

Mock ACT

ERB4



ENGLISH TEST

35 Minutes—50 Questions

DIRECTIONS: In the passages that follow, certain words and phrases are underlined and numbered. In the right-hand column, you will find alternatives for the underlined part. You are to choose the best answer to each question. If you think the original version is best, choose “No Change.”

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

A Mouthful of Music

Mouth music is the name for the many ways of imitating the sounds of musical instruments with the human voice. Forms of mouth music are performed around the world, but the genre being particularly popular in England, Ireland, and Scotland.

Celtic mouth music exists to accompany dancing. Instead of using traditional lyrics, singers often produce nonsense syllables, called vocables to represent specific instrumental sounds, such as those of bagpipes or violins. The results are songs that rarely make literal sense—they focus instead on rhythm and sound—but nevertheless flow in a way that is easy to dance to.

Because of this, one Scottish form of mouth music, *puirt-a-beul*, is performed entirely in the Gaelic language and accompanies traditional dance steps.

- Which choice makes the sentence most grammatically acceptable?
 - No Change
 - was being
 - is
 - Delete the underlined portion.
- Which choice makes the sentence most grammatically acceptable?
 - No Change
 - syllables called vocables,
 - syllables, called vocables,
 - syllables called, vocables,

GO ON TO THE NEXT PAGE.



The often tongue-twisting lyrics require much practice to perfect.

4 Instruments were prohibitively expensive and thus scarce in isolated Scottish villages. In order to fill the void, mouth music emerged and provided residents with the music they wanted for dancing. Additionally, puirt-a-beul gave anyone whomever didn't read music a way to learn and pass on traditional songs.

3. If the writer were to delete the underlined portion, the sentence would primarily lose:
 - A. a description that emphasizes the difficulty of puirt-a-beul.
 - B. information about writing lyrics for puirt-a-beul.
 - C. an indication of how often puirt-a-beul is performed in Celtic culture.
 - D. an example of a training exercise puirt-a-beul singers use to practice lyrics.
4. Given that all the following statements are true, which one, if added here, would most effectively introduce the subject of the paragraph?
 - F. Puirt-a-beul was most likely invented out of necessity.
 - G. Mouth music singers must have a good sense of rhythm.
 - H. Celtic mouth music, including puirt-a-beul, has influenced jazz scat singing.
 - J. Another form of mouth music that originated in Scotland is the waulking song.
5. Which choice makes the sentence most grammatically acceptable?
 - A. No Change
 - B. which
 - C. whom
 - D. who

PASSAGE II

Making the Desert Bloom

More than two thousand years ago, a people the Romans, called the Garamantes, created a complex civilization in one of the world's driest places—the Sahara Desert. Beginning around 500 BCE, they built towns and villages, cloth was manufactured there and jewelry, and traded throughout North Africa and the Mediterranean. They also grew a variety of crops, including wheat, dates, palms, grapes, figs, and melons.

6. Which choice makes the sentence most grammatically acceptable?
 - F. No Change
 - G. Romans called the Garamantes,
 - H. Romans called: the Garamantes
 - J. Romans called the Garamantes
7. Which choice makes the sentence most grammatically acceptable?
 - A. No Change
 - B. the manufacture of cloth took place
 - C. manufactured cloth
 - D. cloth

Taking Additional Practice Tests

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The survival of their civilization depended on hundreds of miles of underground tunnels. These tunnels carried water to desert settlements from an aquifer, an underground water source, in the distant mountains.

The water ran through sloping, hand-dug tunnels⁸ called foggaras, which could be as deep as one hundred thirty feet below ground. These tunnels were connected to the surface by ventilation shafts every thirty feet or so. When the tunnels reached a town or field, the water flowed into more easily accessible surface canals or reservoirs. Having left no clues,⁹ archaeologists don't know how the Garamantes learned to build foggaras. Other such tunnels exist in Iran, Algeria, Tunisia, and elsewhere.

Because the canals were underground, the water they carried stayed clean and didn't evaporate. And because the water came from an aquifer rather then from its rainfall,¹⁰ the supply was unaffected by drought. The Garamantes

could of relied on a constant supply of water for drinking,¹¹

washing, and irrigation. Moreover,¹² the cold, damp air of the foggaras lowered the temperature inside the homes that were built over them, resulting in an ancient form of air-conditioning.

8. Which choice best indicates the method used to build the tunnels?

- F. No Change
- G. underground
- H. dimly lit
- J. desert

9. Which choice makes the sentence most grammatically acceptable?

- A. No Change
- B. A genuine puzzle to scientists, archaeologists
- C. Giving no indication, archaeologists
- D. Archaeologists

10. Which choice makes the sentence most grammatically acceptable?

- F. No Change
- G. than from
- H. then
- J. by

11. Which choice makes the sentence most grammatically acceptable?

- A. No Change
- B. had to of relied
- C. could rely
- D. relies

12. Which transition word or phrase is most logical in context?

- F. No Change
- G. Nevertheless,
- H. In contrast,
- J. Even so,

GO ON TO THE NEXT PAGE.



The Garamantes thrived until about 500 CE, when some archaeologists believe they began to deplete the aquifer. As the foggaras supplied less¹³ and less water, the Garamantes' population declined. Their civilization eventually collapsed. However, at least six hundred of the ancient foggaras survive. The stone mounds that mark their ventilation shafts are still visible in what is now southwestern Libya, where they can be seen even now.¹⁴

13. Which choice is clearest and most precise in context?

- A. No Change
- B. As to when
- C. Whereas
- D. Though

14. Which choice is least redundant in context?

- F. No Change
- G. a place where visitors can see these amazing signs of an ancient civilization.
- H. the location that continues to present visitors with a view of these remnants of a time gone by.
- J. Delete the underlined portion and end the sentence with a period.

Question 15 asks about the preceding passage as a whole.

15. Suppose the writer's primary purpose had been to present information about a civilization's efforts to overcome a natural obstacle in order to survive. Would this essay accomplish that purpose?

- A. Yes, because it explains that the Garamantes traded throughout North Africa and the Mediterranean.
- B. Yes, because it describes the Garamantes' method of bringing water to an otherwise dry area, allowing the Garamantes to thrive there.
- C. No, because the foggaras were not naturally occurring tunnels.
- D. No, because the foggaras ultimately led to the downfall of the Garamantes' civilization.

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PASSAGE III

Faith Ringgold's Quilting Bee

The artist Faith Ringgold has made a name for herself with her “story quilts,” lively combinations of painting, quilting, and storytelling. Each artwork consists of a painting framed by quilted squares of fabric and story panels. One of these artworks, *The Sunflowers Quilting Bee at Arles*, depicts a scene of women at work on a quilt in a field of towering yellow flowers that eight African American women sit around¹⁶ the quilt that covers their laps. Who are these people stitching among the flowers? What brings them so close that their shoulders touch?

Thus, the answers to these questions can be found¹⁷ in the artwork itself. Ringgold has told the story of this gathering on two horizontal panels of text. One panel is sewn into the piece's top border, the other into it's bottom border¹⁸. These eight women, the story explains, strove in their various ways to support the cause of justice in the world.

In reality¹⁹, these women never met to piece together a quilt. The scene comes out of the artists imagination²⁰ as a statement of the unity of purpose that she perceives in their lives.

16. Which choice makes the sentence or sentences most grammatically acceptable?
- F. No Change
G. flowers and eight
H. flowers. Eight
J. flowers, eight
17. Which transition word, if any, is most logical in context?
- A. No Change
B. Instead, the
C. Furthermore, the
D. The
18. Which choice makes the sentence most grammatically acceptable?
- F. No Change
G. its'
H. its
J. their
19. Which transition word is most logical in context?
- A. No Change
B. summary,
C. addition,
D. contrast,
20. Which choice makes the sentence most grammatically acceptable?
- F. No Change
G. artist's imagination
H. artists' imagination
J. artists imagination,

GO ON TO THE NEXT PAGE.



Sojourner Truth and Harriet Tubman fought to abolish slavery and, later, were active in the crusade for suffrage. Newspaper journalist Ida B. Wells courageously spoke out for social and racial justice in the late nineteenth and early twentieth centuries.

Establishing her own hair products business herself in the first decade of the twentieth century, Madam C. J. Walker later bequeathed millions of dollars to charities and educational institutions. Among the schools that benefited from this generosity, were those that Mary McLeod Bethune opened and ran in order to provide a better education for Black students. And Fannie Lou Hamer, Ella Baker, and Rosa Parks showed leadership and strength during the civil rights movement, it happened in the 1950s and 1960s.

In the artwork, Ringgold has surrounded these women with bright sunflowers. The flowers seem to celebrate the women's accomplishments and the beauty of their shared vision.

21. Given that all the choices are true, which one provides the most relevant information at this point in the essay?
 - A. No Change
 - B. married Ferdinand Barnett, editor of the first Black newspaper in Chicago, the *Chicago Conservator*.
 - C. wrote for newspapers in Memphis, New York City, and finally, Chicago.
 - D. was born in Holly Springs, Mississippi, in 1862, the eldest of eight children.
22. Which choice is least redundant in context?
 - F. No Change
 - G. business belonging to her
 - H. business, herself,
 - J. business
23. Which choice makes the sentence most grammatically acceptable?
 - A. No Change
 - B. generosity; were
 - C. generosity were
 - D. generosity were:
24. Which choice makes the sentence most grammatically acceptable?
 - F. No Change
 - G. movement, it took place in
 - H. movement, that happened in
 - J. movement of
25. If the writer were to delete the preceding sentence, the essay would primarily lose:
 - A. an interpretation of the artwork that serves to summarize the essay.
 - B. a reflection on the women depicted in the artwork that compares them to Ringgold.
 - C. a description of a brushwork technique that refers back to the essay's opening.
 - D. an evaluation of Ringgold's artistic talent that places her in a historical context.

Taking Additional Practice Tests

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PASSAGE IV

Neutrinos on Ice

At the IceCube Neutrino Observatory in Antarctica, eighty-six cables descend 2,500 meters into the glacial terrain. Each cable is equipped with sixty digital optical modules (DOMs), which, are programmed, to detect a faint blue flash known as Cherenkov radiation.

This radiation—a veritable shock wave of photonic energy—is emitted when subatomic particles called neutrinos collide with electrons in the molecules of ice.

Although there are countless neutrinos in the universe (fifty trillion neutrinos pass through your body every second), actually detecting them is a formidable task. Neutrinos carry no electrical charge, are practically weightless, and travel at nearly the speed of light.

Neutrinos are rarely affected by matter or electromagnetic fields. For this purpose, many neutrinos have been traveling through space unimpeded for billions of years.

On some occasions, however, neutrinos do collide with other particles. 29

26. Which choice makes the sentence most grammatically acceptable?
- F. No Change
G. (DOMs), which are programmed
H. (DOMs): which are programmed
J. (DOMs); which are programmed
27. If the writer were to delete the underlined portion (adjusting the punctuation as needed), the essay would primarily lose information that:
- A. specifies why neutrinos are practically weightless.
B. explains how neutrinos pass through matter.
C. indicates why there are so many neutrinos.
D. emphasizes how numerous neutrinos are.
28. Which transition word or phrase is most logical in context?
- F. No Change
G. In contrast,
H. Besides,
J. In fact,
29. At this point, the writer is considering adding the following true sentence:
- In 1956, during the Cowan-Reines neutrino experiment, a neutrino was detected for the first time.
- Should the writer make this addition?
- A. Yes, because the information is relevant to the history of neutrino detection outlined in the paragraph.
B. Yes, because the information indicates that sub-zero altitude is essential to the detection of neutrinos.
C. No, because the information is unrelated to the discussion of why scientists selected the location of the IceCube Neutrino Observatory.
D. No, because the information is unrelated to why the detection of neutrinos is facilitated by zero-gravity conditions.

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Scientists specifically selected the site of the IceCube Neutrino Observatory to facilitate the detection of such a collision. Not only is the Antarctic subterranean ice exceptionally clear, it is also less pressurized due to its subzero altitude. These factors increase the chance of DOMs detecting the blue flash that signifies a neutrino collision. Once this detection occurs, data are gathered and transferred to laboratories at the University of Wisconsin. Here, scientists determine the origin of each of these neutrinos by analyzing the direction and intensity of the flash.

Determining neutrinos' origins could provide scientists with new insights into the universe. For instance, some neutrinos are produced during supernovae (the collapsing of stars). The origins of these neutrinos

could give us opulent information about how, when, and why stars collapse. Scientists are optimistic that the neutrinos detected at IceCube could lead to new ways of looking at our galaxy—and galaxies beyond.

30. Which choice makes the sentence or sentences most grammatically acceptable?
- F. No Change
G. Observatory, and to
H. Observatory. To
J. Observatory; to
31. Which choice makes the sentence most grammatically acceptable?
- A. No Change
B. their
C. it's
D. its'
32. Which of the following true sentences best introduces the main idea of the paragraph?
- F. No Change
G. For decades, scientists have been trying to learn more about gamma rays through the study of supernovae.
H. Recently, scientists at IceCube discovered two neutrinos, which they now refer to as Bert and Ernie.
J. Neutrinos can now be created in laboratories using a particle accelerator called a Super Proton Synchrotron.
33. Which choice is clearest and most precise in context?
- A. No Change
B. invaluable
C. upscale
D. lavish
34. The writer wants to emphasize that information garnered from the neutrinos detected at IceCube could have dramatic effects on how scientists study the universe. Which choice best accomplishes that goal?
- F. No Change
G. phenomena that have puzzled scientists over the last decade.
H. common occurrences in space.
J. the world around us.

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Question 35 asks about the preceding passage as a whole.

35. Suppose the writer's primary purpose had been to outline a scientific theory concerning the origins of a particle found in nature. Would this essay accomplish that goal?
- A. Yes, because it explains how scientists are discovering new reasons why neutrinos emit a blue flash known as Cherenkov radiation.
 - B. Yes, because it summarizes how DOMs at the IceCube Neutrino Observatory track neutrinos to their origins despite neutrinos' numerous collisions with matter and electromagnetic forces.
 - C. No, because it describes instead how neutrinos are detected at an observatory and how these detections could benefit future scientific research.
 - D. No, because it details instead how new research on neutrinos could potentially contradict a commonly held theory about supernovae.

PASSAGE V

Clinton Hill's Found Artist

[1]

At the Urban Vintage, my favorite café here in Clinton Hill, Brooklyn, I found a table by the window and checked the day's news on my laptop. On the *New York Times* home page, I noticed an article about Rafael Leonardo Black, a 64-year-old Clinton Hill artist ³⁶ who had just been discovered. [A]

[2]

Black, a native of Aruba, ³⁷ has been creating art in his New York City studio apartment for over three decades. Until recently, few people had seen his work.

36. Which choice makes the sentence most grammatically acceptable?
- F. No Change
 - G. of whom
 - H. which
 - J. whom
37. Which choice is least redundant in context?
- A. No Change
 - B. originally from Aruba, for more than half his life
 - C. living in Clinton Hill but a native of Aruba,
 - D. a newly found artist originally from Aruba,

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I wondered why—and learned he simply never cared to share it. Black has worked as a typist, a salesperson, and a receptionist. However, in May of 2013, art dealer Francis Naumann, directed to Black's art by one of Black's longtime friends, displayed sixteen of the artist's drawings in a solo show.

38

Within days, ten of Black's pieces sold for, prices ranging from \$16,000 to \$28,000. [B]

39

[3]

Black draws collages in black No. 2 pencil on white board. They're packed with depictions, in the form of drawings, of ancient myths, historical events, and popular culture. I found a collage titled *Seven Lamps* in a quick search online. [C] It features a representation of a British psychedelic poster, a portrayal of Danish surrealist painter, Wilhelm Freddie, at work, and a tiny figure of Los Angeles architect Simon Rodia. The images are stacked, forming a surreal tower. I wasn't sure how the drawings in *Seven Lamps*—so detailed that I could see the folds in Rodia's clothing—fit together logically, but I liked that there was so much for me to puzzle over.

40

41

42

38. Given that all the choices are accurate, which one provides the best transition to the information in the following sentence?
- F. No Change
 - G. was taking down an artist's long-running exhibition at his Manhattan gallery.
 - H. became aware that Black had never shown his drawings, formally or otherwise.
 - J. recognized that no one in the New York City art world had heard of Black.
39. Which choice makes the sentence most grammatically acceptable?
- A. No Change
 - B. sold—for
 - C. sold; for
 - D. sold for:
40. Which choice is least redundant in context?
- F. No Change
 - G. black pencil drawings that depict
 - H. drawings that create collages of
 - J. depictions of
41. Which choice makes the sentence most grammatically acceptable?
- A. No Change
 - B. painter Wilhelm Freddie,
 - C. painter, Wilhelm Freddie
 - D. painter Wilhelm Freddie
42. If the writer were to delete the underlined portion (adjusting the punctuation as needed), the essay would primarily lose a:
- F. claim arguing that the reason Naumann chose to show Black's art is that the art offers so much for a viewer to reflect upon and analyze.
 - G. detail indicating that the narrator appreciated Black's collage even though he or she might not have understood its overall intent.
 - H. comment suggesting that though the narrator enjoys only some of Black's art, he or she is glad that Black has been discovered.
 - J. statement revealing the narrator's belief that the best modern art is understood only by the artist who created it.

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Maybe this complexity in May helps explain why
 Black's work created such a stir.

[4]

I read that Black observes the sudden interest in
 his drawings. [D] He says he's always been an artist,
 regardless of who knew it. Now that I know about him,
 I'll keep checking the *Times* for word of his next show.
 When I walk home from the Urban Vintage tonight, I
 wonder if I'll pass the brownstone building where Black
 creates his fascinating, newly found art.

43. The best placement for the underlined portion would be:
- A. where it is now.
 - B. after the word *Maybe*.
 - C. after the word *explain*.
 - D. after the word *stir* (and before the period).
44. The writer wants to clearly establish that the newspaper article claims Black is unmoved by the sudden interest in his art. Which choice best accomplishes that goal?
- F. **No Change**
 - G. is nearly a celebrity in Clinton Hill due to
 - H. has benefited financially from
 - J. gives little thought to

Question 45 asks about the preceding passage as a whole.

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

Fortunately, the web page included a key that identified the people, places, and events—most of which I had never even heard of—that Black portrays in this piece.

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

- A. Point A in Paragraph 1.
- B. Point B in Paragraph 2.
- C. Point C in Paragraph 3.
- D. Point D in Paragraph 4.

PASSAGE VI

Cher Ami, Pigeon Hero

In many urban areas, pigeons are considered little
 more than, "rats with wings," blamed for spreading
 disease and despoiling statues. For example,
 one species, the homing pigeon, is among
 the best navigators of the natural world.

46. Which choice makes the sentence most grammatically acceptable?

- F. **No Change**
- G. than—
- H. than;
- J. than

47. Which transition word or phrase is most logical in context?
- A. **No Change**
 - B. Similarly,
 - C. However,
 - D. Thus,

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There navigational ability has earned the homely
⁴⁸
 pigeon an undeniable place in history.

The most famous avian war hero is perhaps Cher Ami, whose name means *dear friend*. One of six hundred birds used by the US Army Signal Corps in France during World War I, all twelve of Cher Ami's missions were
⁴⁹
deemed successful. His last was instrumental in saving
⁴⁹
 hundreds of lives.

Near Verdun, France, the 77th Infantry Division became separated from US forces. The men were surrounded by German troops and were rapidly running out of rations. They were separated from other US forces.
⁵⁰
 They had but one link to headquarters: homing pigeons. Major Whittlesey wrote a note about the 77th's location, placed it in a canister attached to the pigeon's leg, and watched as the bird flew out in the midst of battle. Despite being wounded in flight, Cher Ami managed to deliver the message to headquarters; the unit known as "the Lost Battalion" would be rescued.

48. Which choice makes the sentence most grammatically acceptable?

- F. No Change
- G. They're
- H. It's
- J. Its

49. Which choice makes the sentence most grammatically acceptable?

- A. No Change
- B. the twelve missions Cher Ami flew were successful.
- C. successful missions by Cher Ami numbered twelve.
- D. Cher Ami flew twelve successful missions.

50. Which choice is least redundant in context?

- F. No Change
- G. German troops were all around them.
- H. They would soon be out of rations.
- J. Delete the underlined portion.

END OF TEST 1

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

2



2

MATHEMATICS TEST

50 Minutes—45 Questions

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

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

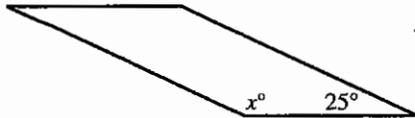
You are permitted to use a calculator on this test. You may use your calculator for any problems you choose,

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

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

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

1. The parallelogram shown has consecutive angles with measures x° and 25° . What is the value of x ?



- A. 100
B. 115
C. 130
D. 155
2. A retail sales associate's daily commission during 1 week was \$30 on Monday and Tuesday and \$70 on Wednesday, Thursday, and Friday. What was the associate's average daily commission for these 5 days?
- F. \$50
G. \$51
H. \$54
J. \$55
3. What is the greatest common factor of 45, 50, and 84?
- A. 0
B. 1
C. 2
D. 3
4. For what value of x is the equation $2(x - 12) + x = 36$ true?
- F. 4
G. 8
H. 16
J. 20

DO YOUR FIGURING HERE.

GO ON TO THE NEXT PAGE.



DO YOUR FIGURING HERE.

5. A bag contains exactly 22 solid-colored buttons: 4 red, 6 blue, and 12 white. What is the probability of randomly selecting 1 button that is **not** white?

- A. $\frac{5}{11}$
 B. $\frac{5}{6}$
 C. $\frac{1}{22}$
 D. $\frac{1}{10}$

6. On a map, $\frac{1}{2}$ inch represents 12 miles. Two towns that are 5 inches apart on this map are how many miles apart?

- F. 120
 G. 60
 H. 30
 J. 24

7. An on-demand movie service charges \$5 per month, plus \$2 for each movie rented. Which of the following equations models the relationship between M , the number of movies rented per month, and T , the total monthly charge, in dollars, for the service?

- A. $M = 5 + 2T$
 B. $M = 2 + 5T$
 C. $T = 5 + 2M$
 D. $T = 2 + 5M$

8. What are the solutions to the quadratic equation $(2x + 5)(3x - 4) = 0$?

- F. -5 and 4
 G. $-\frac{5}{2}$ and $-\frac{4}{3}$
 H. $-\frac{5}{2}$ and $\frac{4}{3}$
 J. $\frac{5}{2}$ and $-\frac{4}{3}$

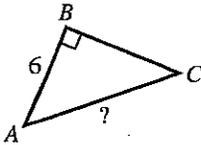
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2**2**

9. In a class of tenth graders, no student participated in more than 1 of the following extracurricular activities: $\frac{2}{3}$ of the class played in the band; $\frac{1}{6}$ sang in the chorus; $\frac{1}{10}$ played football; and $\frac{1}{60}$ played basketball. What fraction of the class did **not** participate in any 1 of these 4 activities?

DO YOUR FIGURING HERE.

- A. 0
 B. $\frac{1}{20}$
 C. $\frac{74}{79}$
 D. $\frac{57}{60}$
10. In $\triangle ABC$ shown, $\sin C = \frac{2}{3}$, and the length of \overline{AB} is 6 inches. What is the length, in inches, of \overline{AC} ?



- F. $\sqrt{5}$
 G. $\sqrt{13}$
 H. 4
 J. 9
11. The table shows the first 5 terms of an arithmetic sequence. Which of the following is a general expression for the n th term?

Term position (n)	n th term
1	1
2	5
3	9
4	13
5	17

- A. $2n - 1$
 B. $3n - 2$
 C. $4n - 3$
 D. $5n - 4$

GO ON TO THE NEXT PAGE.



DO YOUR FIGURING HERE.

12. So far this basketball season, Sherita has made 46 of her first 60 free throws, which gives her a free throw average of about 76.7%. What is the minimum number of free throws she would need to make from now on in order to have a free throw average of at least 80%?
- F. 2
G. 3
H. 10
J. 14
13. Two functions are defined as $f(x) = 2x - 1$ and $g(x) = x^2 + 1$. Which of the following expressions represents $f(g(x))$?
- A. $x^2 + 2x$
B. $2x^2 + 1$
C. $2x^2 + 2$
D. $4x^2 - 4x + 2$
14. Dataset A consists of the 8 numbers listed. Dataset B consists of the 8 numbers in A and a 9th number that is greater than 90. How will the mean and the median of B compare to the mean and the median of A ?
- 62, 76, 76, 80, 82, 87, 94, 96
- F. The mean and the median of B will each be greater than the mean and the median of A , respectively.
G. The mean and the median of B will each be less than the mean and the median of A , respectively.
H. The mean of B will be the same as the mean of A , and the median of B will be greater than the median of A .
J. The mean of B will be greater than the mean of A , and the median of B will be the same as the median of A .
15. A truck traveling at 35 mph has a leaky radiator that is losing 4 fluid ounces per minute. If the radiator held 480 fluid ounces when it began to leak, how many miles will the truck travel before the radiator is empty?
- A. 17.5
B. 35.0
C. 70.0
D. 120.0
16. In the standard (x,y) coordinate plane, what is the midpoint of the line segment that has endpoints $(-5,8)$ and $(3,-1)$?
- F. $(-2,-9)$
G. $(-1, \frac{7}{2})$
H. $(4, -\frac{9}{2})$
J. $(8,-9)$

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2



2

17. The ordered pairs (x,y) in one of the following tables belong to a linear function. Which one?

DO YOUR FIGURING HERE.

A.

x	y
0	2
1	1
2	1
3	0

C.

x	y
0	0
1	1
2	0
3	1

B.

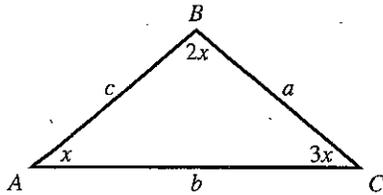
x	y
0	3
1	2
2	1
3	0

D.

x	y
0	0
1	1
2	4
3	9

18. In $\triangle ABC$ shown, $m\angle A = x^\circ$, $m\angle B = (2x)^\circ$, $m\angle C = (3x)^\circ$, $AB = c$ inches, $AC = b$ inches, and $BC = a$ inches. Which of the following inequalities correctly relates the side lengths of $\triangle ABC$?

(Note: $m\angle A$ denotes the measure of $\angle A$, and AB denotes the length of \overline{AB} . The triangle is NOT drawn to scale.)



- F. $a < b < c$
 G. $a < c < b$
 H. $b < a < c$
 J. $c < b < a$
19. What is the slope of the line that passes through $(1,5)$ and $(17,7)$ in the standard (x,y) coordinate plane?

- A. $\frac{1}{8}$
 B. $\frac{2}{3}$
 C. $\frac{3}{2}$
 D. 8

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DO YOUR FIGURING HERE.

20. The perimeter of a particular rectangle is 36 centimeters. The longer sides of the rectangle are each 2 centimeters longer than each of the shorter sides of the rectangle. What is the length, in centimeters, of one of the longer sides of this rectangle?

F. 8
G. 9
H. 10
J. 18

21. One side of square $ABCD$ has a length of 18 meters. A rectangle whose area is equal to the area of $ABCD$ has a width of 6 meters. What is the length, in meters, of that rectangle?

A. 18
B. 24
C. 27
D. 54

22. The 2×2 matrices A and B are related to matrix C by the equation $C = 2A - 3B$. What is matrix C ?

$$A = \begin{bmatrix} 3 & 5 \\ -2 & 1 \end{bmatrix} \quad B = \begin{bmatrix} -4 & 5 \\ 2 & 1 \end{bmatrix}$$

F. $\begin{bmatrix} 18 & -5 \\ -10 & -1 \end{bmatrix}$
G. $\begin{bmatrix} 10 & 5 \\ -6 & 1 \end{bmatrix}$
H. $\begin{bmatrix} 6 & -1 \\ -5 & -1 \end{bmatrix}$
J. $\begin{bmatrix} -6 & 25 \\ 2 & 5 \end{bmatrix}$

23. In the United States, phone numbers begin with a 3-digit area code. Now, there are restrictions on some of the digits, but in the future, as more and more area codes are needed, the restrictions may need to be lifted. If, and when, there are no restrictions and each of the 3 digits can be any integer from 0 through 9, how many area codes will be possible?

A. 30
B. 720
C. 729
D. 1,000

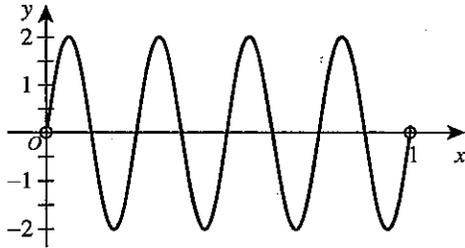
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24. The function $y = 2 \sin(8\pi x)$ is graphed in the standard (x, y) coordinate plane. How many x -intercepts does the graph of this function have on the interval $0 < x < 1$?



- F. 4
G. 7
H. 8
J. 9

DO YOUR FIGURING HERE.

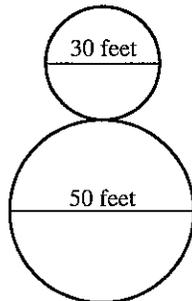
25. If both x and $(\frac{x}{3} + \frac{x}{7} + \frac{x}{9})$ are positive integers, what is the least possible value of x ?

- A. 21
B. 27
C. 36
D. 63

26. Which of the following expressions is equal to $(a + \sqrt{b})(a - 2\sqrt{b})$ for all positive real numbers a and b ?

- F. $a^2 - 3a\sqrt{b}$
G. $a^2 - a\sqrt{b} - 2b$
H. $a^2 - a\sqrt{b} - 2\sqrt{2b}$
J. $a^2 - 3a\sqrt{b} - 2b$

27. The track for a model railroad display is set up as 2 circles that are tangent to one another and have diameters of 30 feet and 50 feet, as shown. The engine of the train travels at a constant rate of 75 feet per minute. To the nearest minute, how many minutes does the engine take to go in a figure-8 pattern around the entire track exactly 1 time?



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

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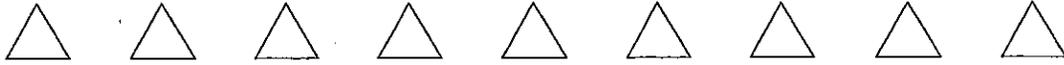


28. $\left(\frac{4}{5}\right)^{-\frac{3}{2}} = ?$

DO YOUR FIGURING HERE.

- F. $\frac{5}{2}$
- G. $\frac{5\sqrt{5}}{8}$
- H. $\frac{4\sqrt{2}}{5}$
- J. $\frac{\sqrt{5}}{2}$
29. What is the value of the positive real number x such that $\log_x\left(\frac{1}{25}\right) = -2$?
- A. 5
- B. 50
- C. $\frac{1}{50}$
- D. $\frac{1}{5}$
30. The points $(-4, -5)$, $(0, -3)$, and $(6, 0)$ lie on a line in the standard (x, y) coordinate plane. Which of the following points also lies on that line?
- F. $(-3, -4)$
- G. $(-1, -4)$
- H. $(1, -2)$
- J. $(4, -1)$
31. The CFO of Math King Enterprises estimates that if the company sells its new product for x cents per unit, the weekly profit will be modeled by $p(x) = 1,600x - 4x^2$, where $0 \leq x \leq 400$. According to this model, for which of the following values of x will the weekly profit for this product be the greatest?
- A. 40
- B. 100
- C. 200
- D. 400
32. Given consecutive positive integers a , b , c , and d such that $a < b < c < d$, which of the following expressions has the greatest value?
- F. $\frac{b}{c}$
- G. $\frac{c}{d}$
- H. $\frac{a+b}{b+c}$
- J. $\frac{b+c}{c+d}$

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2**2**

33. The ratio of the perimeters of two squares is 2:3. If the area of the larger square is 324 square feet, what is the length, in feet, of the side of the smaller square?

A. 12
 B. 18
 C. 24
 D. 36

DO YOUR FIGURING HERE.

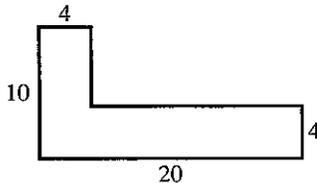
34. What is the set of all integer solutions for the inequality $-1 \leq x - \sqrt{5} < 4$?

F. {3, 4, 5}
 G. {2, 3, 4, 5, 6}
 H. {2, 3, 4, 5}
 J. {1, 2, 3, 4, 5, 6}

35. Wind blowing against a flat surface exerts a maximum force equal to kSv^2 , where S is the area of the surface, v is the wind's velocity, and k is a constant. If a 40-mile-per-hour (mph) wind can exert a maximum force of 50 pounds on a 1-square-foot flat surface, what is the maximum force, in pounds, that an 80 mph wind can exert on a 2-square-foot flat surface?

A. 100
 B. 200
 C. 400
 D. 1,600

36. Roger is pouring concrete to make a sidewalk with the dimensions, in feet, shown in the figure. He pours the concrete to a depth of 4 inches. One bag of concrete mix makes 0.6 cubic feet of concrete. What is the least whole number of bags of concrete mix that Roger needs in order to make the sidewalk?



F. 44
 G. 50
 H. 58
 J. 67

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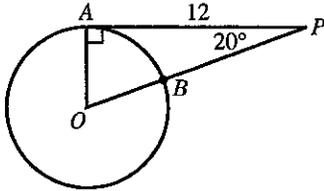
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37. Radius \overline{OA} of the circle shown is perpendicular to \overline{AP} . The circle intersects \overline{OP} at B . The length of \overline{AP} is 12 centimeters, and the measure of $\angle APO$ is 20° . Which of the following values is closest to the length, in centimeters, of \overline{BP} ?

DO YOUR FIGURING HERE.



(Note: $\sin 20^\circ \approx 0.342$, $\cos 20^\circ \approx 0.940$, and $\tan 20^\circ \approx 0.364$)

- A. 4.4
 B. 6.9
 C. 7.6
 D. 8.4
38. The average of 10 test scores is x . When the highest score and lowest score are removed from the 10 scores, the average is y . Which of the following is an expression for the average of the highest score and lowest score?
- F. $10x - 8y$
 G. $\frac{x+y}{2}$
 H. $\frac{10x+8y}{2}$
 J. $\frac{10x-8y}{2}$
39. Which of the following is the solution set of $27^n = 9^{5n-4}$?
- A. $\left\{-4, \frac{2}{3}\right\}$
 B. $\left\{-1, \frac{8}{3}\right\}$
 C. $\left\{-\frac{2}{3}, 4\right\}$
 D. $\left\{\frac{4}{3}, 2\right\}$

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2**2**

40. Each face of 2 cubes with faces numbered from 1 through 6 has a $\frac{1}{6}$ chance of landing faceup when the 2 cubes are tossed. What is the probability that the sum of the numbers on the faces landing faceup will be less than 6?

- F. $\frac{13}{36}$
 G. $\frac{5}{12}$
 H. $\frac{5}{18}$
 J. $\frac{5}{36}$

DO YOUR FIGURING HERE.

41. At 2:00 p.m., Louisa leaves Kansas City in her car traveling east on I-70 toward St. Louis at an average speed of 68 mph. At precisely the same time, Antonio leaves St. Louis in his car traveling west on I-70 toward Kansas City at an average speed of 57 mph. The driving distance from St. Louis to Kansas City is 240 miles. At what time, to the nearest minute, will Louisa and Antonio drive past each other on I-70?

- A. 3:46 p.m.
 B. 3:53 p.m.
 C. 3:55 p.m.
 D. 4:06 p.m.

42. There are 10 points in a plane, and no 3 of the points are collinear. These 10 points, taken 2 points at a time, determine how many distinct lines?

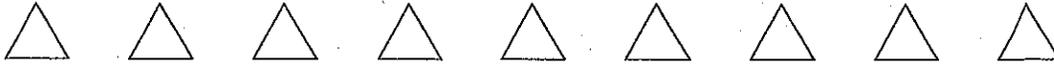
- F. 10
 G. 20
 H. 45
 J. 90

43. The expression $n!$ (read as “ n factorial”) is defined as the product of all positive integers up to and including n whenever n is a positive integer. For example, $4! = 1 \cdot 2 \cdot 3 \cdot 4$. Whenever n is a positive integer, which of the following is equivalent to $\frac{(n+1)!6!}{n!3!}$?

- A. $120(n+1)$
 B. 120
 C. $\frac{2(n+1)}{n}$
 D. $\frac{(6n+6)!}{(3n)!}$

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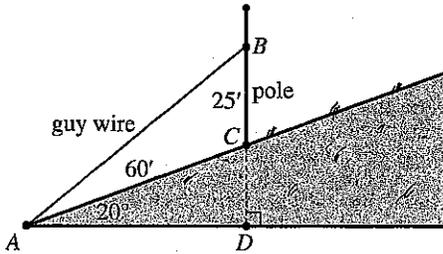
44. When $(x + 1)^4$ is expanded and like terms are combined, what is the coefficient of x^2 ?

- F. 0
- G. 1
- H. 4
- J. 6

DO YOUR FIGURING HERE.

45. A hill makes an angle of 20° with the horizontal, \overrightarrow{AD} , as shown in the figure. A taut guy wire, \overline{AB} , extends from the base of the hill, point A , to point B on a vertical pole. Point B is 25 ft directly above where the pole is inserted into the ground at point C . Given that the length of \overline{AC} is 60 ft, which of the following expressions represents the length, in feet, of the guy wire?

(Note: For a triangle with sides of lengths a , b , and c that are opposite angles $\angle A$, $\angle B$, and $\angle C$, respectively, $\frac{\sin \angle A}{a} = \frac{\sin \angle B}{b} = \frac{\sin \angle C}{c}$ and $c^2 = a^2 + b^2 - 2ab \cos \angle C$.)



- A. $\frac{25 \sin 60^\circ}{\sin 20^\circ}$
- B. $\frac{25 \sin 70^\circ}{\sin 20^\circ}$
- C. $\sqrt{60^2 + 25^2 - 2(60)(25) \cos 70^\circ}$
- D. $\sqrt{60^2 + 25^2 - 2(60)(25) \cos 110^\circ}$

END OF TEST 2

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

DO NOT RETURN TO THE PREVIOUS TEST.

READING TEST

40 Minutes—36 Questions

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

Passage I

LITERARY NARRATIVE: Passage A is adapted from the essay "Touring Home" by Susan Power (©1996 by Susan Power). Passage B is adapted from the memoir *Beyond the Narrow Gate: The Journey of Four Chinese Women from the Middle Kingdom to Middle America* by Leslie Chang (©1999 by Leslie Chang).

Passage A by Susan Power

My mother tells me stories every day: while she cleans, while she cooks, on our way to the library, standing in the checkout line at the supermarket. I like to share her stories with other people and chatter away 5 when I am able to command adult attention.

"She left the reservation when she was sixteen years old," I tell my audience. Sixteen sounds very old to me, but I always state the number because it seems integral to my recitation. "She had never been on a train 10 before or used a telephone. She left Standing Rock to take a job in Chicago so she could help out the family during the War. She was so petrified of the new surroundings, she stayed in her seat all the way from McLaughlin, South Dakota, to Chicago, Illinois, and 15 didn't move once."

I usually laugh after saying this because I cannot imagine my mother being afraid of anything. She is so tall, a true Dakota woman; she rises against the sun like a skyscraper, and when I draw her picture in my note- 20 book, she takes up the entire page. She talks politics and attends sit-ins and says what's on her mind.

I am her small shadow and witness. I am the timid daughter who can rage only on paper.

We don't have much money, but Mom takes me 25 from one end of the city to the other, on foot, on buses. I will grow up believing that Chicago belongs to me, because it was given to me by my mother.

Some days we haunt the Art Institute, and my mother pauses before a Picasso. "He did this during his 30 blue period," she tells me.

I squint at the blue man holding a blue guitar. "Was he very sad?" I ask.

"Yes, I think he was." My mother takes my hand and looks away from the painting. I can see a story 35 developing behind her eyes, and I tug on her arm to release the words. She will tell me why Picasso was blue, what his thoughts were as he painted this canvas. She relates anecdotes I will never find in books, never see footnoted in a biography of the master artist. I don't 40 even bother to check these references because I like my mother's version best.

Passage B by Leslie Chang

Water belongs to everyone and to no one. For this reason, I have always had a particular affinity for it, which may strike some as mysterious. Westerners ask 45 me where my parents were born, as though the answer will enable them to glean some knowledge. The answer is Beijing and Luoyang. The truth is that this response signifies nothing. The meaningful question would be to ask where my ancestors lived. The answer to that is 50 inland. My father's people came from Wuhan, birthplace of the Chinese republic and the capital of Hubei, that sweltering province sandwiched between Sichuan and Anhui. My mother's father was from Inner Mongolia, land of desert and grassy plains.

55 Yet water calls to me. I remain convinced that I would find peace if I could only have a house by the ocean. I insisted on being married near the sea. This bond, I know, comes from my mother.

She longs for a view more than anything else. 60 Once, staying at a hotel in San Francisco, she insisted on seeing three different rooms before she found one with which she was satisfied. It was on a floor so high it made me dizzy, with a corner window overlooking the bay. Even so, my mother spent most of her time on 65 the bridge linking the elevator bank to our wing. The bridge consisted almost entirely of windows. It offered a view in either direction that was brilliant and blinding. If there had been a chair, she could have sat forever, letting the gold sun and blue sea overwhelm her through 70 the glass.

My mother may have descended from inland people, but they were also nomads. Her father once rode his horse practically the length of China, from Inner Mongolia to Guangzhou, a distance of some 75 twelve hundred miles. My mother could only become a

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nomad herself—forever moving, changing and going, yet always retaining some essential part of her being, recognizable and intact in spite of all the places she has been. In this, she is like water, not dead water but fear-
80 somely alive. When she gazes out on its shimmering expanse, she sees her own reflection. When I gaze out, I see her, my mother, always pulling away, returning and pulling away again. I drink from her, and she slips between my fingertips. She has borne me all this way. I
85 cannot decide whether I want her to stay or go. When she is here, I wish she would leave. When she is gone, I wish she would return. She pulls away again, a force as elemental as the ebbing tide. I remain a child on the shore, eagerly collecting the sea glass and driftwood
90 she has left behind.

1. In Passage A, the narrator directly compares her mother to a:
 - A. Picasso painting.
 - B. shadow and witness.
 - C. story behind someone's eyes.
 - D. skyscraper against the sun.
2. The narrator of Passage A most strongly suggests that the reason she began to believe Chicago belongs to her is that she:
 - F. could eventually take several different routes to travel from one end of the city to the other without getting lost.
 - G. had watched her mother directly influence the politics of the city.
 - H. felt she could move about the city almost unseen, like a small shadow.
 - J. initially explored the city with her mother as her affirming guide, so her connection to the city seemed familial.
3. It can most reasonably be inferred from Passage A that the narrator doesn't bother to verify that her mother's ideas about Picasso and his work are accurate primarily because the narrator:
 - A. doesn't know which references would be best for her to consult.
 - B. is confident that what her mother says about the artist is accurate and feels that checking references would be a waste of time.
 - C. doesn't care whether her mother is accurate given how much the narrator likes what her mother says about the artist.
 - D. wants to hold to her own ideas about the artist, regardless of what her mother says about him.
4. In Passage B, the narrator most strongly suggests that she believes her answer to which of the following questions does not provide significant information about her background?
 - F. How is your mother like your other ancestors?
 - G. Where did your ancestors live?
 - H. Where were your parents born?
 - J. Why does water call to you?
5. As they are used in Passage B, the word *blinding* (line 67) and the word *overwhelm* (line 69) both have a connotation that most strongly suggests a feeling of:
 - A. fright.
 - B. awe.
 - C. regret.
 - D. quietness.
6. The last sentence of Passage B can best be described as a:
 - F. metaphor for the narrator's feelings as her mother goes away from her.
 - G. memory of childhood and of her mother that the narrator holds dear.
 - H. literal explanation of the way the narrator reacts to her mother's actions.
 - J. reference to a set of objects that the narrator as a child often found on the shore.
7. Which of the following actions do the narrators of both passages closely connect with their mothers?
 - A. Traveling and moving
 - B. Exploring Chicago streets
 - C. Speaking openly and boldly
 - D. Staying at hotels in cities
8. The narrator of Passage B would be more likely than the narrator of Passage A to describe her relationship with her mother as being marked by:
 - F. moments of lively conversation and pure joy.
 - G. years of fierce competition and debate.
 - H. displays of physical affection and warmth.
 - J. feelings of distance and tension.
9. In both Passage A and Passage B, the narrator of the passage shares information about her mother's:
 - A. personal history.
 - B. physical appearance.
 - C. academic interests.
 - D. relationship to the narrator's father.

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Passage II

INFORMATIONAL: This passage is adapted from *The Frozen-Water Trade: A True Story* by Gavin Weightman (©2003 by Gavin Weightman).

When the first comprehensive report on the ice industry of the United States was commissioned in 1879 as part of a national census, it was estimated that about eight million tons were harvested annually, though the business was so extensive and production so poorly documented that this was, at best, a well-informed guess. The figures were put together by one Henry Hall, who signed himself “special agent” and gave an account of the great growth of the industry in the preceding ten years. Of the eight million tons of ice harvested, about five million reached the consumer—the rest melted during shipment and storage. By far the biggest market was in New York, and none of its ice was manufactured artificially: it was all cut in winter and stored in hundreds of timber warehouses that lined the lakes and rivers and had a capacity of up to fifty thousand tons each. Between New York and Albany, 150 miles up the Hudson River, there were 135 icehouses, but even this was not enough to supply the metropolis, which relied heavily on imports. In fact, in the year of the great ice census, New York and Philadelphia suffered one of their recurrent ice “famines,” when unseasonably warm weather destroyed the harvest on the Hudson and local lakes, and the price of ice rose from \$4 to \$5 a ton. That year the ice was fifteen to twenty inches thick in Maine, a top-quality crop, and it could be shipped down to New York at an estimated cost of \$1.50 a ton. This produced a frenzy of harvesting on the Kennebec, Penobscot, and Sheepscot Rivers, and two thousand cargoes of ice packed in hay and sawdust were shipped south to New York, Philadelphia, and other more southern cities, where they were sold for a total of around \$1.5 million.

Though the demand for ice rose annually, the New York suppliers did not explore the use of artificial refrigeration. Instead, they began to buy up sections of the Kennebec River shoreline and to erect great wooden warehouses there, transforming the landscape of the river for many miles. It was the same farther inland, where ice companies bought up shoreline along the lakes and put up storehouses to supply the meat industry of Chicago and the brewers of Milwaukee, as well as millions of domestic consumers.

The first real crisis in the natural-ice trade was caused not by competition from artificial manufacture, but by pollution. As the cities grew, they encroached on the rivers and lakes from which the ice was cut, and soon there were health scares. This produced a search for cleaner supplies away from towns, and stimulated the search for a means of manufacturing ice with pure water. The realization that the bacteria that cause diseases such as typhoid were not killed off in frozen water added to the urgency of finding safer forms of refrigeration.

The natural-ice trade began to decline from the early decades of the twentieth century, though in more remote areas of North America where electric power was not available but lake ice was abundant in winter, it survived as late as the 1950s. As ice harvesting died out, the evidence of its former vast scale rapidly disappeared. There was no alternative use for the great icehouses, many of which simply burned down, often set alight by a spark from a steam train—they were surprisingly flammable, as most were made of wood and kept as dry as possible to better preserve the blocks of ice they housed. But the majority were demolished or simply rotted away.

Over a wide area of the northern states, young diving enthusiasts with no knowledge of the former ice trade still emerge from lakes and rivers clutching an impressive variety of odd implements—plows and chisels and scrapers that fell through the ice during the harvesting. One or two museums keep small displays of these tools, and collectors have preserved manufacturers’ catalogs that proudly present their versions of the ice plow, the ice saw, the grapple, the Jack grapple, the breaking-off bar, the caulk bar, the packing chisel, the house bar, the fork bar, the float hook, the line marker, and many other specialist implements the use of which has long been forgotten.

The inner-city icehouses have also gone, and the ice wagon and the iceman are rapidly fading memories. All that is left in America of this once-great industry is the water itself, which provided a continuously renewable supply of ice each winter. There are few memorials on the banks of the rivers and lakes that once produced such a vital crop.

10. Which of the following events referred to in the passage occurred last chronologically?
- F. The first comprehensive report on the ice industry of the United States was commissioned.
 - G. Divers emerged from lakes and rivers clutching ice industry implements.
 - H. Two thousand cargoes of ice were sold for around \$1.5 million.
 - J. The price of ice rose from \$4 to \$5 a ton.
11. The passage states that, in terms of the natural-ice industry, the decade from 1869 to 1879 was characterized by:
- A. significant growth.
 - B. damaging publicity.
 - C. high shipping prices.
 - D. mildly declining demand.

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12. As it is used in lines 19–20, the phrase *the metropolis* most likely refers to:
- F. Albany.
 - G. New York City.
 - H. Philadelphia.
 - J. the average US city of the 1870s.
13. Based on the passage, the 1879 Maine ice that was fifteen to twenty inches thick can best be described as:
- A. a top-quality crop that was shipped to New York City, Philadelphia, and destinations farther south.
 - B. sufficient for local demand but not a solution to the problem of the ice “famine” in the South.
 - C. typical of Maine crops of ice until the ice “famine” struck.
 - D. remarkable but surpassed in size and quality by crops the following year.
14. The main idea of the fourth paragraph (lines 55–67) is that:
- F. the natural-ice industry declined over several decades, leaving few traces of its magnitude.
 - G. the arrival of the steam train signaled the demise of ice harvesting.
 - H. icehouses were extremely flammable and therefore few remain.
 - J. in the 1950s, the natural-ice industry experienced a short-lived revival.
15. The author most clearly indicates that the contents of the manufacturers’ catalogs referred to in the fifth paragraph (lines 68–80) typify the natural-ice industry’s:
- A. rapid response to market changes.
 - B. ability to erect icehouses quickly.
 - C. wide array of tools.
 - D. simple work.
16. On which of the following points does the author contradict himself elsewhere in the passage?
- F. “Of the eight million tons of ice harvested, about five million reached the consumer” (lines 10–11).
 - G. “The New York suppliers did not explore the use of artificial refrigeration” (lines 34–36).
 - H. “There was no alternative use for the great icehouses” (lines 61–62).
 - J. “All that is left in America of this once-great industry is the water itself” (lines 83–84).
17. According to the passage, in the time period referred to in the first paragraph, how much of New York City’s ice was made artificially?
- A. The vast majority
 - B. About half
 - C. About ten percent
 - D. None
18. The passage indicates that the first real crisis in the natural-ice industry can be attributed to:
- F. polluted water.
 - G. weather pattern changes.
 - H. the advent of refrigeration.
 - J. the Great Depression.

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Passage III

INFORMATIONAL: This passage is adapted from the article “Read My Lips” by Chiara Barzini (©2012 by the Harper’s Magazine Foundation).

In the passage, *dubbing* primarily refers to providing a film with a new soundtrack, especially dialogue in a different language.

Filmmakers have debated the respective merits of subtitles and dubbing since the earliest sound films. In “The Impossible Life of Clark Costa,” published in 1940 in the film journal *Cinema*, director Michelangelo Antonioni wrote that Romolo Costa, the person who dubbed all of actor Clark Gable’s performances, was a “hybrid individual born out of a chemical combination.” This “half Clark, half Costa” was unbearable to Antonioni, who considered dubbing to be a mere “acoustic surrogate” of acting. To him, dubbing compromised the intention of the director, leading to an artificial product that lacked artistic unity. Director Pier Paolo Pasolini, who called both dubbing and subtitles “evils,” said that, between the two, dubbing was the less harmful, since it allowed you to see the picture in full. Director Jean Renoir called dubbing a “monstrosity, a challenge to human and divine laws.”

Director Federico Fellini didn’t agree with any of them. Dubbing was an extension of his shoots, a technique he would use to retouch and rewrite. He mercilessly dubbed over his actors, changing dialogue in postproduction, sometimes having worked without a script. (He reportedly instructed his actors to count aloud in front of the camera so that he could insert new dialogue afterward.) Renato Cortesi, a veteran Fellini dubber, told me that, during the filming of *Amarcord* (1973), he witnessed Fellini ask an old Neapolitan lady to tell him a sad story. Over footage of this woman recounting a tragic tale about her grandson, Fellini added a new sound track about war and hunger recorded by an actor from Emilia-Romagna, combining the vivid expressiveness of the South with his favorite northern accent.

If you visit a dubbing studio, the over-the-top zest of the actors is evident in everything from their melodramatic speech to their movements; standing in front of the microphone, they coil and twitch. I asked Cortesi whether this was a consequence of having to focus one’s lifelong talent into the few centimeters between mouth and microphone, a kind of bodily rebellion to the condition of being heard but not seen, and he laughed. “Of course it isn’t easy to spend a life in the darkness, but this is hardly the reason why they twitch and turn! Dubbers are used to reciting while trying to re-create the bodily sensations of what they see on the screen before them. If there is running in the film, they will run on their feet. The moving,” he explained, “is the result of re-creating large movements in small spaces.”

There are still few options for those seeking to watch subtitled, original-language films at a movie house in Italy. The Metropolitan cinema on Via del Corso closed recently after a long battle involving intel-

lectuals, show-business people, and American and British expats in Rome, to be replaced with a clothing store. Italians remain hooked on dubbing—perhaps because of simple affection. Familiar voices yield emotional attachment.

Francesco Vairano, a dubber and dubbing director known for adapting foreign films considered to be “undubbable,” such as the French box office hit *Bienvenue chez les Ch’tis* (“Welcome to the Sticks,” 2008), which relies on linguistic misunderstandings for much of its comedy, explained that actors become just as attached to their parts as audiences do. Vairano has been one of the few directors to break the habit of matching the same Italian dubber to a foreign actor for all his films, preferring instead to select the dubber according to the requirements of the role, and, he admits, he was hated by all the prima donna dubbers for this. “If you take that actor away from them,” he told me, “they will insult you.”

In 2007, I met dubber Luca Ward, who provided the voice of the narrator for a romantic comedy I co-wrote, *Scusa ma Ti Chiamo Amore* (“Sorry but I Love You”). What I didn’t then know was that everyone Ward met wanted him to recite actor Samuel L. Jackson’s Ezekiel 25:17 passage from the film *Pulp Fiction*, and that I should consider it an honor that he would offer a performance to a stranger. When he finally did recite the monologue, it was astonishing, every dramatic pause carefully timed and every word perfectly enunciated. I understood that, if anybody took Samuel L. Jackson away from Ward, it would have meant taking away a part of his soul; he was, as Antonioni would say, half Ward, half Jackson. Leaving the day’s recording session, Ward told me he was off to have dinner with actress Meg Ryan, before raising an eyebrow and clarifying, “With Meg Ryan’s dubber . . . I am having dinner with Meg Ryan’s voice.”

19. The last sentence of the passage primarily serves to illustrate the passage author’s central claim that:
- A. dubbers want others in the film industry to respect the actors they usually dub.
 - B. the work of Ryan’s dubber is as effective as that of Jackson’s dubber.
 - C. dubbers begin to seem almost like hybrids of themselves and the actors they dub.
 - D. Ward is unlike most dubbers in that he prefers to dub many different actors.
20. It can reasonably be inferred from the passage that regarding whether dubbing is useful or valuable, Vairano would most strongly sympathize with the views of:
- F. Antonioni.
 - G. Fellini.
 - H. Pasolini.
 - J. Renoir.

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21. The main function of the second paragraph (lines 18–33) is for the passage author to present:
- her own ideas as an example of a contemporary perspective on the merits of dubbing.
 - a perspective on dubbing that bluntly counters those outlined in the first paragraph.
 - Fellini's personal, direct response to Renoir's criticism of his work.
 - a claim, centered on Fellini's work, that strengthens the argument she makes in the first paragraph.
22. The anecdote about Fellini's footage of a woman recounting a tragic tale (lines 25–33) primarily serves to:
- explain why Fellini preferred to feature voices with northern accents in his films.
 - provide a famous example of Fellini closely following scripted dialogue.
 - illustrate the extent to which dubbing was a part of Fellini's craft.
 - show why Fellini preferred his actors to follow a script rather than tell their own stories.
23. As Cortesi is presented in the passage, does he agree with the passage author's assumptions about the reason for dubbers' "over-the-top zest" (line 34)?
- Yes, and he thinks she should visit his dubbing studio to see how he works.
 - Yes, and he suggests that the reason is a dubber's condition of being heard but not seen.
 - No, and he gruffly makes clear his belief that she does not at all understand a dubber's work.
 - No, and he corrects her misinterpretation with an explanation of his own.
24. It can most reasonably be inferred from the passage that the Metropolitan cinema on Via del Corso was known for showing films that had been:
- dubbed only.
 - subtitled only.
 - both dubbed and subtitled.
 - neither dubbed nor subtitled.
25. The passage indicates that a foreign film with which of the following characteristics is particularly difficult to dub?
- Linguistic misunderstanding that creates comedy
 - Dramatic action that advances the plot
 - Reverse chronology that provides context
 - Extensive monologues that further characterization
26. According to the passage, the work of dubbing director Vairano differs from that of most other Italian directors in that Vairano:
- focuses on dubbing French films into Italian.
 - does not match the same Italian dubber to the same foreign actor for all his films.
 - works mostly with "prima donna" dubbers.
 - does not believe that dialogue should be rewritten during a dubbing session.
27. As it is used in line 17, the phrase *a challenge to* most nearly means:
- an assault on.
 - a declaration of.
 - a question for.
 - an offer to.

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Passage IV

INFORMATIONAL: This passage is adapted from the essay "Making Stuff: From Bacon to Bakelite" by Philip Ball (©2010 by Philip Ball).

During the Industrial Revolution, the high price of steel meant that many large engineering projects were carried out that used instead cast iron, which is brittle and prone to failure. This was why Henry Bessemer's new process for making steel was greeted with jubilation: the details, announced at a meeting of the British Association in 1856, were published in full in *The Times*. Bessemer himself was lauded not just as an engineer but as a scientist, being elected a Fellow of the Royal Society in 1879.

Bessemer's process controlled the amount of carbon mixed with iron to make steel. That the proportion of carbon governs the hardness was first noted in 1774 by the Swedish metallurgist Torbern Bergmann. Bergmann made an extensive study of the propensity of different chemical elements to combine with one another—a property known as elective affinity, central to the eighteenth-century notion of chemical reactivity.

Oxygen, as a component of air, was the key to the Bessemer process. It offered a way of removing impurities from pig iron and adjusting its carbon content during conversion to steel. A blast of air through the molten metal turned impurities such as silicon into light silica slag (a collection of compounds removed from metal in the smelting process), and removed carbon in the form of volatile carbon dioxide. Pig iron contains as much as 4 per cent carbon; steels have only around 0.3–2 per cent.

It was long known that steel can be improved with a spice of other elements. A dash of the metal manganese helps to remove oxygen and sulphur from the iron. Manganese also makes steel stronger, while nickel and chromium improve its hardness. And chromium is the key additive in stainless steel—in a proportion of more than about 11 per cent, it makes the metal rust-resistant. Most modern steels are therefore alloys blended to give the desired properties.

But is this science? Some of the early innovations in steel alloys were chance discoveries, often due to impurities incorporated by accident. In this respect, metallurgy has long retained the air of an artisan craft, akin to the trial-and-error explorations of dyers, glass-makers and potters. But the reason for this empiricism is not that the science of metallurgy is trivial; it is because it is so difficult. According to Rodney Cotterill, a remarkable British physicist whose expertise stretched from the sciences of materials to that of the brain, "metallurgy is one of our most ancient arts, but is often referred to as one of the youngest sciences."

One of the principal difficulties in understanding the behaviour of materials such as steel is that this depends on its structure over a wide range of length

scales, from the packing of individual atoms to the size and shape of grains micrometres or even millimetres in size. Science has trouble dealing with such a span of scales. One might regard this difficulty as akin to that in the social sciences, where social behaviour is governed by how individuals behave but also how we interact on the scale of families and neighbourhoods, within entire cities, and at a national level.

The mechanical properties of metals depend on how flaws in the crystal structure, called defects, move and interact. These defects are produced by almost inevitable imperfections in the regular stacking of atoms in the crystalline material. The most common type of stacking fault is called a dislocation. Metals bend, rather than shattering like porcelain, because dislocations can shift around and accommodate the deformation. But if dislocations accumulate and get entangled, restricting their ability to move, the metal becomes brittle. Dislocations can also get trapped at the boundaries between the fine, microscopic grains that divide a metal into mosaics of crystallites. The arrest of dislocations at grain edges means that metals may be made harder by reducing the size of their grains, a useful trick for modifying their mechanical behaviour.

28. The main purpose of the passage is to:
- F. explain in detail the various experiments Bessemer conducted in order to develop a better steel.
 - G. provide an overview of some of the scientific principles that apply to the creation and behavior of steel.
 - H. describe some of the philosophical questions concerning metallurgy.
 - J. illustrate the differences between pig iron and cast iron.
29. The author most likely includes details about the initial response to Bessemer's new steel-making process in order to:
- A. emphasize that Bessemer's new process was a significant achievement for industry.
 - B. provide support for the author's opinion that Bessemer's new process was prone to failure.
 - C. describe Bessemer's qualifications as an engineer.
 - D. provide specific examples of the criticism that Bessemer's new process received.
30. According to the passage, which of the following conversions is a direct result of adding oxygen to molten pig iron?
- F. Light silica slag is converted into carbon dioxide.
 - G. Carbon dioxide is converted into carbon.
 - H. Silicon is converted into light silica slag.
 - J. Impurities in the metal are converted into silicon.

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31. In the context of the passage, the main effect of the word "spice" (line 30) is to emphasize that:
- A. elements must be gradually mixed into steel in order to produce the desired effect.
 - B. adding certain elements to steel can enrich the steel's quality.
 - C. manganese, chromium, and nickel are used sparingly in steel because of their expense.
 - D. blending elements is a trial-and-error process that has not yet yielded positive results.
32. Based on the passage, with which of the following statements would the author most likely agree?
- F. Metallurgy is not an art because it requires too much scientific knowledge.
 - G. Metallurgy is too difficult to be considered a science.
 - H. Metallurgy is a science as well as an art.
 - J. Metallurgy is a trivial science.
33. The passage most strongly suggests that the study of the behavior of materials and the study of the social sciences are similar because they:
- A. require analyses that span a wide range of scales.
 - B. are based on trial-and-error experimentation.
 - C. involve examination of the size and shape of individual atoms.
 - D. produce results that must be interpreted by both scientists and artists.
34. The main idea of the last paragraph is that:
- F. defects in the crystal structure of a metal determine that metal's mechanical properties.
 - G. dislocations are the most common type of stacking fault in a metal.
 - H. the mechanical behavior of a metal can be modified by increasing the size of a metal's grains.
 - J. microscopic grains divide a metal into mosaics of crystallites.
35. As it is used in line 47, the word *stretched* most nearly means:
- A. strained.
 - B. exaggerated.
 - C. extended.
 - D. amplified.
36. According to the passage, reducing the size of a metal's grains can make the metal:
- F. more rust-resistant.
 - G. more brittle.
 - H. finer.
 - J. harder.

END OF TEST 3

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

DO NOT RETURN TO A PREVIOUS TEST.

4



4

SCIENCE TEST

40 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 termite *Reticulitermes flavipes* consumes wood and bark. A study examined whether the consumption of wood or bark mulch by *R. flavipes* varies with the type of mulch or the age of the mulch. Separate portions of each of 5 types of mulch were aged (allowed to decay) for 1, 24, and 48 weeks. Then, 2 g of each type of 1-week-old mulch were put into a box, 2 g of each type of 24-week-old mulch were put into a second box, and 2 g of each type of 48-week-old mulch were put into a third box. Next, 1 g of *R. flavipes* was added to each box. After 15 days, the mass of mulch consumed, in milligrams (mg), was determined for each type and age of mulch (see figure).

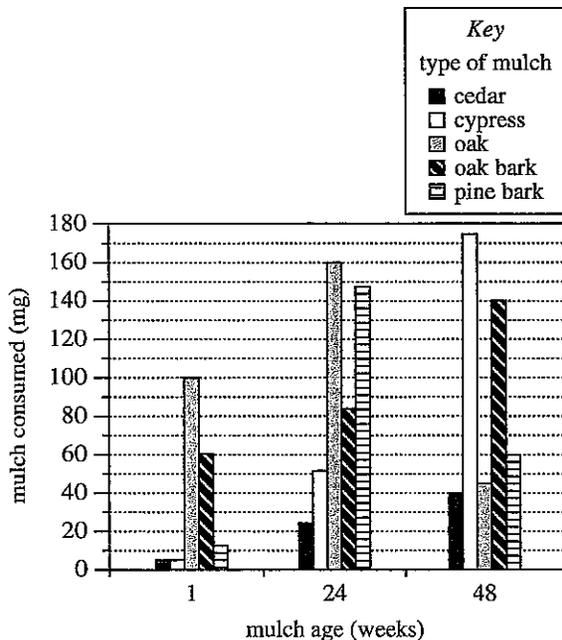
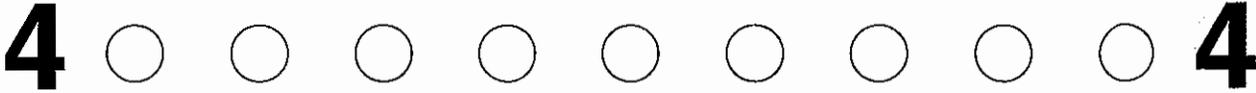


Figure adapted from O. P. Pinzon, R. M. Houseman, and C. J. Starbuck, "Feeding, Weight Change, Survival, and Aggregation of *Reticulitermes flavipes* (Kollar) (Isoptera: Rhinotermitidae) in Seven Varieties of Differentially-Aged Mulch." ©2006 by the Horticultural Research Institute.

- Of the following combinations of type of mulch and mulch age, which combination resulted in the greatest mass of mulch consumed by *R. flavipes*?
 - Type of mulch: oak
Mulch age: 24 weeks
 - Type of mulch: pine bark
Mulch age: 24 weeks
 - Type of mulch: oak
Mulch age: 48 weeks
 - Type of mulch: pine bark
Mulch age: 48 weeks
- Which of the following statements about the effect of mulch age on the consumption of mulch by *R. flavipes* is consistent with the figure? As mulch age increased from 1 week through 48 weeks, the mass of mulch consumed by *R. flavipes*:
 - decreased only for all 5 types of mulch.
 - increased only for all 5 types of mulch.
 - initially decreased for all 5 types of mulch and then increased for some of the 5 types of mulch.
 - initially increased for all 5 types of mulch and then decreased for some of the 5 types of mulch.
- Based on the passage, would *R. flavipes* be classified as an autotroph or as a detritivore, and why?
 - Autotroph, because *R. flavipes* produces its own energy without consuming organic material.
 - Autotroph, because *R. flavipes* obtains its energy by consuming decaying organic material.
 - Detritivore, because *R. flavipes* produces its own energy without consuming organic material.
 - Detritivore, because *R. flavipes* obtains its energy by consuming decaying organic material.

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4. Which of the following statements comparing the consumption by *R. flavipes* of 1-week-old oak mulch, 24-week-old oak mulch, and 48-week-old oak mulch is supported by the figure?
- F. More 1-week-old mulch was consumed than 24-week-old mulch, and more 24-week-old mulch was consumed than 48-week-old mulch.
 - G. Less 1-week-old mulch was consumed than 24-week-old mulch, and less 24-week-old mulch was consumed than 48-week-old mulch.
 - H. More 1-week-old mulch was consumed than 24-week-old mulch, and less 24-week-old mulch was consumed than 48-week-old mulch.
 - J. Less 1-week-old mulch was consumed than 24-week-old mulch, and more 24-week-old mulch was consumed than 48-week-old mulch.
5. What mass, in grams (**not** milligrams), of the 48-week-old oak bark mulch was consumed by *R. flavipes*?
- A. 0.06 g
 - B. 0.14 g
 - C. 0.6 g
 - D. 1.4 g

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Passage II

Samples of Species C bacteria must often be transported from the areas in which they are collected. During transport, the samples are typically packed in ice to keep them alive. However, ice is not always available where the samples are collected.

Scientists studied how lyophilization (a freeze-drying process that doesn't require ice) followed by incubation affects the survival of 2 strains (Strain E and Strain V2) of Species C bacteria.

Experiment 1

The scientists placed a 100 μL ($1 \mu\text{L} = 10^{-3} \text{ mL}$) sample of a nutrient medium containing 4×10^6 Strain E elementary bodies into each of 8 sterile test tubes. An elementary body is the infective form of Species C. The sample in each of the tubes was then lyophilized, and each tube was sealed. Two of the tubes were incubated at 4°C , 2 were incubated at 20°C , 2 were incubated at 30°C , and 2 were incubated at 37°C .

One week after the start of incubation, the *percent survival* (the percent of the elementary bodies that survived) was determined for the sample in 1 of the 2 tubes at each temperature. Then, 1 month after the start of incubation, the percent survival was determined for the sample in the remaining tube at each temperature. The results are shown in Table 1.

Strain	Incubation temperature ($^\circ\text{C}$)	Percent (%) survival at:	
		1 week	1 month
E	4	52	51
	20	69	42
	30	5	4
	37	0	0

Experiment 2

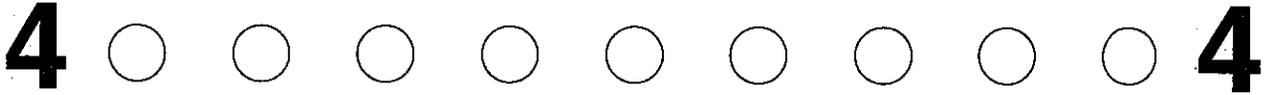
The scientists repeated Experiment 1, except with Strain V2 instead of Strain E. The results are shown in Table 2.

Strain	Incubation temperature ($^\circ\text{C}$)	Percent (%) survival at:	
		1 week	1 month
V2	4	59	6
	20	29	4
	30	2	2
	37	0	0

Tables adapted from the article DOI: 10.1128/JCM.00968-06 by Adrian Eley et al. (©2006 by American Society for Microbiology).

6. Which of the following statements describes a difference between Experiment 1 and Experiment 2?
- F. A different incubation temperature was tested in Experiment 1 than in Experiment 2.
 - G. A different strain of Species C was tested in Experiment 1 than in Experiment 2.
 - H. Samples in Experiment 1 were lyophilized before being transported, whereas samples in Experiment 2 were transported on ice.
 - J. Samples in Experiment 1 were incubated for 1 week before being transported, whereas samples in Experiment 2 were incubated for 1 month before being transported.

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7. Suppose that in Experiment 2 the scientists had determined the percent survival for a sample incubated at 25°C for 1 week. The percent survival of the Strain V2 elementary bodies in the sample would most likely have been:
- A. 0%.
 - B. between 2% and 29%.
 - C. between 29% and 59%.
 - D. greater than 59%.
8. Which of the following questions was **not** addressed by the experiments?
- F. Does incubation time affect the percent survival of Strain E and Strain V2 elementary bodies after lyophilization?
 - G. Does temperature affect the percent survival of Strain E and Strain V2 elementary bodies after lyophilization?
 - H. Does the number of Strain E or Strain V2 elementary bodies present in a sample before lyophilization affect their percent survival?
 - J. Do Strain E elementary bodies have a greater percent survival than Strain V2 elementary bodies after lyophilization and incubation?
9. One week after the start of incubation, which of the 4 samples of Strain V2 elementary bodies would have been least likely to infect another organism that came into contact with the samples?
- A. The sample that had been incubated at 4°C
 - B. The sample that had been incubated at 10°C
 - C. The sample that had been incubated at 20°C
 - D. The sample that had been incubated at 37°C

10. Suppose that a scientist wants to transport a lyophilized sample of Strain E elementary bodies. Based on the results of Experiment 1, which of the following combinations of temperature and transportation time would most likely ensure the greatest percent survival of the elementary bodies?
- F. 4°C and 1 week
 - G. 4°C and 1 month
 - H. 20°C and 1 week
 - J. 20°C and 1 month

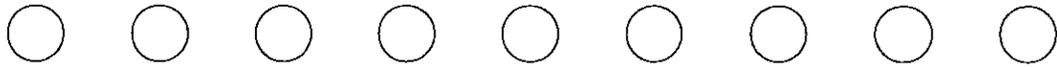
11. Consider the rating system in the table below for the percent survival of elementary bodies after lyophilization.

Rating	Percent survival
Excellent	> 90%
Good	≥ 30% and ≤ 90%
Poor	< 30%

Based on this table, what is the total number of tubes in Experiment 1 that contained samples having a poor percent survival?

- A. 2
- B. 4
- C. 6
- D. 8

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Passage III

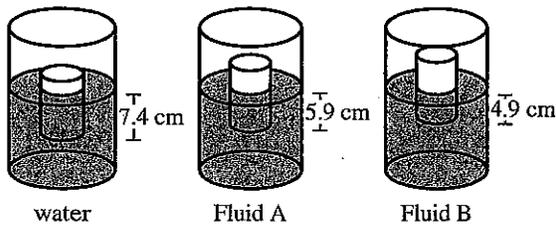
When an object is submerged in a fluid, the object displaces a volume of fluid equal to the object's submerged volume. The fluid exerts an upward buoyant force on the object that is equal in magnitude to the weight of the displaced fluid. The object floats if the buoyant force equals the object's weight.

A group of students conducted 2 studies on buoyant forces using 3 fluids—water, Fluid A, and Fluid B—having densities of 1.0 g/cm^3 , 1.25 g/cm^3 , and 1.50 g/cm^3 , respectively.

Study 1

The students placed a 10 cm long cylinder in a container of water and measured the length of the portion of the cylinder that was submerged. They then repeated this procedure with a container of Fluid A and a container of Fluid B (see Figure 1).

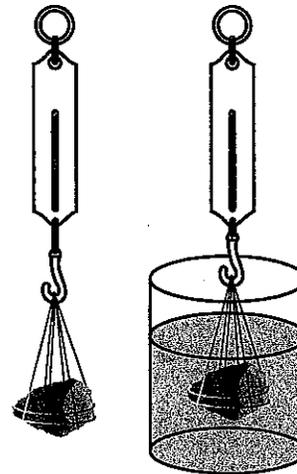
Figure 1



Study 2

The students placed a stone—either Stone X, Stone Y, or Stone Z—in a net that was tied to a spring balance. They recorded the force measured by the balance as the stone's weight, W . They then submerged the stone in water and again recorded the force measured by the balance (see Figure 2).

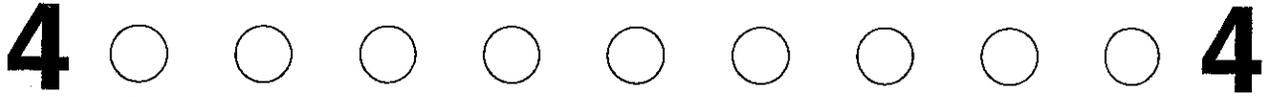
Figure 2



The students calculated the buoyant force on the stone in water as W minus the force that was measured when the stone was submerged. They repeated this procedure to test all 3 stones in all 3 fluids. Table 1 lists each stone's volume, in cm^3 , and W , in newtons (N), as well as the buoyant force, in N, on each stone in the fluid.

Table 1					
Stone	Volume (cm^3)	W (N)	Buoyant force (N) in:		
			water	Fluid A	Fluid B
X	48	1.50	0.47	0.59	0.70
Y	96	1.50	0.94	1.18	1.41
Z	96	3.00	0.94	1.18	1.41

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12. Based on the results of Study 2, as the density of the fluid in which Stone X was submerged increased, the buoyant force on Stone X:
- F. decreased only.
 - G. increased only.
 - H. decreased and then increased.
 - J. varied with no general trend.
13. Based on the results of Study 2, for Stone Y, what was the difference between the buoyant force in Fluid A and the buoyant force in Fluid B?
- A. 0.11 N
 - B. 0.23 N
 - C. 0.47 N
 - D. 0.71 N
14. Suppose the students decide to study whether a cylinder's volume determines the submerged length of the cylinder in a given fluid. Which of the following procedural changes should the students make to Study 1? The students should test:
- F. multiple cylinders with a single fluid; the cylinders should have different weights but the same volume.
 - G. multiple cylinders with a single fluid; the cylinders should have different volumes but the same density.
 - H. a single cylinder with multiple fluids; the fluids should have different densities.
 - J. a single cylinder with multiple fluids; the fluids should each have the same density as the cylinder.
15. In Study 1, did the cylinder displace a greater volume of water or a greater volume of Fluid A?
- A. Water, because the cylinder's submerged length was greater in water than in Fluid A.
 - B. Water, because the cylinder's submerged length was greater in Fluid A than in water.
 - C. Fluid A, because the cylinder's submerged length was greater in water than in Fluid A.
 - D. Fluid A, because the cylinder's submerged length was greater in Fluid A than in water.
16. Suppose that in Study 2 the students had tested a stone having the same weight as Stone Z but a larger volume than Stone Z. Which of the following statements about the buoyant force on this submerged stone would be correct? The buoyant force on this stone in:
- F. water would have been less than 0.94 N.
 - G. Fluid A would have been less than 1.18 N.
 - H. Fluid B would have been greater than 1.41 N.
 - J. water would have been greater than the buoyant force on this stone in Fluid A.
17. Assume that Atlantic Ocean water has a density of 1.01 g/cm^3 and that Pacific Ocean water has a density of 1.03 g/cm^3 . Based on the results of Study 1, in which ocean would a given iceberg more likely have the greater submerged volume?
- A. The Atlantic Ocean, because the results of Study 1 indicate that submerged volume increases as fluid density decreases.
 - B. The Atlantic Ocean, because the results of Study 1 indicate that submerged volume decreases as fluid density decreases.
 - C. The Pacific Ocean, because the results of Study 1 indicate that submerged volume increases as fluid density decreases.
 - D. The Pacific Ocean, because the results of Study 1 indicate that submerged volume decreases as fluid density decreases.

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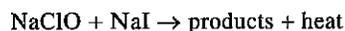


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Passage IV

Chemical reactions that release heat are exothermic reactions. The amount of heat released depends on the number of moles of reactants consumed in the reaction. A mole of any substance is 6×10^{23} molecules or formula units of the substance.

When sodium hypochlorite (NaClO) and sodium iodide (NaI) are dissolved in acidic H_2O , an exothermic reaction occurs:



Students did an experiment to study this reaction.

Experiment

In each of 8 trials, the students performed Steps 1–5:

1. A known volume of a 0.2 mole/L aqueous NaClO solution was poured into a foam coffee cup. A lid was placed on the cup.
2. A thermometer was placed into the solution through a hole in the lid. The solution's initial temperature, T_i , of 22.0°C was recorded.
3. The lid was lifted, and a known volume of a 0.2 mole/L aqueous NaI solution, also at a T_i of 22.0°C , was poured into the cup. The lid was put back on the cup, and the solution was swirled.
4. The solution's final (maximum) temperature, T_f , was measured.
5. The change in temperature, ΔT , was calculated:

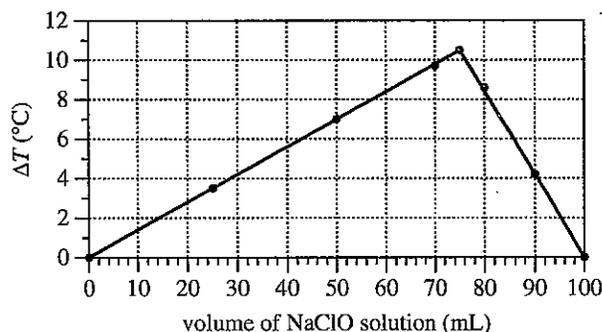
$$\Delta T = T_f - T_i$$

The data for each trial are shown in Table 1.

Trial	Volume of NaClO solution (mL)	Volume of NaI solution (mL)	T_f ($^\circ\text{C}$)	ΔT ($^\circ\text{C}$)
1	0	100	22.0	0.0
2	25	75	25.5	3.5
3	50	50	29.0	7.0
4	70	30	31.7	9.7
5	75	25	32.5	10.5
6	80	20	30.6	8.6
7	90	10	26.2	4.2
8	100	0	22.0	0.0

The students plotted ΔT versus the volume of NaClO solution for each trial (see Figure 1).

Figure 1



Then they identified the trial for which ΔT had its greatest value. The ratio of the volume of the NaClO solution to the volume of the NaI solution for this trial is the mole ratio for the reaction.

Table and figure adapted from M. Jerome Bigelow, "Thermochemistry of Hypochlorite Oxidations." ©1969 by Division of Chemical Education, Inc., American Chemical Society.

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18. Before the experiment, a student predicted that ΔT for Trial 2 would be greater than ΔT for Trial 6. Do the results shown in Table 1 support this prediction?
- F. No; ΔT for Trial 2 was 5.1°C less than ΔT for Trial 6.
G. No; ΔT for Trial 2 was 8.6°C less than ΔT for Trial 6.
H. Yes; ΔT for Trial 2 was 5.1°C greater than ΔT for Trial 6.
J. Yes; ΔT for Trial 2 was 8.6°C greater than ΔT for Trial 6.
19. In each trial, the total volume of solution poured into the cup was:
- A. 25 mL.
B. 50 mL.
C. 75 mL.
D. 100 mL.
20. Consider the trial for which the volume of NaClO was 4 times as great as the volume of NaI. For this trial, T_f was:
- F. 25.5°C .
G. 26.2°C .
H. 30.6°C .
J. 32.5°C .
21. Suppose a trial had been performed with 20 mL of NaClO solution and 80 mL of NaI solution. Based on Figure 1, ΔT for this new trial would most likely have been closest to which of the following?
- A. 1°C
B. 3°C
C. 5°C
D. 7°C
22. Which of the following statements best explains why ΔT was 0.0°C for Trial 8? The volume of solution added was 0 mL for one of the:
- F. products, NaClO, so no reaction had occurred.
G. products, NaI, so no reaction had occurred.
H. reactants, NaClO, so no reaction had occurred.
J. reactants, NaI, so no reaction had occurred.
23. Suppose that the reaction studied had been endothermic. As the endothermic reaction progressed, would the solution temperature more likely have decreased or increased?
- A. Decreased, because the reaction would have released heat.
B. Decreased, because the reaction would have absorbed heat.
C. Increased, because the reaction would have released heat.
D. Increased, because the reaction would have absorbed heat.

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Passage V

Tomato plants grow poorly in high-salt environments. This effect is caused by 2 processes:

- A net movement of H_2O between the cytoplasm of the plants' cells and the environment via osmosis
- An increase in the cytoplasmic Na^+ concentration

The plant *Arabidopsis thaliana* carries a gene, *AtNHX1*. The product of this gene, VAC, facilitates uptake of cytoplasmic Na^+ by the plant's vacuoles.

A researcher created 4 genetically identical lines of tomato plants (L1–L4). An *AtNHX1* gene from *Arabidopsis thaliana* was isolated and 2 identical copies of this gene were incorporated into L1's genome. This process was repeated with L2 and L3 using a different *AtNHX1* allele for each line, so that L1, L2, and L3 had different genotypes for *AtNHX1*. The researcher then did an experiment.

Experiment

Fifty seedlings from each of the 4 lines were grown in 10 L of nutrient solution for 80 days. The 10 L nutrient solution contained H_2O , 12 g of fertilizer, and 3 g of NaCl. The nutrient solution was replaced every 5 days. After 80 days, average height, average mass (without fruit), and average fruit mass (per plant) were measured (see Table 1).

3 g of NaCl/10 L nutrient solution			
Line	Height (cm)	Mass (kg)	Fruit mass (kg)
L1	124	1.2	2.1
L2	128	1.2	2.0
L3	120	1.2	2.1
L4	124	1.2	2.0

This process was repeated except the 10 L nutrient solution contained 60 g of NaCl instead of 3 g of NaCl (see Table 2).

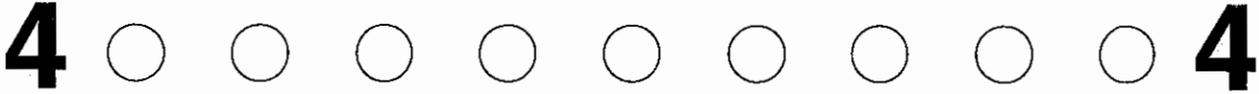
60 g of NaCl/10 L nutrient solution			
Line	Height (cm)	Mass (kg)	Fruit mass (kg)
L1	119	1.1	1.9
L2	121	1.1	1.9
L3	61	0.4	1.1
L4	63	0.5	1.0

The process was repeated again except the 10 L nutrient solution contained 120 g of NaCl instead of 3 g of NaCl (see Table 3).

120 g of NaCl/10 L nutrient solution			
Line	Height (cm)	Mass (kg)	Fruit mass (kg)
L1	118	1.0	1.8
L2	115	1.0	1.7
L3	34	0.2	0
L4	36	0.3	0

Tables 1–3 adapted from Hong-Xia Zhang and Eduardo Blumwald, "Transgenic Salt-Tolerant Tomato Plants Accumulate Salt in Foliage But Not in Fruit." ©2001 by Nature Publishing Group.

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24. One plant produced no fruit and had a height of 21 cm. Which of the following most likely describes this plant?
- F. It was from L2 and was grown in a 10 L nutrient solution containing 60 g of NaCl.
 - G. It was from L2 and was grown in a 10 L nutrient solution containing 120 g of NaCl.
 - H. It was from L4 and was grown in a 10 L nutrient solution containing 60 g of NaCl.
 - J. It was from L4 and was grown in a 10 L nutrient solution containing 120 g of NaCl.
25. During osmosis, water migrates through a semipermeable barrier. The osmosis referred to in the passage occurs through which of the following structures?
- A. Chromosomes
 - B. Nuclear envelope
 - C. Cell membrane
 - D. Rough endoplasmic reticulum
26. For each line, as the concentration of salt in the nutrient solutions increased, average plant mass:
- F. increased only.
 - G. decreased only.
 - H. increased and then decreased.
 - J. decreased and then increased.
27. Which of the following was an independent variable in the experiment?
- A. Whether a line received *AtNHX1*
 - B. Whether a tomato plant was used
 - C. Plant mass without fruit
 - D. Plant height
28. Suppose the data for all of the plants were plotted on a graph with height on the x -axis and mass (without fruit) on the y -axis. Suppose also that the best-fit line for these data was determined. Which of the following would most likely characterize the slope of this line?
- F. The line would not have a slope, because the line would be vertical.
 - G. The slope of the line would be zero.
 - H. The slope of the line would be negative.
 - J. The slope of the line would be positive.
29. The researchers included 1 of the 4 lines to serve as a control. This line was most likely which one?
- A. L1
 - B. L2
 - C. L3
 - D. L4

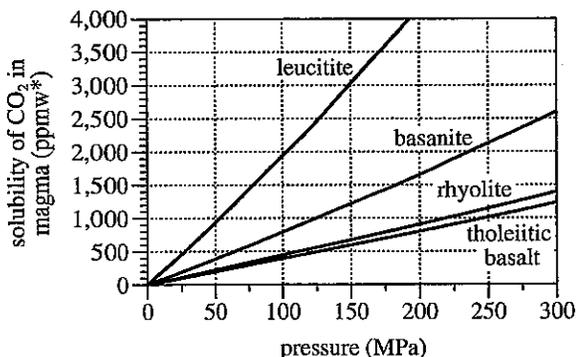
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Passage VI

When rocks are melted at very high temperatures beneath Earth's surface, magma (molten rock) is formed. The gases CO₂ and H₂O can dissolve in magma. Figure 1 shows, for 4 different magmas (leucitite, basanite, rhyolite, and tholeiitic basalt), how the solubility of CO₂ in the magma at 1,150°C varies with pressure (in megapascals, MPa).

Figure 1



*parts per million by weight

Figure 2 shows, at 3 different pressures, how the solubility of CO₂ in rhyolite magma varies with temperature.

Figure 2

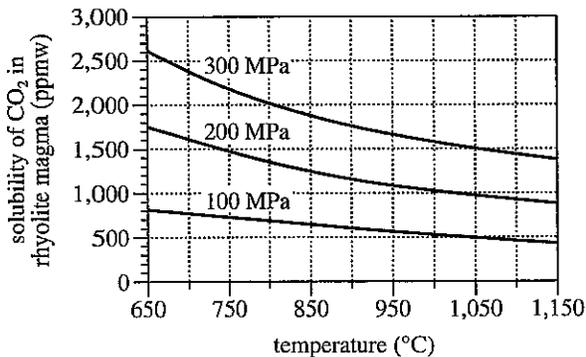
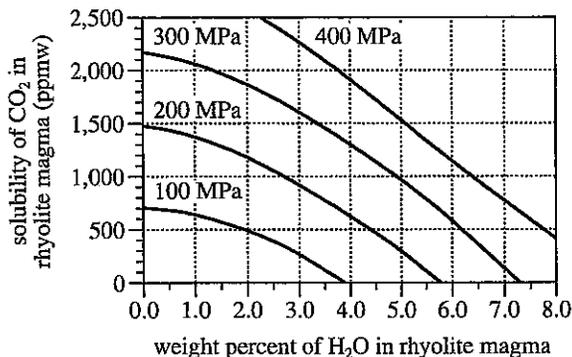


Figure 3 shows, at 4 different pressures, how the solubility of CO₂ in rhyolite magma at 750°C varies with the weight percent of H₂O in the magma.

Figure 3



Figures 1 and 3 adapted from Jacob B. Lowenstern, "Carbon Dioxide in Magmas and Implications for Hydrothermal Systems." ©2001 by Springer-Verlag.

Figure 2 adapted from Robert A. Fogel and Malcolm J. Rutherford, "The Solubility of Carbon Dioxide in Rhyolitic Melts: A Quantitative FTIR Study." ©1990 by the Mineralogical Society of America.

30. Based on Figure 2, at 300 MPa, the solubility of CO₂ in rhyolite magma is closest to 2,000 ppmw at which of the following temperatures?

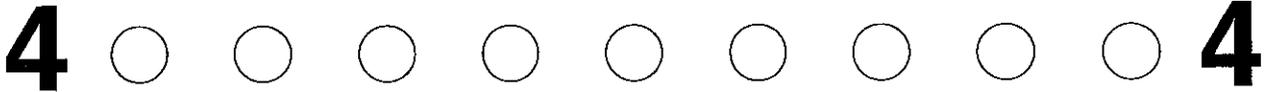
- F. 700°C
- G. 750°C
- H. 800°C
- J. 850°C

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31. Based on Figure 1, at 1,150°C, the solubility of CO₂ in basanite magma and the solubility of CO₂ in tholeiitic basalt magma are closest in value at which of the following pairs of pressures?
- A. Basanite magma: 50 MPa
Tholeiitic basalt magma: 200 MPa
 - B. Basanite magma: 50 MPa
Tholeiitic basalt magma: 250 MPa
 - C. Basanite magma: 125 MPa
Tholeiitic basalt magma: 200 MPa
 - D. Basanite magma: 125 MPa
Tholeiitic basalt magma: 250 MPa
32. Based on Figure 1, at 1,150°C and 150 MPa, the solubility of CO₂ in leucitite magma is approximately how much greater than or less than the solubility of CO₂ in rhyolite magma?
- F. 1,750 ppmw greater
 - G. 2,300 ppmw greater
 - H. 1,750 ppmw less
 - J. 2,300 ppmw less
33. Based on Figure 2, increasing the temperature from 650°C to 1,150°C has the lesser effect on the solubility of CO₂ in rhyolite magma at which pressure, 100 MPa or 300 MPa?
- A. 100 MPa; the solubility of CO₂ decreases by about 400 ppmw.
 - B. 100 MPa; the solubility of CO₂ decreases by about 1,300 ppmw.
 - C. 300 MPa; the solubility of CO₂ decreases by about 400 ppmw.
 - D. 300 MPa; the solubility of CO₂ decreases by about 1,300 ppmw.
34. Consider the solubility of CO₂ in rhyolite magma at 750°C and 200 MPa, as shown in Figure 2. Based on Figure 3, this rhyolite magma has a weight percent of H₂O closest to which of the following?
- F. 0.0%
 - G. 2.0%
 - H. 4.0%
 - J. 6.0%

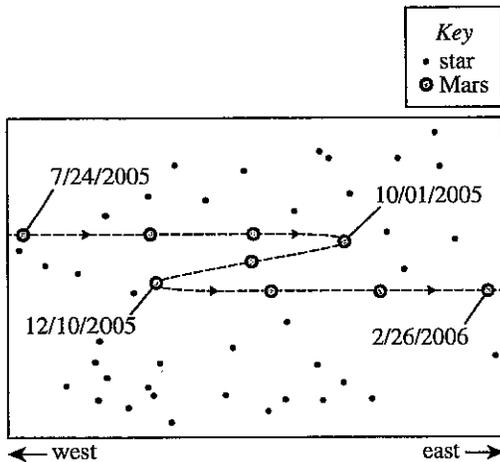
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Passage VII

When viewed from Earth, the other planets in the solar system usually appear to move prograde (eastward relative to the stars). Occasionally, however, each planet appears to briefly move retrograde (westward relative to the stars). For example, Figure 1 shows Mars's position relative to the stars on 9 dates between July 24, 2005, and February 26, 2006.

Figure 1

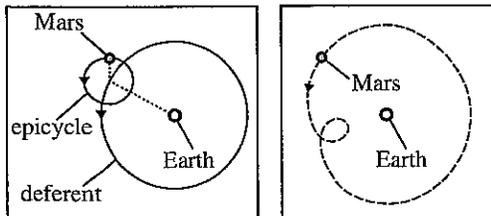


Two hypotheses were proposed to explain why the planets occasionally appear to move retrograde.

Hypothesis 1

Earth is the solar system's central body, and the other bodies move around Earth in looped orbits. Each body (except Earth) has 2 circles associated with it: a deferent and an epicycle. Both circles rotate counterclockwise, and their combined motions result in a body following a looped orbit. In Figure 2, the left panel shows Mars's deferent and epicycle, and the right panel shows Mars's orbit.

Figure 2



As a body passes through a loop, the body's motion changes from prograde to retrograde and back. The larger a body's deferent, the more loops in the body's orbit, and the more often that body passes through a loop.

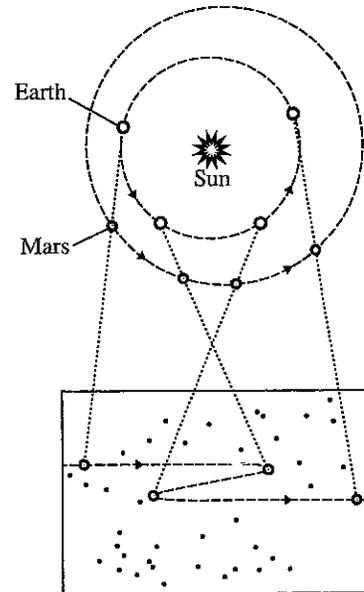
Hypothesis 2

The Sun is the solar system's central body, and the planets move counterclockwise around the Sun in elliptical orbits. The larger a planet's orbit, the more time the planet takes to complete a revolution around the Sun. As a result, the line of sight from Earth to a given planet drifts over time. Figure 3 shows the orbits of Earth and Mars, and the positions of Earth and Mars, on each of the 4 dates labeled in Figure 1. For each date, the line of sight from Earth to Mars is projected onto a view of the sky.

There are 2 rules for apparent retrograde motion:

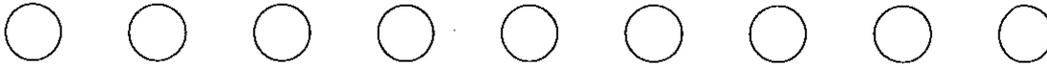
- A planet with an orbit larger than Earth's appears to move retrograde whenever Earth passes between the Sun and that planet. The larger that planet's orbit, the more often a pass occurs.
- A planet with an orbit smaller than Earth's appears to move retrograde whenever that planet passes between the Sun and Earth. The smaller that planet's orbit, the more often a pass occurs.

Figure 3



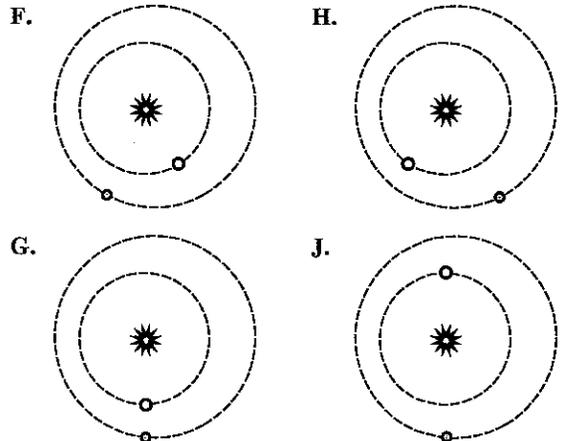
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35. Which of the following statements best describes a primary difference between the two hypotheses? Hypothesis 1 claims that all planets follow:
- looped orbits around Earth, whereas Hypothesis 2 claims that all planets follow elliptical orbits around the Sun.
 - looped orbits around Earth, whereas Hypothesis 2 claims that all planets follow elliptical orbits around Earth.
 - elliptical orbits around the Sun, whereas Hypothesis 2 claims that all planets follow looped orbits around the Sun.
 - elliptical orbits around the Sun, whereas Hypothesis 2 claims that all planets follow looped orbits around Earth.
36. Assume that Figures 2 and 3 are drawn to scale. Which of the figures, if either, implies that the distance between Earth and Mars varies with time?
- Figure 2 only
 - Figure 3 only
 - Both Figure 2 and Figure 3
 - Neither Figure 2 nor Figure 3
37. Consider both the interval of time represented in Figures 1 and 3 and the reason that, according to Hypothesis 2, the line of sight from Earth to Mars drifts over time. Is the top portion of Figure 3 consistent with that reason?
- Yes; Earth is shown as having the smaller orbit and as having completed a greater percentage of its revolution around the Sun than is Mars.
 - Yes; Earth is shown as having the larger orbit and as having completed a greater percentage of its revolution around the Sun than is Mars.
 - No; Earth is shown as having the smaller orbit and as having completed a greater percentage of its revolution around the Sun than is Mars.
 - No; Earth is shown as having the larger orbit and as having completed a greater percentage of its revolution around the Sun than is Mars.
38. Based on Figure 1, as viewed from Earth, for approximately how many days between July 2005 and February 2006 did Mars move retrograde?
- 30
 - 70
 - 150
 - 220
39. A supporter of Hypothesis 1 and a supporter of Hypothesis 2 would both be likely to agree with which of the following statements? When viewed from Earth, if a planet appears to be moving prograde, that planet is actually moving:
- clockwise around Earth.
 - clockwise around the central body in the solar system.
 - counterclockwise around the Sun.
 - counterclockwise around the central body in the solar system.
40. Based on Figures 1 and 3, if Hypothesis 2 is correct, which of the following figures most likely shows the positions of Earth and Mars on November 7, 2005?



END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.