
B. have lead
C. have led
D. has lead
18. F. NO CHANGE
G. as aides to scientists' underwater studies.
H. since divers' time underwater is limited.
J. DELETE the underlined portion and end the sentence with a period.
19. A. NO CHANGE
B. topography being functions that
C. topography, which
D. topography

[2]

Powerful thrusters have helped some robots surge
20

through the depths. Such equipment, however
21
or even harm sea life. The engineers developing the robot

AQUA2 imagined a robot able to use advanced imaging
22
and electromechanical systems. To do so, it would need
22
to swim as naturally as a fish, a squid, or—as it turned
out—a turtle.

[3]

AQUA2 has also proved remarkably well adapted
to land. Its flippers reverse direction in shallow water,
pushing the robot up onto sturdy, arched legs. The
23

legs 24 propel the robot out of the surf. Rubber treads
on each leg allow AQUA2 to scale sand dunes or
snowbanks, making the robot as suitable for studies

in the Caribbean as well as those in the Arctic.
25

[4]

Like its biological counterpart, AQUA2 has
flippers that allow it to glide through the water, dive
to the ocean floor, and ascend from the bottom. Unlike
thruster-powered robots, AQUA2 can make subtle changes
26
in course simply by altering the positions of its flippers.
26

20. F. NO CHANGE

G. cascade

H. flood

J. gush

21. A. NO CHANGE

B. equipment, however,

C. equipment however,

D. equipment however

22. Given that all the choices are accurate, which one provides the best transition between the preceding sentence and the next sentence?

F. NO CHANGE

G. operate equally smoothly in tethered or untethered modes.

H. perform in mere minutes tasks that take scientists hours.

J. move in harmony with the creatures it would study.

23. A. NO CHANGE

B. by doing so, they push the robot

C. then, the robot is pushed

D. this pushes the robot

24. At this point, the writer is considering adding the following accurate information:

rotate like windmill blades to

Should the writer make this addition here?

F. Yes, because it explains how the engineers came up with the design for the legs.

G. Yes, because it provides a description that helps clarify how the legs work.

H. No, because it introduces a comparison to windmills that is not developed in the rest of the essay.

J. No, because it blurs the paragraph's focus on the robot's ability to move from land to water.

25. A. NO CHANGE

B. as it is for

C. but also

D. or

26. F. NO CHANGE

G. a possibility exists for subtle changes in course to be made simply by AQUA2

H. subtle changes in course can be made by AQUA2 simply

J. subtle changes in course can be made simply by AQUA2

By holding two flippers still, as it gently paddles, with
the other four, for example, the robot can “hover” in

place underwater. This exquisite competency will allow
it to avoid disturbing the sea life it is designed to observe.

[5]

Now, AQUA2 faces a new challenge; even more tricky
than reacting to different terrains is interacting with human
divers. During field tests amid busy coral reefs in Barbados
and the silty beds of lakes in Canada, AQUA2 practices
following divers’ instructions. Soon, scientists may be able
to conduct more frequent, more efficient dives with robotic
partners at their sides.

27. A. NO CHANGE
B. still, as it gently, paddles
C. still as it gently paddles,
D. still as it gently paddles

28. F. NO CHANGE
G. superhuman power
H. unique ability
J. weird trick

29. Which choice best maintains the word pattern of the
previous example involving Barbados coral reefs?

- A. NO CHANGE
B. silty lake beds in Canada,
C. silty Canadian lake beds,
D. Canada’s silty lake beds,

Question 30 asks about the preceding passage
as a whole.

30. For the sake of logic and cohesion, Paragraph 3 should
be placed:

- F. where it is now.
G. after Paragraph 1.
H. after Paragraph 4.
J. after Paragraph 5.

PASSAGE III

The Fisherman of Porgy Key

[1]

Covering 173,000 acres of clear water and dozens
of islands off the tip of Florida, Biscayne National Park
features many unusual species of plants. Today, the park
is a refuge for sea turtles, manatees, and alligators. In the
1960s, though, land developers saw commercial potential
for the area. Some wanted to build an oil refinery. [A]

31. Given that all the choices are true, which one provides
the most specific description of plant life in Biscayne
National Park?

- A. NO CHANGE
B. colorful orchids, rare cacti, and mangrove forests.
C. many species that are difficult to find in the wild.
D. four distinct ecosystems.

Others, because of Biscayne Bay’s natural beauty, wanted beach resorts. However, Lancelot Jones, one of two year-round residents, of the islands ³² wanted to preserve the bay.

[2]

Porgy Key had always been home for Jones, a small ³³ island in Biscayne Bay. His father had purchased the land for \$300 in 1897, and Jones grew up there, cultivating ³⁴

pineapples and Key limes. Therefore, in 1935, Jones began ³⁵ guiding fishing trips; his knowledge of fishing earned him the reputation for being the area’s best fishing guide. [B]

Among his clientele were several US presidents, including: ³⁶ Hoover, Kennedy, and Nixon.

[3]

[1] In 1961, fourteen of the eighteen landowners came to Biscayne Bay and voted to found a city on the bay’s islands to expedite commercial development of the land. [2] Jones abstained from voting. [3] He refused to sell his land because ³⁷ he wanted the area

to be conserved. 38

[4]

Jones wasn’t alone, some Florida residents, and ³⁹ frequent visitors sought to preserve Biscayne Bay by turning it into a national park. Their efforts were furthered by *Miami Herald* reporter Juanita Greene, whose articles helped sway public opinion. [C] Finally,

32. F. NO CHANGE
 G. However Lancelot Jones, one of two year-round residents, of the islands,
 H. However, Lancelot Jones, one of two year-round residents of the islands,
 J. However Lancelot Jones, one of two year-round residents of the islands
33. A. NO CHANGE
 B. Jones had lived on Porgy Key his entire life,
 C. Porgy Key always was a home for Jones,
 D. Jones had always lived on Porgy Key,
34. F. NO CHANGE
 G. 1897 and Jones, grew up there, cultivating
 H. 1897, and Jones grew up there cultivating,
 J. 1897 and Jones grew up there cultivating,
35. A. NO CHANGE
 B. Likewise, in
 C. Thus, in
 D. In
36. F. NO CHANGE
 G. presidents, who were including
 H. presidents, including
 J. presidents; including
37. A. NO CHANGE
 B. land; because
 C. land,
 D. land
38. Which of the following sequences of sentences makes this paragraph most logical?
 F. NO CHANGE
 G. 1, 3, 2
 H. 3, 1, 2
 J. 2, 1, 3
39. A. NO CHANGE
 B. alone. Some Florida residents
 C. alone; some Florida residents,
 D. alone, some Florida residents

in 1968, President Johnson signed a bill that put the bay under federal protection. ⁴⁰

[5]

First to sell their land to the National Park ⁴¹

Service was Lancelot Jones, who was permitted to ⁴²

remain on Porgy Key. Since he still led fishing trips, ⁴³
and he taught schoolchildren about the environment of Biscayne Bay. [D] In exchange for teaching each class, he asked only for a Key lime pie in return for the class. ⁴⁴
Jones lived alone, but he said, “When you have plenty of interests, like the water and the woods, the birds and the fish, you don’t get lonely.”

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

Biscayne National Park is similar to Grand Canyon National Park in that both parks were initially designated national monuments.

Should the writer make this addition here?

- F. Yes, because it explains why Biscayne National Park was a national monument at first.
G. Yes, because it compares Biscayne National Park to another national park.
H. No, because it presents information that is only loosely related to the rest of the essay.
J. No, because it repeats information that is discussed earlier in the essay.

41. A. NO CHANGE

B. one’s
C. there
D. his

42. F. NO CHANGE

G. Service, was Lancelot Jones,
H. Service, was Lancelot Jones
J. Service was Lancelot Jones

43. A. NO CHANGE

B. Even though he
C. Because he
D. He

44. F. NO CHANGE

G. that he requested in exchange.
H. for teaching the class.
J. DELETE the underlined portion and end the sentence with a period.

Question 45 asks about the preceding passage as a whole.

45. The writer wants to add the following sentence to the essay:

The park idea gained momentum.

The sentence would most logically be placed at:

- A. Point A in Paragraph 1.
B. Point B in Paragraph 2.
C. Point C in Paragraph 4.
D. Point D in Paragraph 5.

PASSAGE IV

Close Encounters of the Bird Kind

In June of 1995, due to NASA technicians⁴⁶ inspecting the space shuttle *Discovery* for an upcoming launch found over two hundred punctures in a fuel tank. Video surveillance revealed the culprits; two northern flickers, a species of woodpecker, was attempting to excavate a nest in the fuel tank's⁴⁷ foam insulation. Upon striking the solid metal beneath, the flickers would stubbornly choose a new spot and try again. 48

[1] In the northern United States, where most flickers return each summer to mate and raise broods, the birds' persistence is⁴⁹ well known.

[2] By lacking⁵⁰ a distinct song, flickers drum their beaks against hard surfaces to announce themselves to mates. [3] The louder the noise an object makes, the more attractive it is to flickers. [4] Among their favorite noisemakers are drainpipes, TV antennas, and even farm equipment. [5] At the Kennedy Space Center in Florida, though⁵¹ the flickers' persistence seemed mysterious. [6] Worse, it posed a serious risk.

46. F. NO CHANGE
 G. because NASA technicians, who were
 H. NASA technicians
 J. DELETE the underlined portion.
47. A. NO CHANGE
 B. was attempting to be excavating
 C. were attempted to excavate
 D. were attempting to excavate
48. If the writer were to delete the preceding sentence, the paragraph would primarily lose information that:
 F. establishes that flickers are persistent and helps explain how the fuel tank came to have over two hundred punctures.
 G. describes the physical features that allow flickers to strike metal and explains how they locate hollow spots.
 H. indicates why the flickers were initially attracted to the fuel tank and what eventually drove them away.
 J. identifies the components of a space shuttle's fuel tank and the particular parts the flickers damaged.
49. A. NO CHANGE
 B. bird's persistence are
 C. birds' persistence are
 D. birds' persistences is
50. F. NO CHANGE
 G. As opposed to lacking
 H. Because they lack
 J. Just as they lack
51. A. NO CHANGE
 B. Florida, though;
 C. Florida, though,
 D. Florida though

[7] For solid metal to stop the birds from trying
⁵²
 to nest at the launch site, how could NASA prevent

damage to its equipment and keep the species
⁵³

safe? 54

NASA put together a committee, dubbed the Bird Investigation Review and Deterrent (BIRD) team, to consult with wildlife experts. After learning that flickers seek out soft, rotted wood when excavating nests, the team recommended the removal of dead trees from the area. For instance, upon learning that flickers
⁵⁵

forage for food on the ground, BIRD determined that
⁵⁶
 tidy lawns made crawling insects easily visible. The

team advised NASA to let the grass grow long to give
⁵⁷

the birds the impression that food was hard to catch. 58

52. F. NO CHANGE
 G. Although solid metal didn't
 H. By using solid metal to
 J. If solid metal didn't

53. A. NO CHANGE
 B. there
 C. it's
 D. its'

54. The writer wants to divide this paragraph into two in order to separate the information about flickers' drumming behavior from the discussion about NASA's concerns regarding the flickers. The best place to begin the new paragraph would be at the beginning of Sentence:
 F. 3.
 G. 4.
 H. 5.
 J. 6.

55. A. NO CHANGE
 B. Likewise,
 C. That is,
 D. Indeed,

56. Which choice most effectively emphasizes that BIRD considered the conclusion it reached to be hypothetical?
 F. NO CHANGE
 G. speculated
 H. contended
 J. realized

57. Which of the following alternatives to the underlined portion would NOT be acceptable?
 A. long, which might give
 B. long; this might give
 C. long and giving
 D. long, giving

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

Flickers are particularly fond of ants, which contain an acid that the birds use to preen their feathers.

Should the writer make this addition here?

- F. Yes, because it emphasizes how likely the flickers would be to leave the area if they thought ants were scarce.
 G. Yes, because it demonstrates how carefully the BIRD team researched the flickers' habits.
 H. No, because it suggests that the plan adopted by NASA would eliminate flickers' favorite source of food.
 J. No, because it detracts from the paragraph's focus on BIRD's strategies for deterring flickers.

Other, less subtle strategies were implemented to ensure that the birds didn't settle in. Deterred by plastic owls and floating balloons, alternatively, the flickers ⁵⁹ soon left for new territory. Their visit to the launchpad, however, was not soon forgotten. *Discovery's* successful launch was delayed five weeks while workers flocked to repair the fuel tank the flickers had favored.

59. A. NO CHANGE
B. incidentally,
C. however,
D. DELETE the underlined portion.

Question 60 asks about the preceding passage as a whole.

60. Suppose the writer's primary purpose had been to describe a typical space shuttle launch. Would this essay accomplish that purpose?
- F. Yes, because it describes the process the BIRD team goes through before a launch to identify possible interferences from wildlife.
G. Yes, because it details how NASA inspected the *Discovery* prior to its successful launch.
H. No, because its primary subjects are the unique nesting habits and warm-weather habitat of the northern flicker.
J. No, because it focuses on a single incident in which wildlife affected the course of a launch.

PASSAGE V

The following paragraphs may or may not be in the most logical order. Each paragraph is numbered in brackets, and question 74 will ask you to choose where Paragraph 3 should most logically be placed.

Choreographing Change

[1]

The late German choreographer Pina Bausch once said, "I am not interested in how people move, but what moves them." Indeed, Bausch did not even consider herself a choreographer, but rather a kind of director. Her *Tanztheater*, translated "dance theater," pieces received international acclaim for those expressive, unconventional ⁶¹

style and the often-raw emotional feelings they portrayed. ⁶²

61. A. NO CHANGE
B. their
C. that
D. its
62. F. NO CHANGE
G. expressive emotions
H. feelings of emotion
J. emotions

[2]

When Bausch began her formal dance education in 1955, Expressionism was again the dominant style. Bausch followed the Expressionists' lead (and that of other dance pioneers like Martha Graham from the '20s). She tackled existential themes—identity, alienation, romantic entanglements, suffering—portrayed through intense, sometimes violent, movements.

[3]

By the 1920s and up until the onset of World War II.
 German art was flourishing and had turned to the

abstract. Expressionism, as it was called, 64 replaced representational, or literal, modes of painting. Bausch,

born in 1940, having grown up in postwar Germany.

The country was attempting to rebuild its economy, its infrastructure, and even

the country's national identification after
 the fall of Hitler's regime. German

artists, of whom work was previously

suppressed by the Nazi party, could refresh
 without fear. They began to depict the country's fragile state in their work.

63. A. NO CHANGE
 B. 1920s (and up until the onset of World War II),
 C. 1920s, and up until the onset of World War II
 D. 1920s and up until the onset of World War II
64. At this point, the writer is considering adding the following phrase:
 with its splashes of color, stark lines, and distorted objects,
 Given that the information is accurate, should the writer make this addition here?
 F. Yes, because it describes features of Expressionist art with which the reader might be unfamiliar.
 G. Yes, because it explains why representational modes were no longer preferred.
 H. No, because it repeats information found elsewhere in the essay.
 J. No, because it detracts from the paragraph's focus on who influenced Bausch's specific style of dance.
65. A. NO CHANGE
 B. and grew
 C. growing
 D. grew
66. Which choice most closely maintains the pattern established in the sentence?
 F. NO CHANGE
 G. how it identified itself
 H. its identity
 J. an identity
67. A. NO CHANGE
 B. artists, whose
 C. artists, who's
 D. artists'
68. F. NO CHANGE
 G. resume
 H. renew
 J. recur

[4]

A Bausch piece may include any number of dancers of any age. Dancers' emotions are conveyed through gestures—joy, passion, grief—that range from subtle to explosive, stationary to dynamic. In *Café Müller*, one of her most famous works, dancers stumble across the stage, crashing into tables and chairs. *Rite of Spring* begins with a dancer lying prostrate on a stage, covered entirely with soil.

[5]

Travel to places such as Turkey, Portugal, and India have informed much of Bausch's work. She, often, incorporated, and combined dance traditions from the East and West, inspiring future choreographers. Her lasting influence lives on through revivals of her work.

Questions 74 and 75 ask about the preceding passage as a whole.

69. The best placement for the underlined portion would be:
- A. where it is now.
 - B. after the word *emotions*.
 - C. after the word *subtle*.
 - D. after the word *stationary*.
70. F. NO CHANGE
G. having laid
H. lain down
J. laying
71. Which choice is grammatically correct and indicates that the stage, rather than the dancer, was covered with soil?
- A. NO CHANGE
 - B. stage, that was
 - C. stage, having been
 - D. stage
72. F. NO CHANGE
G. were informing
H. informed
J. inform
73. A. NO CHANGE
B. She often, incorporated and combined,
C. She often incorporated, and combined
D. She often incorporated and combined
74. For the sake of logic and cohesion, Paragraph 3 should be placed:
- F. where it is now.
 - G. after Paragraph 1.
 - H. after Paragraph 4.
 - J. after Paragraph 5.
75. Suppose the writer's primary purpose had been to describe how an artist's particular style was shaped by cultural and historical events. Would this essay accomplish that purpose?
- A. Yes, because the essay describes Bausch's particular choreographic style and frames it within the backdrop of her life in Germany.
 - B. Yes, because the essay explains how American and European forms of dance were influenced by shifting national identities.
 - C. No, because the essay mainly focuses on Bausch's *Tanztheater* and the international acclaim it received.
 - D. No, because the essay illustrates why Bausch's style is relevant today rather than explaining how it was shaped.

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. Given $x = 5$, $y = 3$, and $z = -6$, $(x + y - z)(y + z) = ?$

- A. -42
- B. -6
- C. 6
- D. 11
- E. 18

DO YOUR FIGURING HERE.

2. Each student attending the East Central High School preprom dinner must choose 1 item from each of 3 categories: entrée, side dish, and beverage. There are 3 entrée choices, 4 side dish choices, and 2 beverage choices. How many different dinner combinations for each student are possible?

- F. 8
- G. 9
- H. 12
- J. 14
- K. 24

3. A bag contains 13 solid-colored marbles: 3 red, 5 white, 4 black, and 1 yellow. If only 1 marble is selected, what is the probability of randomly selecting 1 marble that is NOT black?

- A. $\frac{1}{9}$
- B. $\frac{4}{9}$
- C. $\frac{4}{13}$
- D. $\frac{9}{13}$
- E. $\frac{9}{26}$

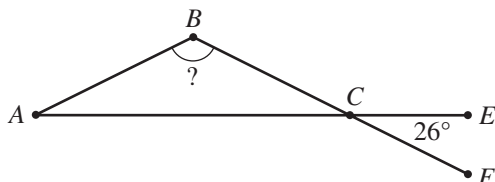


4. Sam works at Glendale Hospital and earns \$12 per hour for the first 40 hours and \$18 per hour for every additional hour he works each week. Last week, Sam earned \$570. To the nearest whole number, how many hours did he work?

F. 32
G. 35
H. 38
J. 45
K. 48

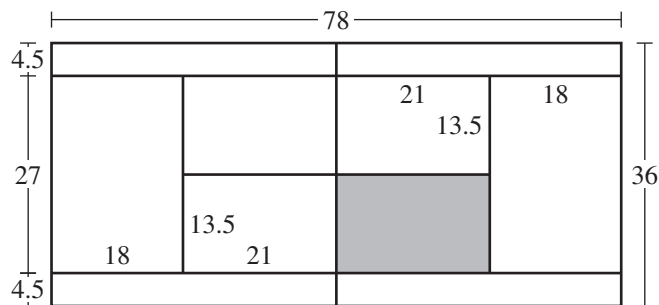
DO YOUR FIGURING HERE.

5. In the figure below, \overline{AB} is congruent to \overline{BC} , and \overline{AE} intersects \overline{BF} at C . What is the measure of $\angle B$?



A. 26°
B. 38°
C. 52°
D. 128°
E. 154°

6. The dimensions, in feet, of a standard tennis court are shown in the figure below. All lines that meet in the figure do so at right angles. Which of the following values is closest to the area, in square feet, of the 1 service box shown shaded?



F. 284
G. 527
H. 567
J. 1,053
K. 1,134

7. In scientific notation, what is the product of 3 and 0.000 000 72?

A. 2.16×10^{-7}
B. 2.16×10^{-6}
C. 2.4×10^{-8}
D. 2.4×10^{-7}
E. 6.9×10^{-7}

GO ON TO THE NEXT PAGE.



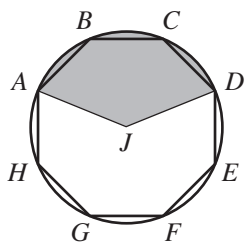
8. If $f(x) = (4x + 3)^2$, then $f(1) = ?$

F. 7
G. 14
H. 19
J. 25
K. 49

DO YOUR FIGURING HERE.

9. Regular octagon $ABCDEFGH$ is inscribed in a circle, as shown below. The sector of the circle bounded by radii \overline{AJ} and \overline{DJ} and by \widehat{AD} is shaded. The area of the shaded sector is what fraction of the area of the circle?

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



10. The expression $(2x + 3)(5x - 6)$ is equivalent to:

F. $7x^2 - 18$
G. $7x^2 + 3x - 18$
H. $10x^2 - 18$
J. $10x^2 - 3x - 18$
K. $10x^2 + 3x - 18$

11. A cake recipe requires $\frac{5}{8}$ cup of flour. Mary and Haloa decide to make the cake together. Mary has $\frac{1}{3}$ cup of flour and Haloa has $\frac{1}{4}$ cup of flour. How many more cups of flour do they need to make the cake?

A. $\frac{1}{24}$
B. $\frac{2}{7}$
C. $\frac{19}{56}$
D. $\frac{13}{24}$
E. $\frac{17}{24}$



12. Coach Shannon is buying packages of granola bars, juice boxes, and apples as snacks for her soccer team. The table below gives the number of snacks per package and the price per package.

Snack type	Snacks per package	Price per package
Granola bars	3	\$2.50
Juice boxes	4	\$3.00
Apples	5	\$4.50

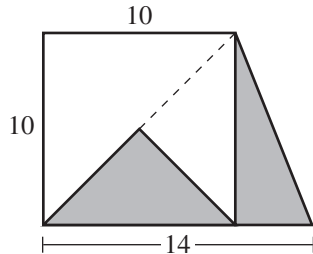
What is the minimum total price of the snacks, all bought in whole packages, Coach Shannon buys so that each of the 15 girls on the team gets at least 1 snack of each type?

- F. \$30.00
 G. \$35.00
 H. \$38.00
 J. \$42.00
 K. \$50.00
13. Given functions $f(x) = 5x + 1$ and $g(x) = x^2 - 2$, what is the value of $f(g(-3))$?
- A. -198
 B. -54
 C. -39
 D. 36
 E. 194
14. For $7y = 2x - 5$, which of the following expressions gives x in terms of y ?
- F. $\frac{7y - 5}{2}$
 G. $\frac{7y + 5}{2}$
 H. $\frac{7}{2}y - 5$
 J. $\frac{7}{2}y + 5$
 K. $5y + 5$
15. For an angle with measure α in a right triangle, $\sin \alpha = \frac{4}{5}$ and $\tan \alpha = \frac{4}{3}$. What is the value of $\cos \alpha$?
- A. $\frac{3}{\sqrt{41}}$
 B. $\frac{3}{5}$
 C. $\frac{3}{4}$
 D. $\frac{3}{\sqrt{7}}$
 E. $\frac{5}{3}$

DO YOUR FIGURING HERE.



16. A scale drawing of a proposed trapezoidal landscape design is shown in the figure below, with the given dimensions in meters. The trapezoid consists of a right triangle and a square divided into 3 isosceles right triangles. The unshaded regions will be white rock; the shaded triangular regions will be black rock. What is the area, in square meters, that will be black rock?



- F. 20
G. 25
H. 45
J. 60
K. 70
17. One construction sign flashes every 6 seconds, and another construction sign flashes every 10 seconds. At a certain instant, the 2 signs flash at the same time. How many seconds elapse until the 2 signs next flash at the same time?
- A. 4
B. 8
C. 16
D. 30
E. 60
18. Which of the following expressions is equivalent to $4x^2 + 8x - 12$?
- F. $(4x - 3)(x + 4)$
G. $(4x + 3)(x - 4)$
H. $4(x - 3)(x - 1)$
J. $4(x - 3)(x + 1)$
K. $4(x + 3)(x - 1)$
19. A person's *vertical jump* is the difference between the maximum height the person can reach at the top of a jump and the maximum height the person can reach when standing. The maximum height Donald can reach at the top of his jump is 10 feet 4 inches, and the maximum height he can reach when standing is 7 feet 10 inches. What is Donald's vertical jump?
- A. 2 feet 0 inches
B. 2 feet 4 inches
C. 2 feet 6 inches
D. 3 feet 0 inches
E. 3 feet 6 inches

DO YOUR FIGURING HERE.



Use the following information to answer questions 20–22.

DO YOUR FIGURING HERE.

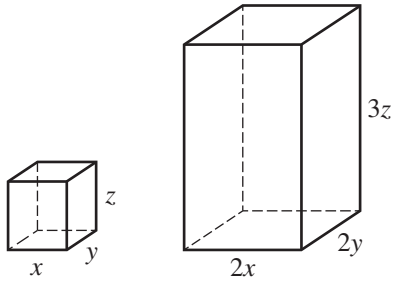
Jocelyn wants to become a member of 1 of 3 gyms. The onetime sign-up fee, the monthly fee, and the late fee for each gym are shown in the table below. Monthly fees are due on the 1st day of each month for each gym. A onetime late fee is added to the monthly fee if the monthly fee is paid after the 1st day of that particular month. Felix, a coworker of Jocelyn's, became a member of PowerPeople on March 1.

Gym	Sign-up fee	Monthly fee	Late fee
PowerPeople	\$35	\$50	\$ 5
FirmFactory	\$ 0	\$65	\$10
TrimTime	\$25	\$60	\$10

20. Given that Jocelyn becomes a member of TrimTime on July 1 and that she pays all monthly fees on time, what total amount will Jocelyn have paid to the gym by September 2 of that year?
- F. \$ 85
G. \$145
H. \$180
J. \$205
K. \$215
21. Before October 1, Felix had paid all 7 of his monthly gym fees on time. He will make his next gym payment on October 4. What total amount must Felix pay on October 4 so that his gym account will be paid in full?
- A. \$50
B. \$55
C. \$70
D. \$75
E. \$90
22. Another gym, Good-As-New, has a sign-up fee equal to the mean of all the sign-up fees in the table. What is the sign-up fee for Good-As-New?
- F. \$ 8
G. \$15
H. \$20
J. \$30
K. \$58



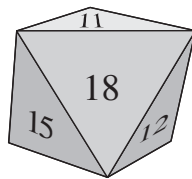
23. The dimensions, in inches, of 2 rectangular prisms are shown in the figure below. The volume of the large prism is the same as the volume of how many of the small prisms?



- A. 2
B. 4
C. 6
D. 7
E. 12
24. For what real number value of x is the equation $64^{\frac{1}{3}} = 2^x$ true?

- F. $\frac{1}{3}$
G. 2
H. 4
J. 6
K. 8

25. Suppose that the 8 identical faces of a regular octahedron, like the one shown below, are numbered from 11 through 18, with 1 number per face, and each face is equally likely to land down when the octahedron is tossed. What is the probability that, on 1 toss of this octahedron, the number on the face landing down is a prime number or an even number?

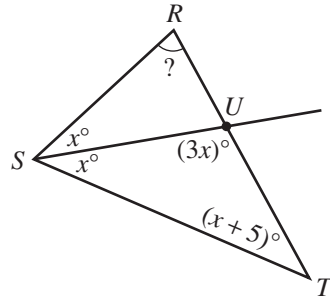


- A. 0
B. $\frac{1}{8}$
C. $\frac{1}{4}$
D. $\frac{1}{2}$
E. $\frac{7}{8}$

DO YOUR FIGURING HERE.



26. In $\triangle RST$ below, U is a point on \overline{RT} such that \overrightarrow{SU} is an angle bisector of $\angle RST$. What is $m\angle R$?



- F. 43.75°
 G. 50°
 H. 70°
 J. 90°
 K. 100°

DO YOUR FIGURING HERE.

27. A lawn-and-garden store sells 2 types of grass seed: shade and sun. The numbers of bags sold on Friday and Saturday last week are given in matrix A ; the selling price per bag and the profit per bag are given in matrix B . Price and profit are in dollars. What is the total profit for the sale of the 2 types of grass seed sold on Friday and Saturday?

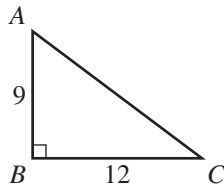
$$A = \begin{array}{cc} \begin{array}{c} \text{shade} \\ \text{sun} \end{array} & \begin{bmatrix} 12 & 25 \\ 13 & 15 \end{bmatrix} \\ \text{Friday} & \\ \text{Saturday} & \end{array} \quad B = \begin{array}{cc} \begin{array}{c} \text{price} \\ \text{profit} \end{array} & \begin{bmatrix} 11.75 & 1.70 \\ 8.00 & 1.50 \end{bmatrix} \\ \text{shade} & \\ \text{sun} & \end{array}$$

- A. \$ 65.00
 B. \$ 97.50
 C. \$102.50
 D. \$110.50
 E. \$208.00

28. What real value of x satisfies the equation $36^{x-1} = 6$?

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

29. In right triangle $\triangle ABC$ shown below, $AB = 9$ units and $BC = 12$ units. What is $\sin A$?



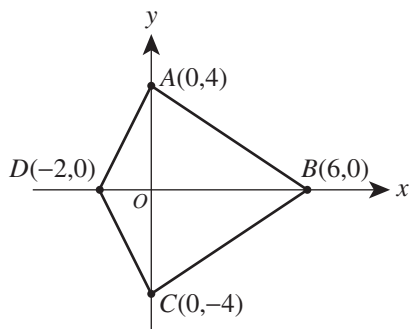
- A. $\frac{3}{5}$
 B. $\frac{3}{4}$
 C. $\frac{4}{5}$
 D. $\frac{5}{4}$
 E. $\frac{4}{3}$



Use the following information to answer questions 30–32.

DO YOUR FIGURING HERE.

Shown below is quadrilateral $ABCD$ in the standard (x,y) coordinate plane.



30. What is the area, in square coordinate units, of $ABCD$?

- F. 16
- G. 24
- H. 32
- J. 48
- K. 64

31. What is the perimeter, in coordinate units, of $ABCD$?

- A. $4\sqrt{5}$
- B. $4\sqrt{5} + 4\sqrt{13}$
- C. $4\sqrt{13}$
- D. 16
- E. 144

32. What are the coordinates of the image of point B resulting from a rotation of 180° about the origin?

- F. $(-10, 0)$
- G. $(-6, 0)$
- H. $(-2, 0)$
- J. $(0, -6)$
- K. $(6, 0)$

33. Which of the following expressions is equivalent to

$$\frac{x^2 + 4x - 12}{x^2 - 36} \text{ for } x^2 - 36 \neq 0 ?$$

- A. $\frac{4x}{3}$
- B. $\frac{x-2}{x-6}$
- C. $\frac{x+2}{x+6}$
- D. $\frac{x-3}{-9}$
- E. $\frac{x+3}{x+9}$



34. The rectangular top surface of a patio is 4 feet longer than it is wide and has an area of 192 square feet. What is the width, in feet, of the rectangular top surface of the patio?

F. 12
G. 16
H. 24
J. 46
K. 48

DO YOUR FIGURING HERE.

35. In the standard (x,y) coordinate plane, what is the slope of the line that contains $(-2,-2)$ and has a y -intercept of 1?

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

36. Veronica delivers 27 copies of the *News Report* and 22 copies of the *City Times* to 38 of the 40 houses on Oakland Street. No house receives more than 1 copy of each newspaper. How many houses receive both newspapers?

F. 2
G. 5
H. 7
J. 9
K. 11

37. $|-3| + |-5|(7 - 3) = ?$

A. -41
B. -23
C. 23
D. 32
E. 35

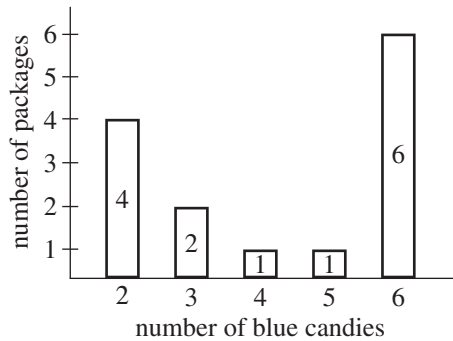
38. Julia, an archaeology student, needs to dig 6 cylindrical pits at an archaeological site. Each pit will be 8 feet in diameter and 6 feet deep. Since she needs to work slowly and carefully, Julia can remove dirt at an average rate of 3 cubic feet per hour. Which of the following values is closest to the number of hours it will take Julia to dig all 6 pits?

(Note: The volume, V , of a cylinder with radius r and height h is $V = \pi r^2 h$; $\pi \approx 3.14$.)

F. 100
G. 200
H. 400
J. 600
K. 800



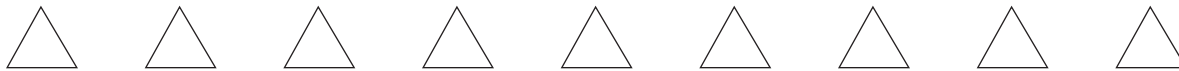
39. Hector counted the number of blue candies in each of 14 packages and summarized his data in the frequency bar graph below.



What is the median of the numbers of blue candies in the 14 packages?

- A. 4.0
 - B. 4.2
 - C. 4.5
 - D. 5.0
 - E. 6.0
40. In certain years, July, a month with 31 days, has exactly 4 Mondays and 4 Fridays. The first of July in those years will be on:
- F. Tuesday.
 - G. Wednesday.
 - H. Thursday.
 - J. Saturday.
 - K. Sunday.
41. Ms. Siochi has a rectangular lot with a perimeter of 100 meters. She paid \$2,420.00 for fencing to install along the entire perimeter. She chose standard fencing for 3 sides of the lot and decorative fencing for 1 of the 20-meter sides. Ms. Siochi paid \$1.00 more per meter for the decorative fencing than for the standard fencing. How much did Ms. Siochi pay per meter for the decorative fencing?
- A. \$22.40
 - B. \$23.40
 - C. \$24.00
 - D. \$25.00
 - E. \$26.00
42. Students use dowel rods to learn about equations. They lay several rods, some of which are red and some of which are white, end to end. The length of each red rod is R centimeters, and the length of each white rod is W centimeters. The students determine that the total length of 2 red rods and 7 white rods is the same as the total length of 4 red rods and 3 white rods. Based on this relationship, which of the following equations must be true?
- F. $R = 2W$
 - G. $R = 3W$
 - H. $3R = 5W$
 - J. $7R = 9W$
 - K. $9R = 7W$

DO YOUR FIGURING HERE.



43. For $i = \sqrt{-1}$, $(2 + 2i)^2 = ?$

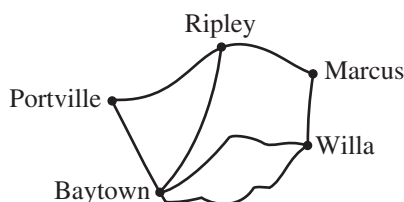
- A. -16
- B. 0
- C. $8i$
- D. $4 + 2i$
- E. $4 + 4i$

DO YOUR FIGURING HERE.

44. For all θ such that $\cos \theta \neq 0$ and $\sin \theta \neq 0$, which of the following expressions is equal to $\frac{\tan \theta}{\sec \theta}$?

- F. $\cos \theta$
- G. $\sin \theta$
- H. $\frac{1}{\sin \theta}$
- J. $\frac{\cos \theta}{\sin^2 \theta}$
- K. $\frac{\sin \theta}{\cos^2 \theta}$

45. The map below shows the 5 villages and the 7 roads on Gull Island. All residential mailboxes on Gull Island are located along these roads. During a mail run, the island's mail carrier travels on each road exactly once, but she may pass through a village more than once. The carrier starts her run in 1 of the 5 villages and ends her run in 1 of the 4 remaining villages. One of the following pairs of villages gives the starting point and ending point for the mail run. Which one?



- | | <u>starting point</u> | <u>ending point</u> |
|----|-----------------------|---------------------|
| A. | Baytown | Marcus |
| B. | Baytown | Ripley |
| C. | Marcus | Portville |
| D. | Portville | Willa |
| E. | Ripley | Willa |

46. Which of the following sets is the range of the function $f(x) = 3 + \left(\frac{x^2 - 5x + 6}{x^2 + 5x - 6} \right)^2$?

- F. $(0, 3)$
- G. $[0, \infty)$
- H. $(-\infty, \infty)$
- J. $[-3, \infty)$
- K. $[3, \infty)$



47. Mr. Schulte has a fair 12-sided die, with the sides numbered from 1 through 12. On both Monday and Tuesday, Mr. Schulte will roll the die 1 time. If the side that lands faceup is numbered with a prime number, Mr. Schulte will collect the homework that day—otherwise, he will not collect the homework. What is the probability that Mr. Schulte will collect homework on both Monday and Tuesday?

(Note: 1 is NOT a prime number.)

- A. $\left(\frac{5}{12}\right)^2$
 B. $\left(\frac{6}{12}\right)^2$
 C. $\left(\frac{7}{12}\right)^2$
 D. $2\left(\frac{5}{12}\right)$
 E. $2\left(\frac{6}{12}\right)$

48. The table below gives the number of Jerry's Construction workers needed to frame a specific type of house in certain selected numbers of days. Given that all the workers work at the same rate, how many workers will it take to frame this specific type of house in 10 days?

Workers	Days
2	15
?	10
6	5
30	1

- F. 3
 G. 4
 H. 7
 J. 10
 K. 12
49. Considering only positive integer factors, which of the following integers has an odd number of distinct factors?
- A. 16
 B. 20
 C. 23
 D. 27
 E. 35

DO YOUR FIGURING HERE.

GO ON TO THE NEXT PAGE.



50. A solution is 5% alcohol and 95% water. A second solution is 20% alcohol and 80% water. If 2 gallons of the first solution are mixed with 1 gallon of the second solution, the resulting solution is what percent alcohol?

F. 10%
 G. $12\frac{1}{2}\%$
 H. 15%
 J. 25%
 K. 30%

DO YOUR FIGURING HERE.

51. In the standard (x,y) coordinate plane, the graph of the equation $y = 3 \sin(2x + 0.5\pi)$ has what amplitude and period?

	<u>amplitude</u>	<u>period</u>
A.	3	π
B.	3	2π
C.	3	4π
D.	6	π
E.	6	2π

52. A pet shop always has 54 hamsters that are either solid-colored or multicolored in the front of the store for customers to see. Any additional hamsters are kept in an area at the back of the store. Which of the following ratios of solid-colored hamsters to multicolored hamsters is possible for the hamsters in the front of this pet shop?

F. 1:54
 G. 2:7
 H. 3:2
 J. 6:1
 K. 6:9

53. A cookie jar contains 10 cookies of 3 types. There are 5 chocolate-chip cookies, 3 oatmeal-raisin cookies, and 2 sugar cookies. You reach into the jar and choose a cookie at random and then, without replacing the first cookie, reach into the jar and choose another cookie at random. What is the probability that both of the cookies you choose are the same type?

A. $\frac{2}{10}$
 B. $\frac{10}{27}$
 C. $\frac{28}{90}$
 D. $\frac{28}{100}$
 E. $\frac{30}{720}$

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54. Quadrilateral $ABCD$ is a parallelogram. Which of the following statements about $ABCD$ *must* be true?

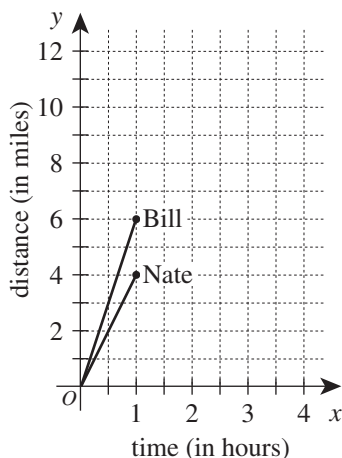
F. The diagonals bisect each other.
 G. The diagonals are perpendicular.
 H. The diagonals are congruent.
 J. All 4 sides are congruent.
 K. All 4 interior angles are congruent.

DO YOUR FIGURING HERE.

55. For all m such that $0 < m < 1$, the value of m^{-1} *must* be:

A. greater than m .
 B. equal to m .
 C. less than m , but greater than 0.
 D. equal to 0.
 E. less than 0.

56. Bill and Nate are participating in a fund-raising event in which they run or walk a distance of 30 miles. A graph representing their progress during the first hour is shown in the standard (x,y) coordinate plane below.



Assume that Bill continues to travel at the same speed until he reaches the finish line. One of the following phrases describes how Nate will need to change his average speed for the remainder of the event in order to finish at exactly the same time as Bill. Which one?

F. Decrease it by 2 mph
 G. Decrease it by 2.5 mph
 H. Increase it by 2 mph
 J. Increase it by 2.5 mph
 K. Increase it by 4 mph



57. The math club is selling T-shirts as a fund-raiser. There is a linear relationship between x , the number of T-shirts sold, and y , the profit in dollars from selling the T-shirts. When the club sells 6 shirts, it makes a profit of \$10; when it sells 10 shirts, it makes a profit of \$20. Which of the following equations gives the relationship between x and y ?

- A. $y = \frac{2}{5}x + 2$
- B. $y = \frac{2}{5}x + \frac{38}{5}$
- C. $y = \frac{5}{2}x + 4$
- D. $y = \frac{5}{2}x + 5$
- E. $y = \frac{5}{2}x - 5$

58. For the following system of equations

$$\begin{aligned} 2^{x-y} &= 32 \\ 2^{x+y} &= 8, \end{aligned}$$

$y = ?$

- F. -3
- G. -1
- H. 1
- J. 2
- K. 3

59. Nineteen students are eligible to play doubles tennis. What is the maximum number of different 2-person teams possible?

- A. 9
- B. 38
- C. 76
- D. 171
- E. 342

60. In the equation $ax^2 + bx + c = 0$, coefficients a , b , and c are positive real numbers. If $a = c$ and both roots of the quadratic equation are real numbers, which of the following relations must hold between a and b ?

- F. $a > 2c$
- G. $a = b$
- H. $a \geq 2b$
- J. $a > b$
- K. $a \leq \frac{b}{2}$

DO YOUR FIGURING HERE.

END OF TEST 2

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

DO NOT RETURN TO THE PREVIOUS TEST.

READING TEST

35 Minutes—40 Questions

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

Passage I

LITERARY NARRATIVE: This passage is adapted from the essay "Atop the Mound" by William Least Heat-Moon (©1991 by William Least Heat-Moon).

What I cherish I've come to slowly, usually blindly, not seeing it for some time, and that's just how I discovered Jacobs' Mound. This old travelers' marker shows up clearly from two highways, yet I was here
5 several days before I noticed it, this isolated frustum so distinct. I must have been looking too closely and narrowly, but once I saw its volcano-cone symmetry I was drawn to it as western travelers have always been to lone protuberances—Independence Rock, Pompey's
10 Pillar, Chimney Rock—and within a day I headed down the Bloody Creek Road until the lane played out in a grassed vale.

I walked down a hawk-harried ridge and struck out toward the mound, seemingly near enough to reach
15 before sunset. In places the October grasses reached to my belt and stunted my strides. From the tall heads of Indian grass and the brown stalks of gayfeather, gossamer strung out in the slow wind, and these web lines snagged my trousers and chest and head until, after a
20 mile, I was bestrung and on my way to becoming cocooned. I stopped to watch small events but never for long because the mound was drawing me as if it were a stone vortex in a petrified sea.

There are several ways not to walk in the prairie,
25 and one of them is with your eye on a far goal, because you then begin to believe you're not closing the distance any more than you would with a mirage. My woodland sense of scale and time didn't fit this country, and I started wondering whether I could reach the
30 summit before dark. On the prairie, distance and the miles of air turn movement to stasis and openness to a wall, a thing as difficult to penetrate as dense forest. It seemed every time I raised a step the earth rotated under me so that my foot fell just where it had lifted
35 from. Limits and markers make travel possible for people: circumscribe our lines of sight and we can really get somewhere. Before me lay the Kansas of popular conception from Coronado on—that place you have to get through, that purgatory of mileage.

40 But I kept walking, and, when I dropped into hollows and the mound disappeared, I focused on a rock or

a tuft of grass to keep from convoluting my track. Hiking in the woods allows a traveler to imagine comforting enclosures, one leading to the next, and the
45 walker can possess those little encompassed spaces, but the prairie and plains permit no such possession. Whatever else prairie is—grass, sky, wind—it is most of all a paradigm of infinity, a clearing full of many things except boundaries, and its power comes from its apparent
50 limitlessness; there is no such thing as a small prairie any more than there is a little ocean.

I came up out of a hollow, Jacobs' Mound big now on the horizon, and I could feel its swell in my legs, and then I was in the steep climb up its slope, and: I was on
55 top. From the highway I'd guessed the summit to be the size of a city block, but it was less than a baseball infield, its elliptical perimeter just a hundred strides. So, its power lay not in size but rather in shape and dominion and its thrust into the imagination.

60 I sat and looked. The thousands of acres that lay encircled around the knob I really didn't see, not at first. I saw air, and I recalled a woman saying, *Seems the air here hasn't ever been used before*. From a plane you look down, and from a mountain you look down,
65 but from Jacobs' Mound you look out, out into. You're not up in the sky and you're not on the ground: you're nicely in-between, at the altitude of those who fly in their dreams and skim roofs and treetops. Jacobs' Mound is thrush-flight high.

70 And then I understood: I like this prairie county because of its illusion of being away, out of, and I like how its unpopulousness seems to isolate it. Seventy percent of Americans live on two percent of the land, but in front of me, no percentage of them lived. Yet, in
75 the far southeast, I could see trucks inching out the turnpike miles, the turbulence of their passage silenced by distance. And I could see fence lines, transmission towers, and dug ponds, things the pioneers would have viewed as marks of a progressive civilization but which
80 to me, a grouching neo-primitivist, were signs of the continuing onslaught. The view I had homesteaders would have loved, and the one they had of unbroken vegetation and its diversities I would cherish. In the nineteenth century, the Kansas clergyman and author
85 William Quayle traded his autograph for an acre of prairie, and, yesterday, I thought him a thief, but now, seeing the paltriness of an acre, I figured he was the one swindled.

1. The point of view from which the passage is told can best be described as that of a first person narrator who:
 - A. is uncomfortable when he must traverse a large section of unfamiliar prairie.
 - B. has an experience that leads to a deeper appreciation of the prairie.
 - C. visits the prairie in order to experience life as early settlers might have.
 - D. has traded arduous hikes in the woods for leisurely walks in the prairie.
2. How does the narrator see the power of the wider prairie differing, if at all, from the power of Jacobs' Mound?
 - F. The prairie's power comes from its apparent limitlessness; the power of Jacobs' Mound comes from its hold on the imagination.
 - G. The prairie's power comes from its unpopulousness; the power of Jacobs' Mound comes from its size.
 - H. The prairie's power comes from its flat terrain; the power of Jacobs' Mound comes from its height.
 - J. Both places derive power from their size.
3. The main idea of the sixth paragraph (lines 60–69) is that:
 - A. few people other than the narrator have visited the summit of Jacobs' Mound.
 - B. the air at the top of Jacobs' Mound is noticeably different from the air at the bottom.
 - C. Jacobs' Mound gives the impression of being away from civilization.
 - D. the summit of Jacobs' Mound exists in a special place between the earth and the sky.
4. Based on the passage, which of the following can most reasonably be inferred about the narrator?
 - F. He traveled to the area specifically to climb Jacobs' Mound.
 - G. He has already climbed Independence Rock and Pompey's Pillar.
 - H. He prefers open, unpopulated areas to crowded urban areas.
 - J. He believes urban development is annoying but necessary.
5. As it is used in line 23, the phrase *petrified sea* refers to:
 - A. Jacobs' Mound.
 - B. the sky.
 - C. the prairie.
 - D. the highway.
6. According to the narrator, focusing on a distant goal while walking in the prairie is not recommended because:
 - F. distant objects often move in and out of sight.
 - G. there is the potential to miss small objects nearby.
 - H. walkers need to be aware of their immediate surroundings.
 - J. doing so makes progress difficult to measure.
7. When Jacobs' Mound disappears from the narrator's sight, he shifts his focus to:
 - A. clouds in the sky.
 - B. rocks and patches of grass.
 - C. fences and highways.
 - D. birds flying overhead.
8. According to the narrator, what is the main difference between walking in wooded areas and walking in the prairie?
 - F. Wooded areas provide walkers with comforting enclosures that the prairie lacks.
 - G. It takes longer to navigate wooded areas than it does to navigate the prairie.
 - H. The flora and fauna are more diverse on the prairie than in the woods.
 - J. The sun is much stronger on the prairie than in the woods.
9. Which of the following statements best expresses how the narrator first feels when he reaches the summit of Jacobs' Mound?
 - A. He is triumphant that he has reached a place few other people have been.
 - B. He is somewhat surprised that the summit is not as large as he had believed it would be.
 - C. He is overwhelmed by the brightness of the sun and the smell of the grass.
 - D. He is pleased to see thrushes nesting on the mound.
10. The narrator most likely includes the William Quayle anecdote at the end of the passage to:
 - F. reveal the extent of his amazement that he has finally reached the summit of Jacobs' Mound.
 - G. help illustrate why he was drawn to Jacobs' Mound in the first place.
 - H. give an example of the type of person who once lived on the prairie.
 - J. further convey his sense of wonder at the sheer size of the prairie.

Passage II

SOCIAL SCIENCE: This passage is adapted from *The History of Money* by Jack Weatherford (©1997 by Jack McIver Weatherford).

Of the many great civilizations that flourished and withered in ancient Anatolia, the Lydian does not rank among the best known. The Lydians formed a small kingdom in the seventh century BC, but at its height, the Lydian kingdom was little more than an overgrown city-state spread out from Sardis. The Lydian kings were not celebrated in myth or song as great warriors, conquerors, builders, or even lovers. Only one name of ancient Lydia is commonly known today—Croesus. He ascended to the Lydian throne in 560 BC to rule a kingdom that was already rich. His ancestors had made a firm economic basis for the kingdom's wealth by manufacturing some of the best perfumes and cosmetics of the ancient world; yet these goods alone could not have raised Croesus to the level of wealth that myth accords him. For that, he depended on another invention of his ancestors—coins, a new and revolutionary form of money.

Something similar to money and something resembling markets can be found in Mesopotamia, China, Egypt, and many other parts of the world, but they did not actually use coins until the rise of Lydia and the subsequent minting of the first coins, between 640 and 630 BC. The genius of the Lydian kings can be seen in their recognition of the need for very small and easily transported ingots worth no more than a few days' labor or a small part of a farmer's harvest. By making these small ingots in a standardized size and weight, and by stamping on them an emblem that verified their worth to even the illiterate, the kings of Lydia exponentially expanded the possibilities of commercial enterprise.

The Lydians made the first coins of electrum, a naturally occurring mixture of gold and silver. They made the electrum into oval slugs several times thicker than modern coins, or about the size of the end digit of an adult's thumb. To ensure their authenticity, the king had each one stamped with the emblem of a lion's head. The stamping also flattened the lumps, beginning their transition from an oval nugget to a flat, circular coin.

By making the nuggets the same weight and thus approximately the same size, the king eliminated one of the most time-consuming steps in commerce: the need to weigh the gold each time a transaction was made. Now merchants could assess the value by tale, or by simply counting the number of coins. Such standardization greatly reduced the opportunity for cheating on the amount or quality of gold and silver in an exchange. One did not need to be an expert in handling a scale or in judging the purity of metal in order to buy a basket of wheat, a pair of sandals, or an amphora of olive oil. The use of coins that had been weighed and stamped in the royal workshop made it possible for commerce to proceed much more rapidly and honestly, and it allowed people to participate even if they did not own a scale.

The commerce of coins opened up new dimensions for new segments of the population.

The wealth of Croesus and his ancestors arose not from conquest but from trade. During his reign (560–546 BC), Croesus created new coins of pure gold and silver rather than electrum. Using their newly invented coins as a standardized medium of exchange, the Lydian merchants traded in the daily necessities of life—grain, oil, leather, pottery, and wood—as well as in luxury goods such as perfumes, cosmetics, jewelry, musical instruments, glazed ceramics, bronze figurines, mohair, purple cloth, marble, and ivory.

The variety and abundance of commercial goods quickly led to another innovation: the retail market. Rather than leaving buyers to seek out the home of someone who might have oil or jewelry to sell, the kings of Sardis set up an innovative new system in which anyone, even a stranger, with something to sell could come to a central market. Numerous small shops lined the market, and each merchant specialized in particular goods. One sold meat, and another offered grain. One sold jewelry, another cloth. One sold musical instruments, another pots. This market system began in the late seventh century BC, but its descendants can clearly be seen in the later Greek agora, in the medieval market squares of northern Europe, and in suburban shopping malls of the contemporary United States.

With the conquest of Lydia by Cyrus, the reign of Croesus ended, and the Lydian kingdom disappeared from the pages of history. The impact of that small and relatively unknown kingdom has remained vastly disproportionate to its geographic size and relatively minor role in ancient history.

11. The main idea of the passage is that:

- A. the system of coins and trade created by Lydians radically transformed commerce.
- B. the development of currency can be traced chronologically from 640 BC to 560 BC.
- C. money was invented when Croesus became king of Lydia.
- D. the coins minted in Lydia are the first gold coins known to exist.

12. According to the passage, one outcome of stamping Lydian coins with the emblem of a lion's head was that the coins:

- F. became easier to distinguish from currency used in the common marketplace.
- G. were no longer clearly marked as property of the king.
- H. varied more in size and weight.
- J. became flatter and more circular.

13. What is the “innovative new system” referred to in line 71?
- A. The sale of goods by a producer to a merchant and then to a consumer
 - B. The sale of goods over long distances
 - C. The use of scales in the marketplace for business transactions
 - D. The sale of many types of goods in one marketplace
14. The author most likely uses the term *overgrown city-state* (lines 5–6) in order to:
- F. emphasize the importance of Lydia.
 - G. indicate the rapid growth of Sardis.
 - H. make the point that Lydia was small.
 - J. identify the government structure of Lydia.
15. The passage states that when Croesus ascended the throne, Lydia was already:
- A. celebrated in myths.
 - B. past the peak of its political power.
 - C. at war with Sardis.
 - D. in a firm economic position.
16. As it is used in line 15, the word *accords* most nearly means:
- F. confines.
 - G. assigns.
 - H. owes.
 - J. measures.
17. According to the passage, which of the following is true of electrum?
- A. It is naturally occurring.
 - B. It was worth more than gold under Croesus’s rule.
 - C. It is easier to stamp than silver or gold.
 - D. It is heavier than silver.
18. Which of the following cause-effect relationships is referred to in the passage?
- F. Instituting scales in the marketplace led to greater honesty in transactions.
 - G. Introducing standardized coins into commerce made it more inclusive of a wide range of people.
 - H. Stamping designs on coins initially led some buyers to confuse coins with jewelry.
 - J. Lydia’s conquering of neighboring countries allowed Lydia to replace their monetary systems.
19. In the passage, wood is mentioned as an example of a:
- A. material that coins were made of prior to the reign of Croesus.
 - B. material from which Croesus first made coins.
 - C. daily necessity of life during the reign of Croesus.
 - D. precious material Lydia imported for use by the wealthy class.
20. Which of the following statements best paraphrases the last sentence of the passage?
- F. Lydia played a minor role in ancient history, in spite of its rulers’ attempts to achieve glory.
 - G. The world before Lydia and the one after Lydia are vastly different, due to the greed of Croesus.
 - H. Despite its size and historical status, Lydia has had an enormous influence on the world.
 - J. The kings of Lydia made decisions about commerce that relegated their kingdom to a minor role in history.

Passage III

HUMANITIES: Passage A is adapted from the article “The Tension of Modern Bunraku” by Theodora Skipitares (©2004 by Performing Arts Journal, Inc.). Passage B is adapted from the article “Lifelike” by Joan Acocella (©2009 by Condé Nast).

Passage A by Theodora Skipitares

Even before I began using puppets in my performances in 1982, I had always felt connected to the Japanese Bunraku theatre. The structure of the Bunraku theatre as a series of three splits or fragments of the conventions of Western theatre (text, music, and puppet) seemed to me a new way to organize a performance. The puppet, along with the manipulator, was a separate entity, and so was the narrator, as was the musician (the latter two on a platform to one side). Bunraku presented a total, though divided, spectacle. One’s focus could go back and forth between the manipulator or the puppet, the manipulation or the resulting gesture.

Japanese puppet drama developed at a rapid pace in the 1700s. Male puppeteers were hidden from the public by a curtain while they held (one-man) puppets, about two feet tall, above their heads. The narrator and musician were also hidden. In 1703, a group of puppeteers created a sensation when they appeared in full view of the audience, separated only by a translucent curtain. The curtain itself was eliminated two years later. In 1728, the narrator and musician were given their own auxiliary stage, the yuka. Since then, one unusual feature of the Japanese puppet theatre is that the manipulator makes no attempt to conceal the fact that he is manipulating the puppets. Unlike puppet performances from other countries, this Japanese form does not require the illusion that the puppets are moving and talking on their own.

In 1983, I began to use a modified Bunraku performance style for certain life-size human figures. I spent plenty of time trying to make them super-realistic, so that their skin looked lifelike, their eyes blinked “naturally,” and their hands could actually grab objects. What I didn’t understand then about Bunraku theatre was that its greatness lay in the constant tension, and the attempt to strike a balance between realism and nonrealism. Bunraku was not trying to persuade the audience it was watching reality, rather than a play. And I was very much interested in creating a flat surface of reality. Looking back, I feel that I was barely exploring the full potential of the Japanese form.

Passage B by Joan Acocella

Japanese puppetry takes its great power from the fact that it is very realistic and very artificial at the same time. As was proved again by the Awaji Puppet Theatre Company’s recent season at Japan Society, what strikes you first is the realism. The puppeteers seem to have spent five centuries (that is the genre’s estimated age, at minimum) working out the precise

rhythm with which a weeping woman would dab her eyes with her sleeve. The lifelikeness is indeed a thrill. But the reason that we can enjoy the realism is that in other respects, most respects, these figures are not at all like us. The Awaji puppets are about three feet tall, to start with. Furthermore, to get around, they need three men, with rods and springs, manipulating them. The puppeteers are clothed and masked in black, but that doesn’t mean that we don’t see them.

All this, maybe, we could shut out, and enter fully into the illusion, but there is another thing stopping us: the fixity of the puppets’ faces. Awaji dramas, like their Bunraku counterparts, often concern the furthest out-districts of human emotion. In one of the offerings at Japan Society, “Hidakagawa Irai Zakura” (1759), a woman becomes so jealous that she turns into a green sea monster. Such dramatic events are preceded by long, histrionic speeches, but, as the characters deliver their orations, their faces, eerily, do not move. The emotion is displaced from the face and thereby gains in subtlety and force.

As for the characters’ words, those, too, are displaced—to a chanter. This person, considered the star of the puppetry team, sits to the side of the stage, where he tells the story and, when necessary, speaks the dialogue. The crux, however, is not the words but the singing. The chanter sobs; he gasps; he calls on Heaven to witness his grief. (And he does so in male and female, old and young, high-status and low-status voices.) When the woman in “Hidakagawa” describes her jealousy, the chanter runs the gamut of vocal expressiveness: head notes and belly notes, squeals and grunts, trills and runs without end. Meanwhile, the lady for whom he is speaking stands there with an unmoving face, white and lustrous, like a pearl. We seem, here, to get everything that art can give: the abstemious and the unleashed, the Gothic and the Baroque. The logic is not logical; it is lyrical, musical.

Questions 21–24 ask about Passage A.

21. The author of Passage A suggests that changes in Bunraku that occurred in the early 1700s led to which of the following effects?
- A. They made Bunraku more popular in countries beyond Japan.
 - B. They differentiated Bunraku from the puppetry of other countries.
 - C. They created the illusion that Bunraku puppets moved and talked on their own.
 - D. They brought about a shift in the kinds of stories that were recounted in Bunraku theater.

22. One main function of the last paragraph of Passage A (lines 30–42) is to:
- F. explain the author’s perspective on the Japanese methods used to create puppets.
 - G. suggest that puppets are inevitably unrealistic in their appearance.
 - H. describe a shortcoming in the author’s early understanding of Bunraku.
 - J. assert that the complexity of Bunraku comes from its depiction of a flat surface of reality.
23. In Passage A, how does the author explain her interest in Bunraku?
- A. She indicates that she had always felt a connection to Bunraku.
 - B. She suggests that her own experimentation with puppet performances led her to Bunraku.
 - C. She states that she had always appreciated the long history of Bunraku.
 - D. She describes how performances at Japan Society inspired her to explore Bunraku.
24. The author of Passage A identifies Bunraku theater as combining what three fragments of Western theater?
- F. Puppet, manipulator, and musician
 - G. Music, auxiliary stage, and puppet
 - H. Narrator, puppet, and text
 - J. Text, music, and puppet

Questions 25–27 ask about Passage B.

25. In Passage B, how does the statement that “Awaji dramas, like their Bunraku counterparts, often concern the furthest outdistricts of human emotion” (lines 61–63) figure into the author’s discussion?
- A. It is a generalization the author mentions but does not discuss further in the passage.
 - B. It is an assertion the author makes to emphasize the disparity between the intensity of the story and the stillness of the puppets’ faces.
 - C. It is a widely held assumption the author mentions as part of her claim that most people fail to see the hidden strength of Japanese puppetry.
 - D. It is an opinion the author supports with several examples of Japanese puppetry from the 1700s to today.
26. It can reasonably be inferred from Passage B that the chanter is often considered the star of Awaji theater mainly because the:
- F. chanter’s dynamic singing conveys the intensity and drama of the story.
 - G. chanter occupies the stage along with the puppets and interacts with them.
 - H. chanter’s responsibilities include directing and coordinating the other puppeteers.
 - J. chanter composes the text that ultimately gives meaning to the puppets’ gestures.

27. In the first paragraph of Passage B (lines 43–58), the author provides the example of the weeping woman most likely to:
- A. suggest that the Awaji Puppet Theatre Company focuses on plays that are sad.
 - B. indicate that the Awaji Puppet Theatre Company has existed for five centuries.
 - C. emphasize the range of emotions that Awaji puppets are visibly able to express.
 - D. explain the artistic precision that makes the Awaji puppets’ gestures seem realistic.

Questions 28–30 ask about both passages.

28. Regarding the perspectives from which the passage authors write, the two passages are:
- F. similar; both authors indicate that they are writing from the perspective of a spectator of puppet theater.
 - G. similar; both authors indicate that they are writing from the perspective of a practitioner of puppet theater.
 - H. different; the author of Passage A writes from the perspective of a practitioner of puppet theater and the author of Passage B from that of a spectator.
 - J. different; the author of Passage A writes from the perspective of a spectator of puppet theater and the author of Passage B from that of a practitioner.
29. Which of the following statements regarding the gender of the puppeteers in Japanese theater can most reasonably be inferred from the passages?
- A. Traditionally, the performers have been male.
 - B. Women began taking part in performances in the early 1700s.
 - C. Japanese theater is unique in that it has always incorporated both male and female performers.
 - D. Men hold the puppets, but women speak and sing.
30. The passages are similar in that both authors reach the conclusion that the form of Japanese puppetry they discuss:
- F. reached the height of its popularity in Japan in the 1700s.
 - G. is difficult to fully appreciate without years of study.
 - H. derives strength from its balance of realism and artificiality.
 - J. is at its best when used to tell complex fictional stories.

Passage IV

NATURAL SCIENCE: This passage is adapted from the article “Sociable, and Smart” by Carl Zimmer (©2008 by The New York Times Company).

Scientists have long puzzled over the enormous size of the human brain. It is seven times larger than one would predict for an average mammal of our size. Many of our extra neurons are in a region of the brain
5 called the frontal cortex, where much of the most sophisticated thought takes place.

To understand how we ended up with such a strange organ, many scientists have turned to our fellow primates. They also have large brains, although not as
10 large as our own. It turns out that primates with a big frontal cortex tend to live in large groups.

Primates may be pushed into larger groups thanks to predators or to patchy sources of food like fruit trees. As their numbers grow, natural selection may favor
15 social intelligence. The primates form long-term alliances with each other and compete with rivals. They begin to keep track of a larger and larger social network.

A boost in social intelligence can lead to an evolutionary edge for primates. Well-connected female baboons, for example, dominate their bands. They have more babies than lower-ranking females, and their babies enjoy better health and faster growth.

Brain imaging studies have revealed that when
25 people think about other people, parts of the frontal cortex become active. Advocates of the social brain hypothesis say the frontal cortex expanded in our ancestors because natural selection favored social intelligence.

Most of the research on the social brain hypothesis has focused on primates. One reason for that bias, Dr. Kaye Hlekamp, a professor at Michigan State University, said, is many scientists thought that no other animals were worth studying. “Primatologists have
35 argued for years,” she said, “that primates are unique in terms of the complexity of their social lives.”

From her experience with hyenas, Dr. Hlekamp had her doubts. So she began to run experiments on spotted hyenas similar to the ones run on primates. She
40 would play recordings of hyenas, for example, to see if other hyenas recognized them individually. They did. She soon came to see the primates-only view of the social brain as deeply flawed.

“I would argue that’s not true at all: spotted hyenas
45 live in a society just as large and just as complex as baboons’,” Dr. Hlekamp said, noting that spotted hyenas live in the largest social groups of any carnivore. “We’re talking about 60 to 80 individuals who all know each other individually.”

To understand the social intelligence of hyenas, Dr. Hlekamp and her colleagues track the animals from birth to death. Their work begins in the communal dens where the cubs live for their first few months. Older spotted hyenas pay regular visits to the dens,
55 giving the cubs an opportunity to learn about the rigid hierarchy in which they live. Spotted hyena societies have one dominant female at the top, and a series of hyenas below her. Each cub learns exactly where it fits into the hierarchy, and where all the other spotted
60 hyenas fit as well.

The hierarchy reveals itself most vividly when it is time to eat. When one or two hyenas make a kill, other members of the clan will join them to fight over the prey. But the dominant female always wins.

There are times, however, when the entire group of
65 hyenas comes together. Spotted hyena clans patrol the borders of their territory together. “When the whole group territory is on the line,” Dr. Hlekamp said, “all these unrelated individuals join forces and engage in a
70 clan war.”

What makes the social complexity of spotted hyenas particularly enlightening, Dr. Hlekamp said, are their relatives. They belong to a family of four species, and the other three live in strikingly different
75 societies. Dr. Hlekamp wonders if this range of social arrangements is reflected in the structure of hyena brains.

From a CT-scan of a hyena skull, it is possible to reconstruct the three-dimension structure of the brain it
80 held. Dr. Hlekamp and her colleagues have been working to survey dozens of skulls from all four species in the hyena family. Their preliminary results indicate hyenas follow the same rules as primates.

“It’s just what the social complexity hypothesis
85 would predict,” Dr. Hlekamp said. “The hyenas with the simplest social systems have the tiniest frontal cortices. The spotted hyena, which lives in the most complex societies, has far and away the largest frontal cortex.”

Joan Silk, an expert on monkey societies at the University of California, Los Angeles, praises Dr. Hlekamp’s research, calling it “directly relevant to our understanding of the origins of social complexity and intelligence.”

31. One main purpose of the passage is to:
- A. contrast the structure of a hyena's brain with the structure of a human's brain.
 - B. argue that studies of hyenas have revealed more about brain function than have studies of primates.
 - C. discuss what the study of hyenas has revealed about the evolution of social intelligence.
 - D. compare the evolutionary histories of the four species in the hyena family.
32. The author cites brain imaging studies in the fifth paragraph (lines 24–29) primarily to support the passage's point that:
- F. the frontal cortex is the center of social intelligence.
 - G. most of a human's extra neurons are located in the frontal cortex.
 - H. the majority of research on the social brain hypothesis is focused on primates.
 - J. it's possible to reconstruct the three-dimension structure of the hyena brain from a CT scan of a skull.
33. When the author states that hyenas "follow the same rules as primates" (line 83), he most likely means that:
- A. the hyena's diet closely resembles that of primates.
 - B. primates and hyenas who live in large groups have large frontal cortices.
 - C. primates and hyenas tend to form long-term alliances with other species.
 - D. the structure of the hyena skull is identical to that of the primate skull.
34. Based on the passage, Holekamp's research most directly challenges which of the following arguments made by some primatologists?
- F. Primates with a high social rank have more babies than do high-ranking members of other animal species.
 - G. Primates are the only animals that live in large groups.
 - H. Primates are favored by natural selection because they are better equipped to locate patchy sources of food.
 - J. Primates are the only animals worth studying for social brain hypothesis research.
35. According to the passage, when Holekamp and her colleagues analyzed hyena skulls, they determined that:
- A. subtle differences in hyena skulls enable hyenas to recognize fellow clan members.
 - B. hyenas with larger skulls tend to have a smaller frontal cortex.
 - C. the structure of the hyena brain varies among the different hyena species.
 - D. the structure of the hyena brain has changed little over the centuries.
36. The author speculates that primates may be pushed to live in large groups due in part to:
- F. territory disputes with hyenas.
 - G. an innate desire to stay close to their relatives.
 - H. the presence of predators.
 - J. a lack of suitable shelter.
37. In the passage, the author discusses female baboons primarily to illustrate how:
- A. female primates have higher social intelligence than do male primates.
 - B. limited sources of food cause animals to be aggressive toward one another.
 - C. primates learn the hierarchy of their social group from their mothers.
 - D. increased social intelligence can give animals an evolutionary advantage.
38. Which of the following theories about the evolution of the human brain is presented in the passage?
- F. During the early stages in the evolution of the human brain, growth in the frontal cortex was inhibited by the structure of the skull.
 - G. After developing the ability to produce sophisticated thought, the human brain began to produce extra neurons.
 - H. Because natural selection favors social intelligence, the human frontal cortex began to increase in size.
 - J. Humans first developed a frontal cortex when they began to form long-term alliances to better compete with rivals.
39. According to the passage, when does a spotted hyena first learn its place in the hierarchy of its clan?
- A. While participating in its first fight over prey
 - B. While living in the communal den
 - C. When patrolling the clan's territory for the first time
 - D. Shortly after leaving the communal den
40. According to the passage, compared to other species of hyenas, spotted hyenas:
- F. are more likely to be carnivores.
 - G. are less likely to be territorial.
 - H. have smaller frontal cortices.
 - J. live in more complex societies.

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

The whitefly *Bemisia argentifolii* is an insect that has 3 distinct life stages: egg, *nymph* (juvenile), and adult. A study examined the effects of external temperature on the duration of each of the 3 life stages of *B. argentifolii* and on egg production by adult female *B. argentifolii*. Figure 1 shows, for each of 5 external temperatures, the average duration of each life stage. Figure 2 shows, for each of the 5 temperatures, the average number of eggs produced per female per day during the first 7 days of adult life.

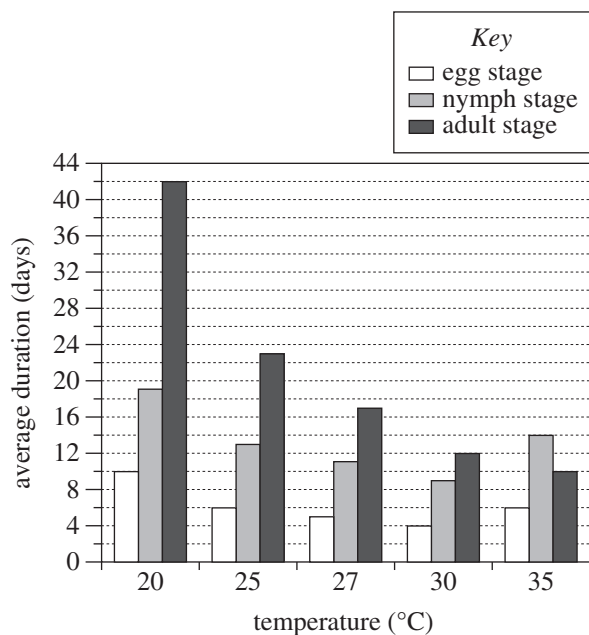


Figure 1

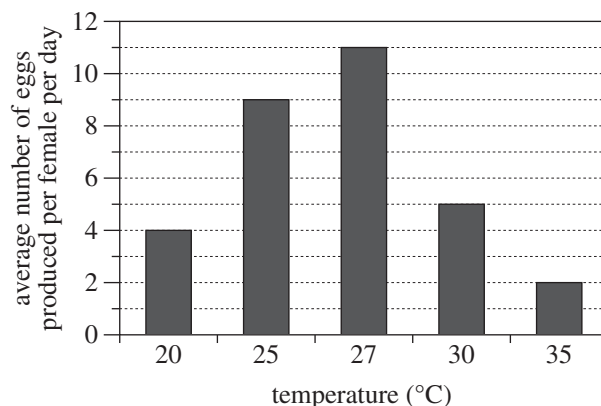


Figure 2

Figures adapted from Kaihong Wang and James H. Tsai, "Temperature Effect on Development and Reproduction of Silverleaf Whitefly (Homoptera: Aleyrodidae)." ©1996 by Entomological Society of America.

1. According to Figure 1, for how many of the temperatures tested was the average duration of the egg stage longer than 1 week?
 - A. 1
 - B. 2
 - C. 4
 - D. 5



2. According to Figures 1 and 2, as the temperature increased from 20°C through 27°C, on average, did the duration of the adult stage increase or decrease, and did the number of eggs produced per female per day increase or decrease?

	<u>duration of adult stage</u>	<u>number of eggs produced per female per day</u>
F.	increase	increase
G.	decrease	decrease
H.	increase	decrease
J.	decrease	increase

3. Consider the statement “The temperature that resulted in the shortest average duration of the egg stage was also the temperature that resulted in the longest average duration of the adult stage.” Is this statement consistent with the results shown in Figure 1 ?
- A. Yes; that temperature was 20°C.
 B. Yes; that temperature was 30°C.
 C. No; on average, the duration of the egg stage was shortest at 20°C, whereas the duration of the adult stage was longest at 30°C.
 D. No; on average, the duration of the egg stage was shortest at 30°C, whereas the duration of the adult stage was longest at 20°C.

4. Based on Figure 1, at 26°C, the nymph stage would most likely last:

F. fewer than 5 days.
 G. between 5 days and 11 days.
 H. between 11 days and 13 days.
 J. more than 13 days.

5. Based on Figure 2, at a temperature of 25°C, an adult female *B. argentifolii* will produce, on average, a total of how many eggs over the first 7 days of her adult stage?

A. 28
 B. 54
 C. 63
 D. 77

6. Based on Figure 2, the average number of eggs produced per female per day was how many times as great at 35°C as it was at 20°C ?

F. $\frac{1}{5}$
 G. $\frac{1}{2}$
 H. 2
 J. 5



Passage II

Primary amines (PAs) are compounds containing an *amino* (NH_2) group bound to a *hydrocarbon chain* (a group made up of C and H atoms). Table 1 lists, for each of 5 PAs, the chemical formula, *molecular mass* (mass of 1 molecule) in atomic mass units (amu), melting point (MP), and boiling point (BP).

Table 1				
PA	Chemical formula	Molecular mass (amu)	MP* ($^{\circ}\text{C}$)	BP* ($^{\circ}\text{C}$)
1-propanamine	$\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$	59	-85	47
1-butanamine	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$	73	-49	77
1-pentanamine	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$	87	-55	104
1-hexanamine	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$	101	-23	133
1-heptanamine	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$	115	-18	156
*at 101.3 kilopascals (kPa) of pressure				

Table 2 lists, for each of the 5 PAs, the *flash point* (the lowest temperature at which a flammable mixture is formed in the air above a liquid) and the temperature at which the *vapor pressure* (the pressure exerted by a vapor in equilibrium with its liquid state) equals 0.1 kPa, 1 kPa, 10 kPa, and 100 kPa.

Table 2					
PA	Flash point* ($^{\circ}\text{C}$)	Temperature (in $^{\circ}\text{C}$) at which the vapor pressure equals:			
		0.1 kPa	1 kPa	10 kPa	100 kPa
1-propanamine	-37	-63	-38	-4	46
1-butanamine	-12	-46	-18	20	76
1-pentanamine	-1	-29	1	43	102
1-hexanamine	29	-10	22	66	131
1-heptanamine	54	5	39	87	154
*at 101.3 kPa of pressure					

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



7. According to Table 1, among the 5 PAs, as the molecular mass increases, the BP at 101.3 kPa:
- A. decreases only.
 - B. increases only.
 - C. decreases, then increases.
 - D. varies, but with no general trend.
8. According to Tables 1 and 2, the PA that has a flash point of -1°C at 101.3 kPa has a molecular mass of:
- F. 59 amu.
 - G. 73 amu.
 - H. 87 amu.
 - J. 101 amu.
9. Based on Table 2, the vapor pressure of 1-pentanamine at 11°C would most likely be:
- A. less than 0.1 kPa.
 - B. between 0.1 kPa and 1 kPa.
 - C. between 1 kPa and 10 kPa.
 - D. greater than 10 kPa.
10. Consider the PA *ethanamine*, $\text{CH}_3\text{CH}_2\text{NH}_2$. Based on Table 1, the molecular mass of ethanamine is closest to which of the following?
- F. 31 amu
 - G. 45 amu
 - H. 59 amu
 - J. 73 amu
11. Consider the PA *1-octanamine*, $\text{CH}_3(\text{CH}_2)_7\text{NH}_2$. Based on Tables 1 and 2, the temperature at which the vapor pressure of 1-octanamine equals 100 kPa would most likely be:
- A. less than 102°C .
 - B. between 102°C and 131°C .
 - C. between 131°C and 154°C .
 - D. greater than 154°C .
12. Which of the PAs listed in Table 1 would exist in the liquid state at -65°C and 101.3 kPa ?
- F. 1-propanamine only
 - G. 1-pentanamine only
 - H. 1-propanamine and 1-butanamine only
 - J. 1-pentanamine and 1-butanamine only



Passage III

Oil spills in the ocean are cleaned up by using a *sorbent* to soak up the oil floating on the water's surface. Two studies examined the effectiveness of 4 sorbents: 3 natural (milkweed, cotton, and kenaf) and 1 synthetic (polypropylene).

Before the studies, the following procedures were performed for each sorbent: A 1 g sample of the sorbent was completely dried and then placed in a beaker containing 500 mL of seawater. Ten minutes later, the sample was removed from the beaker and its mass was measured. The mass of seawater the sample had soaked up, m_s , was calculated. The sample was discarded.

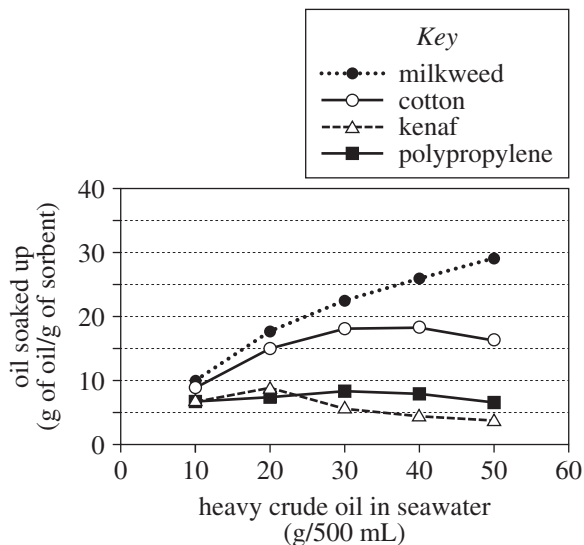


Figure 1

Study 2

The procedures of Study 1 were repeated except that each sorbent was placed in light crude oil and seawater instead of heavy crude oil and seawater. The results are shown in Figure 2.

Study 1

The following procedures were performed for each sorbent:

- A 500 mL volume of seawater was poured into each of 5 identical 1 L beakers.
- A different mass of heavy crude oil—10 g, 20 g, 30 g, 40 g, or 50 g—was added to each beaker.
- A 1 g sample of completely dried sorbent was added to each beaker.
- The beakers were gently shaken for 10 min.
- Immediately after the beakers were shaken, each sample was removed from its beaker, and its final mass, m_f , was measured. The mass of oil that had been soaked up by the sample, m_o , was calculated as follows:

$$m_o = m_f - m_s - 1 \text{ g}$$

The results, given in grams of oil soaked up per gram of sorbent, are shown in Figure 1.

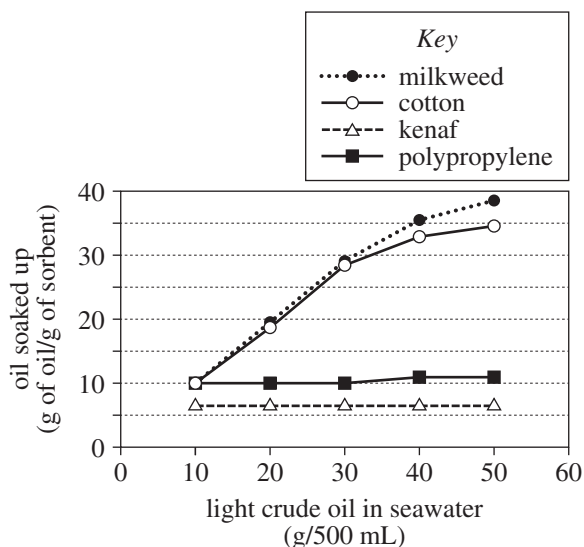


Figure 2

Figures adapted from Hyung-Min Choi and Rinn M. Cloud, "Natural Sorbents in Oil Spill Cleanup." ©1992 by the American Chemical Society.



13. Based on the results of the studies, which of the sorbents would be most effective in cleaning up an ocean spill of heavy crude oil, and which of the sorbents would be most effective in cleaning up an ocean spill of light crude oil?
- | | <u>heavy crude oil</u> | <u>light crude oil</u> |
|----|------------------------|------------------------|
| A. | milkweed | milkweed |
| B. | cotton | kenaf |
| C. | kenaf | polypropylene |
| D. | polypropylene | polypropylene |
14. Which procedure was most likely intended to simulate the effect of waves in the ocean?
- F. Pouring seawater into a beaker
 G. Adding oil to a beaker of seawater
 H. Shaking a beaker of seawater for 10 min
 J. Removing a sample of sorbent from a beaker of seawater
15. Consider the results of both studies for an oil mass of 30 g. Which of the sorbents soaked up a greater mass of light crude oil than of heavy crude oil at that oil mass?
- A. Cotton only
 B. Milkweed and kenaf only
 C. Cotton and polypropylene only
 D. All 4 sorbents
16. In each study, after heavy crude oil or light crude oil was added to a beaker of seawater, the oil floated on the surface of the seawater. This information is consistent with which of the following statements comparing the density of seawater with the density of heavy crude oil and with the density of light crude oil? Seawater is:
- F. less dense than heavy crude oil and less dense than light crude oil.
 G. more dense than heavy crude oil and more dense than light crude oil.
 H. less dense than heavy crude oil but more dense than light crude oil.
 J. more dense than heavy crude oil but less dense than light crude oil.
17. According to the results of Study 2, in the beakers containing 20 g or more of light crude oil in seawater, did 1 g of any of the natural sorbents soak up more oil than did 1 g of synthetic sorbent?
- A. Yes; 1 g of milkweed and 1 g of cotton each soaked up more oil than did 1 g of kenaf.
 B. Yes; 1 g of milkweed and 1 g of cotton each soaked up more oil than did 1 g of polypropylene.
 C. No; 1 g of milkweed and 1 g of cotton each soaked up less oil than did 1 g of kenaf.
 D. No; 1 g of milkweed and 1 g of cotton each soaked up less oil than did 1 g of polypropylene.
18. Consider the statement “As the mass of oil added to 500 mL of seawater increased, the mass of oil soaked up by 1 g of sorbent always increased.” This statement is consistent with the results of Study 1 for which of the sorbents?
- F. Milkweed only
 G. Polypropylene only
 H. Milkweed and cotton only
 J. Kenaf and polypropylene only
19. Suppose that, in Study 1, 0.5 g of dry cotton and 0.5 g of dry polypropylene had been thoroughly mixed and then added to a 1 L beaker containing 500 mL of seawater and 50 g of heavy crude oil. The number of grams of oil soaked up by the 1 g sorbent mixture would most likely have been:
- A. less than 8.
 B. between 8 and 16.
 C. between 16 and 26.
 D. greater than 26.

Passage IV

Three experiments were performed to study the surface tension and pH of colorless aqueous solutions of 4 different acids: nitric acid, formic acid, chloroacetic acid, and acetic acid. A liquid's *surface tension* in millijoules per square meter (mJ/m^2) is equal to the energy in millijoules required to increase the surface area of the liquid by 1 m^2 .

Experiment 1

Twenty 250 g aqueous solutions—5 of nitric acid, 5 of formic acid, 5 of chloroacetic acid, and 5 of acetic acid—were prepared. Each of the 5 solutions of a given acid had a different percent by mass of acid (10%, 20%, 30%, 40%, or 50%). The surface tension of each solution and of distilled H_2O was measured at 25°C (see Figure 1).

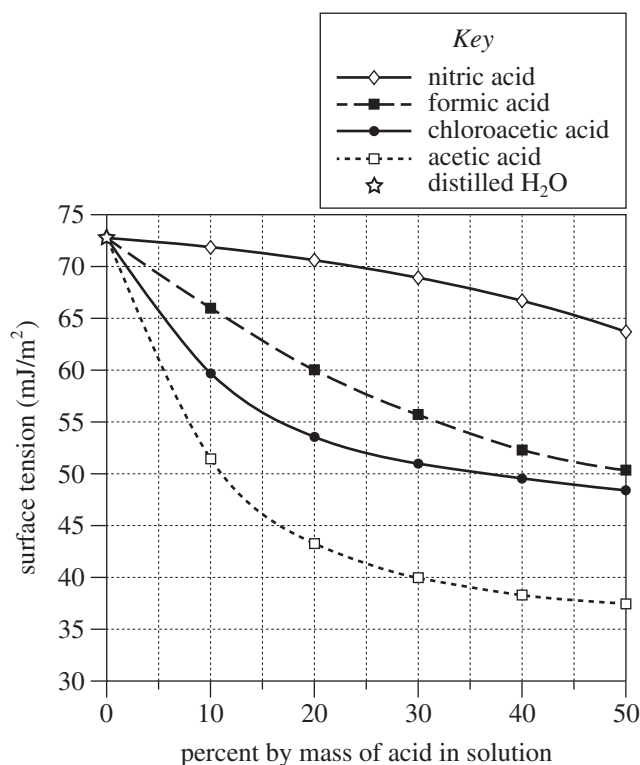


Figure 1

Experiment 2

One gram of each of the 50% by mass acid solutions prepared in Experiment 1 was diluted with distilled H_2O to a total mass of 10 g, forming four 5% by mass acid solutions. Six drops of *methyl violet*, a pH indicator, were added to each of these solutions. (A *pH indicator* is a compound whose color is determined by the pH of the solution in which the compound is dissolved.) The color of each resulting solution at 25°C was recorded (see Table 1).

Table 1	
Acid solution (5% by mass)	Color of resulting solution
Nitric acid	yellow-green
Formic acid	blue-violet
Chloroacetic acid	blue
Acetic acid	violet

Table 1 adapted from Kenneth E. Kolb and Doris Kolb, "Illustrating the Inductive Effect on Acid Strength of Carboxylic Acids." ©1989 by Division of Chemical Education, Inc., American Chemical Society.

Experiment 3

One gram of each of the 20 solutions prepared in Experiment 1 was diluted with distilled H_2O to a total mass of 10 g. The pH of each resulting solution was measured at 25°C (see Figure 2).

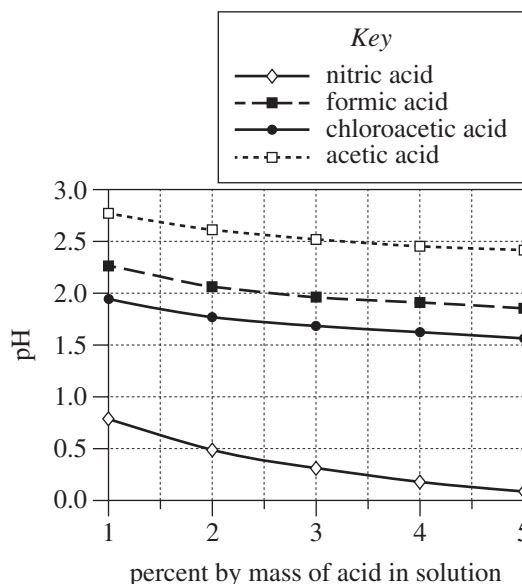


Figure 2

Figures 1 and 2 adapted from W. M. Haynes, ed., *CRC Handbook of Chemistry and Physics on CD-ROM*, Version 2011. ©2011 by CRC Press, LLC.

20. Based on the results of Experiment 2, if 6 drops of methyl violet are added to a 5% by mass nitric acid solution, what will be the color of the resulting solution at 25°C ?

F. Blue
 G. Blue-violet
 H. Violet
 J. Yellow-green



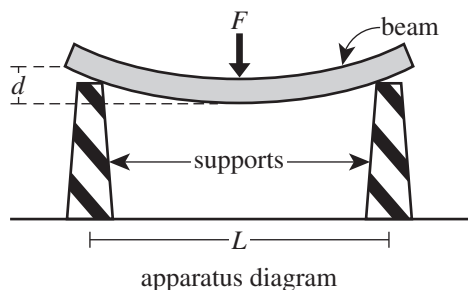
21. Based on the results of Experiment 1, for each of the 4 acids, as acid concentration increased from 10% by mass through 50% by mass, the surface tension at 25°C:
- A. increased only.
 - B. decreased only.
 - C. increased, then decreased.
 - D. decreased, then increased.
22. A student predicted that, if a formic acid solution and an acetic acid solution have the same acid concentration by mass and are both at 25°C, the formic acid solution has a greater surface tension than does the acetic acid solution. The results of which experiment better support or refute this prediction?
- F. Experiment 1's results better support this prediction.
 - G. Experiment 1's results better refute this prediction.
 - H. Experiment 2's results better support this prediction.
 - J. Experiment 2's results better refute this prediction.
23. Based on the results of Experiment 3, the pH of a 2.5% by mass formic acid solution at 25°C would most likely have been closest to which of the following?
- A. 1.8
 - B. 2.0
 - C. 2.2
 - D. 2.4
24. Suppose that 6 drops of methyl violet are added to an aqueous solution of an acid with a pH of 2.5 at 25°C. Based on the results of Experiments 2 and 3, the color of the resulting solution at 25°C will most likely be:
- F. blue.
 - G. blue-violet.
 - H. violet.
 - J. yellow-green.
25. Which of the following factors was kept the same for all the acid solutions in Experiment 2 but was NOT kept the same for all the acid solutions in Experiment 1 and in Experiment 3 ?
- A. Acid concentration
 - B. pH
 - C. Surface tension
 - D. Temperature
26. Based on the results of Experiment 3, which is the stronger acid, nitric acid or acetic acid?
- F. Nitric acid, because at each concentration the nitric acid solution had the lower pH.
 - G. Nitric acid, because at each concentration the nitric acid solution had the higher pH.
 - H. Acetic acid, because at each concentration the acetic acid solution had the lower pH.
 - J. Acetic acid, because at each concentration the acetic acid solution had the higher pH.



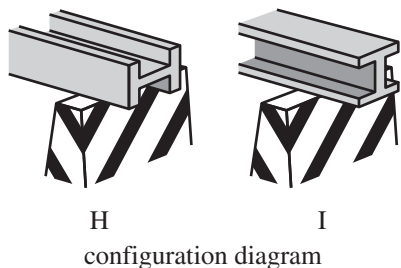
Passage V

A structural beam, such as one used in construction, will *deflect* (bend) when a sufficiently large force is applied perpendicular to the beam's length. Three studies of 12 trials each were performed on the deflection of 2 straight structural beams—a concrete beam and a steel beam—that had identical dimensions.

In each trial, 2 supports were separated by a distance L , measured in centimeters (cm), and a beam was centered on top of the supports. A force, F , measured in kilonewtons (kN), was then applied to the center of the beam, and the maximum deflection of the beam, d , was measured in millimeters (mm). See the apparatus diagram.



The beam was oriented in either the *H configuration* or the *I configuration* (see the configuration diagram).



Study 1

Twelve trials were performed in which L was varied and F was 1 kN. In the first 6 trials, the concrete beam was tested in the H configuration. In the last 6 trials, the concrete beam was tested in the I configuration. Figure 1 shows the results of these trials.

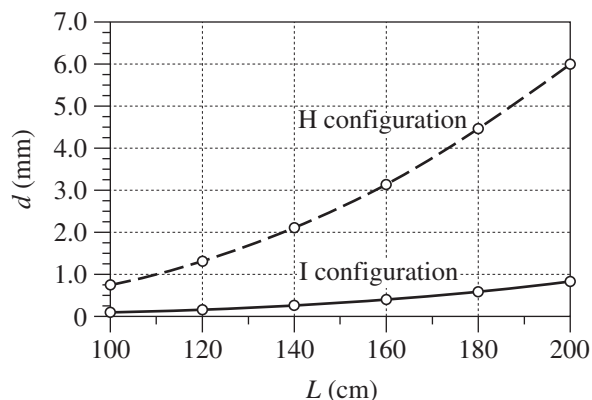


Figure 1

Study 2

In 12 trials, the procedures of Study 1 were repeated, except that the steel beam was tested. Figure 2 shows the results of these trials.

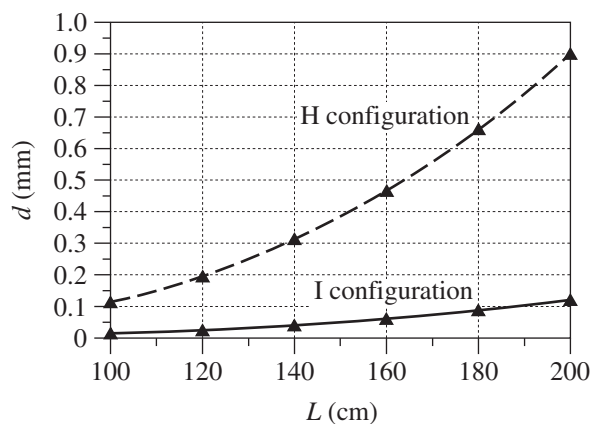


Figure 2

**Study 3**

Twelve trials were performed in which L was 100 cm and F was varied. In the first 6 trials, the concrete beam was tested in the I configuration. In the last 6 trials, the steel beam was tested in the I configuration. Figure 3 shows the results of these trials.

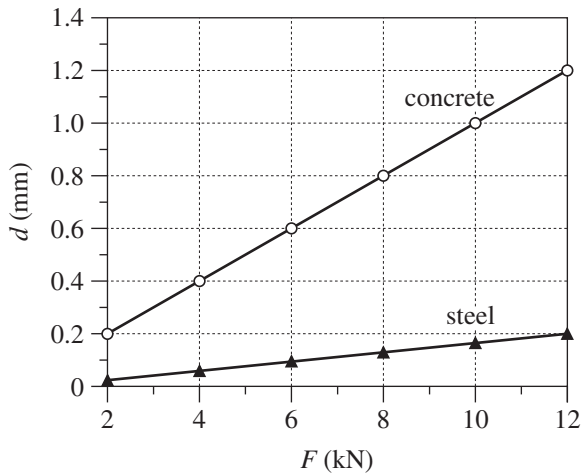


Figure 3

27. Based on the apparatus diagram, Figure 1, and Figure 2, each of the 2 beams tested must have been longer than:
- A. 200 cm.
 - B. 250 cm.
 - C. 300 cm.
 - D. 350 cm.
28. Consider the difference between d for a beam in the H configuration and d for that beam in the I configuration. As L was increased, the absolute value of this difference:
- F. increased for the concrete beam but decreased for the steel beam.
 - G. decreased for the concrete beam but increased for the steel beam.
 - H. increased for both beams.
 - J. decreased for both beams.

29. For the studies to be performed as described, which of the following criteria must have been satisfied during any given trial?

- A. The beam must have been perfectly rigid.
- B. The supports must have been fixed in position.
- C. The applied force must have been less than the weight of the beam.
- D. The maximum deflection must have been measured prior to applying the force.

30. In how many studies was the concrete beam tested, and in how many studies, if any, was *only* the concrete beam tested?

	concrete tested	only concrete tested
F.	1	0
G.	2	1
H.	2	2
J.	3	2

31. Suppose that in Study 3 the 2 beams had been tested in the H configuration. How would the results most likely have compared with the data shown in Figure 3? For each beam, the graph of d versus F would have been a straight line whose slope was:

- A. negative, and the line would have been steeper than the corresponding line graphed in Figure 3.
- B. negative, and the line would have been less steep than the corresponding line graphed in Figure 3.
- C. positive, and the line would have been steeper than the corresponding line graphed in Figure 3.
- D. positive, and the line would have been less steep than the corresponding line graphed in Figure 3.

32. Can it be determined on the basis of Study 2 whether the maximum deflection of the steel beam depended on the strength of the applied force?

- F. Yes, because F was held constant in Study 2.
- G. Yes, because F was varied in Study 2.
- H. No, because F was held constant in Study 2.
- J. No, because F was varied in Study 2.

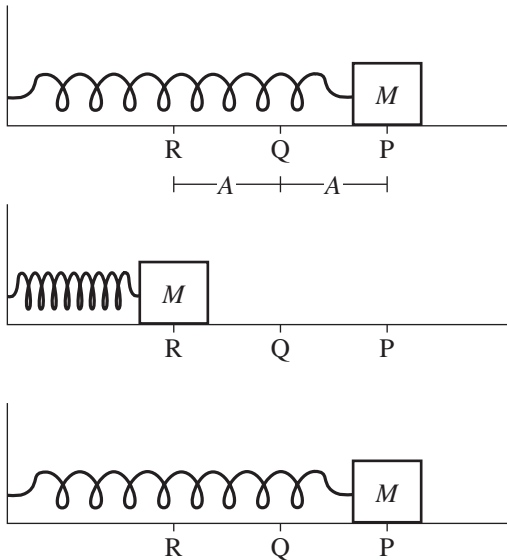
33. Suppose that a doorway is to be supported by one of the two beams tested in the studies. The doorway is 150 cm wide, and the beam must be able to support a force of at least 1 kN. However, d for the beam must never exceed 0.5 mm. Which beam, when oriented in which configuration, CANNOT be used to support this doorway?

- A. The concrete beam in the H configuration
- B. The concrete beam in the I configuration
- C. The steel beam in the H configuration
- D. The steel beam in the I configuration



Passage VI

A spring with a *spring constant* k (which indicates the spring's stiffness) is attached to a cube of mass M and then to a wall. The cube initially rests at Point Q on a frictionless horizontal surface. The cube is pulled from Point Q to Point P, stretching the spring. Once released, the cube oscillates between Points P and R, each a distance A (the *amplitude*) from Point Q (see the diagram).



The *frequency*, f , is the number of times per second the cube completes a *cycle* (travels from P to R, then back to P); v is the average speed of the cube during 1 cycle.

The teacher asks each of 3 students to predict which combination of the independent variables k , M , and A would produce the highest f .

Student 1

As k increases, v decreases, because a stiffer spring moves less freely. Therefore, f decreases because it takes more time for the cube to complete each cycle.

As M increases, v decreases, and so f also decreases.

As A increases, v increases, because the distance the cube travels during a complete cycle increases. Therefore, f also increases.

The highest f would be produced when each of k and M has its least value and A has its greatest value.

Student 2

As k increases, v increases, because the force exerted on the cube by the spring also increases, giving the cube a greater average acceleration and, therefore, a greater v . When v increases, f increases.

As M increases, v and f increase, because during the spring's oscillations, the momentum of the cube keeps its average speed from decreasing.

As A increases, the force exerted on the cube by the spring increases, so v , f , and average acceleration increase.

The highest f would be produced when each of k , M , and A has its greatest value.

Student 3

As k increases, the potential energy stored in the spring just before its release increases, so both v and f also increase.

As M increases, the cube's average acceleration decreases, and so both v and f decrease.

As A increases, both the cube's average acceleration and v increase, but so does the total distance through which the cube must travel. Consequently, f remains the same.

The highest f would be produced when k has its greatest value and M has its least value.

34. Based on Student 3's predictions, which of the variables listed below does NOT affect f ?

- I. k
- II. M
- III. A

- F. II only
- G. III only
- H. I and II only
- J. I and III only



35. According to the predictions of Student 1 and Student 2, respectively, as cube mass increases, does the cube's average speed during a cycle increase or decrease?

	<u>Student 1</u>	<u>Student 2</u>
A.	increase	increase
B.	increase	decrease
C.	decrease	increase
D.	decrease	decrease

36. Based on Student 2's predictions, which of the changes listed below would cause f to *decrease*?

- I. Increasing k
- II. Decreasing M
- III. Decreasing A

- F. I only
- G. II only
- H. I and III only
- J. II and III only

37. Based on Student 1's predictions, as k increases, the cube's average kinetic energy will:

- A. increase, because v will increase.
- B. increase, because v will decrease.
- C. decrease, because v will increase.
- D. decrease, because v will decrease.

38. Suppose that $M = 1$ kg for Cube R and that $M = 2$ kg for Cube S. Based on Student 3's predictions, for given values of k and A , the average acceleration will be greater for which cube?

- F. R, because average acceleration increases as cube mass increases.
- G. R, because average acceleration increases as cube mass decreases.
- H. S, because average acceleration increases as cube mass increases.
- J. S, because average acceleration increases as cube mass decreases.

39. Consider 2 springs, Spring X and Spring Y. Spring X has a smaller k than does Spring Y. Student 1 would probably agree that the cube will take a longer time to complete a cycle if it is attached to which spring?

- A. Spring X, because it is the stiffer spring.
- B. Spring X, because it is the less stiff spring.
- C. Spring Y, because it is the stiffer spring.
- D. Spring Y, because it is the less stiff spring.

40. Based on the information given, what total distance will the cube travel during 1 complete cycle?

- F. $1A$
- G. $2A$
- H. $3A$
- J. $4A$

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.