
















**Marking Directions:** Mark only **one** oval for each question. Fill in response completely. Erase errors cleanly without smudging.

**Correct mark:**   

**Do NOT use these incorrect or bad marks.**

Incorrect marks:     
 Overlapping mark:     
 Cross-out mark:     
 Smudged erasure:     
 Mark is too light:   

BOOKLET NUMBER

1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
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FORM

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Print your 3-character **Test Form** in the boxes above and fill in the corresponding oval at the right.

☐ PRE

**BE SURE TO FILL IN THE CORRECT FORM OVAL.**

## TEST 1

1 (A) (B) (C) (D)	14 (F) (G) (H) (J)	27 (A) (B) (C) (D)	40 (F) (G) (H) (J)	53 (A) (B) (C) (D)	66 (F) (G) (H) (J)
2 (F) (G) (H) (J)	15 (A) (B) (C) (D)	28 (F) (G) (H) (J)	41 (A) (B) (C) (D)	54 (F) (G) (H) (J)	67 (A) (B) (C) (D)
3 (A) (B) (C) (D)	16 (F) (G) (H) (J)	29 (A) (B) (C) (D)	42 (F) (G) (H) (J)	55 (A) (B) (C) (D)	68 (F) (G) (H) (J)
4 (F) (G) (H) (J)	17 (A) (B) (C) (D)	30 (F) (G) (H) (J)	43 (A) (B) (C) (D)	56 (F) (G) (H) (J)	69 (A) (B) (C) (D)
5 (A) (B) (C) (D)	18 (F) (G) (H) (J)	31 (A) (B) (C) (D)	44 (F) (G) (H) (J)	57 (A) (B) (C) (D)	70 (F) (G) (H) (J)
6 (F) (G) (H) (J)	19 (A) (B) (C) (D)	32 (F) (G) (H) (J)	45 (A) (B) (C) (D)	58 (F) (G) (H) (J)	71 (A) (B) (C) (D)
7 (A) (B) (C) (D)	20 (F) (G) (H) (J)	33 (A) (B) (C) (D)	46 (F) (G) (H) (J)	59 (A) (B) (C) (D)	72 (F) (G) (H) (J)
8 (F) (G) (H) (J)	21 (A) (B) (C) (D)	34 (F) (G) (H) (J)	47 (A) (B) (C) (D)	60 (F) (G) (H) (J)	73 (A) (B) (C) (D)
9 (A) (B) (C) (D)	22 (F) (G) (H) (J)	35 (A) (B) (C) (D)	48 (F) (G) (H) (J)	61 (A) (B) (C) (D)	74 (F) (G) (H) (J)
10 (F) (G) (H) (J)	23 (A) (B) (C) (D)	36 (F) (G) (H) (J)	49 (A) (B) (C) (D)	62 (F) (G) (H) (J)	75 (A) (B) (C) (D)
11 (A) (B) (C) (D)	24 (F) (G) (H) (J)	37 (A) (B) (C) (D)	50 (F) (G) (H) (J)	63 (A) (B) (C) (D)	
12 (F) (G) (H) (J)	25 (A) (B) (C) (D)	38 (F) (G) (H) (J)	51 (A) (B) (C) (D)	64 (F) (G) (H) (J)	
13 (A) (B) (C) (D)	26 (F) (G) (H) (J)	39 (A) (B) (C) (D)	52 (F) (G) (H) (J)	65 (A) (B) (C) (D)	

## TEST 2

1 (A) (B) (C) (D) (E)	11 (A) (B) (C) (D) (E)	21 (A) (B) (C) (D) (E)	31 (A) (B) (C) (D) (E)	41 (A) (B) (C) (D) (E)	51 (A) (B) (C) (D) (E)
2 (F) (G) (H) (J) (K)	12 (F) (G) (H) (J) (K)	22 (F) (G) (H) (J) (K)	32 (F) (G) (H) (J) (K)	42 (F) (G) (H) (J) (K)	52 (F) (G) (H) (J) (K)
3 (A) (B) (C) (D) (E)	13 (A) (B) (C) (D) (E)	23 (A) (B) (C) (D) (E)	33 (A) (B) (C) (D) (E)	43 (A) (B) (C) (D) (E)	53 (A) (B) (C) (D) (E)
4 (F) (G) (H) (J) (K)	14 (F) (G) (H) (J) (K)	24 (F) (G) (H) (J) (K)	34 (F) (G) (H) (J) (K)	44 (F) (G) (H) (J) (K)	54 (F) (G) (H) (J) (K)
5 (A) (B) (C) (D) (E)	15 (A) (B) (C) (D) (E)	25 (A) (B) (C) (D) (E)	35 (A) (B) (C) (D) (E)	45 (A) (B) (C) (D) (E)	55 (A) (B) (C) (D) (E)
6 (F) (G) (H) (J) (K)	16 (F) (G) (H) (J) (K)	26 (F) (G) (H) (J) (K)	36 (F) (G) (H) (J) (K)	46 (F) (G) (H) (J) (K)	56 (F) (G) (H) (J) (K)
7 (A) (B) (C) (D) (E)	17 (A) (B) (C) (D) (E)	27 (A) (B) (C) (D) (E)	37 (A) (B) (C) (D) (E)	47 (A) (B) (C) (D) (E)	57 (A) (B) (C) (D) (E)
8 (F) (G) (H) (J) (K)	18 (F) (G) (H) (J) (K)	28 (F) (G) (H) (J) (K)	38 (F) (G) (H) (J) (K)	48 (F) (G) (H) (J) (K)	58 (F) (G) (H) (J) (K)
9 (A) (B) (C) (D) (E)	19 (A) (B) (C) (D) (E)	29 (A) (B) (C) (D) (E)	39 (A) (B) (C) (D) (E)	49 (A) (B) (C) (D) (E)	59 (A) (B) (C) (D) (E)
10 (F) (G) (H) (J) (K)	20 (F) (G) (H) (J) (K)	30 (F) (G) (H) (J) (K)	40 (F) (G) (H) (J) (K)	50 (F) (G) (H) (J) (K)	60 (F) (G) (H) (J) (K)

## TEST 3

1 (A) (B) (C) (D)	8 (F) (G) (H) (J)	15 (A) (B) (C) (D)	22 (F) (G) (H) (J)	29 (A) (B) (C) (D)	36 (F) (G) (H) (J)
2 (F) (G) (H) (J)	9 (A) (B) (C) (D)	16 (F) (G) (H) (J)	23 (A) (B) (C) (D)	30 (F) (G) (H) (J)	37 (A) (B) (C) (D)
3 (A) (B) (C) (D)	10 (F) (G) (H) (J)	17 (A) (B) (C) (D)	24 (F) (G) (H) (J)	31 (A) (B) (C) (D)	38 (F) (G) (H) (J)
4 (F) (G) (H) (J)	11 (A) (B) (C) (D)	18 (F) (G) (H) (J)	25 (A) (B) (C) (D)	32 (F) (G) (H) (J)	39 (A) (B) (C) (D)
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6 (F) (G) (H) (J)	13 (A) (B) (C) (D)	20 (F) (G) (H) (J)	27 (A) (B) (C) (D)	34 (F) (G) (H) (J)	
7 (A) (B) (C) (D)	14 (F) (G) (H) (J)	21 (A) (B) (C) (D)	28 (F) (G) (H) (J)	35 (A) (B) (C) (D)	

## TEST 4

1 (A) (B) (C) (D)	8 (F) (G) (H) (J)	15 (A) (B) (C) (D)	22 (F) (G) (H) (J)	29 (A) (B) (C) (D)	36 (F) (G) (H) (J)
2 (F) (G) (H) (J)	9 (A) (B) (C) (D)	16 (F) (G) (H) (J)	23 (A) (B) (C) (D)	30 (F) (G) (H) (J)	37 (A) (B) (C) (D)
3 (A) (B) (C) (D)	10 (F) (G) (H) (J)	17 (A) (B) (C) (D)	24 (F) (G) (H) (J)	31 (A) (B) (C) (D)	38 (F) (G) (H) (J)
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6 (F) (G) (H) (J)	13 (A) (B) (C) (D)	20 (F) (G) (H) (J)	27 (A) (B) (C) (D)	34 (F) (G) (H) (J)	
7 (A) (B) (C) (D)	14 (F) (G) (H) (J)	21 (A) (B) (C) (D)	28 (F) (G) (H) (J)	35 (A) (B) (C) (D)	

# Form B04



The **ACT**<sup>®</sup>

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## Directions

This booklet contains tests in English, mathematics, reading, and science. These tests measure skills and abilities highly related to high school course work and success in college. Calculators may be used on the mathematics test only.

The questions in each test are numbered, and the suggested answers for each question are lettered. On the answer document, the rows of ovals are numbered to match the questions, and the ovals in each row are lettered to correspond to the suggested answers. For each question, first decide which answer is best. Next, locate on the answer document the row of ovals numbered the same as the question. Then, locate the oval in that row lettered the same as your answer. Finally, fill in the oval completely. Use a soft lead pencil and make your marks heavy and black. Do not use ink or a mechanical pencil.

Mark only one answer to each question. If you change your mind about an answer, erase your first mark thoroughly before marking your new answer. For each question, make certain that you mark in the row of ovals with the same number as the question.

Only responses marked on your answer document will be scored. Your score on each test will be based only on the number of questions you answer correctly during the time allowed for that test. You will not be penalized for guessing. It is to your advantage to answer every question even if you must guess.

You may work on each test only when the testing staff tells you to do so. If you finish a test before time is called for that test, you should use the time remaining to reconsider questions you are uncertain about in that test. You may not look back to a test on which time has already been called, and you may not go ahead to another test. To do so will disqualify you from the examination.

Lay your pencil down immediately when time is called at the end of each test. You may not for any reason fill in or alter ovals for a test after time is called for that test. To do so will disqualify you from the examination.

Do not fold or tear the pages of your test booklet.

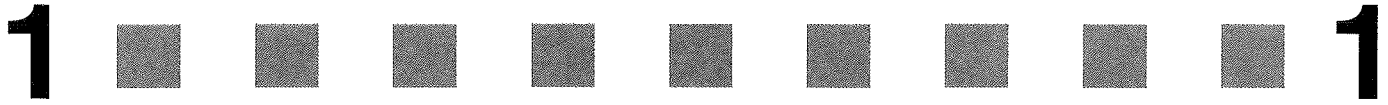
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Test begins on the next page.



## ENGLISH TEST

45 Minutes—75 Questions

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

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

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

### PASSAGE I

#### Sliding Stones to the Forbidden City

[1]

The Forbidden City, built in the fifteenth and sixteenth centuries in Beijing, China, is a complex<sup>1</sup> consisting of the imperial palace and 980 surrounding buildings. A large number of massive stones were used in its construction, some of them featured elaborate<sup>2</sup> carvings. Because China had developed sophisticated wheeled vehicles two thousand years before construction on the city began, scholars assumed that workers had used carts to transport the stones to the site. However, a document translated by researchers Jiang Li, Haosheng Chen, and Howard Stone, in 2013<sup>3</sup> revealed that workers used a surprising means of transportation<sup>4</sup>; a sledge pulled on ice. [A]

1. A. NO CHANGE  
B. China, which is  
C. China—  
D. China,
2. F. NO CHANGE  
G. were engraved with  
H. of these had  
J. with
3. A. NO CHANGE  
B. researchers Jiang Li, Haosheng Chen, and Howard Stone in 2013  
C. researchers Jiang Li, Haosheng Chen, and Howard Stone in 2013,  
D. researchers, Jiang Li, Haosheng Chen, and Howard Stone, in 2013
4. F. NO CHANGE  
G. transportation: being  
H. transportation:  
J. transportation

[2]

The document that was later translated by Jiang,  
Haosheng, and Stone stated that in January 1557  
 a team of men hauled a 123-ton stone to the Forbidden  
 City on a sledge (a platform with wooden runners).

[B] The men pulled the sledge forty-five miles in  
 twenty-eight days, moving about twenty feet per minute.

Jiang, Haosheng, and Stone wondered why the workers  
 chose to slide the stones on sledges instead of using  
 carts. [C] They calculated that the city's largest  
 stones—some weighing up to: 300 tons—were too  
 heavy for sixteenth-century carts to carry. In addition,  
 the rough, bumpy roads of the time made maneuvering  
 the carts difficult. Sledges were easier, smoother, and  
 more reliable.

[3]

But how could a team of men only drag a heavy  
 sledge forty-five miles in a few weeks? [D] The

researchers discovered that to confront friction,

the workers created artificial ice paths that poured  
 water on the ground. They let the winter air freeze

the water and then pulling the sledge over the ice.

5. A. NO CHANGE  
 B. that was the same one that described the use of a sledge  
 C. (it was translated in 2013)  
 D. DELETE the underlined portion.

6. F. NO CHANGE  
 G. Stone themselves wondered about the reason for why  
 H. Stone, who were researchers, wondered why  
 J. Stone asked why and for what reason

7. A. NO CHANGE  
 B. to 300 tons—  
 C. to 300 tons,  
 D. to 300 tons

8. The writer wants to emphasize that a few weeks was a short period of time in which to move a sledge forty-five miles. Which placement of the underlined portion best accomplishes that goal?  
 F. Where it is now  
 G. After the word *could*  
 H. After the word *sledge*  
 J. After the word *in*

9. A. NO CHANGE  
 B. counter  
 C. dispute  
 D. debate

10. F. NO CHANGE  
 G. capable of pouring  
 H. by pouring  
 J. pouring

11. A. NO CHANGE  
 B. water then they pulled  
 C. water and then pulled  
 D. water, then pulling

The workers also dug wells along the route so  
they could pour fresh water over the ice,<sup>12</sup>

thereby further reducing friction. The  
combination of the hard, icy surface and<sup>13</sup>

water lubrication were to mean that a small  
team of workers could move the massive stones<sup>14</sup>  
quickly and safely. These artificial ice paths made  
possible the construction of the Forbidden City,  
one of China's most enduring landmarks.

12. F. NO CHANGE  
G. route this was so  
H. route, thus,  
J. route,

13. If the writer were to delete the underlined portion (adjusting the punctuation as needed), the essay would primarily lose information that:  
A. adds more detail about the method workers used to dig wells along the route.  
B. illustrates why carts were ineffective at transporting the stones.  
C. helps clarify the reason workers poured water over the ice.  
D. reveals the methods workers used to pour water over the ice.

14. F. NO CHANGE  
G. were used so  
H. have meant  
J. meant

Question 15 asks about the preceding passage as a whole.

15. The writer wants to add the following true sentence to the essay:

The secret was ice.

The sentence would most logically be placed at:

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

## PASSAGE II

### Cecilia Payne-Gaposchkin and Star Composition

In 1923, when Cecilia Payne-Gaposchkin arrived in the United States to study astronomy, however, a widely  
held belief in her chosen field was that the stars, including<sup>16</sup>

the Sun, varied widely in its composition. Her PhD thesis,  
<sup>17</sup>

published in 1925, asserting that, unlike the planets, all  
stars are largely composed of hydrogen and helium. The  
idea instantly met with vehement opposition from her  
colleagues.<sup>18</sup>

16. F. NO CHANGE  
G. furthermore,  
H. instead,  
J. DELETE the underlined portion.

17. A. NO CHANGE  
B. their  
C. one  
D. a

18. F. NO CHANGE  
G. asserted that,  
H. an assertion,  
J. asserted

[1] Within a few years, however, studies by other astronomers, Otto Struve in particular went on to prove<sup>19</sup> that Payne-Gaposchkin's assertion was correct.

[2] Payne-Gaposchkin eventually published more than 150 papers and monographs and rose to be the first woman to chair a department at Harvard

University. [3] Struve, in fact, said that her<sup>20</sup>

work was "the most brilliant thesis ever"<sup>21</sup>

written in astronomy." 22

To accomplish the groundbreaking work of her thesis, published in 1925,<sup>23</sup> Payne-Gaposchkin had applied astrophysicist Meghnad Saha's newly developed theory of ionization to the study of stellar atmospheres. [A] She labored by what was at the time<sup>24</sup>

the world's largest collection of stellar spectra on<sup>25</sup> photographic plates in the world. To the untrained eye, stellar spectra look like random smears on a sheet of paper. The images that were created with a<sup>26</sup> spectroscope, an instrument that, when attached to a telescope, captures the various wavelengths of starlight on a color spectrum. [B] Payne-Gaposchkin turned most of her attention to the "absorption lines," the dark gaps where light at certain wavelengths was missing. [C]<sup>27</sup>

19. A. NO CHANGE  
B. particular when he proved  
C. particular, proved  
D. particular proved

20. Which choice best emphasizes that Struve felt strongly about his opinion of Payne-Gaposchkin's thesis?  
F. NO CHANGE  
G. mentioned  
H. declared  
J. noted

21. A. NO CHANGE  
B. considered to be  
C. being  
D. to be

22. Which sequence of sentences makes this paragraph most logical?  
F. NO CHANGE  
G. 1, 3, 2  
H. 3, 1, 2  
J. 2, 1, 3

23. A. NO CHANGE  
B. with a publication year of 1925,  
C. a 1925 publication,  
D. DELETE the underlined portion.

24. F. NO CHANGE  
G. upon  
H. over  
J. to

25. A. NO CHANGE  
B. largest stellar spectra  
C. largest (globally)  
D. largest

26. F. NO CHANGE  
G. having been  
H. were  
J. being

27. A. NO CHANGE  
B. showed her that  
C. indicated where  
D. let her know

She concluded, ultimately that the variations among  
<sup>28</sup>  
 stellar spectra were not, as previously thought, an  
 indication of different stellar composition. [D] Instead,  
 she took the position that the gaps could be attributed  
<sup>29</sup>  
 to the different temperatures of stars but that the stars'  
 elemental makeup was largely uniform. The discovery  
 is, to this day, considered one of the greatest in the field  
 of astronomy. 30

28. F. NO CHANGE  
 G. ultimately that,  
 H. ultimately, that  
 J. ultimately, that,
29. A. NO CHANGE  
 B. had her say in the matter  
 C. put pen to paper, saying  
 D. went ahead and told everyone

30. The writer wants to add the following true statement to the preceding paragraph:

The gaps represent the chemical elements in a star's atmosphere that absorb the light.

The sentence would most logically be placed at:

- F. Point A.  
 G. Point B.  
 H. Point C.  
 J. Point D.

### PASSAGE III

#### Theater in the Small

For a brief trip in 2011, *Theatre for One* was  
<sup>31</sup>  
 situated in New York City's Times Square, just a  
 few steps from Broadway's mainstream theaters. This  
 four-by-eight-foot black booth, trimmed in steel and lined  
 in red velvet, it served as the locale for five plays. Each  
<sup>32</sup>  
 play had a single actor and a single audience member. 33

And intriguingly, each demanded the spectator's  
<sup>34</sup>  
 involvement.

31. A. NO CHANGE  
 B. airing  
 C. stint  
 D. shift
32. F. NO CHANGE  
 G. velvet, which  
 H. velvet and  
 J. velvet,
33. If the writer were to delete the preceding sentence, the essay would primarily lose:
- A. a note about the main similarities between *Theatre for One* and the mainstream theaters of Broadway.  
 B. a detail that helps convey the small scale of the five *Theatre for One* plays.  
 C. a description of how the audience became involved in the play.  
 D. an explanation of the inspiration for intimate theater.
34. F. NO CHANGE  
 G. intriguingly; each  
 H. intriguingly; each  
 J. intriguingly each,



In making the audience a part of the play, *Theatre for One* epitomizes “intimate theater,” a movement that has seen a recent rise in popularity. Meanwhile, intimate<sup>35</sup> theater collapses the “wall” separating the audience from the actors. It creates an immersive experience in which the audience participates in creating the play.

Audience involvement can be physical or verbal.<sup>36</sup> In a London production of Edgar Allan Poe’s *Masque of the Red Death*, audiences silently wandered the

halls of the 1893 Battersea Arts Centre while scenes<sup>37</sup> from the story played out in various rooms. People

could walk in on a scene already in progress or leave<sup>38</sup> before a scene finished. Actors drew the spectators in by making eye contact, touching someone’s arm, or beckoning someone to follow them to a new location.

A person’s show, specifically, quite literally depended<sup>39</sup>

on your own particular movements.<sup>40</sup>

35. A. NO CHANGE  
B. In contrast, intimate  
C. As a result, intimate  
D. Intimate
36. F. NO CHANGE  
G. take the form of either physical involvement or of being verbal instead.  
H. fall into the two categories of being considered physical or verbal.  
J. be by either a physical or verbal method of involvement.
37. The writer is considering revising the underlined portion to the following:  
Centre, built by E. W. Mountford,  
Should the writer make this revision?  
A. Yes, because it offers a detail suggesting that the building had been constructed specifically for the production of *Masque of the Red Death*.  
B. Yes, because it provides a detail that helps describe the plot of *Masque of the Red Death*.  
C. No, because it is an irrelevant detail that does not contribute to the description of the *Masque of the Red Death* production.  
D. No, because it adds a detail that could cause confusion over who wrote *Masque of the Red Death*.
38. F. NO CHANGE  
G. that was already in the process of being performed for anyone who might enter  
H. from the story that the actors were already in the process of performing  
J. from Poe’s story that had already started but not yet finished
39. A. NO CHANGE  
B. similarly,  
C. therefore,  
D. however,
40. F. NO CHANGE  
G. his or her  
H. its  
J. DELETE the underlined portion.

Some productions rely almost completely on actor-audience dialogue. An Edinburgh festival featured<sup>41</sup> *Live Art Speed Dating*, for which each theatergoer met with each of the twelve actors individually for a series of “mini-dates.” For *Internal*, audience members first paired off with actors to talk for twenty-five minutes and then sat in a circle for something seemingly more akin to group therapy than theater. Such experiences could be both exhilarating and unsettling.

Intimate theater breaks in the rules of traditional<sup>42</sup> theater. Relying on the audience’s personal involvement in the creation of the performance, it sometimes blurs the line among illusion and reality.<sup>43</sup> Whether it’s in Times Square

or Edinburgh, intimate theater is definitely not Broadway.<sup>44</sup>

41. A. NO CHANGE  
B. festival, which featured  
C. festival that featured  
D. festival, featuring

42. F. NO CHANGE  
G. out  
H. off  
J. DELETE the underlined portion.

43. A. NO CHANGE  
B. between allusion  
C. between illusion  
D. among allusion

44. Which choice best concludes the essay by linking back to an idea presented in the first sentence of the essay?  
E. NO CHANGE  
G. with many actors or just a few, theatrical performances are always fun.  
H. intimate theater appeals to a wide range of people.  
J. a play can help you see things from a new angle.

Question 45 asks about the preceding passage as a whole.

45. Suppose the writer’s primary purpose had been to offer an overview of a particular movement in theater. Would this essay accomplish that purpose?  
A. Yes, because it defines intimate theater and focuses on the buildings constructed to feature these unconventional performances.  
B. Yes, because it discusses the central elements of intimate theater with examples of specific performances.  
C. No, because it focuses on historical shifts in theatrical performance in general rather than specifically on intimate theater.  
D. No, because it offers several examples of intimate theater but does not identify any specific elements that are common to it.

## PASSAGE IV

## Lily's Mission: Dyer's Woad

Lily barks as she turns in a circle. Then she sits down, patiently waiting for her handler, conservationist Aimee Hurt. The yellow Labrador retriever's actions tell Hurt that Lily has detected dyer's woad, the invasive

46

weed the two are searching for the wildflower-speckled hillside of Mount Sentinel in Montana. Lily's actions also

triggers the GPS unit attached to her harness to record the dog's precise location. Once Hurt catches up to Lily,

48

the retriever gets ready for what's next. Hurt can then find

49

the one-inch-tall plant, pulling it up as she watches, anticipating her reward. In a few weeks, the team will return to the spot to confirm that the weed has not resprouted.

50

Lily is one of several dogs on the crew of Working Dogs for Conservation, a nonprofit organization based in Three Forks, Montana. The group trains dogs and works with humans on a variety of conservation-related initiatives. In 2010, the

51

organization from the state joined one of Montana's longest-running projects to eradicate dyer's woad.

52

46. F. NO CHANGE  
G. woad the plant is  
H. woad, it's  
J. woad it's
47. A. NO CHANGE  
B. for on  
C. on at  
D. on
48. F. NO CHANGE  
G. trigger  
H. has triggered  
J. is important for triggering
49. Which choice provides the best transition from this sentence to the following sentence?  
A. NO CHANGE  
B. wags her tail, as she always does when Hurt approaches.  
C. is no longer permitted to bark incessantly.  
D. points her nose directly at the woad.
50. F. NO CHANGE  
G. he or she watches,  
H. Lily watches,  
J. you watch,
51. Which choice most clearly indicates that the dogs are working with humans on conservation tasks?  
A. NO CHANGE  
B. to work  
C. and does work  
D. while working
52. Which placement of the underlined portion puts the clearest emphasis on the organization's goal to remove dyer's woad specifically from Montana?  
F. Where it is now  
G. After the word *joined*  
H. After the word *projects*  
J. After the word *woad* (and before the period)

Since the 1950s, the hardy, fast-growing weed has choked out native plants and overrun wildlife habitats in several Montana counties. 53

Specially trained dogs can dig out the tiny, young 54

specimens of dyer's woad that humans often miss.

With the dogs' <sup>55</sup> help, conservationists are better able

to locate and remove woad; before it matures and 56 reproduces, releasing thousands of seeds.

Hurt thanks Lily by tossing a tennis ball for her to chase; Lily's long-time favorite reward for identifying 57 the scent of dyer's woad. A former shelter dog now living with one of her handlers, Lily was assigned to the dyer's woad project for her ability much like a police dog's to 58 ignore all other scents while she is working. After Lily returns with her ball, she and Hurt continue on their search. Lily's nose, like the noses of a small number 59 of other conservation dogs, has helped humans find a new way to strengthen their bonds with dogs. 60

53. In the preceding sentence, the writer is considering revising the phrase "choked out" to the word "harmed" and the word "overrun" to the word "affected." Should the writer make these revisions?
- A. Yes, because the revisions provide clearer reasons for the initiatives to remove dyer's woad from Montana.
  - B. Yes, because the revisions add a level of technical detail to an otherwise casual essay.
  - C. No, because the revisions suggest that the work of the group Lily belongs to has been largely ineffective.
  - D. No, because the revisions downplay how destructive dyer's woad has been in Montana.
54. Which choice best reinforces the way the dogs work to find woad as established in the essay as a whole?
- F. NO CHANGE
  - G. sniff out
  - H. uncover
  - J. pull up
55. A. NO CHANGE  
B. specimens, of dyer's woad,  
C. specimens, of dyer's woad  
D. specimens of dyer's woad,
56. F. NO CHANGE  
G. woad, before it matures,  
H. woad before it, matures  
J. woad before it matures
57. A. NO CHANGE  
B. chase; which is  
C. chase,  
D. chase.
58. F. NO CHANGE  
G. ability—much like a police dog's—  
H. ability—much like a police dog's  
J. ability much like a police dog's,
59. A. NO CHANGE  
B. them belonging to  
C. that belonging to  
D. the nose of
60. Given that all the choices are accurate, which one would most effectively conclude this paragraph and the essay?
- F. NO CHANGE
  - G. locate dyer's woad, find fungi, survey kit foxes, and even track the blunt-nosed leopard lizard.
  - H. almost completely weed out dyer's woad in several areas of Montana.
  - J. make strides with an initiative that has been popular in Montana.

## PASSAGE V

## Riders on the Storm

[1]

[1] But exactly how these tiny creatures avoid being knocked out of the air during storms were puzzling to<sup>61</sup> entomologists for years. [2] While a typical mosquito measures about three millimeters in length, a raindrop is usually between two and eight millimeters in diameter. [3] More important, a single raindrop can weigh up to fifty times more than the average mosquito. [4] A mosquito might be hit by a drop this size over and over<sup>62</sup> while flying through a moderate rainstorm. [5] Mosquitoes

don't dodge raindrops. 63

[2]

To study how mosquitoes contend with raindrops, mechanical engineer and biologist Dr. David Hu placed mosquitoes inside a clear acrylic box with mesh over the<sup>64</sup> top. [A] He then sprayed water through the mesh at varying intensities to simulate rainstorms and used high-speed videography to film the mosquitoes in action. [B]

[3]

When struck in the legs (the most common point of impact), a mosquito simply rolls sideways and then resumes regular flight.<sup>65</sup>

61. A. NO CHANGE  
B. have been puzzling  
C. have puzzled  
D. has puzzled
62. Which choice provides the clearest and most specific information about how often a mosquito is struck during a moderate rainstorm?  
F. NO CHANGE  
G. approximately every twenty seconds  
H. at a strikingly high rate of frequency  
J. a number of times every minute
63. For the sake of logic and cohesion, Sentence 5 should be placed:  
A. where it is now.  
B. before Sentence 1.  
C. after Sentence 1.  
D. after Sentence 2.
64. F. NO CHANGE  
G. clear, acrylic, box with,  
H. clear acrylic, box with  
J. clear, acrylic box, with
65. If the writer were to delete the underlined portion (ending the sentence with a period), the essay would primarily lose a detail that helps:  
A. emphasize that getting hit by a raindrop in the legs does not have a significant impact on mosquitoes.  
B. indicate that rolling sideways is a normal part of a mosquito's regular flight pattern.  
C. describe what happens each time a droplet strikes a mosquito.  
D. clarify how mosquito anatomy influences flight strategies.

But when struck squarely on the body, the insect  
 joins the droplet, suddenly riding along as the droplet  
hurtles downward for up to twenty mosquito body lengths.

66

Then the mosquito, which appears to use its long legs  
 and wings to twist free from the droplet and smoothly

67

glide off and away from the droplet. This midair moment

68

of separation occurs so quickly that—the mechanics

69

remain unclear. The entire interaction, therefore, lasts  
 only a fraction of a second. [C]

70

[4]

Despite the uncertainties, it is clear that the  
 features that would seem to put the mosquito at risk in  
 storms—its size and low weight in comparison with the  
 drops—are precisely what allow it to effectively elude the  
 force of an impact by riding a raindrop. This investigation  
 has yielded information that, perhaps surprisingly, could  
 benefit humans. [D] Mosquitoes have relinquished a new  
 model for the development of tiny airborne robots that can  
 be used for search-and-rescue operations as well as for  
 surveillance. With these robots, as with mosquitoes,  
rainstorms play a significant role in nature.

73

66. Which choice best emphasizes the high speed with which the mosquito falls?  
 F. NO CHANGE  
 G. heads to the ground  
 H. loses altitude  
 J. descends
67. A. NO CHANGE  
 B. Then the mosquito appears  
 C. Then the mosquito, appearing  
 D. Then, as the mosquito appears
68. F. NO CHANGE  
 G. off, free of the droplet.  
 H. off, freely on its own.  
 J. away.
69. A. NO CHANGE  
 B. quickly—that  
 C. quickly, that  
 D. quickly that
70. F. NO CHANGE  
 G. for example,  
 H. after all,  
 J. however,
71. A. NO CHANGE  
 B. they're  
 C. there  
 D. it's
72. F. NO CHANGE  
 G. turned over  
 H. provided  
 J. recorded
73. Which choice best concludes the paragraph and the essay?  
 A. NO CHANGE  
 B. the smaller and lighter the body, the more durable it may be in rainstorms.  
 C. it is a tough task to figure out how to make something fly.  
 D. technology is changing quickly every day, just like nature.



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

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

This controlled environment and documentation were necessary because capturing footage of mosquitoes flying through storms in nature is nearly impossible.

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

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

75. Suppose the writer's primary purpose had been to offer an overview of how insects fly. Would this essay accomplish that purpose?

- A. Yes, because it describes the general flight pattern for mosquitoes and how that pattern changes during storms.
- B. Yes, because it explains several strategies mosquitoes use when flying through storms.
- C. No, because it mainly focuses on how Dr. Hu's study of mosquitoes can be applied to other scientific fields.
- D. No, because it mainly focuses on a specific study of how mosquitoes stay aloft in rainstorms.

**END OF TEST 1**

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

**MATHEMATICS TEST***60 Minutes—60 Questions*

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

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

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

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

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

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

1. Given  $3x - 7 = 5x - 13$  is true,  $x = ?$

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

**DO YOUR FIGURING HERE.**

2. Aleka earns her regular pay of \$14 per hour for up to 40 hours of work per week. For each hour over 40 hours of work per week, Aleka earns  $1\frac{1}{2}$  times her regular pay. How much does Aleka earn in a week in which she works 48 hours?

- F. \$ 576
- G. \$ 672
- H. \$ 728
- J. \$ 744
- K. \$1,008

3. A water tank that initially contained 200 gallons of water is leaking water at a constant rate of 4 gallons per minute. For the amount of time the tank has water, which of the following function models gives the number of gallons,  $G$ , in the tank  $t$  minutes after the leak started?

- A.  $G(t) = 196 - t$
- B.  $G(t) = 200 - 4t$
- C.  $G(t) = 200t - 4$
- D.  $G(t) = 200t - 4t^2$
- E.  $G(t) = 200\left(\frac{3}{4}\right)^t$





4. Which of the following expressions is equivalent to  $(x^5y^3z^2)(x^4y^3z^6)$  for all real values of  $x$ ,  $y$ , and  $z$ ?

F.  $x^9y^6z^8$   
G.  $x^9y^9z^8$   
H.  $x^{20}y^6z^8$   
J.  $x^{20}y^9z^{12}$   
K.  $x^{21}y^6z^{12}$

DO YOUR FIGURING HERE.

5. The 1st term in the geometric sequence below is  $-12$ . If it can be determined, what is the 6th term?

$-12, 24, -48, 96, -192, \dots$

- A.  $-384$   
B.  $-288$   
C.  $288$   
D.  $384$   
E. Cannot be determined from the given information
6. How many *minutes* would it take a car to travel 120 miles at a constant speed of 50 miles per hour?  
(Note: There are 60 minutes in 1 hour.)
- F. 25  
G. 42  
H. 70  
J. 100  
K. 144

7. Patrick and Ayako are painting a room in the city hall.

They started with 6 gallons of paint. On the first day, Patrick used  $\frac{1}{2}$  gallon of paint and Ayako used  $1\frac{3}{4}$  gallons of paint. How many gallons of paint were left when they completed their first day of painting?

- A.  $2\frac{1}{4}$   
B.  $3\frac{3}{4}$   
C.  $4\frac{1}{4}$   
D.  $4\frac{3}{4}$   
E.  $5\frac{1}{2}$
8. The length of the hypotenuse of a certain right triangle is 50 inches, and the length of one of its legs is 40 inches. What is the length, in inches, of the other leg of the triangle?
- F. 10  
G. 30  
H. 45  
J. 64  
K. 90

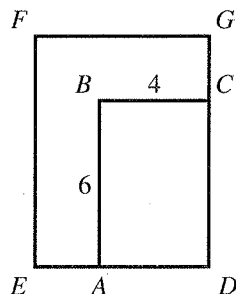


DO YOUR FIGURING HERE.

9. Of the 450 parking spaces in a parking lot, 8% of the spaces are reserved for handicapped parking. Of those parking spaces NOT reserved for handicapped parking, 18 are suitable for compact cars only. How many spaces that are NOT reserved for handicapped parking are suitable for noncompact cars?
- A. 432  
B. 424  
C. 414  
D. 396  
E. 369
10. A gardener is planting 7 rows of trees in a triangular plot. The first row contains 1 tree. Each successive row contains 2 more trees than the previous row. How many trees will the gardener plant in the triangular plot?
- F. 14  
G. 15  
H. 48  
J. 49  
K. 64
11. Let  $a = 3$ ,  $b = 5$ , and  $c = 8$ . What is  $\frac{a}{b^2} + \frac{c}{2}$ ?
- A.  $\frac{43}{10}$   
B.  $\frac{7}{25}$   
C.  $\frac{103}{25}$   
D.  $\frac{109}{25}$   
E.  $\frac{11}{27}$
12. What is the least common denominator of the fractions  $\frac{4}{21}$ ,  $\frac{1}{12}$ , and  $\frac{3}{8}$ ?
- F. 56  
G. 168  
H. 252  
J. 672  
K. 2,016
13. The relationship between the sum of the measures of the interior angles of a polygon,  $S$ , and the number of sides of the polygon,  $n$ , is given by the equation  $S = 180(n - 2)$ . The sum of the interior angle measures of a certain polygon is  $1,440^\circ$ . How many sides does this polygon have?
- A. 6  
B. 8  
C. 10  
D. 12  
E. 16



14. In the figure shown below,  $\overline{CG} \cong \overline{AE}$ , and rectangle  $ABCD$  has a length of 6 inches and a width of 4 inches. The area of rectangle  $EFGD$  is 2 times the area of rectangle  $ABCD$ . What is the length, in inches, of  $\overline{CG}$ ?



- F. 2  
G. 2.4  
H. 3.5  
J. 4  
K. 4.8

15. Point A is located at (3,8) in the standard (x,y) coordinate plane. What are the coordinates of  $A'$ , the image of A after it is reflected across the y-axis?

- A. ( 3,-8)  
B. (-3,-8)  
C. (-3, 8)  
D. ( 8, 3)  
E. (-8, 3)

16. What is the sum of the 2 solutions of the equation  $x^2 + 3x - 54 = 0$ ?

- F. -54  
G. -9  
H. -3  
J. 0  
K. 6

17. The area of a certain square is 36 square inches. What is the perimeter of this square, in inches?

- A. 6  
B. 9  
C. 12  
D. 18  
E. 24

18.  $\frac{1}{4} \cdot \frac{2}{5} \cdot \frac{3}{6} \cdot \frac{4}{7} \cdot \frac{5}{8} \cdot \frac{6}{9} \cdot \frac{7}{n} = ?$

- F. 1  
G.  $\frac{1}{n}$   
H.  $\frac{1}{12n}$   
J.  $\frac{2}{9n}$   
K.  $\frac{6}{17n}$

DO YOUR FIGURING HERE.

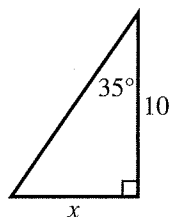


19. What is 3% of  $5.13 \times 10^5$ ?

- A. 15,390
- B. 17,100
- C. 171,000
- D. 153,900
- E. 1,539,000

DO YOUR FIGURING HERE.

20. The triangle below has side lengths given in meters.



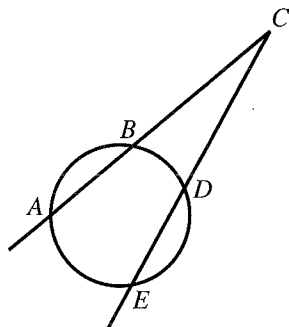
Which of the following expressions is equal to  $x$ ?

- F.  $\sin 35^\circ$
- G.  $\cos 35^\circ$
- H.  $\frac{1}{10} \sin 35^\circ$
- J.  $\frac{1}{10} \cos 35^\circ$
- K.  $10 \tan 35^\circ$

21. Mr. Evans is going to buy new markers for his students to use for a project. He will buy  $n$  packs of markers, and each pack will contain 40 markers. He will distribute the markers so that each of his 24 students will have the same number of markers with none left over. Which of the following integers could NOT be the value of  $n$ ?

- A. 3
- B. 8
- C. 12
- D. 15
- E. 24

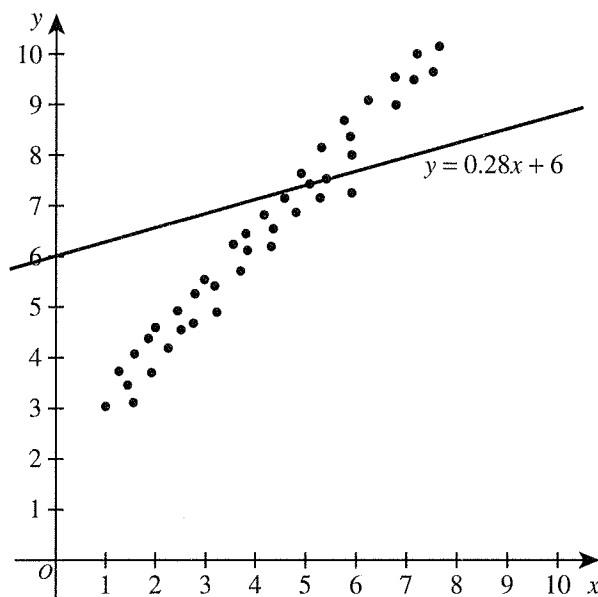
22. Points  $A$ ,  $B$ ,  $D$ , and  $E$  lie on the circle shown below. Secants  $\overleftrightarrow{AC}$  and  $\overleftrightarrow{CE}$  intersect at  $C$ . The chords  $\overline{AB}$  and  $\overline{DE}$  are congruent. Minor arc  $\widehat{AE}$  measures  $106^\circ$ . Minor arc  $\widehat{BD}$  measures  $64^\circ$ . What is the measure of minor arc  $\widehat{DE}$ ?



- F.  $42^\circ$
- G.  $84^\circ$
- H.  $85^\circ$
- J.  $90^\circ$
- K.  $95^\circ$



23. Jayla plotted the data from her science project as a scatterplot in the standard  $(x,y)$  coordinate plane. She found the line containing 2 of the points to be  $y = 0.28x + 6$ . The scatterplot and the line are shown below.



Jayla decided that this line was not a good fit for her data. To transform her line into the regression line for her data, Jayla *must*:

- A. increase both the slope and the y-intercept.
  - B. increase the slope and decrease the y-intercept.
  - C. decrease both the slope and the y-intercept.
  - D. decrease the slope and increase the y-intercept.
  - E. use either a horizontal or vertical line.
24. The probability that Event A will occur is 0.2. The probability that Event B will occur is 0.6. Given that Events A and B are mutually exclusive, what is the probability that Event A *or* Event B will occur?
- F. 0.12
  - G. 0.2
  - H. 0.3
  - J. 0.4
  - K. 0.8
25. Given that  $\sin A = \frac{15}{17}$  and that  $0 < A < \frac{\pi}{2}$ , then what is the value of  $\cos A$ ?

- A.  $-\frac{17}{15}$
- B.  $-\frac{8}{17}$
- C.  $\frac{8}{17}$
- D.  $\frac{17}{15}$
- E.  $\frac{17}{8}$

**DO YOUR FIGURING HERE.**



Use the following information to answer questions 26–29.

DO YOUR FIGURING HERE.

Widely considered one of the greatest film directors, Alfred Hitchcock directed over 60 films. The table below gives some information about Hitchcock's last 12 films.

Title	Year of release	Length (minutes)
<i>The Trouble with Harry</i>	1955	99
<i>The Man Who Knew Too Much</i>	1956	120
<i>The Wrong Man</i>	1956	105
<i>Vertigo</i>	1958	128
<i>North by Northwest</i>	1959	136
<i>Psycho</i>	1960	109
<i>The Birds</i>	1963	119
<i>Marnie</i>	1964	130
<i>Torn Curtain</i>	1966	128
<i>Topaz</i>	1969	143
<i>Frenzy</i>	1972	?
<i>Family Plot</i>	1976	?

26. What is the median of the given lengths, in minutes, of the 10 Hitchcock films released before 1972 ?

F. 120.0  
G. 121.7  
H. 122.5  
J. 124.0  
K. 128.0

27. Hector owns all 12 films listed. He will randomly select 1 of them to view this weekend. What is the probability that he will choose a film that has only 1 word in its title, given that the film he chooses will have a release date after 1965 ?

A.  $\frac{2}{4}$   
B.  $\frac{2}{5}$   
C.  $\frac{4}{5}$   
D.  $\frac{2}{12}$   
E.  $\frac{7}{12}$

28. Recently, a director made a new version of *Vertigo*. The new version is 20% shorter in length than Hitchcock's version. Which of the following values is closest to the length, in minutes, of the new version?

F. 64  
G. 102  
H. 105  
J. 108  
K. 125



29. At a Hitchcock film festival, Lelei watched *Topaz* and *Frenzy* once each and *Family Plot* twice, for a total of 501 minutes. *Family Plot* is 5 minutes longer than *Frenzy*. What is the sum of the lengths, in minutes, of *Frenzy* and *Family Plot*?

A. 237  
B. 243  
C. 244  
D. 286  
E. 358

DO YOUR FIGURING HERE.

30. Matrices  $A$  and  $B$  are given below.

$$A = \begin{bmatrix} 3 & -5 \\ -2 & 9 \end{bmatrix} \quad B = \begin{bmatrix} -7 & 6 \\ 4 & 5 \end{bmatrix}$$

Which of the following matrices is  $A - B$ ?

F.  $\begin{bmatrix} -10 & 11 \\ 6 & -4 \end{bmatrix}$   
G.  $\begin{bmatrix} -4 & 2 \\ 1 & 14 \end{bmatrix}$   
H.  $\begin{bmatrix} -4 & 1 \\ 2 & 14 \end{bmatrix}$   
J.  $\begin{bmatrix} 10 & -6 \\ -11 & 4 \end{bmatrix}$   
K.  $\begin{bmatrix} 10 & -11 \\ -6 & 4 \end{bmatrix}$

31. In 2001, the U.S. Mint in Philadelphia produced 10,334,590,000 1-cent pieces, commonly called pennies. These pennies were then bagged, with \$50 in pennies per bag. This process resulted in how many bags of pennies?

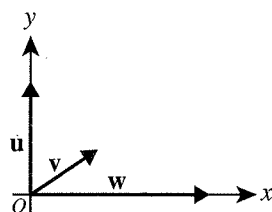
A. 2,066,918  
B. 206,691,800  
C. 5,167,295,000  
D. 20,669,180,000  
E. 51,672,950,000,000

32. Given that the equation  $\frac{3x-y}{x+y} = \frac{4}{7}$  is true, what is the value of  $\frac{x}{y}$ ?

F.  $\frac{2}{17}$   
G.  $\frac{4}{7}$   
H.  $\frac{11}{17}$   
J.  $\frac{11}{4}$   
K.  $\frac{11}{5}$



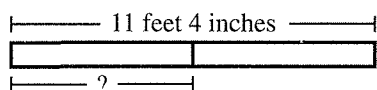
33. The vectors  $\mathbf{u}$ ,  $\mathbf{v}$ , and  $\mathbf{w}$  are represented in the standard  $(x,y)$  coordinate plane below.



**DO YOUR FIGURING HERE.**

- In what general direction will the vector  $\mathbf{u} - \mathbf{v} + \mathbf{w}$  point?
- Up and to the right
  - Up and to the left
  - Down and to the right
  - Down and to the left
  - To the right but neither up nor down

34. Shown below, a board 11 feet 4 inches long is cut into 2 equal parts. What is the length, to the nearest inch, of each part?



- 5 feet 5 inches
  - 5 feet 7 inches
  - 5 feet 8 inches
  - 6 feet 5 inches
  - 6 feet 6 inches
35. Which of the following are linear factors of  $krx^2 + (kn + rm)x + mn$ , a general quadratic expression in  $x$ ?
- $(kx - m)$  and  $(rx - n)$
  - $(kx - m)$  and  $(rx + n)$
  - $(kx + m)$  and  $(rx - n)$
  - $(kx + m)$  and  $(rx + n)$
  - $(kr - n)$  and  $(rx - m)$

36. Which of the following numbers has the greatest value?

F.  $\frac{15}{101}$

G.  $\frac{150}{999}$

H. 0.15

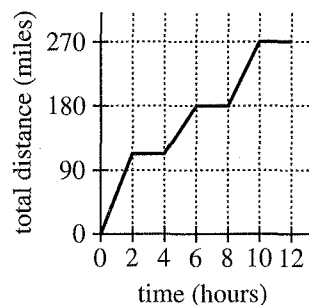
J.  $0.\overline{15}$

K.  $0.\overline{151}$



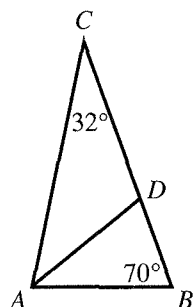


37. Diane traveled to 3 locations during a workday. Diane remained at each location a whole number of hours. The graph below shows the relationship between time, in hours, into her workday and total distance, in miles, traveled. Which of the following values is closest to Diane's average speed, in miles per hour, for the parts of the workday when she was traveling?



- A. 27  
B. 34  
C. 36  
D. 45  
E. 56
38. Let  $f(x) = x^2 + 2$  and  $g(x) = x + 3$ . For all values of  $x$ , which of the following expressions gives  $f(g(x))$ ?
- F.  $x^2 + 11$   
G.  $x^2 + x + 5$   
H.  $x^2 + 6x + 11$   
J.  $x^3 + 6$   
K.  $x^3 + 3x^2 + 2x + 6$

39. In  $\triangle ABC$  below, the measure of  $\angle ABD$  is  $70^\circ$ , the measure of  $\angle ACB$  is  $32^\circ$ ,  $D$  is on  $\overline{BC}$ , and  $\overline{AD}$  is a bisector of  $\angle BAC$ . What is the measure of  $\angle ADB$ ?



40. Given the function below, what is  $f(4)$ ?

$$f(x) = \begin{cases} 2x + 1; & x < 4 \\ -\frac{1}{2}x - 3; & x \geq 4 \end{cases}$$

- F. -5  
G.  $\frac{1}{2}$   
H. 4  
J. 9  
K. 14

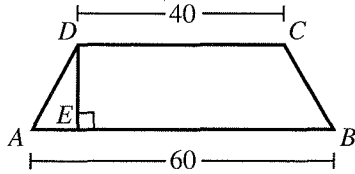
DO YOUR FIGURING HERE.



DO YOUR FIGURING HERE.

41. The base lengths of isosceles trapezoid  $ABCD$  shown below are in centimeters, and  $E$  is on  $\overline{AB}$ . What is the ratio of the area of  $ABCD$  to the area of  $\triangle AED$ ?

- A. 2:1  
B. 4:1  
C. 5:1  
D. 10:1  
E. 20:1

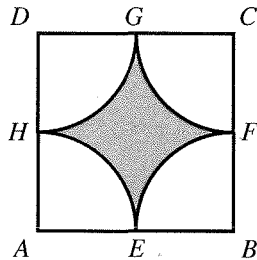


42. What real value of  $x$  satisfies the equation  $\log_5(25^2) = 2x$ ?

- F. 2  
G. 4  
H. 8  
J. 25  
K. 125

43. In the figure below, points  $E$ ,  $F$ ,  $G$ , and  $H$  are on the sides of square  $ABCD$ . Arc  $\widehat{EH}$  has center at  $A$ ,  $\widehat{EF}$  at  $B$ ,  $\widehat{FG}$  at  $C$ , and  $\widehat{GH}$  at  $D$ . All of the arcs have a radius of 3 feet. What is the area, in square feet, of the shaded region?

- A.  $24 - 6\pi$   
B.  $24 - 9\pi$   
C.  $36 - \frac{9}{2}\pi$   
D.  $36 - 3\pi$   
E.  $36 - 9\pi$



44. For all real values of  $x$  such that  $0 < x < \frac{\pi}{2}$ , which of the following expressions is NOT equivalent to  $\tan x$ ?

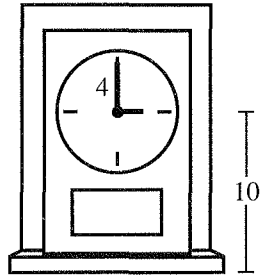
- F.  $\frac{1}{\cot x}$   
G.  $\frac{\sec x}{\csc x}$   
H.  $\frac{\sin x}{\cos x}$   
J.  $(\cos x)(\csc x)$   
K.  $(\sin x)(\sec x)$

45. A shirt has a sale price of \$30.40, which is 20% off the original price. How much less than the original price is the sale price?

- A. \$ 0.38  
B. \$ 1.52  
C. \$ 6.08  
D. \$ 7.60  
E. \$10.40

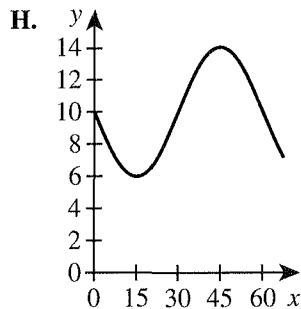
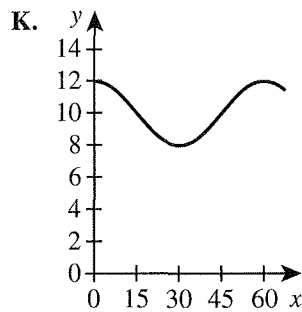
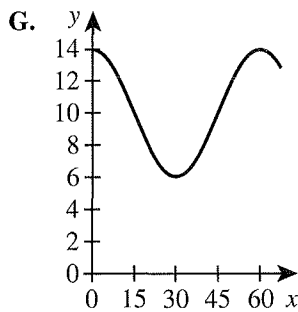
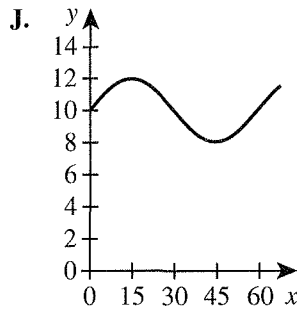
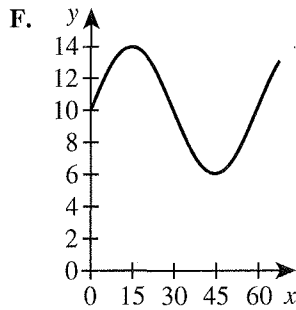


46. The clock shown below has a minute hand that is 4 inches long, and the center of the clock face is 10 inches above the bottom surface of the clock.



DO YOUR FIGURING HERE.

Let  $x$  be the time in minutes after the clock strikes 3:00. Let  $y$  be the height in inches that the end of the minute hand is above the bottom surface of the clock. One of the following graphs in the standard  $(x,y)$  coordinate plane shows the height,  $y$ , as a function of time,  $x$ . Which graph shows this relationship?



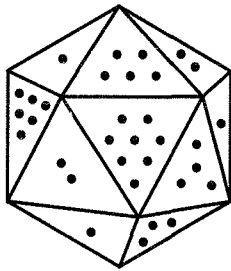


Use the following information to answer questions 47–49.

DO YOUR FIGURING HERE.

A *regular icosahedron* is a solid that has 20 congruent faces, each of which is an equilateral triangle. Each vertex is shared by 5 faces, and each edge is shared by 2 faces.

A specialty die used in a certain board game is in the shape of a regular icosahedron with a certain number of dots on each of the 20 faces. In the image below, 10 faces of the die are visible.



The table below lists the total number of faces on this die that have the given number of dots.

Number of dots	Number of faces
1	6
2	4
3	3
4	2
5	1
6	1
7	1
8	1
9	1

47. How many *edges* does the specialty die have?

- A. 10
- B. 18
- C. 20
- D. 30
- E. 36

48. What is the area, in square centimeters, of 1 face of the specialty die, given that the length of each of its edges is 2 centimeters?

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



49. When the specialty die is rolled, only 1 face will land on top. Each of its faces has the same probability of landing on top. Which of the following values is closest to the probability that the face that lands on top will have 3 dots?

A. 0.05  
 B. 0.14  
 C. 0.15  
 D. 0.18  
 E. 0.45

**DO YOUR FIGURING HERE.**

50. Tom is in Ms. Zhu's class. To choose 4 students from her class of 24 students to answer questions, Ms. Zhu will put 24 cards, each with the name of a different student from her class on it, in a box. Next, Ms. Zhu will randomly draw 4 cards from the box without replacing any of the cards. What is the probability that Tom's card will NOT be drawn?

F.  $\frac{1}{24}$   
 G.  $\frac{1}{6}$   
 H.  $\frac{19}{24}$   
 J.  $\frac{5}{6}$   
 K.  $\frac{23}{24}$

51. There are 2 sections of Algebra I taught at the local high school. The average score on the final exam for the 20 students in the first section was 74. The average score on the final exam for the 25 students in the second section was 92. What was the average of the final exam scores of students in Algebra I ?

A. 74  
 B. 78  
 C. 83  
 D. 84  
 E. 92

52. The table below gives some statistics based on the points Veronica earned on each of her first 3 math exams.

Statistic	Points
Median	80
Range	11
Maximum	90

If it can be determined, what is the mean number of points Veronica earned on her first 3 math exams?

F. 79  
 G. 80  
 H. 83  
 J. 85  
 K. Cannot be determined from the given information



DO YOUR FIGURING HERE.

53. A club has 30 members. The positions of president, vice president, and treasurer will be assigned to 3 distinct members. Which of the following expressions gives the maximum number of distinct assignments that can be made?

A.  $30^3$   
 B.  $30(3)$   
 C.  $30(29)(28)$   
 D.  $30(29)(28)(3)(2)(1)$   
 E.  $\frac{30(29)(28)}{3(2)(1)}$

54. Jane and Margaret moved to Newcity at the same time several years ago and have lived there ever since. Jane

has lived there  $\frac{1}{2}$  of her life, while Margaret has lived there  $\frac{3}{5}$  of her life. If  $j$  represents Jane's present age,

which of the following expressions represents Margaret's present age?

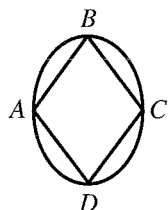
F.  $\frac{3j}{10}$   
 G.  $\frac{j}{2}$   
 H.  $\frac{5j}{6}$   
 J.  $\frac{6j}{5}$   
 K.  $2j$

55. When  $7^{126}$  is multiplied out, what is the digit in the ones place?

A. 1  
 B. 2  
 C. 3  
 D. 7  
 E. 9

56. Shown below is quadrilateral  $ABCD$  inscribed in an ellipse. The figure will be placed in the standard  $(x,y)$  coordinate plane, and the ellipse will be described by the equation  $\frac{x^2}{9} + \frac{(y-5)^2}{16} = 1$ . Given that  $\overline{AC}$  is the minor axis and  $\overline{BD}$  is the major axis of the ellipse, what will be the coordinates of points  $A$  and  $B$ ?

	point $A$	point $B$
F.	$(-9,0)$	$(0,16)$
G.	$(-9,5)$	$(0,21)$
H.	$(-3,0)$	$(0, 4)$
J.	$(-3,5)$	$(0, 9)$
K.	$(-3,5)$	$(4, 5)$



**DO YOUR FIGURING HERE.**

57. There are 90 equally spaced dots marked on a circle. Shannon chooses an integer,  $n$ . Beginning at a randomly chosen dot, Shannon goes around the circle clockwise and colors in every  $n$ th dot. He continues going around and around the circle coloring in every  $n$ th dot, counting each dot whether it is colored in or not, until he has colored in every dot. Which of the following could have been Shannon's integer  $n$ ?

A. 3  
B. 4  
C. 5  
D. 6  
E. 7

58. There are 100 file folders, each 0.45 inches thick, that will be placed in drawers. Each drawer can hold file folders with a combined thickness of no more than 7.5 inches. No folder is split between 2 drawers. All but one drawer will hold the maximum number of folders. What is the combined thickness, in inches, of the folders that are in the partially filled drawer?

F. 1.8  
G. 2.0  
H. 2.7  
J. 4.0  
K. 6.0

59. Which of the following expressions is equivalent to the

$$\text{sum } \frac{3}{x^2 - 9} + \frac{6}{x^2 + 3x - 18} ?$$

A.  $\frac{3x + 12}{(x - 1)(x + 1)(x + 2)}$   
B.  $\frac{9}{(x - 3)(x + 3)(x + 6)}$   
C.  $\frac{9}{2x^2 + 3x - 27}$   
D.  $\frac{9x}{(x - 3)^2(x + 6)}$   
E.  $\frac{9x + 36}{(x - 3)(x + 3)(x + 6)}$

60. For all positive  $x$  and  $y$ ,  $x^{\frac{1}{3}}y^{\frac{5}{4}}$  can be written in which of the following radical forms?

F.  $\sqrt[12]{xy^5}$   
G.  $\sqrt[12]{x^4y^3}$   
H.  $\sqrt[12]{x^5y^5}$   
J.  $y\sqrt[12]{x^4y^3}$   
K.  $xy\sqrt[12]{x^7y^7}$

**END OF TEST 2**

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

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

## READING TEST

35 Minutes—40 Questions

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

## Passage I

**LITERARY NARRATIVE:** The following excerpt is adapted from the short story "Unaccustomed Earth" by Jhumpa Lahiri (©2008 by Jhumpa Lahiri).

Ruma is trying to decide whether to ask her father, who is visiting, to move in with her family.

"My dad's planting flowers in the backyard," she told Adam that night on the phone.

"Does he plan to be around to take care of them?"

His flippancy irritated her, and she felt defensive  
5 on her father's behalf. "I don't know."

"It's Thursday, Ruma. How long are you going to torture yourself?"

She didn't feel tortured any longer. She had planned to tell Adam this, but now she changed her  
10 mind. Instead she said, "I want to wait a few more days. Make sure everyone gets along."

"For heaven's sake, Ruma," Adam said. "He's your father. You've known him all your life."

And yet, until now, she had not known certain  
15 things about him. She had not known how self-sufficient he could be, how helpful, to the point where she had not had to wash a dish since he'd arrived. At dinner he was flexible, appreciating the grilled fish and chicken breasts she began preparing after the Indian  
20 food ran out, making do with a can of soup for lunch. But it was her son Akash who brought out a side of her father that surprised Ruma most. In the evenings her father stood beside her in the bathroom as she gave Akash his bath, scrubbing the caked-on dirt from his  
25 elbows and knees. He helped put on his pajamas, brush his teeth, and comb back his soft damp hair. When Akash had fallen asleep one afternoon on the living-room carpet, her father made sure to put a pillow under his head, drape a cotton blanket over his body. By now  
30 Akash insisted on being read to at night by her father, sleeping downstairs in her father's bed.

The first night Akash slept with her father she went downstairs to make sure he'd fallen asleep. She saw a sliver of light under her father's door and heard

35 the sound of his voice, reading *Green Eggs and Ham*. She imagined them both under the covers, their heads reclining against the pillows, the book between them, Akash turning the pages as her father read. It was obvious that her father did not know the book by heart, as  
40 she did, that he was encountering it for the first time in his life. He read awkwardly, pausing between the sentences, his voice oddly animated as it was not in ordinary speech. Still, his effort touched her, and as she stood by the door she realized that for the first time in  
45 his life her father had fallen in love. She was about to knock and tell her father that it was past Akash's bedtime, that he should turn out the light. But she stopped herself, returning upstairs, briefly envious of her own son.

50 The garden was coming along nicely. It was a futile exercise, he knew. He could not picture his daughter or his son-in-law caring for it properly, noticing what needed to be done. In weeks, he guessed, it would be overgrown with weeds, the leaves chewed up  
55 by slugs. Then again, perhaps they would hire someone to do the job. He would have preferred to put in vegetables, but they required more work than flowers. It was a modest planting, some slow-growing myrtle and phlox under the trees, two azalea bushes, a row of hostas, a  
60 clematis to climb one of the posts of the porch, and in honor of his wife, a small hydrangea. In a plot behind the kitchen, unable to resist, he also put in a few tomatoes, along with some marigolds and impatiens; there was just time for a small harvest to come in by the fall.  
65 He spaced out the delphiniums, tied them to stalks, stuck some gladiola bulbs into the ground. He missed working outside, the solid feeling of dirt under his knees, getting into his nails, the smell of it lingering on his skin even after he'd scrubbed himself in the shower.  
70 It was the one thing he missed about the old house, and when he thought about his garden was when he missed his wife most keenly. She had taken that from him. For years, after the children had grown, it had just been the two of them, but she managed to use up all the vegetables, putting them into dishes he did not know how to  
75 prepare himself. In addition, when she was alive, they regularly entertained, their guests marveling that the potatoes were from their own backyard, taking away bagfuls at evening's end.

80 He looked over at Akash's little plot, the dirt carefully mounded up around his toys, pens and pencils



stuck into the ground. Pennies were there, too, all the spare ones he'd had in his pocket.

85 "When will the plants come out?" Akash called out from the swimming pool, where he stood crouching over a little sailboat.

"Soon."

"Tomorrow?"

90 "Not so soon. These things take time, Akash. Do you remember what I taught you this morning?"

And Akash recited his numbers in Bengali from one to ten.

1. The point of view from which the passage is told is best described as that of:
  - A. an unidentified narrator relating the thoughts and actions of both Ruma and Ruma's father.
  - B. an unidentified narrator relating the thoughts and actions of both Ruma and Adam.
  - C. Ruma, who relates her own thoughts and actions.
  - D. Ruma's father, who relates his own thoughts and actions.
2. The passage can best be described as an exploration of a:
  - F. family's ongoing disagreement.
  - G. family's shifting dynamics.
  - H. husband's relationship with his wife.
  - J. mother's struggle with raising a child.
3. Based on the passage, Akash's attitude toward Ruma's father can best be described as:
  - A. patient.
  - B. diffident.
  - C. resentful.
  - D. adoring.
4. In the context of the passage, the word "drape" (line 29) mainly serves to highlight the:
  - F. hasty way in which Akash covers himself with the blanket.
  - G. attentive way in which Ruma's father tends to Akash.
  - H. endearing way in which Akash is sprawled on the ground for his nap.
  - J. meticulous way in which Ruma's father tidies Ruma's home.
5. Which of the following statements most effectively summarizes the action described in the eighth paragraph (lines 32–49)?
  - A. Ruma goes to see if Akash is sleeping, overhears her father reading him a book, and decides not to interrupt them.
  - B. Ruma tells her father that it's past Akash's bedtime but allows Akash and her father to finish the book they are reading.
  - C. Ruma goes to get Akash ready for bed and overhears him and her father taking turns reading a book.
  - D. Ruma overhears her father reading Akash a book, tells her father that it's past Akash's bedtime, and returns upstairs.
6. Based on the passage, Ruma's father plants fewer vegetables in Ruma's garden than he would have liked because he:
  - F. knows that Ruma is unlikely to incorporate the vegetables into the meals she serves.
  - G. has lost interest in growing and harvesting most types of vegetables.
  - H. knows that Ruma and Adam are unlikely to put in the work it takes to tend the vegetables.
  - J. is worried that Akash will trample his vegetable plot.
7. In the context of the passage, the detail about the toys, pens, pencils, and pennies in the ground mainly serves to indicate that:
  - A. Akash often leaves his things in the backyard.
  - B. Ruma's father has more work to do in order to clean up Ruma's garden.
  - C. Ruma has neglected the garden in the backyard.
  - D. Akash has been inspired by his grandfather to start a garden of his own.
8. In the context of the passage, the detail that Ruma is "briefly envious of her own son" (lines 48–49) suggests that Ruma:
  - F. believes that her father and Akash's relationship is stronger than her and her father's relationship.
  - G. wishes that Akash would show her the same level of affection that he shows her father.
  - H. is less patient with Akash than she would like to be.
  - J. is less emotionally mature than Akash is.
9. According to the passage, Ruma's father plants a small hydrangea in the garden mainly because he:
  - A. knows that it is easy to take care of.
  - B. remembers that it is Ruma's favorite.
  - C. wants to honor his wife's memory.
  - D. believes it will bring Ruma and Adam good luck.
10. As it is used in line 64, the phrase *come in* most nearly means:
  - F. take part.
  - G. approach.
  - H. perform.
  - J. mature.

## Passage II

**SOCIAL SCIENCE:** This passage is adapted from the book *Atlantic* by Simon Winchester (©2010 by Simon Winchester).

The Minoans and Phoenicians are ancient cultures known for sailing the Mediterranean Sea. The Pillars of Hercules are the rocks on each side of the Strait of Gibraltar, which separates Spain from Morocco.

The Phoenicians were the first to build proper ships and to brave the rough waters of the Atlantic.

To be sure, the Minoans before them traded with great vigor and defended their Mediterranean trade routes with swift and vicious naval force. Their ships—built with tools of sharp-edged bronze—were elegant and strong: they were made of cypress trees, sawn in half and lapped together, with white-painted and sized linen stretched across the planks, and with a sail suspended from a mast of oak, and oars to supplement their speed. But they worked only by day, and they voyaged only between the islands within a few days' sailing of Crete; never once did any Minoan dare venture beyond the Pillars of Hercules, into the crashing waves of the Sea of Perpetual Gloom.

The Minoans, like most of their rival thalassocracies, accepted without demur the legends that enfolded the Atlantic, the stories and the sagas that conspired to keep even the boldest away. The waters beyond the Pillars, beyond the known world, beyond what the Greeks called the *oekumen*, the inhabited earth, were simply too fantastic and frightful to even think of braving. There might have been some engaging marvels: close inshore, the Gardens of the Hesperides, and somewhat farther beyond, that greatest of all Greek philosophical wonderlands, Atlantis. But otherwise the ocean was a place wreathed in terror: *I can find no way whatever of getting out of this gray surf*, Odysseus might well have complained, *no way out of this gray sea*. The winds howled too fiercely, the storms blew up without warning, the waves were of a scale and ferocity never seen in the Mediterranean.

Nevertheless, the relatively peaceable inland sea of the Western classical world was to prove a training ground, a nursery school, for those sailors who in time, and as an inevitable part of human progress, would prove infinitely more daring and commercially ambitious than the Minoans. At just about the time that Santorini erupted and, as many believe, gave the final fatal blow to Minoan ambitions, so the more mercantile of the Levantines awoke. From their sliver of coastal land—a sliver that, in time, would become Lebanon, Palestine, and Israel—the big Phoenician ships ventured out and sailed westward, trading, battling, dominating.

When they came to the Pillars of Hercules, some time around the seventh century B.C., they, unlike all of their predecessors, decided not to stop. Their captains, no doubt bold men and true, decided to sail right through, into the onrushing waves and storms, and see before all other men just what lay beyond.

The men from the port of Tyre appear to have been the first to do so. Their boats, broad-beamed, sickle-shaped “round ships” or *galloi*—so called because of the sinuous fat curves of the hulls, and often with two sails suspended from hefty masts, one at midships and one close to the forepeak—were made of locally felled and surprisingly skillfully machined cedar planks, fixed throughout with mortise and tenon joints and sealed with tar. Most of the long-haul vessels from Tyre, Byblos, and Sidon had oarsmen, too—double banks of thirteen oarsmen on either side of the larger ships, which gave them a formidable accelerative edge. Their decorations were grand and often deliberately intimidating—enormous painted eyes on the prow, many-toothed dragons and roaring tigers tipped with metal ram-blades, in contrast to the figureheads of women later beloved by Western sailors.

Phoenician ships were built for business. The famous Bronze Age wreck discovered at Uluburun in southern Turkey by a sponge diver in 1982 (and which, while not definitely Phoenician, was certainly typical of the period) displayed both the magnificent choice of trade goods available in the Mediterranean and the vast range of journeys to be undertaken. The crew on this particular voyage had evidently taken her to Egypt, to Cyprus, to Crete, to the mainland of Greece, and possibly even as far as Spain. When they sank, presumably when the cargo shifted in a sudden storm, the holds of the forty-five-foot-long *galloi* contained a bewildering and fatally heavy amassment of delights, far more than John Masfield, who wrote a poem about ships' cargoes, could ever have fancied. There were ingots of copper and tin, blue glass and ebony, amber, ostrich eggs, an Italian sword, a Bulgarian axe, figs, pomegranates, a gold scarab with the image of Nefertiti, a set of bronze tools, a ton of terebinth resin, hosts of jugs and vases and Greek storage jars, silver and gold earrings, and innumerable lamps.

11. In the fourth paragraph (lines 33–45), the focus of the passage shifts from information about the Minoans to a discussion of the:

- A. reasons that the Phoenicians traded with various other nations.
- B. shipbuilding and sailing prowess of the Phoenicians.
- C. first Phoenician ship to sail into and return from the Atlantic.
- D. specific journeys Phoenicians are known to have taken.

12. Based on the passage, the Minoans and Phoenicians were similar in that their primary reason for sailing was to:
- F. explore unknown regions.
  - G. trade with other nations.
  - H. conquer neighboring nations.
  - J. keep their lands safe from attack.
13. The passage makes clear that Minoan ships and Phoenician ships were similar in that most featured:
- A. mortise and tenon joints for stability.
  - B. hulls made from cypress trees.
  - C. oars for added speed.
  - D. two masts.
14. The main idea of the third paragraph (lines 16–32) is that the Minoans and other sailors at the time:
- F. created myths about the Atlantic to prevent people from exploring it.
  - G. told terrifying tales of the voyages they took near the Atlantic.
  - H. feared the Atlantic because of its storms and the legends told about it.
  - J. lacked the skills and tools necessary for navigating the Atlantic.
15. Details in the passage suggest that the author considers the Phoenicians' venturing into the Atlantic to be an act that was both:
- A. ambitious and unnecessary.
  - B. unwise and ill-fated.
  - C. brave and foolish.
  - D. courageous and inevitable.
16. Which of the following statements about Minoan sailors is most strongly supported by the passage?
- F. They frequently battled the Phoenicians.
  - G. They traded only with Greece and Egypt.
  - H. They sailed only during the daytime.
  - J. They painted elaborate designs on their ships.
17. The passage states that, according to many people, the fatal blow to Minoan ambitions occurred when:
- A. the Phoenicians reached the Pillars of Hercules.
  - B. the Minoans lost control of their trade routes.
  - C. Minoan was conquered.
  - D. Santorini erupted.
18. According to the passage, the first Phoenicians to sail through the Pillars of Hercules were most likely from:
- F. Crete.
  - G. Byblos.
  - H. Sidon.
  - J. Tyre.
19. In the passage, what contrast does the author establish between Phoenician ships and the Western ships that came later?
- A. Phoenician ships' decorations were designed to be more intimidating than those of Western ships that came later.
  - B. Phoenician ships' sails were designed to be stronger than those of Western ships that came later.
  - C. Phoenician ships' hull size was more impressive than that of Western ships that came later.
  - D. Phoenician ships' acceleration was more formidable than that of Western ships that came later.
20. Based on the passage, the statement that the ship discovered at Uluburun sank when the cargo shifted in a storm can best be described as a:
- F. fact supported by the damage that the ship's hull sustained in the storm.
  - G. fact supported by an entry in ancient shipping records.
  - H. reasoned judgment supported by the evidence of the heavy load the ship was carrying.
  - J. reasoned judgment supported by how the cargo was spread out on the seafloor.

### Passage III

**HUMANITIES:** Passage A is adapted from the article “Heroes and Wretches” by Suzie Mackenzie (©2004 by Guardian News and Media Limited). Passage B is adapted from the article “Alice Neel: The Art Modernism Neglected” by Jeremy Lewison (©2010 by Telegraph Media Group Limited).

#### Passage A by Suzie Mackenzie

Francis Bacon used to say that no artist in their lifetime can possibly know whether or not he/she is any good. Only time, he said, could sort out the twin perils that beset every artist: theory, by which “most people enter a painting”, and fashion—what an audience feels it should or should not be moved by. Bacon reckoned this “sort out” period to be somewhere between 75 and 100 years, by which time the artist would most likely be dead. For this reason, he also said, success in an artist’s lifetime is no indicator of greatness—on the contrary. Every artist works within a void “and will never know”.

In this sense, if no other, the American portrait artist Alice Neel can be said to have been lucky. She can never have had any expectations, because to be a woman and an artist on the cusp of the 20th century was to cast yourself into a void. Neel was born in 1900, into a middle-class Philadelphia family, at a time when, as Henry James had observed only 19 years earlier, to be a lady was to be a portrait. She worked all her long life: against the prevailing theory of what it was to be a woman, that it was not becoming for a woman to be an artist, to have a public life, that women were framed for the interior. And against fashion: she remained a figurative artist when the rest of the New York art establishment was in the grip of abstract expressionism. Neel doesn’t seem ever to have had any notion of “becoming” an artist, or even “being” an artist. She simply was an artist. Even after the mid-1970s, when she finally did become “fashionable”—helped by a major retrospective at New York’s Whitney Museum of American Art in 1974—Neel rarely took commissions. She painted for herself.

At the Victoria Miro Gallery in London is the first ever solo exhibition of Neel’s work in Europe—a collection spanning three decades, curated by Jeremy Lewison. Looking back now, 20 years after Neel’s death, it is possible to see how she took a quintessentially bourgeois form—the portrait—and radically transformed it, while making the innate constraints of portraiture work for her. Hers are not portraits as advertising, they don’t flatter the sitter or inspire envy in the viewer. You don’t look at a Neel painting and recognise power, affluence, beauty—though these ingredients may be there. Her greatest gift as a portraitist, Lewison says, is her psychological acuity.

#### Passage B by Jeremy Lewison

Neel had a natural flair for paint. She painted thick and thin, dry and wet, and in the later stages of her career ignored any conventions of finish, rather deciding for herself when a work was complete enough. At

50 times she felt that a painting had reached a point where to go further would spoil it. In some instances she painted a second version. Ultimately what mattered to Neel was to keep the painting fresh and alive.

In our present era portraiture has been relegated to 55 a minor art. The portrait survives largely in the wooden paintings commissioned by academic colleges or national portrait galleries from artists who have facility but little flair or psychological understanding or vision.

Photography has replaced painting as the means of 60 choice for portraiture but photography is concerned with capturing the moment. Painting is about the synthesis of time. Moreover a photograph, with its smooth reflective surface, printed by a chemical reaction or digitally manipulated with no material depth or presence, is entirely different from a painted portrait. 65

Neel’s work is an assimilation of many different moments and moods, a distillation of many hours of scrutiny of the subject that concludes in a single summarising image where the impressions captured over 70 time are related not simply through an image but through the material quality of paint, the flicks of the wrist and the movements of an arm, paint laid on hastily and contours outlined slowly.

Neel’s art displays a range of marks made in the 75 service of communicating an image rather than at the behest of any conceptual programme, for Neel is a natural painter and apparently unselfconscious.

Looking at Neel’s work now is to see a review of the twentieth century in New York. She represents 80 changes in fashion and social mores, racial and gender issues, class differential, political agendas, feminist advances; in short her work effortlessly reflects a century of change as much as that of any photographer from the same era. With the abandonment of the modernist project, museums and galleries now make room 85 for multiple voices to be heard, to uncover the art of those whom modernism neglected.

Questions 21–23 ask about Passage A.

21. The main purpose of the first paragraph of Passage A is to:
- A. establish the idea that artists who are popular during their lives tend to stand the test of time.
  - B. question Bacon’s ideas about artists’ long-term success and begin to debunk them.
  - C. argue that artists who manage to satisfy both theory and fashion will likely be successful.
  - D. present a philosophy of evaluating artistic success before considering one particular artist.

22. When the author of Passage A states that during Neel's time, "women were framed for the interior" (lines 22–23), she most nearly means that women were:
- F. often the subjects of commissioned portraits.
  - G. expected to lead private lives in the home.
  - H. thought to have superior interior design skills.
  - J. ineligible to paint portraits of public figures.
23. As it is used in line 25, the phrase "in the grip of" most nearly means:
- A. misled by.
  - B. forced into.
  - C. immersed in.
  - D. squeezed by.

Questions 24–27 ask about Passage B.

24. The claim in Passage B that "Neel is a natural painter and apparently unselfconscious" (lines 76–77) is one the author supports by:
- F. providing information about Neel's instructors and mentors.
  - G. describing Neel's approach to painting her portraits.
  - H. including statements Neel made during her lifetime.
  - J. discussing specific portraits Neel painted over the years.
25. Based on Passage B, compared to photographic portraits, painted portraits:
- A. are worth more money because they take longer to produce.
  - B. have become the method of choice for most artists.
  - C. represent the subject over time rather than in just one moment.
  - D. are not able to convey the richness of photographs.
26. The main idea of the last paragraph of Passage B is that Neel's work:
- F. reflected societal changes that occurred during her lifetime.
  - G. mostly depicted the concerns of the wealthy and influential.
  - H. caused changes in public policy in response to social ills.
  - J. proved that painting is a better medium than photography.
27. According to Passage B, compared to art museums during the era when modernism was at its height, today's art museums are:
- A. more likely to acquire the best modernist works.
  - B. more likely to feature previously neglected artists.
  - C. less likely to include the works of female artists.
  - D. less likely to exhibit photographic portraits.
- Questions 28–30 ask about both passages.
28. Both passages are written from the perspective of writers who are:
- F. supportive of Neel's work and want to bring attention to it.
  - G. critical of Neel's work and question her status as a great artist.
  - H. neutral in their feelings about Neel's importance.
  - J. uninformed about the significance of Neel's work.
29. Passage A differs from Passage B in that Passage A:
- A. explains why Neel was not discovered until the 1970s, while Passage B provides a history of the modernist movement.
  - B. describes the challenges Neel faced as an artist, while Passage B focuses on the art of portraiture and Neel's place in it.
  - C. shows how conforming to social norms ensured Neel's success, while Passage B examines Neel's biography.
  - D. focuses on Bacon's theory of evaluating artistic greatness, while Passage B applies that theory to Neel and her work.
30. Based on both passages, it can reasonably be inferred that during most of Neel's career, figurative portraits such as hers were generally considered by the art establishment to be:
- F. sophisticated.
  - G. unfashionable.
  - H. difficult to understand.
  - J. deserving of more attention.

## Passage IV

**NATURAL SCIENCE:** This passage is adapted from *Lost Discoveries: The Ancient Roots of Modern Science—from the Babylonians to the Maya* by Dick Teresi (©2002 by Dick Teresi).

Antoine-Laurent Lavoisier (1743–1794) was a financier, established a system of weights and measures that led to the metric system, lived through the early turmoil of the French Revolution, and was a pioneer in scientific agriculture. He has been called the father of modern chemistry, and, in the course of his busy life, he brought Europe out of the dark ages of that science.

One of Lavoisier's early contributions resulted from his boiling water for long periods of time. In eighteenth-century Europe, many scientists believed in transmutation. They thought, for instance, that water could be transmuted into earth, among other things. Chief among the evidence for this was water boiling in a pot. Solid residue forms on the inside surface. Scientists proclaimed this to be water turning into a new element. Robert Boyle, the great seventeenth-century British chemist and physicist who flourished a hundred years before Lavoisier, believed in transmutation. Having watched plants grow by soaking up water, he concluded, as many had before him, that water can be transformed into leaves, flowers, and berries. In the words of chemist Harold Goldwhite, of California State University, Los Angeles, "Boyle was an active alchemist."

Lavoisier noticed that weight was the key, and that measurement was critical. He poured distilled water into a special "tea kettle" called a pelican, an enclosed pot with a spherical cap, which caught the water vapor and returned it to the base of the pot via two handlelike tubes. He boiled the water for 101 days and found substantial residue. He weighed the water, the residue, and the pelican. The water weighed exactly the same. The pelican weighed slightly less, an amount equal to the weight of the residue. Thus, the residue was not a transmutation, but part of the pot—dissolved glass, silica, and other matter.

As scientists continued to believe that water was a basic element, Lavoisier performed another crucial experiment. He invented a device with two nozzles and squirted different gases from one into the other, to see what they made. One day, he mixed oxygen with hydrogen, expecting to get acid. He got water. He percolated the water through a gun barrel filled with hot iron rings, splitting the water back into hydrogen and oxygen and confirming that water was not an element.

Lavoisier measured everything, and on each occasion that he performed this experiment, he got the same numbers. Water always yielded oxygen and hydrogen in a weight proportion of 8 to 1. What Lavoisier saw was that nature paid strict attention to weight and proportion. Ounces or pounds of matter did not disappear or appear at random, and the same ratios of gases always

yielded the same compounds. Nature was predictable . . . and therefore malleable.

Ancient Chinese alchemy, circa 300 to 200 B.C., was built around the concept of two opposing principles. These could be, for example, active and passive, male and female, or sun and moon. The alchemists saw nature as having a circular balance. Substances could be transformed from one principle to another, and then rendered back to their original state.

A prime example is cinnabar, known commonly today as mercuric sulfide, a heavy red mineral that is the principal ore of mercury. Using fire, these early alchemists decomposed cinnabar into mercury and sulfur dioxide. Then they found that mercury would combine with sulfur to form a black substance called metacinnabar, "which then can be sublimed into its original state, the bright red cinnabar, when once more heated," according to science historian Wang Kuik. Both mercury's liquid quality and the cyclic transformation from cinnabar to mercury and back again gave it magical qualities. Kuik calls mercury "huandan, a cyclically transformed regenerative elixir" associated with longevity. These ancient practitioners became familiar with the concept that substances could be transformed and then come full circle to their original state. They developed exact proportions of the amounts of mercury and sulfur, as well as recipes for the exact length and intensity of the heating required. Most important, according to Kuik, these operations could be performed "without the slightest loss of the total weight."

It would appear that the ancient Chinese alchemists were empirically familiar with the conservation of mass fifteen hundred years before Lavoisier's experiment. He and his alchemist precursors discovered that the weight of the products in a chemical reaction equal the weight of the reactants.

31. In the sixth paragraph (lines 55–61), the focus of the passage shifts from a discussion of:

- Lavoisier's system of weights and measures to a description of ancient Chinese measurement systems.
- the findings of European alchemists to an explanation of how ancient Chinese alchemy undermined these findings.
- some of Lavoisier's most important scientific findings to a discussion of similar, earlier findings in China.
- Boyle's influence on Lavoisier's work to a discussion of how Chinese alchemists influenced Lavoisier's work.

32. One of the main purposes of the passage is to:
- F. provide a historical overview of how alchemy evolved.
  - G. highlight scientific experiments that prove that mass is always conserved.
  - H. demonstrate how ancient Chinese science experiments inform studies in science today.
  - J. describe the importance of a few chemical elements in famous historical experiments.
33. The passage suggests that, regarding the method Lavoisier used to conduct his experiments, what was most critical was:
- A. using the most accessible chemical elements.
  - B. inventing the equipment to use in his experiments.
  - C. consulting the research of his contemporaries.
  - D. ensuring precise measurements.
34. Based on the passage, Lavoisier's hydrogen-and-oxygen experiment and the ancient Chinese cinnabar experiment have in common the fact that they both:
- F. disproved earlier scientific theories about weight and proportion.
  - G. involved minerals associated with longevity.
  - H. transformed substances to different forms and then back to their original states.
  - J. required specially designed equipment.
35. The main purpose of the first paragraph is to introduce Lavoisier by:
- A. noting his varied accomplishments and historical importance.
  - B. describing his contributions to science and the French Revolution.
  - C. subtly questioning his title as the father of modern chemistry.
  - D. suggesting that his pioneering work in scientific agriculture brought Europe out of the Dark Ages.
36. The main idea of the second paragraph (lines 8–24) is that:
- F. in the eighteenth century, Boyle and Lavoisier were leading scientists who made significant contributions to alchemy.
  - G. Lavoisier hypothesized that boiled water would transmute into a new element.
  - H. Boyle developed the theory of transmutation after watching plants soak up water and grow leaves, flowers, and berries.
  - J. transmutation was a long-held theory that, among other things, explained why residue remained in a pot after boiling water.
37. It can logically be concluded that Lavoisier's hydrogen-and-oxygen experiment was "crucial" (line 38) mainly because it:
- A. was the first to mix naturally occurring elements.
  - B. refuted an established scientific belief.
  - C. introduced new methods of measurement.
  - D. led to the invention of a device used in other experiments.
38. As it is used in line 14, the word *forms* most nearly means:
- F. constitutes.
  - G. models.
  - H. arranges.
  - J. accumulates.
39. According to the passage, when Lavoisier first mixed oxygen with hydrogen, he expected to get:
- A. water.
  - B. acid.
  - C. vapor.
  - D. sulfur.
40. The example of the sun and moon in the passage helps illustrate the point that Chinese alchemists:
- F. focused on the concept of two opposing principles.
  - G. were some of the earliest scientific practitioners.
  - H. often transformed substances from one principle to another.
  - J. believed nature was predictable and malleable.

**END OF TEST 3**

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

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

## SCIENCE TEST

35 Minutes—40 Questions

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

You are NOT permitted to use a calculator on this test.

## Passage I

Jumping spiders prey on many types of small insects. Researchers predicted that the jumping spider *Habronattus pyrrithrix* would prefer prey of some colors over prey of other colors. Three experiments were conducted to test this prediction.

## Experiment 1

Small crickets (*Acheta domesticus*) were dyed either red, yellow, green, blue, or brown when they drank water containing a dye. Two crickets of each color were placed in the same box. Then, an *H. pyrrithrix* jumping spider that had been recently captured from the wild (wild-caught) was placed in the center of the box, and the color of each cricket eaten by the spider during 1 hr was recorded. Each time a cricket was eaten, an additional cricket of the same color was added to the box. This procedure was repeated with 99 additional wild-caught *H. pyrrithrix* jumping spiders. The average number of crickets of each color eaten in 1 hr is shown in Figure 1.

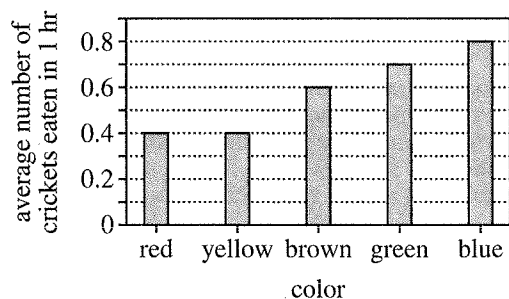


Figure 1

## Experiment 2

Experiment 1 was repeated using the same set of 100 wild-caught jumping spiders, which had been kept in cages in the laboratory for 4 weeks. The average number of crickets of each color eaten in 1 hr is shown in Figure 2.

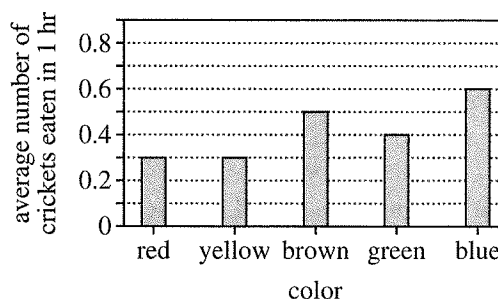


Figure 2

## Experiment 3

Experiment 1 was repeated except with 100 laboratory-raised *H. pyrrithrix* jumping spiders that had spent their entire lives in cages in the laboratory. The average number of crickets of each color eaten in 1 hr is shown in Figure 3.

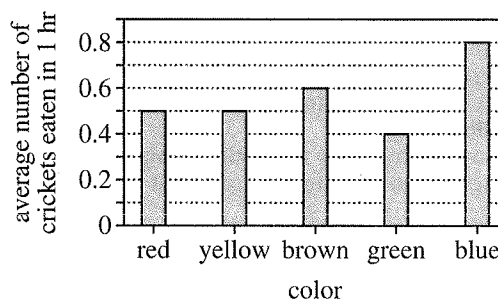


Figure 3

Figures adapted from Lisa A. Taylor et al., "Colour Use by Tiny Predators: Jumping Spiders Show Colour Biases During Foraging." ©2014 by The Association for the Study of Animal Behaviour.





1. Suppose that in a new experiment the researchers repeated Experiment 3 except that they recorded the color of each cricket eaten by a spider during 2 hr. Assuming that the spiders ate crickets for the entire 2 hr, would the total number of crickets eaten by the spiders more likely have been less than or greater than the total number of crickets eaten in Experiment 3 ?
  - A. Less, because the amount of time the spiders spent eating crickets would have been one-third as great.
  - B. Less, because the amount of time the spiders spent eating crickets would have been one-half as great.
  - C. Greater, because the amount of time the spiders spent eating crickets would have been two times as great.
  - D. Greater, because the amount of time the spiders spent eating crickets would have been three times as great.
2. Were the results of the experiments consistent with the researchers' prediction?
  - F. Yes; in each experiment, on average, the spiders ate the same number of crickets of each color in 1 hr.
  - G. Yes; in each experiment, on average, the spiders ate more blue crickets than crickets of any other given color in 1 hr.
  - H. No; in each experiment, on average, the spiders ate the same number of crickets of each color in 1 hr.
  - J. No; in each experiment, on average, the spiders ate more blue crickets than crickets of any other given color in 1 hr.
3. What was the total number of spiders needed to conduct Experiments 1–3 ?
  - A. 100
  - B. 200
  - C. 300
  - D. 400
4. A student wanted to determine if the results for wild-caught spiders tested shortly after they were captured would be the same for different species of prey. Which of the following experiments should the student conduct?
  - F. Repeat Experiment 1 with *A. domesticus* as the species of prey.
  - G. Repeat Experiment 3 with *A. domesticus* as the species of prey.
  - H. Repeat Experiment 1 with a species of prey other than *A. domesticus*.
  - J. Repeat Experiment 3 with a species of prey other than *A. domesticus*.
5. Each of the values plotted in Figure 1 was most likely calculated using which of the following expressions?
  - A. 
$$\frac{\text{Total number of crickets that were eaten by laboratory-raised spiders}}{\text{Number of laboratory-raised spiders}}$$
  - B. 
$$\frac{\text{Total number of crickets that were eaten by wild-caught spiders}}{\text{Number of wild-caught spiders}}$$
  - C. 
$$\frac{\text{Number of crickets of a particular color that were eaten by laboratory-raised spiders}}{\text{Number of laboratory-raised spiders}}$$
  - D. 
$$\frac{\text{Number of crickets of a particular color that were eaten by wild-caught spiders}}{\text{Number of wild-caught spiders}}$$
6. Which, if either, of the statements given below about the spiders tested in the experiments is(are) consistent with the information in the passage?
  - I. All the spiders belonged to the same genus.
  - II. All the spiders belonged to the same species.
  - F. I only
  - G. II only
  - H. Both I and II
  - J. Neither I nor II
7. Which of the following statements is best supported by the results of Experiments 1 and 2 ? After the wild-caught spiders had been kept in cages for 4 weeks, they ate, on average:
  - A. more green crickets in 1 hr than did the laboratory-raised spiders.
  - B. fewer green crickets in 1 hr than did the laboratory-raised spiders.
  - C. more crickets in 1 hr than they did when they had recently been captured from the wild.
  - D. fewer crickets in 1 hr than they did when they had recently been captured from the wild.

### Passage II

The Indian beech tree (*Millettia pinnata*) produces oil-rich seeds. The oil is inedible; however, it can be converted to *biodiesel fuel* in a chemical reaction with methanol (a solvent) and a catalyst. Scientists studied the production of biodiesel fuel from *M. pinnata* oil.

#### Experiment

In each trial, the following steps were performed:

1. Twenty mL of *M. pinnata* oil was mixed with 80 mL of methanol in a flask to form a solution.
2. A particular mass of a catalyst—either sodium hydroxide (NaOH) or potassium hydroxide (KOH)—was dissolved in the flask.

3. The flask was fitted with a temperature probe, sealed, placed in a microwave oven, and then microwaved until the contents reached 60°C.
4. The flask was maintained at 60°C in the microwave for a particular amount of time (the *microwave time*).
5. The flask was immersed in an ice water bath.
6. The amount of biodiesel fuel produced was measured, and the percentage of the *M. pinnata* oil that had been converted to biodiesel fuel was calculated.

For any given combination of conditions (identity of catalyst, concentration of catalyst, and microwave time), 4 trials were conducted. The table shows, for each set of trials, the experimental conditions and the average percent of the oil that was converted to biodiesel fuel.

Set of trials	Catalyst	Catalyst concentration (percent by mass)	Microwave time (min)	Average percent of <i>M. pinnata</i> oil converted to biodiesel fuel
1–4	NaOH	0.5	5	95.0
5–8	NaOH	1.0	5	91.2
9–12	NaOH	1.5	5	N.D.*
13–16	KOH	0.5	5	89.2
17–20	KOH	1.0	5	96.0
21–24	KOH	1.5	5	95.0
25–28	NaOH	1.0	3	93.2
29–32	NaOH	1.0	7	96.4
33–36	KOH	1.0	3	88.6
37–40	KOH	1.0	7	96.5
41–44	KOH	1.0	10	97.3
*N.D.—Not determined.				

Table adapted from M. L. Savaliya and B. Z. Dholakiya, "Chemical Transformation of Triglycerides of Fatty Acid of *Pongamia pinnata* Seed to Fatty Acid Methyl Esters by Microwave Irradiation." ©2013 by M. L. Savaliya and B. Z. Dholakiya.

8. Which step was most likely performed to stop the reaction that was occurring in the flask?
- F. Step 3  
G. Step 4  
H. Step 5  
J. Step 6
9. According to the table, which of the following combinations of catalyst, catalyst concentration, and microwave time resulted in the *lowest* average percent of *M. pinnata* oil being converted to biodiesel fuel?
- |    | catalyst | catalyst concentration | microwave time |
|----|----------|------------------------|----------------|
| A. | NaOH     | 1.0%                   | 3 min          |
| B. | NaOH     | 1.0%                   | 7 min          |
| C. | KOH      | 1.0%                   | 7 min          |
| D. | KOH      | 1.5%                   | 5 min          |
10. Consider the results for each combination of catalyst concentration and microwave time that was tested. Compared with the average percent of *M. pinnata* oil converted to biodiesel fuel in the NaOH trials, the average percent of *M. pinnata* oil converted to biodiesel fuel in the KOH trials was:
- F. always higher.  
G. always lower.  
H. always the same.  
J. sometimes higher and sometimes lower.
11. Which of the following expressions gives the volume of methanol used in the experiment?
- A.  $\frac{80 \text{ mL methanol}}{\text{trial}} \times 11 \text{ trials}$   
B.  $\frac{80 \text{ mL methanol}}{\text{trial}} \times 44 \text{ trials}$   
C.  $\frac{100 \text{ mL methanol}}{\text{trial}} \times 11 \text{ trials}$   
D.  $\frac{100 \text{ mL methanol}}{\text{trial}} \times 44 \text{ trials}$
12. The average percent of *M. pinnata* oil converted to biodiesel fuel in Trials 25–28 differed from that in Trials 33–36 because the 2 sets of trials differed with respect to the:
- F. identity of the catalyst.  
G. concentration of the catalyst.  
H. microwave time.  
J. temperature at which the flask was maintained.
13. For the trials conducted with 1.0% KOH by mass, as the microwave time increased, the average percent of *M. pinnata* oil converted to biodiesel fuel:
- A. increased only.  
B. decreased only.  
C. increased and then decreased.  
D. decreased and then increased.
14. The solution formed in Step 1 of each trial had a mass of 82 g. Based on this information and the table, the mass of the catalyst added to the flask in Step 2 of Trial 5 was closest to which of the following?
- F. 0.4 g  
G. 0.8 g  
H. 4 g  
J. 8 g

### Passage III

Heating degree-days (HDD) and cooling degree-days (CDD) are used to estimate the amount of energy needed to heat or cool, respectively, any building on a given day. HDD are calculated by subtracting the daily mean temperature ( $T_d$ ) from a base temperature of 65°F. Each degree difference is one HDD. CDD are calculated by subtracting 65°F from  $T_d$ .

Table 1			
City	Latitude	Annual total:	
		HDD	CDD
Miami, FL	25°47' N	114	4,625
Dallas, TX	32°47' N	452	4,740
Los Angeles, CA	34°03' N	1,400	680
Denver, CO	39°44' N	6,596	1,110
New York, NY	40°40' N	4,965	1,076
Chicago, IL	41°53' N	6,684	1,043
Boston, MA	42°21' N	5,726	917
Minneapolis, MN	44°59' N	8,195	1,077
Seattle, WA	47°37' N	2,630	3,033
Anchorage, AK	61°31' N	9,726	88

Note: HDD = 65°F -  $T_d$  for all  $T_d < 65^\circ\text{F}$ ;  
CDD =  $T_d - 65^\circ\text{F}$  for all  $T_d > 65^\circ\text{F}$

Table 1 lists, for each of 10 US cities, the latitude of the city and the city's total HDD and CDD for a 1 yr period.

For the state of Illinois, the annual total HDD and the annual total CDD were determined for each of the years 1985–2010 (see Figure 1).

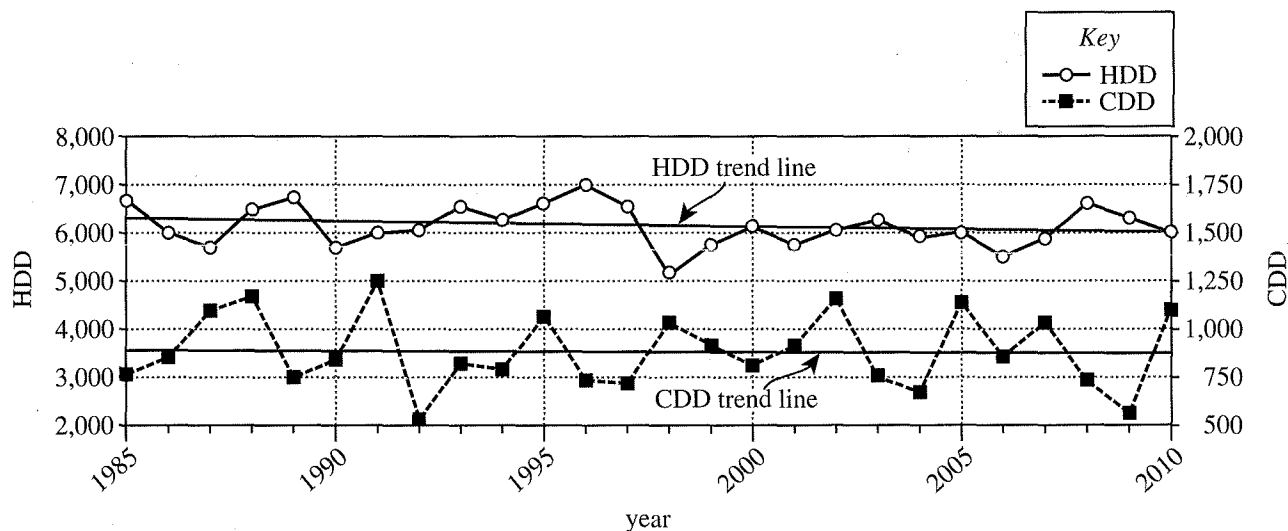


Figure 1

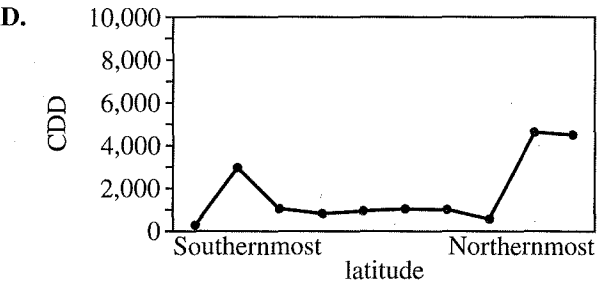
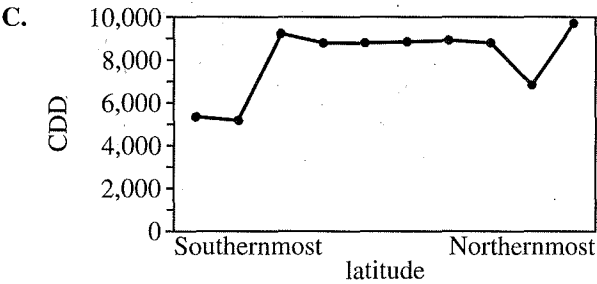
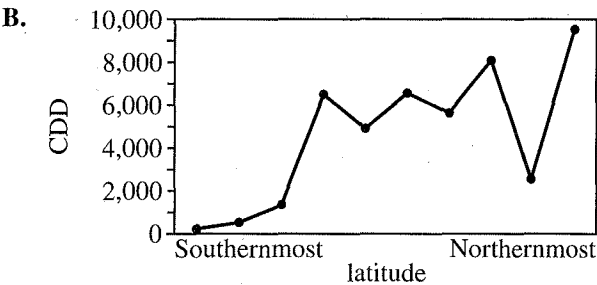
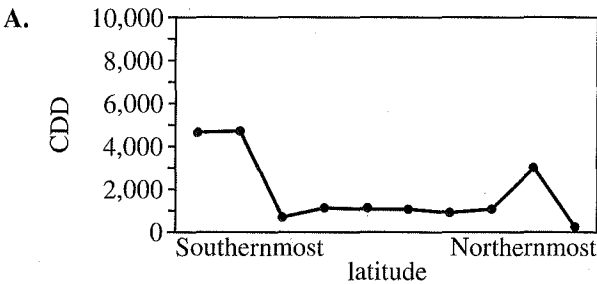
15. According to Figure 1, did the maximum HDD occur during the same year as the minimum CDD ?
- A. Yes; the maximum HDD and the minimum CDD both occurred in 1992.
  - B. Yes; the maximum HDD and the minimum CDD both occurred in 1996.
  - C. No; the maximum HDD occurred in 1992, whereas the minimum CDD occurred in 1996.
  - D. No; the maximum HDD occurred in 1996, whereas the minimum CDD occurred in 1992.

16. Based on Table 1, in Dallas, the total CDD was approximately how many times as great as the total HDD ?
- F.  $\frac{1}{10}$
  - G.  $\frac{1}{5}$
  - H. 5
  - J. 10

17. Based on Table 1, for all the cities between 40°N and 50°N latitude, which of the following statements describing HDD or CDD is accurate? In a 1 yr period, the total:
- A. HDD was always greater than 2,500.
  - B. HDD was always greater than the total CDD.
  - C. CDD was always greater than 1,000.
  - D. CDD was always greater than the total HDD.

18. Assume that on a particular day,  $T_d = 65^{\circ}\text{F}$ . For this day, what HDD value would be calculated and what CDD value would be calculated?
- |    | HDD | CDD |
|----|-----|-----|
| F. | 0   | 0   |
| G. | 0   | 5   |
| H. | 5   | 0   |
| J. | 5   | 5   |

19. Which of the following graphs best illustrates the latitude and the CDD for each of the cities listed in Table 1 ?



20. Consider the HDD equation and the HDD trend line shown in Figure 1. The slope of that trend line is negative, which indicates that, over the 26 yr period, the average value of  $T_d$ :
- F. decreased only.
  - G. increased only.
  - H. remained constant.
  - J. decreased and then increased.

### Passage IV

The amoeba *Entamoeba histolytica* can infect the human digestive tract. Scientists conducted 2 experiments to study the *amoebicidal* (amoeba-killing) activity of human milk.

#### Experiment 1

Ten milliliters of a mixture of *nutrient medium* (NM) and *saline solution* (SS) that was 5% SS by volume was put in a test tube. This procedure was performed twice more, except that the percents by volume of SS were 10% and 15%, respectively. Ten milliliters of only NM was put in a fourth test tube. Next,  $1 \times 10^7$  *E. histolytica* were added to each test tube. Then, a second set of test tubes was likewise prepared, except that human milk was substituted for SS. All 8 test tubes were incubated at 37°C for 1 hr. At the end of incubation, the *percent survival* (percent of the added *E. histolytica* that were still alive) was determined for each test tube (see Figure 1).

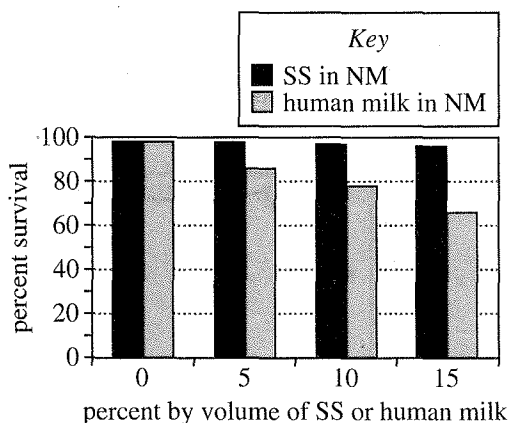


Figure 1

#### Experiment 2

A sample of human milk was separated into 3 fractions: *casein* (a protein), *lipids*, and *noncasein proteins*. Ten milliliters of a mixture of NM and SS that was 10% SS by volume was put in a test tube. This procedure was repeated 3 times, except that each time a different human milk fraction was substituted for SS. Next,  $1 \times 10^7$  *E. histolytica* were added to each of the test tubes. Then, 2 more sets of 4 test tubes were likewise prepared. Each set of test tubes was incubated at 37°C for a different period of time: 3 hr, 6 hr, or 9 hr. At the end of incubation, the percent survival was determined for each test tube (see Figure 2).

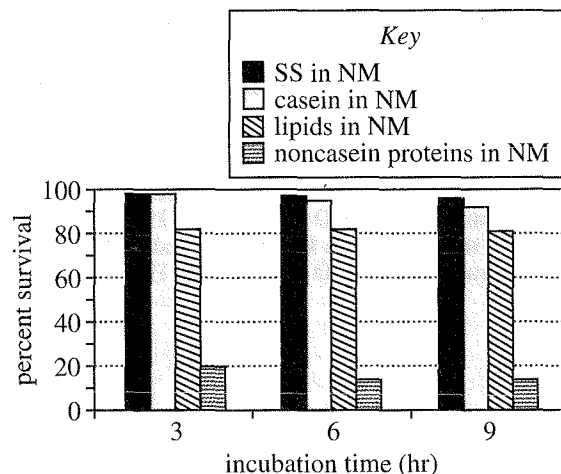
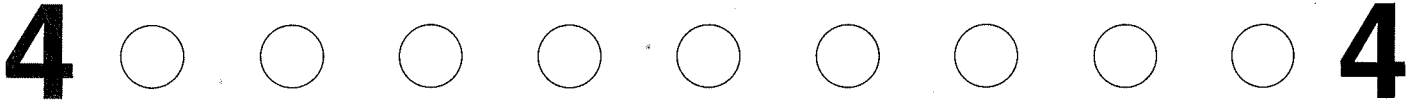


Figure 2

Figures adapted from Nidia León-Sicaïros et al., "Amoebicidal Activity of Milk, Apo-lactoferrin, sIgA and Lysozyme." ©2006 by Marshfield Clinic.

21. In Experiment 2, at each incubation time, which NM mixture resulted in the *fewest* surviving *E. histolytica*?
  - A. SS in NM
  - B. Casein in NM
  - C. Lipids in NM
  - D. Noncasein proteins in NM
22. In Experiment 2, for which of the incubation times did the scientists include a control to determine whether a substantial decrease in *E. histolytica* survival occurred in the absence of a human milk fraction?
  - F. 3 hr only
  - G. 6 hr only
  - H. 9 hr only
  - J. All 3 incubation times
23. Suppose that an incubation time of 12 hr had been tested in Experiment 2. The percent survival of the *E. histolytica* in the test tube containing lipids in NM would most likely have been closest to which of the following values?
  - A. 15%
  - B. 20%
  - C. 80%
  - D. 95%



24. Which of the following questions were the scientists most likely attempting to answer in Experiment 1 ?
- F. Is the percent survival of *E. histolytica* exposed to SS and *E. histolytica* exposed to human milk affected by increasing incubation time from 1 hr to 3 hr ?
  - G. Is the percent survival of *E. histolytica* exposed to SS and *E. histolytica* exposed to lipids affected by increasing incubation time from 1 hr to 3 hr ?
  - H. Does the percent survival for *E. histolytica* exposed to the casein fraction differ from the percent survival for *E. histolytica* exposed to the lipids fraction?
  - J. Does the percent survival for *E. histolytica* exposed to human milk differ from the percent survival for *E. histolytica* exposed to SS ?
25. In Experiment 1, the dye *trypan blue* was added to each test tube at the end of incubation. Dead *E. histolytica* are stained by trypan blue; living *E. histolytica* are NOT stained by trypan blue. Approximately what percent of the *E. histolytica* in the test tube containing 10% human milk in NM were stained by the trypan blue?
- A. 10%
  - B. 20%
  - C. 80%
  - D. 100%
26. To best compare the amoebicidal activity of each of the 3 human milk fractions tested in Experiment 2 to the amoebicidal activity of human milk that has not been separated into fractions, the scientists should repeat the procedures of:
- F. Experiment 1, except include a test tube containing a mixture of NM and noncasein proteins in each set of test tubes.
  - G. Experiment 1, except include a test tube containing a mixture of NM and human milk in each set of test tubes.
  - H. Experiment 2, except include a test tube containing a mixture of NM and noncasein proteins in each set of test tubes.
  - J. Experiment 2, except include a test tube containing a mixture of NM and human milk in each set of test tubes.
27. An *E. histolytica* possesses which of the following pairs of characteristics?
- A. Has a nucleus; is unicellular
  - B. Has a nucleus; is multicellular
  - C. Does not have a nucleus; is unicellular
  - D. Does not have a nucleus; is multicellular



### Passage V

For a demonstration on electric current, a teacher mounted 2 identical copper cables vertically and connected the cables to switch boxes as shown in Figure 1.

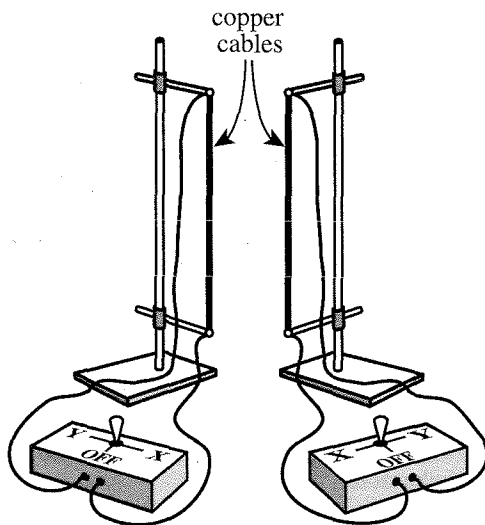


Figure 1

Each switch had 3 positions: X, Y, and OFF. The teacher flipped both switches from the OFF position to Position X, and the cables bent toward each other. Then, she flipped one switch to Position Y, and the cables bent away from each other. Finally, she flipped the other switch to Position Y, and the cables bent toward each other. See Figure 2.

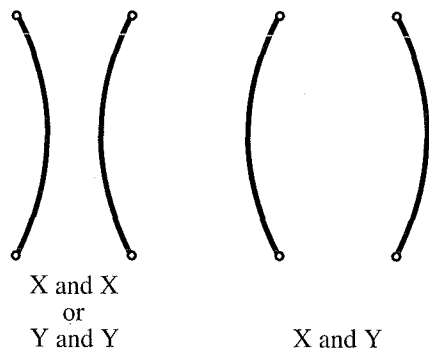


Figure 2

The teacher asked each of 3 students to explain these observations.

#### Student 1

The switches controlled the direction of current flow through the cables: upward in Position X and downward in Position Y.

Each current generated an electric field. Because each current consisted of positive charges, its field pointed in the direction of current flow. Electric fields attract each other when parallel and repel each other when *antiparallel* (pointing in opposite directions). The field generated by one current attracted or repelled the field generated by the other current.

#### Student 2

The switches controlled the direction of current flow as Student 1 described; however, the currents consisted of negative charges.

Each current generated a magnetic field. A magnetic field exerts a force on any charge in motion, and this force is always perpendicular to the direction of the charge's motion. When the currents were parallel, the field generated by one current attracted the charges in the other current. When the currents were antiparallel, the field generated by one current repelled the charges in the other current.

#### Student 3

The switches controlled the signs of charges in the currents: positive in Position X and negative in Position Y.

Regardless of whether they are at rest or in motion, charges of like sign attract each other and charges of opposite signs repel each other. The charges in one current attracted or repelled the charges in the other current.





28. Each of the following statements was either claimed or implied by Student 3. Which is scientifically *inaccurate*?

F. Charges of like sign attract each other.  
 G. Charges can be at rest.  
 H. A current consists of charges in motion.  
 J. There are 2 possible signs for electric charge: positive and negative.

29. Assume that the currents in the demonstration consisted of a single type of charged particle. If Student 2's explanation is correct, these particles were most likely:

A. protons.  
 B. electrons.  
 C. neutrons.  
 D. photons.

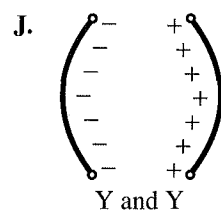
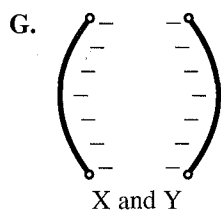
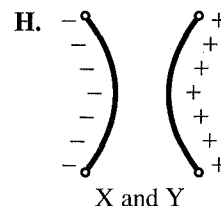
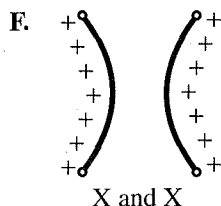
30. If Student 2's explanation is correct, then a magnetic field would be expected to exert a force on which of the following objects?

F. An ion in motion  
 G. An ion at rest  
 H. A neutral atom in motion  
 J. A neutral atom at rest

31. Based on Student 1's explanation, when the switch on the left was in Position X and the switch on the right was in Position Y, were the electric fields generated by the currents parallel or antiparallel?

A. Parallel, because the currents were both flowing upward.  
 B. Parallel, because the currents were both flowing downward.  
 C. Antiparallel, because the left-hand current was flowing upward and the right-hand current was flowing downward.  
 D. Antiparallel, because the left-hand current was flowing downward and the right-hand current was flowing upward.

32. Which of the following figures is consistent with both Figure 2 and Student 3's explanation?



33. In regard to attractive and repulsive interactions, how does Student 1's explanation differ from Student 2's explanation? Student 1 claimed that:

A. a field attracts or repels another field, whereas Student 2 claimed that a field attracts or repels charges.  
 B. a field attracts or repels charges, whereas Student 2 claimed that a field attracts or repels another field.  
 C. charges attract or repel fields, whereas Student 2 claimed that charges attract or repel other charges.  
 D. charges attract or repel other charges, whereas Student 2 claimed that charges attract or repel fields.

34. Which of the following procedures would best test Student 2's explanation? With current flowing through 1 of the cables, determine if:

F. a positively charged plastic rod, when held at rest near the cable, attracts or repels the cable.  
 G. a compass needle is deflected when brought near the cable.  
 H. an uncharged rubber strip, when held at rest near the cable, bends toward or away from the cable.  
 J. a lightbulb is illuminated when connected to the cable.

## Passage VI

Figure 1 shows how the  $H_2O$  vapor pressure (the pressure exerted by the  $H_2O$  vapor in air) varies with the relative humidity ( $RH$ ) of the air at CTP, which denotes a constant temperature of  $25^\circ\text{C}$  and pressure of 101,325 pascals (Pa). Figure 2 shows how air density varies with  $H_2O$  vapor pressure at CTP.

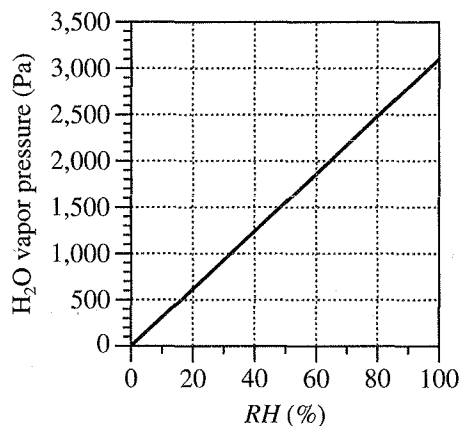


Figure 1

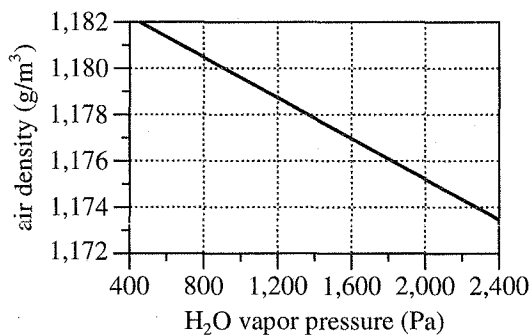


Figure 2

At CTP, the air above an aqueous solution in a closed container has a constant  $RH$ . Figure 3 shows, for 3 compounds, how the  $RH$  of the air at CTP in a closed container varies with the percent by mass of the compound dissolved in the aqueous solution in the container.

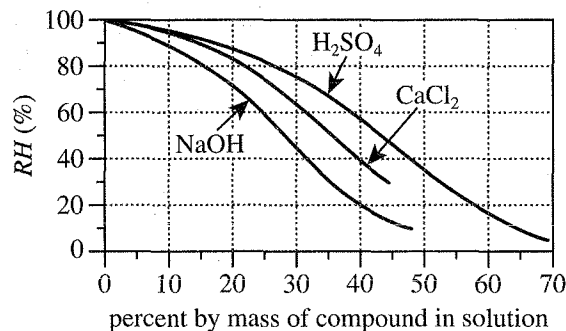


Figure 3

Figure 3 adapted from James G. Speight, *Lange's Handbook of Chemistry*, 16th ed. ©2005 by McGraw-Hill, Inc.

35. Based on Figures 1 and 2, as  $RH$  increases from 20% to 80% at CTP, air density:
- decreases only.
  - increases only.
  - decreases, then increases.
  - increases, then decreases.
36. Based on Figure 2, air at CTP that has a density of  $1,172 \text{ g}/\text{m}^3$  will have an  $H_2O$  vapor pressure closest to which of the following?
- 2,400 Pa
  - 2,700 Pa
  - 3,000 Pa
  - 3,300 Pa



37. According to Figure 3, at CTP, if pure  $\text{H}_2\text{O}$  is kept in a closed container, the  $RH$  of the air in the container will be:
- A. 0%.
  - B. 40%.
  - C. 80%.
  - D. 100%.
38. Based on Figure 2, will a 1 L sample of air at CTP have a greater mass if it has an  $\text{H}_2\text{O}$  vapor pressure of 1,000 Pa or if it has an  $\text{H}_2\text{O}$  vapor pressure of 2,000 Pa?
- F. 1,000 Pa, because it will be less dense.
  - G. 1,000 Pa, because it will be more dense.
  - H. 2,000 Pa, because it will be less dense.
  - J. 2,000 Pa, because it will be more dense.
39. Consider a 35% by mass aqueous solution of  $\text{H}_2\text{SO}_4$  in a closed container. Based on Figures 1–3, if the air above the solution in the container is at CTP, the density of the air will be closest to which of the following?
- A. 1,172  $\text{g/m}^3$
  - B. 1,175  $\text{g/m}^3$
  - C. 1,178  $\text{g/m}^3$
  - D. 1,181  $\text{g/m}^3$
40. Consider two 20% by mass aqueous solutions, one of  $\text{NaOH}$  and one of  $\text{H}_2\text{SO}_4$ , each in a separate, closed container. A student claimed that the  $\text{H}_2\text{O}$  vapor pressure at CTP will be greater in the air above the  $\text{H}_2\text{SO}_4$  solution than it will be in the air above the  $\text{NaOH}$  solution. Do Figures 1 and 3 support this claim?
- F. No, because a higher  $RH$  results from the  $\text{NaOH}$  solution.
  - G. No, because a higher  $RH$  results from the  $\text{H}_2\text{SO}_4$  solution.
  - H. Yes, because a higher  $RH$  results from the  $\text{NaOH}$  solution.
  - J. Yes, because a higher  $RH$  results from the  $\text{H}_2\text{SO}_4$  solution.

**END OF TEST 4**

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