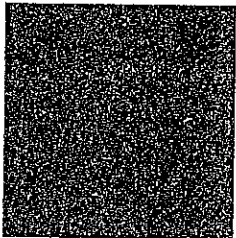


# Form A11

(June 2018)



The **ACT**<sup>®</sup>

2017|2018

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

If you wish to order a photocopy of your answer document—including, if you took the writing test, a copy of your written essay—please use the order form on the inside back cover of this booklet.



## 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. Xuan sold 9 used books for \$9.80 each. With the money from these sales, she bought 4 new books and had \$37.80 left over. What was the average amount Xuan paid for each new book?

- A. \$ 5.60
- B. \$ 9.45
- C. \$10.08
- D. \$12.60
- E. \$22.05

**DO YOUR FIGURING HERE.**

2. A point at  $(-5,7)$  in the standard  $(x,y)$  coordinate plane is translated right 7 coordinate units and down 5 coordinate units. What are the coordinates of the point after the translation?

- F.  $(-12,12)$
- G.  $(0, 0)$
- H.  $(2, 2)$
- J.  $(2,12)$
- K.  $(12,12)$

3. Shantiel left her home at 9:00 a.m. on Tuesday and traveled 648 miles. When she arrived at her destination it was 3:00 a.m. the next day. Given that her home and her destination are in the same time zone, which of the following is closest to her average speed, in miles per hour, for this trip?

- A. 72
- B. 54
- C. 36
- D. 31
- E. 18



4. The text message component of each of Juan's monthly phone bills consists of \$10.00 for the first 300 text messages sent that month, plus \$0.10 for each additional text message sent that month. On Juan's most recent phone bill he was charged a total of \$16.50 for text messages. For how many text messages in total was Juan charged on this bill?

F. 235  
 G. 285  
 H. 315  
 J. 365  
 K. 465

DO YOUR FIGURING HERE.

5. Which of the following matrices is equal to

$$\begin{bmatrix} 9 & 8 \\ -4 & 7 \end{bmatrix} + \begin{bmatrix} -6 & 6 \\ 5 & 4 \end{bmatrix} ?$$

A.  $\begin{bmatrix} 3 & 14 \\ 1 & 11 \end{bmatrix}$

B.  $\begin{bmatrix} 3 & 14 \\ 9 & 11 \end{bmatrix}$

C.  $\begin{bmatrix} 15 & 14 \\ 9 & 11 \end{bmatrix}$

D.  $\begin{bmatrix} 17 & 0 \\ 3 & 9 \end{bmatrix}$

E.  $\begin{bmatrix} -14 & 86 \\ 59 & 4 \end{bmatrix}$

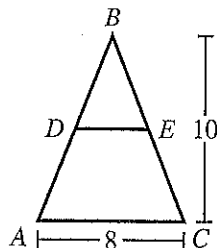
6. A function,  $f$ , is defined by  $f(x,y) = 3x^2 - 4y$ . What is the value of  $f(4,3)$ ?

F. 11  
 G. 24  
 H. 36  
 J. 65  
 K. 132

7. A certain group consists of 5 children, 3 of whom are age 10 and 2 of whom are age 5. What is the mean age of the children in the group?

A. 5  
 B. 7  
 C. 7.5  
 D. 8  
 E. 10

8. In the figure shown below,  $\overline{AC} \parallel \overline{DE}$ ;  $BD = AD$ ;  $D$  and  $E$  are on  $\overline{AB}$  and  $\overline{BC}$ , respectively;  $AC = 8$  feet; and the height of  $\triangle ABC$  is 10 feet. What is  $DE$ , in feet?



F. 2  
 G. 3  
 H. 4  
 J. 5  
 K. 6



9. In a poll of 500 registered voters, 337 voters favored a proposal to increase funding for local schools. Suppose the poll is indicative of how the 22,000 registered voters will vote on the proposal. Which of the following values is closest to how many of the 22,000 registered voters will be expected to vote in favor of the proposal?

A. 13,200  
 B. 14,830  
 C. 21,840  
 D. 22,000  
 E. 32,640

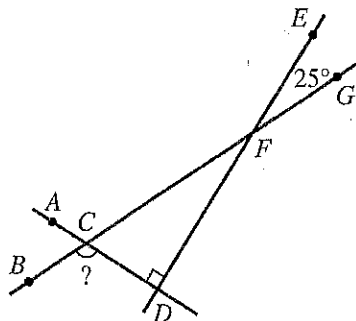
10. Diego purchased a car that had a purchase price of \$13,400, which included all other costs and tax. He paid \$400 as a down payment and got a loan for the rest of the purchase price. Diego paid off the loan by making 48 payments of \$300 each. The total of all his payments, including the down payment, was how much more than the car's purchase price?

F. \$ 1,000  
 G. \$ 1,400  
 H. \$13,000  
 J. \$14,400  
 K. \$14,800

11. In the standard  $(x,y)$  coordinate plane, what is the slope of the line  $4x + 7y = 9$  ?

A.  $-\frac{4}{7}$   
 B.  $\frac{4}{9}$   
 C.  $-4$   
 D.  $4$   
 E.  $9$

12. In the figure below,  $\overleftrightarrow{AD}$  intersects  $\overleftrightarrow{BG}$  at  $C$  and is perpendicular to  $\overleftrightarrow{DE}$ . Line  $\overleftrightarrow{DE}$  intersects  $\overleftrightarrow{BG}$  at  $F$ . Given that the measure of  $\angle EFG$  is  $25^\circ$ , what is the measure of  $\angle BCD$  ?



F.  $65^\circ$   
 G.  $115^\circ$   
 H.  $120^\circ$   
 J.  $130^\circ$   
 K.  $155^\circ$

DO YOUR FIGURING HERE.



13. What is the sum of the 2 solutions of the equation  $x^2 + x - 30 = 0$ ?

A. -30  
 B. -6  
 C. -1  
 D. 0  
 E. 5

DO YOUR FIGURING HERE.

14. The volume of a sphere is  $\frac{4\pi r^3}{3}$ , where  $r$  is the radius of the sphere. What is the volume, in cubic yards, of a sphere with a *diameter* of 4 yards?

F.  $\frac{32}{3}\pi$

G.  $\frac{64}{3}\pi$

H.  $32\pi$

J.  $48\pi$

K.  $\frac{256}{3}\pi$

15. What is the smallest integer greater than  $\sqrt{85}$ ?

A. 5  
 B. 9  
 C. 10  
 D. 12  
 E. 43

16. The 3 statements below are true for the elements of sets  $A$ ,  $B$ ,  $C$ , and  $D$ .

- I. All elements of  $A$  are elements of  $B$ .  
 II. All elements of  $C$  are elements of  $D$ .  
 III. No elements of  $D$  are elements of  $B$ .

Which of the following statements *must* be true?

- F. All elements of  $A$  are elements of  $C$ .  
 G. All elements of  $B$  are elements of  $D$ .  
 H. All elements of  $C$  are elements of  $B$ .  
 J. No elements of  $A$  are elements of  $B$ .  
 K. No elements of  $A$  are elements of  $C$ .

17. In the standard  $(x,y)$  coordinate plane, the midpoint of  $\overline{AB}$  is at  $(2,1)$ , and  $A$  is at  $(8,10)$ . What is the  $x$ -coordinate of  $B$ ?

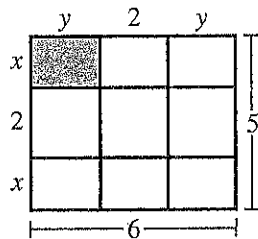
A. -4  
 B. -6  
 C. -8  
 D. 3  
 E. 5



18. Lena will pick 1 card at random from a pack of 25 baseball cards. Each card features the fielding position for 1 of 25 different baseball players. Each player in the pack has only 1 fielding position. The table below lists the frequency of fielding positions in the pack. What is the probability that the card Lena picks will feature an outfielder or a pitcher?

Fielding position	Frequency
Catcher	4
Infielder	6
Pitcher	8
Outfielder	7

- F. 9%  
 G. 28%  
 H. 32%  
 J. 56%  
 K. 60%
19. According to a soil analysis, a certain lawn requires an application of 40.0 kg of nitrogen phosphate when the average temperature is 75.0°F. To avoid burning the grass, the required application amount decreases 1.2 kg for each 1.0°F that the average temperature is above 75.0°F. To the nearest 0.1 kg, what is the required application amount of nitrogen phosphate when the average temperature is 83.0°F?
- A. 30.4  
 B. 30.8  
 C. 33.3  
 D. 38.4  
 E. 38.8
20. In the figure below, all segments that meet do so at right angles. What is the area, in square units, of the shaded region?

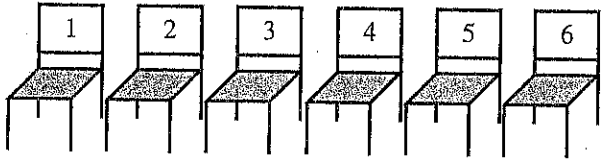


- F.  $2\frac{1}{4}$   
 G. 3  
 H.  $3\frac{1}{3}$   
 J. 4  
 K. 7
21. The perimeter of a certain scalene triangle is 100 inches. The side lengths of the triangle are represented by  $5x$ ,  $3x + 30$ , and  $2x + 10$ , respectively. What is the length, in inches, of the longest side of the triangle?
- A. 6  
 B. 22  
 C. 30  
 D. 48  
 E. 72

DO YOUR FIGURING HERE.



22. The mayor of Westbrook is deciding how to assign the 6 council members to the row of seats below.



From how many different arrangements can she choose?

- F. 21  
 G. 36  
 H. 64  
 J. 720  
 K. 6,000,000
23. The sum of 2 and 200% of 1 has the same value as which of the following calculations?
- A. 100% of 2  
 B. 150% of 2  
 C. 300% of 2  
 D. 300% of 1  
 E. 400% of 1

24. The graph in the standard  $(x,y)$  coordinate plane below is represented by one of the following equations. Which equation?

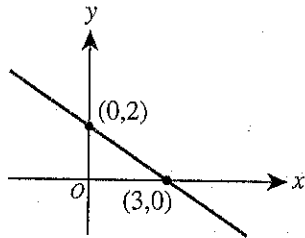
F.  $y = -\frac{3}{2}x + 2$

G.  $y = -\frac{3}{2}x + 3$

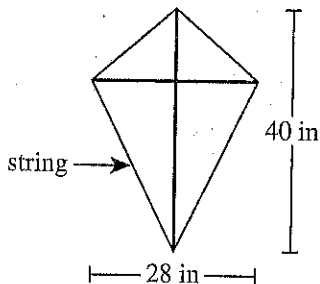
H.  $y = -\frac{2}{3}x + 2$

J.  $y = -\frac{2}{3}x + 3$

K.  $y = \frac{2}{3}x + 2$



25. Kamini is constructing the kite shown below. The kite includes 2 perpendicular supports, one of length 40 inches and the other of length 28 inches. The ends of the supports are connected with string to form a 4-sided figure that is symmetric with respect to the longer support. A layer of paper will cover the interior of the 4-sided figure. Which of the following is closest to the area, in square inches, that Kamini will cover with paper?



- A. 101  
 B. 280  
 C. 560  
 D. 840  
 E. 980

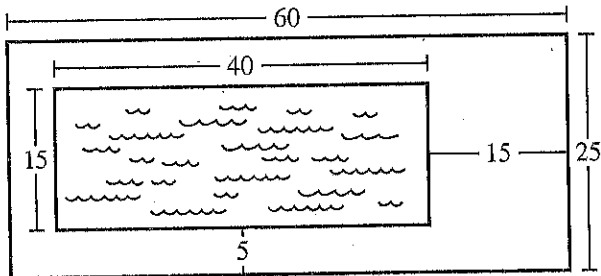
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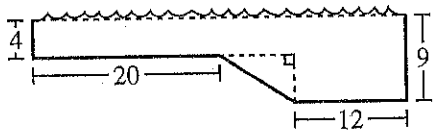
DO YOUR FIGURING HERE.

Use the following information to answer questions 26–29.

The top view and side view of a 40-foot-long swimming pool are shown in the figure below. All dimensions given are in feet.



top view



side view

The top view shows the top rectangular surface of the pool and the surrounding rectangular patio. All 4 walls of the pool are vertical and perpendicular to the top surface. The side view shows a cross section along the length of the pool. All cross sections parallel to the side view are congruent. The shallow end has a constant depth of 4 ft. The deep end has a constant depth of 9 ft. A rectangular surface connects the shallow and deep ends.

26. What is the area, in square feet, of the patio surrounding the pool?

F. 500  
G. 600  
H. 900  
J. 1,100  
K. 1,350

27. Johann put up a fence along the outer edge of the patio. Given that the materials for the fence cost \$12 per foot, what was the total cost of the materials for the fence?

A. \$1,020  
B. \$1,320  
C. \$1,800  
D. \$2,040  
E. \$3,360





28. A full lap is 2 times the length of the pool. Johann swam 5 full laps of the pool in  $4\frac{1}{2}$  minutes. Which of the following values is closest to Johann's average swimming speed, in feet per minute?

F. 35  
G. 45  
H. 60  
J. 90  
K. 120

DO YOUR FIGURING HERE.

29. The side view of the pool is placed in the standard  $(x,y)$  coordinate plane, keeping the same orientation and scale, such that both vertical segments showing depth are parallel to the  $y$ -axis. Which of the following values is closest to the slope of the line segment connecting the shallow end to the deep end?

A. -0.44  
B. -0.63  
C. -0.75  
D. -1.33  
E. -1.60

30. A construction company builds 3 different models of houses (A, B, and C). They order all the bathtubs, shower stalls, and sinks for the houses from a certain manufacturer. Each model of house contains different numbers of these bathroom fixtures. The tables below give the number of each kind of these fixtures required for each model and the cost to the company, in dollars, of each type of fixture.

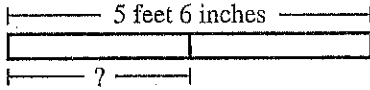
Fixture	Model			Fixture	Cost
	A	B	C		
Bathtubs	1	1	2	Bathtub	\$250
Shower stalls	0	1	1	Shower stall	\$150
Sinks	1	2	4	Sink	\$120

The company plans to build 3 A's, 4 B's, and 6 C's. What will be the cost to the company of exactly enough of these bathroom fixtures to put the required number in all of these houses?

F. \$ 1,940  
G. \$ 2,070  
H. \$ 8,940  
J. \$ 9,180  
K. \$10,450



31. Shown below, a board 5 feet 6 inches long is cut into 2 equal parts. What is the length, to the nearest inch, of each part?



DO YOUR FIGURING HERE.

- A. 2 feet 5 inches  
 B. 2 feet 8 inches  
 C. 2 feet 9 inches  
 D. 3 feet 0 inches  
 E. 3 feet 5 inches
32. A company that builds bridges used a pile driver to drive a post into the ground. The post was driven 18 feet into the ground by the first hit of the pile driver. On each hit after the first hit, the post was driven into the ground an additional distance that was  $\frac{2}{3}$  the distance the post was driven in the previous hit. After a total of 4 hits, the post was driven how many feet into the ground?
- F.  $28\frac{8}{9}$   
 G. 30  
 H.  $43\frac{1}{3}$   
 J. 48  
 K. 54
33. In the standard  $(x,y)$  coordinate plane,  $A'$  is the image resulting from the reflection of the point  $A(2,-3)$  across the  $y$ -axis. What are the coordinates of  $A'$ ?
- A.  $(-3, 2)$   
 B.  $(-2,-3)$   
 C.  $(-2, 3)$   
 D.  $(2, 3)$   
 E.  $(3,-2)$



34. To increase the mean of 4 numbers by 3, by how much would the sum of the 4 numbers have to increase?

F.  $\frac{3}{4}$

G. 1

H.  $\frac{4}{3}$

J. 7

K. 12

DO YOUR FIGURING HERE.

35. Which of the following expressions is equivalent to  $(3 + x)^{-100}$ ?

A.  $-3^{100} - x^{100}$

B.  $-300 - 100x$

C.  $\frac{1}{3^{100}} + \frac{1}{x^{100}}$

D.  $\frac{1}{(3x)^{100}}$

E.  $\frac{1}{(3 + x)^{100}}$

36. Consider the graph of the equation  $y = \frac{3x - 12}{2x - 6}$  in the standard  $(x, y)$  coordinate plane. Which of the following equations represents the *vertical* asymptote of the graph?

F.  $x = 2$

G.  $x = 3$

H.  $x = 4$

J.  $x = 6$

K.  $x = 12$

37. For every pair of real numbers  $x$  and  $y$  such that  $xy = 0$  and  $\frac{x}{y} = 0$ , which of the following statements is true?

A.  $x = 0$  and  $y = 0$

B.  $x \neq 0$  and  $y = 0$

C.  $x = 0$  and  $y \neq 0$

D.  $x \neq 0$  and  $y \neq 0$

E. None of the statements is true for every such pair of real numbers  $x$  and  $y$ .



Use the following information to answer questions 38–40.

DO YOUR FIGURING HERE.

Walter recently vacationed in Paris. While there, he visited the Louvre, a famous art museum. Afterward, he took a 3.7-kilometer cab ride from the Louvre to the Eiffel Tower. A tour guide named Amélie informed him that 2.5 million rivets were used to build the tower, which stands 320 meters tall.

38. Walter's cab ride lasted 15 minutes. Which of the following values is closest to the average speed, in miles per hour, of the cab?

(Note: 1 mile  $\approx$  1.6 kilometers)

- F. 9
- G. 15
- H. 21
- J. 24
- K. 35

39. When written in scientific notation, the number of rivets used to build the Eiffel Tower is equal to which of the following expressions?

- A.  $2.5 \times 10^6$
- B.  $2.5 \times 10^7$
- C.  $2.5 \times 10^8$
- D.  $25 \times 10^6$
- E.  $25 \times 10^7$

40. At a certain point, the angle of elevation formed by the level ground and the line from that point to the top of the Eiffel Tower is  $70^\circ$ . Which of the following expressions is equal to the distance, in meters, between that point and the center of the base of the tower?

- F.  $320 \cos 70^\circ$
- G.  $320 \sin 70^\circ$
- H.  $320 \tan 70^\circ$
- J.  $\frac{320}{\sin 70^\circ}$
- K.  $\frac{320}{\tan 70^\circ}$

41. When the vector  $a\mathbf{i} + 3\mathbf{j}$  is added to the vector  $-2\mathbf{i} + b\mathbf{j}$ , the sum is  $6\mathbf{i} - 6\mathbf{j}$ . What are the values of  $a$  and  $b$ ?

- A.  $a = -9$  and  $b = 8$
- B.  $a = -8$  and  $b = 9$
- C.  $a = -4$  and  $b = 3$
- D.  $a = 4$  and  $b = -3$
- E.  $a = 8$  and  $b = -9$



42. Given  $c = 10b^3 + 50$ , which of the following is an expression for  $b$  in terms of  $c$ ?

F.  $\left(\frac{c}{10} - 5\right)^{\frac{1}{3}}$

G.  $\left(\frac{c}{10} + 5\right)^{\frac{1}{3}}$

H.  $\frac{1}{10}(c - 50)^{\frac{1}{3}}$

J.  $c^3 + 5$

K.  $10c^3 + 50$

DO YOUR FIGURING HERE.

43. Given  $f(x) = x^2 + 3x$  and  $g(x) = x + 1$ , what is  $f(g(x))$ ?

A.  $x^2 + 5x + 4$

B.  $x^2 + 3x + 1$

C.  $x^3 + 5x^2 + 4x$

D.  $x^3 + 4x^2 + 3x$

E.  $x^4 + 4x^3 + 3x^2$

44. The diameter of one circle is 12 inches long. The diameter of a second circle is 25% longer than the diameter of the first circle. To the nearest square inch, how much larger is the area of the second circle than the area of the first circle?

F. 7

G. 28

H. 44

J. 64

K. 254

45. What is the product of the mean and the median of the first 6 prime numbers?

(Note: 2 is the first prime number.)

A. 27

B. 37

C. 39

D. 41

E. 42

46. For all real values of  $x$ , which of the following equations is true?

F.  $\sin(7x) + \cos(7x) = 7$

G.  $\sin(7x) + \cos(7x) = 1$

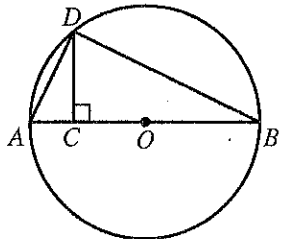
H.  $7 \sin(7x) + 7 \cos(7x) = 14$

J.  $\sin^2(7x) + \cos^2(7x) = 7$

K.  $\sin^2(7x) + \cos^2(7x) = 1$



47. In the figure shown below,  $A$ ,  $B$ , and  $D$  lie on a circle whose center is  $O$ , a diameter is  $\overline{AB}$ ,  $\overline{CD}$  is perpendicular to  $\overline{AB}$  at  $C$ , the length of  $\overline{AD}$  is 5 m, and the length of  $\overline{BD}$  is 12 m. What is the length, in meters, of  $\overline{CD}$ ?



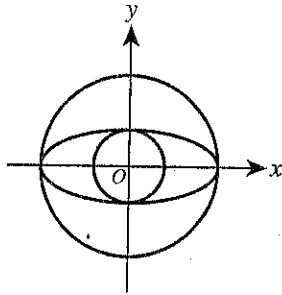
DO YOUR FIGURING HERE.

- A.  $\frac{60}{13}$   
 B.  $\frac{65}{12}$   
 C. 13  
 D.  $\frac{156}{5}$   
 E. 60
48. If  $a$  and  $b$  are real numbers such that  $a > 0$  and  $b < 0$ , then which of the following is equivalent to  $|a| - |b|$ ?
- F.  $|a - b|$   
 G.  $|a + b|$   
 H.  $|a| + |b|$   
 J.  $a - b$   
 K.  $a + b$
49. If  $x < y$  and  $y < 4$ , then what is the greatest possible integer value of  $x + y$ ?
- A. 0  
 B. 3  
 C. 4  
 D. 7  
 E. 8
50. Given that  $y$  varies directly as the *square* of  $x$ , if  $y = 20$  when  $x = 2$ , what is  $y$  when  $x = 3$ ?
- F. 75  
 G. 45  
 H. 30  
 J. 21  
 K. 15



51. Shown below in the standard  $(x,y)$  coordinate plane are 2 circles and 1 ellipse, each centered at  $(0,0)$ . The larger circle has equation  $x^2 + y^2 = 25$  and intersects the ellipse at exactly 2 points, both on the  $x$ -axis. The smaller circle has equation  $x^2 + y^2 = 4$  and intersects the ellipse at exactly 2 points, both on the  $y$ -axis. Which of the following equations represents the ellipse?

- A.  $\frac{x^2}{2} + \frac{y^2}{5} = 1$   
 B.  $\frac{x^2}{4} + \frac{y^2}{25} = 1$   
 C.  $\frac{x^2}{5} + \frac{y^2}{2} = 1$   
 D.  $\frac{x^2}{25} + \frac{y^2}{4} = 1$   
 E.  $\frac{x^2}{100} + \frac{y^2}{16} = 1$



52. The mean of 5 integers is 52. The median of these 5 integers is 82. Three of the integers are 0, 12, and 82. Which of the following could be one of the other integers?

- F. 52  
 G. 66  
 H. 84  
 J. 86  
 K. 105

53. An integer is *abundant* if its positive integer factors, excluding the integer itself, have a sum that is greater than the integer. How many of the integers 6, 8, 10, and 12 are abundant?

- A. 0  
 B. 1  
 C. 2  
 D. 3  
 E. 4

54. Vanna walked at a rate of 2 miles per hour for 10 minutes and then walked at a rate of 3 miles per hour for 5 minutes. Which of the following gives the average rate, in miles per hour, at which she walked over this 15-minute period?

- F.  $\frac{1}{3}$   
 G.  $\frac{7}{3}$   
 H.  $\frac{7}{24}$   
 J.  $\frac{7}{180}$   
 K.  $\frac{35}{2}$

DO YOUR FIGURING HERE.



55. The ratio of Alani's height to Baahir's height is 5:7. The ratio of Baahir's height to Connor's height is 4:3. What is the ratio of Alani's height to Connor's height?

A. 2:3  
B. 8:11  
C. 15:28  
D. 20:21  
E. 28:15

DO YOUR FIGURING HERE.

56. For all  $x > 0$ , which of the following expressions is NOT equivalent to  $\sqrt{\sqrt[3]{x^2}}$ ?

F.  $\sqrt[3]{x}$   
G.  $\sqrt[6]{x^2}$   
H.  $\sqrt[3]{\sqrt{x^2}}$   
J.  $x^{\frac{1}{3}}$   
K.  $x^{\frac{2}{3}}$

57. If the length of a rectangle is increased by 25% and the width is decreased by 10%, the area of the resulting rectangle is larger than the area of the original rectangle by what percent?

A. 2.5%  
B. 12.5%  
C. 15%  
D. 22.5%  
E. 35%

58. Five balls, numbered 1, 2, 3, 4, and 5, are placed in a bin. Two balls are drawn at random without replacement. What is the probability that the sum of the numbers on the balls drawn is 7?

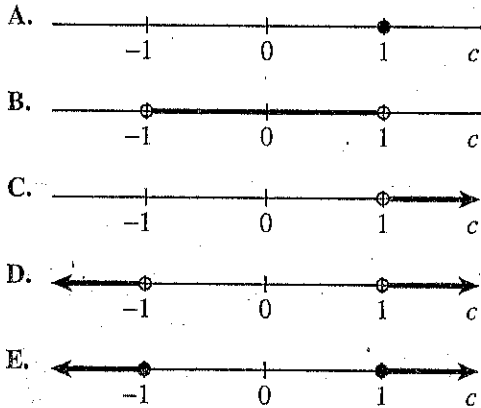
F.  $\frac{1}{5}$   
G.  $\frac{2}{5}$   
H.  $\frac{4}{5}$   
J.  $\frac{5}{9}$   
K.  $\frac{4}{25}$





59. Consider the family of functions  $y = f(x) = \sin x + c$ , where  $c$  is a real number. Which of the following number lines represents the graph of all and only the possible values of  $c$  for which the graph of  $y$  has no  $x$ -intercepts?

DO YOUR FIGURING HERE.



60. Tameka calculates that she needs 360 square feet of new carpet. But the type of carpet that she wants is priced by the square *yard*. How many square yards of carpet does she need?

- F. 15  
 G. 40  
 H. 60  
 J. 90  
 K. 120

END OF TEST 2

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

DO NOT RETURN TO THE 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

Table 1 lists the name, chemical formula, *molecular mass* (the mass of 1 molecule in atomic mass units, amu), and BP (the boiling point at 1 atmosphere of pressure) of various compounds. The first compound listed is composed of the elements carbon (C) and hydrogen (H). Each of the other compounds is composed of C, H, and either fluorine (F), chlorine (Cl), bromine (Br), or iodine (I). The elements F, Cl, Br, and I belong to the *halogen* family.

Name	Chemical formula	Molecular mass (amu)	BP (°C)
Methane	CH <sub>4</sub>	16	-162
Fluoromethane	CH <sub>3</sub> F	34	-78
Difluoromethane	CH <sub>2</sub> F <sub>2</sub>	52	-52
Trifluoromethane	CHF <sub>3</sub>	70	-82
Chloromethane	CH <sub>3</sub> Cl	51	-24
Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	85	40
Trichloromethane	CHCl <sub>3</sub>	119	61
Bromomethane	CH <sub>3</sub> Br	95	4
Dibromomethane	CH <sub>2</sub> Br <sub>2</sub>	174	97
Tribromomethane	CHBr <sub>3</sub>	253	149
Iodomethane	CH <sub>3</sub> I	142	42
Diiodomethane	CH <sub>2</sub> I <sub>2</sub>	268	182
Triiodomethane	CHI <sub>3</sub>	394	218

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

Figure 1 shows a plot of BP versus molecular mass for 3 groups of compounds (Groups 1–3). Each compound in each group is composed of C and 1 or more halogens.

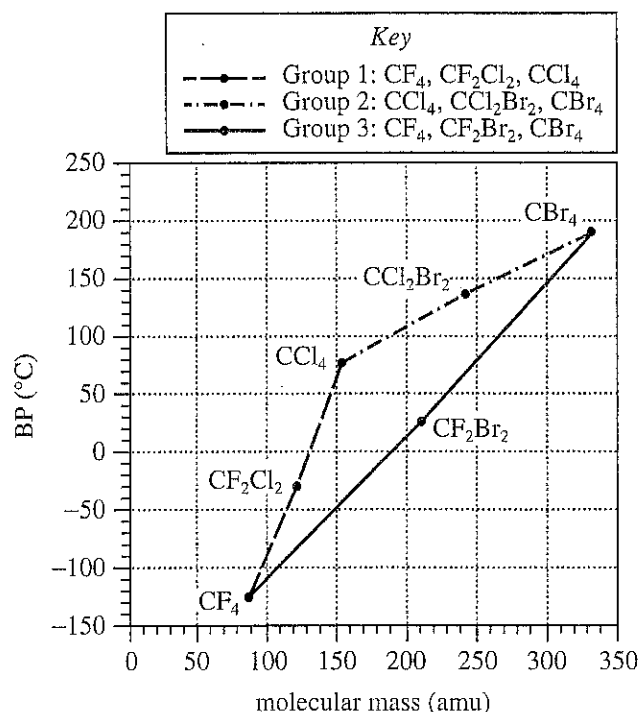


Figure 1

Figure 1 adapted from Michael Laing, "Boiling Points of the Family of Small Molecules, CH<sub>w</sub>F<sub>x</sub>Cl<sub>y</sub>Br<sub>z</sub>: How Are They Related to Molecular Mass?" ©2001 by Division of Chemical Education, Inc., American Chemical Society.

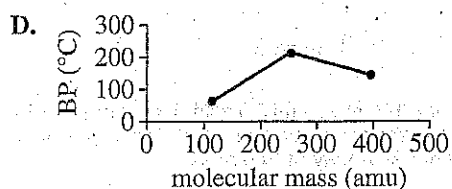
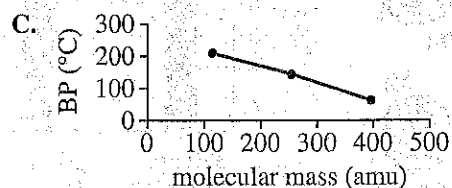
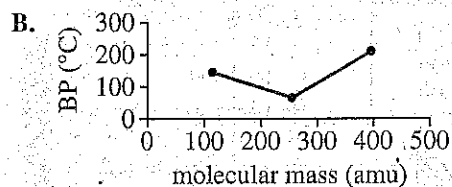
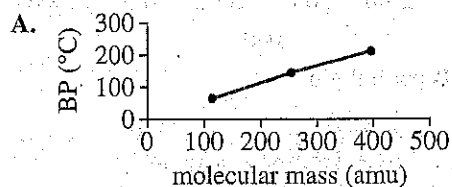
1. The compound represented in Figure 1 that has a BP of  $-30^{\circ}\text{C}$  has a molecular mass of about:

- A. 90 amu.
- B. 120 amu.
- C. 150 amu.
- D. 210 amu.

2. According to Figure 1, of the following compounds, which one has the highest BP?

- F.  $\text{CF}_4$
- G.  $\text{CF}_2\text{Cl}_2$
- H.  $\text{CF}_2\text{Br}_2$
- J.  $\text{CCl}_4$

3. According to Table 1, the relationship between molecular mass and BP among the compounds  $\text{CHCl}_3$ ,  $\text{CHBr}_3$ , and  $\text{CHI}_3$  is best represented by which of the following graphs?



4. At 1 atmosphere of pressure, the temperature at which  $\text{CH}_2\text{I}_2$  boils is how much greater than the temperature at which  $\text{CH}_4$  boils?

- E.  $162^{\circ}\text{C}$
- G.  $268^{\circ}\text{C}$
- H.  $344^{\circ}\text{C}$
- J.  $430^{\circ}\text{C}$

5. According to Table 1 and Figure 1, the molecular mass of  $\text{CF}_4$  is closest to the molecular mass of which of the following compounds?

- A. Dichloromethane
- B. Trichloromethane
- C. Iodomethane
- D. Dibromomethane

6. The *atomic mass* (the mass of 1 atom, in amu) of C is 12 amu. Based on the molecular mass of  $\text{CBr}_4$  shown in Figure 1, the atomic mass of Br is closest to which of the following?

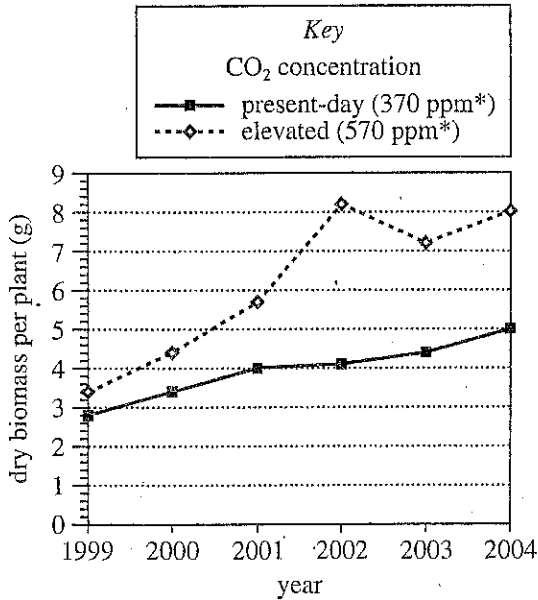
- F. 20 amu
- G. 35 amu
- H. 80 amu
- J. 127 amu

Passage II

*Urushiols* are the oils in poison ivy that cause allergic reactions in humans. The higher the *U:S ratio*—the ratio of unsaturated (U) urushiols to saturated (S) urushiols—the more severe the reaction.

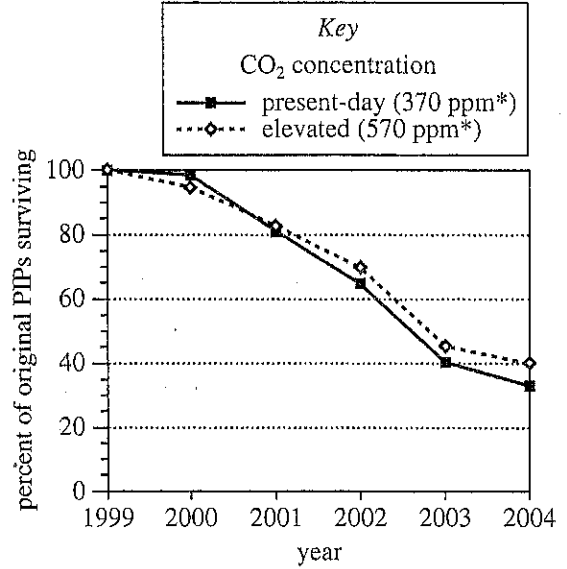
From 1999 to 2004, poison ivy plants (PIPs) were grown in 2 identical outdoor plots under identical conditions except for the atmospheric CO<sub>2</sub> concentration.

Figure 1 shows, for each plot, the yearly dry biomass per plant. Figure 2 shows the yearly percent of original PIPs surviving in each plot. Figure 3 shows, for each plot in 2004, the percent of U urushiols per plant, the percent of S urushiols per plant, and the U:S ratio per plant.



\*ppm = parts per million

Figure 1



\*ppm = parts per million

Figure 2

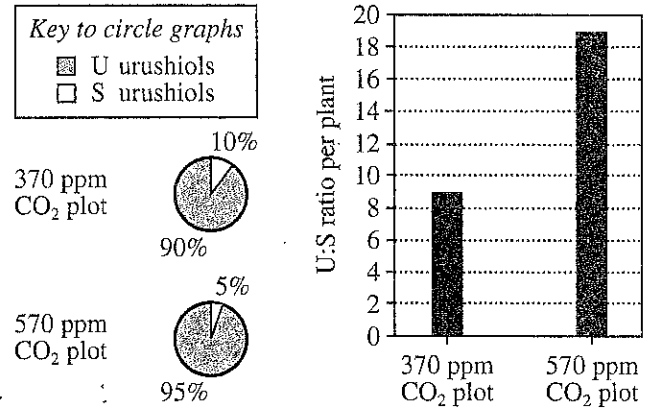


Figure 3

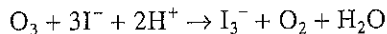
Figures adapted from "Biomass and Toxicity Responses of Poison Ivy (*Toxicodendron radicans*) to Elevated Atmospheric CO<sub>2</sub>." ©2006 by the National Academy of Sciences.

7. According to Figure 3, for the present-day CO<sub>2</sub> concentration plot, the percent of U urushiols per plant in 2004 was:
- A. 10%.
  - B. 20%.
  - C. 50%.
  - D. 90%.
8. According to Figure 2, which plot had the higher percent of original PIPs surviving at the end of the study?
- F. The present-day CO<sub>2</sub> plot, by a difference of 1%
  - G. The present-day CO<sub>2</sub> plot, by a difference of 7%
  - H. The elevated CO<sub>2</sub> plot, by a difference of 1%
  - J. The elevated CO<sub>2</sub> plot, by a difference of 7%
9. Based on the passage, which of the factors listed below was(were) the same for the 2 plots?
- I. Atmospheric CO<sub>2</sub> concentration in each plot
  - II. Soil type in each plot
  - III. Amount of water applied to each plot
- A. I only
  - B. I and II only
  - C. II and III only
  - D. I, II, and III
10. According to Figure 1, from 1999 to 2004, how did the dry biomasses per plant for the 2 plots compare? The dry biomass per plant grown in a CO<sub>2</sub> concentration of 370 ppm was:
- F. always the same as the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
  - G. always greater than the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
  - H. always less than the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
  - J. in some years greater than, but in other years less than, the dry biomass per plant grown in a CO<sub>2</sub> concentration of 570 ppm.
11. Based on Figure 2, what percent of PIPs grown in the plot with a CO<sub>2</sub> concentration of 370 ppm had *died* by the year 2003 ?
- A. 40%
  - B. 45%
  - C. 55%
  - D. 60%
12. According to Figure 3, which plot produced a higher percent of S urushiols per plant?
- F. The present-day CO<sub>2</sub> concentration plot; 10% of the urushiols produced per plant were saturated.
  - G. The present-day CO<sub>2</sub> concentration plot; 90% of the urushiols produced per plant were saturated.
  - H. The elevated CO<sub>2</sub> concentration plot; 5% of the urushiols produced per plant were saturated.
  - J. The elevated CO<sub>2</sub> concentration plot; 95% of the urushiols produced per plant were saturated.



### Passage III

When the ozone ( $O_3$ ) in air is mixed with an acidic solution of iodide ion ( $I^-$ ), the  $O_3$  reacts to form triiodide ion ( $I_3^-$ ),  $O_2$ , and  $H_2O$ .



Students performed an experiment to determine the concentration of  $O_3$  in samples of air. Figure 1 shows the relationship between the concentration of  $I_3^-$ , in  $\mu\text{mol/L}$ , and the concentration of  $O_3$ , in parts per billion (ppb), under the conditions of the experiment.

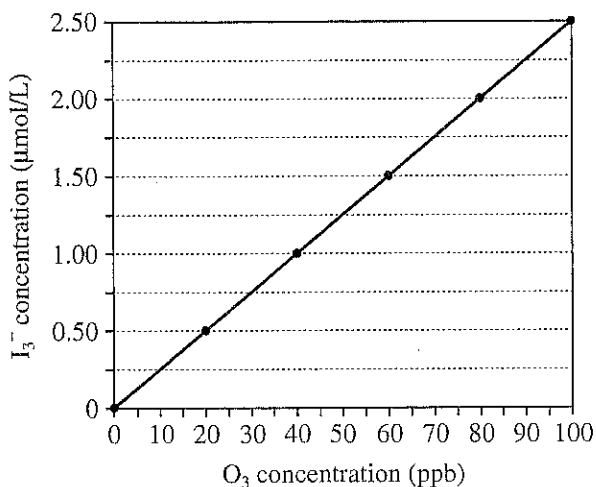


Figure 1

### Experiment

At each of 4 outdoor sites, the students assembled the apparatus shown in Figure 2. First, they attached a long piece of tubing to a stand so that one end of the tubing was 1.5 m above the ground. Then, they placed the other end of the tubing into one hole of a 2-holed stopper. Next, they placed one end of a shorter piece of tubing into the second hole of the 2-holed stopper and attached the other end of the shorter tubing to a vacuum pump.

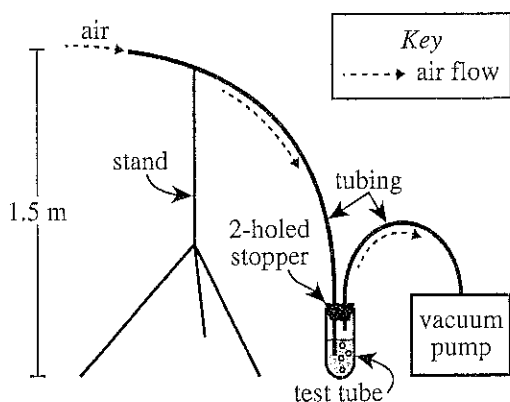


Figure 2

At each site, the students performed the following 2 steps every half hour from 12:30 p.m. to 5:30 p.m. on a particular day:

1. A 10.0 mL volume of an aqueous acidic solution having a 10 mg/mL concentration of  $I^-$  was placed into a clean, empty test tube that was then sealed with the 2-holed stopper.
2. The vacuum pump was turned on for 25 min to collect an air sample. Then, the pump was turned off and the concentration of  $I_3^-$ , in micromoles/liter ( $\mu\text{mol/L}$ ), in the solution was measured.

The results are shown in Figure 3.

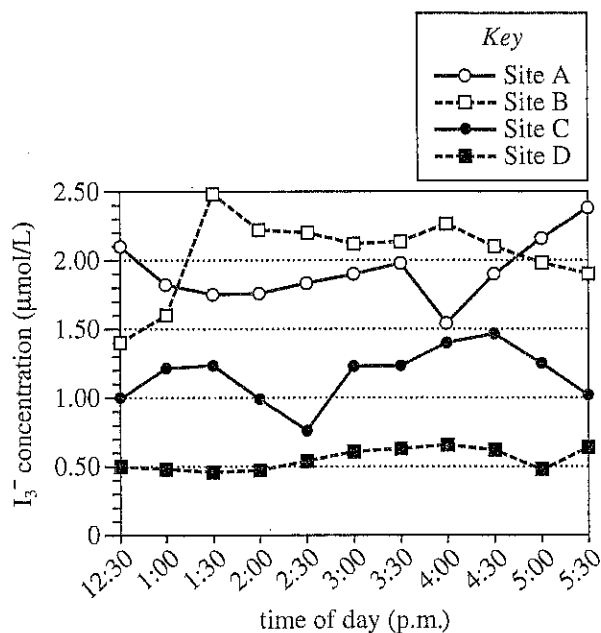


Figure 3

Figures adapted from J. V. Seeley et al., "A Simple Method for Measuring Ground-Level Ozone in the Atmosphere." ©2005 by the Division of Chemical Education, Inc., American Chemical Society.

13. Based on Figures 1 and 3, the air sample collected at which of the following combinations of time and location had the *lowest*  $O_3$  concentration?

time	location
A. 2:30 p.m.	Site B
B. 2:30 p.m.	Site C
C. 4:00 p.m.	Site B
D. 4:00 p.m.	Site C

14. Consider the air samples that were collected at the 4 sites at 2:00 p.m. Based on Figures 1 and 3, what is the order of those samples from lowest  $O_3$  concentration to highest  $O_3$  concentration?
- F. Site A, Site B, Site C, Site D  
 G. Site C, Site B, Site A, Site D  
 H. Site D, Site C, Site A, Site B  
 J. Site D, Site A, Site C, Site B
15. Based on Figures 1 and 3, which site had the highest overall average  $O_3$  concentration across all the air samples?
- A. Site A  
 B. Site B  
 C. Site C  
 D. Site D
16. Based on Figures 1 and 3, the  $O_3$  concentration at 5:00 p.m. at Site B was approximately how many times as great as the  $O_3$  concentration at 2:00 p.m. at Site C?
- F. 0.5  
 G. 2  
 H. 3  
 J. 4
17. At Site A, was the  $O_3$  concentration highest at 4:00 p.m. or at 5:30 p.m.?
- A. 4:00 p.m.; the  $I_3^-$  concentration was highest at 4:00 p.m., and the higher the  $I_3^-$  concentration, the higher the  $O_3$  concentration.  
 B. 4:00 p.m.; the  $I_3^-$  concentration was lowest at 4:00 p.m., and the lower the  $I_3^-$  concentration, the higher the  $O_3$  concentration.  
 C. 5:30 p.m.; the  $I_3^-$  concentration was highest at 5:30 p.m., and the higher the  $I_3^-$  concentration, the higher the  $O_3$  concentration.  
 D. 5:30 p.m.; the  $I_3^-$  concentration was lowest at 5:30 p.m., and the lower the  $I_3^-$  concentration, the higher the  $O_3$  concentration.
18. When a vacuum pump was operating during Step 2, it drew air through the solution in the test tube. Assuming that the pump drew air at a rate of 200 mL/min, how many milliliters of air were drawn through the solution in the test tube each time Step 2 was performed?
- F. 200 mL  
 G. 550 mL  
 H. 2,500 mL  
 J. 5,000 mL
19. Suppose that the actual  $O_3$  concentration at 12:30 p.m. at Site C was 43 ppb. Based on Figures 1 and 3, which of the following expressions would give the percent error for the value of the  $O_3$  concentration that was determined at 12:30 p.m. at Site C?
- A.  $\frac{|40 \text{ ppb} - 43 \text{ ppb}|}{43 \text{ ppb}} \times 100\%$   
 B.  $\frac{|40 \text{ ppb} - 43 \text{ ppb}|}{40 \text{ ppb}} \times 100\%$   
 C.  $\frac{|100 \text{ ppb} - 43 \text{ ppb}|}{43 \text{ ppb}} \times 100\%$   
 D.  $\frac{|100 \text{ ppb} - 43 \text{ ppb}|}{40 \text{ ppb}} \times 100\%$

**Passage IV**

When waves of laser light pass through a narrow slit and onto a screen, they form a pattern of light and dark bands on the screen, as shown in Figure 1.

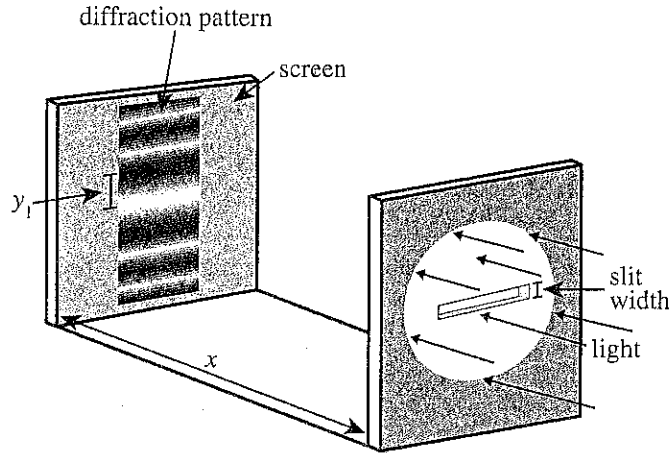


Figure 1

Figure 1 adapted from Francis Sears and Mark Zemanski, *College Physics*. ©1960 by Addison Wesley Publishing Co., Inc.

This phenomenon is called *diffraction*, and the pattern is called a *diffraction pattern*.

In each of the following studies of diffraction, students directed laser light through a slit, forming a diffraction pattern on a screen. They measured  $y_1$ , the distance from the center of the brightest band in the pattern to the center of one of the 2 adjacent dark bands. In each study,  $x$  was the distance between the slit and the screen.

**Study 1**

In Trials 1–4, the slit width was varied, the wavelength of the laser light was fixed, and  $x$  was 6.00 m. The results are shown in Table 1.

Trial	Slit width (mm)	$y_1$ (mm)
1	0.12	30.0
2	0.24	15.0
3	0.36	10.0
4	0.48	7.5

**Study 2**

In Trials 5–8, the slit width was 0.24 mm, the wavelength (color) of the laser light was varied, and  $x$  was 6.00 m. The results are shown in Table 2.

Trial	Wavelength (nm)	$y_1$ (mm)
5	400 (violet)	10.0
6	500 (green)	12.5
7	600 (yellow)	15.0
8	700 (red)	17.5

**Study 3**

In Trials 9–12, the slit width was 0.24 mm, the wavelength was the same as in Study 1, and  $x$  was varied. The results are shown in Table 3.

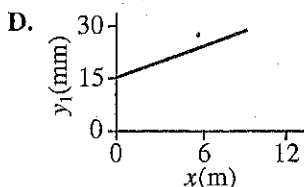
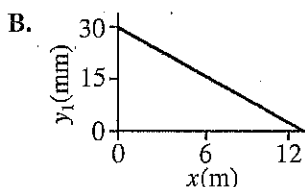
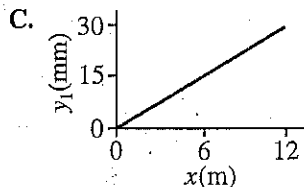
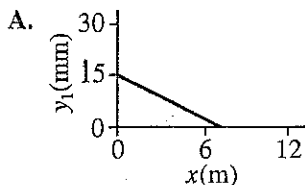
Trial	$x$ (m)	$y_1$ (mm)
9	3.00	7.5
10	6.00	15.0
11	9.00	22.5
12	12.00	30.0

20. In Study 2,  $y_1$  would most likely have been less than 10.0 mm if the students had used a laser emitting light having which of the following wavelengths?

F. 300 nm  
 G. 500 nm  
 H. 700 nm  
 J. 900 nm



21. For fixed values of wavelength and slit width, which of the following graphs best represents the relationship between  $y_1$  and  $x$ ?



22. Suppose that the procedure performed in Trial 2 was repeated, except that  $x$  was 9.00 m. Based on the results of Studies 1 and 3, would  $y_1$  more likely have been greater than 15.0 mm or less than 15.0 mm?

- F. Greater, because  $y_1$  increased as  $x$  increased.  
 G. Greater, because  $y_1$  increased as  $x$  decreased.  
 H. Less, because  $y_1$  decreased as  $x$  increased.  
 J. Less, because  $y_1$  decreased as  $x$  decreased.

23. During the 3 studies, the students did NOT examine the relationship between  $y_1$  and the:

- A. width of the slit.  
 B. wavelength of laser light.  
 C. distance between the slit and the screen.  
 D. distance between the slit and the laser.

24. As the wavelength of light increases, the energy of a *photon* (particle of light) decreases. In which of the following trials of Study 2 was the energy of a photon greatest?

- F. Trial 5  
 G. Trial 6  
 H. Trial 7  
 J. Trial 8

25. For fixed values of wavelength and  $x$ , when the slit width was doubled, the distance from the center of the brightest band in the pattern to the center of one of the 2 adjacent dark bands:

- A. was doubled.  
 B. was halved.  
 C. remained unchanged.  
 D. varied with no general trend.

26. What is the result of Trial 7 expressed in *meters* (m)?

- F. 0.00150 m  
 G. 0.0150 m  
 H. 0.150 m  
 J. 1.50 m



## Passage V

Unlike most volcanoes, *hot spot volcanoes* (HSVs) develop far from tectonic plate boundaries. Two scientists discuss the origin and properties of HSVs.

## Scientist 1

In the mantle beneath an HSV, at depths between 200 km and 400 km, hot magma rises toward Earth's surface in one large column called a *mantle plume*. The ascending magma causes earthquakes and creates networks of large fractures in crustal rocks. Propagation of these fracture networks enables magma to reach the surface more easily, which is why the frequency of eruptions at an HSV typically increases over time. Magma that does not breach Earth's surface will cool and eventually sink back down into the mantle.

HSVs erupt iron-rich lavas that are chemically similar to mantle rocks. Olivine and pyroxenes are the most abundant minerals in mantle rocks and in the lavas erupted at HSVs. The lavas at HSVs also retain a lot of water from the mantle. By weight, water vapor accounts for 75% of the total gas output at HSVs, while CO<sub>2</sub> accounts for only 10%–15%. All other gases combined never account for more than 10%–15% of the total gas output. Kilauea Caldera, in Hawaii, erupts this way.

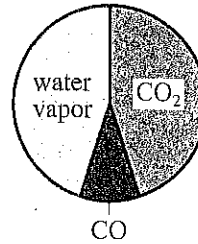
## Scientist 2

In certain places near the top of the mantle, at depths of less than 100 km, a high concentration of dissolved CO<sub>2</sub> allows mantle rocks to melt at lower temperatures than they normally would. This is how the magma that fuels an HSV forms. The magma then rises toward Earth's surface in small isolated bodies that melt through the entire thickness of the crust, sometimes causing small fractures (less than 1 km long) in crustal rocks. Each eruption at an HSV depletes some of the excess CO<sub>2</sub>, which is why eruption frequency at an HSV will typically slow down over time.

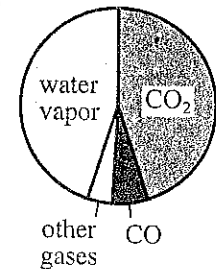
HSVs erupt lavas in which feldspar is the most abundant mineral. These aluminum-rich lavas contain much less water than most mantle rocks. By weight, CO<sub>2</sub> and water vapor each account for 45% of the total gas output at HSVs. Carbon monoxide (CO) accounts for 6% of the total gas output, and all other gases combined account for only 4%. Mt. Erebus, in Antarctica, erupts this way.

27. Which of the following pie charts is most consistent with Scientist 2's description of the total gas output at HSVs?

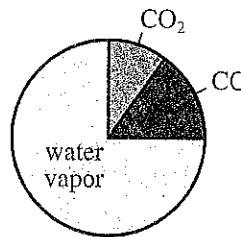
A.



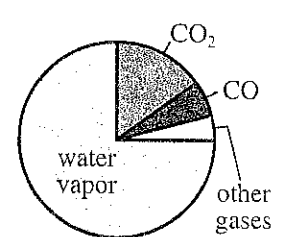
C.



B.



D.



28. Which of the scientists, if either, state(s) that ascending magma causes earthquakes?

F. Scientist 1 only  
 G. Scientist 2 only  
 H. Both Scientist 1 and Scientist 2  
 J. Neither Scientist 1 nor Scientist 2

29. *Basalt* is a volcanic rock that contains abundant iron and is less than 10% feldspar by volume. In contrast, the volcanic rock *phonolite* is mostly feldspar by volume. Based on the passage, which of these 2 types of rock would each scientist more likely expect to see at an HSV?

Scientist 1

Scientist 2

- |    |           |           |
|----|-----------|-----------|
| A. | basalt    | basalt    |
| B. | basalt    | phonolite |
| C. | phonolite | basalt    |
| D. | phonolite | phonolite |



30. Suppose it were discovered that older HSVs erupt more frequently than younger HSVs. This discovery would better support the viewpoint of which scientist?
- F. Scientist 1; Scientist 1 claims that eruption frequency decreases over time.
  - G. Scientist 1; Scientist 1 claims that eruption frequency increases over time.
  - H. Scientist 2; Scientist 2 claims that eruption frequency decreases over time.
  - J. Scientist 2; Scientist 2 claims that eruption frequency increases over time.
31. The *lithosphere* is a zone of Earth's interior that extends from the surface to a maximum depth of approximately 200 km. Which of the scientists, if either, discuss(es) a process that may extend *beneath* the lithosphere?
- A. Scientist 1 only
  - B. Scientist 2 only
  - C. Both Scientist 1 and Scientist 2
  - D. Neither Scientist 1 nor Scientist 2
32. Suppose that another scientist claims that most mantle rocks contain water. Which of the scientists, if either, would be likely to agree with this claim?
- F. Scientist 1 only
  - G. Scientist 2 only
  - H. Both Scientist 1 and Scientist 2
  - J. Neither Scientist 1 nor Scientist 2
33. A material that lowers the melting point of rocks is called a *flux*. The melting of rocks due to the presence of a flux is called *flux melting*. Flux melting is a feature of which scientist's discussion, and based on that scientist's discussion, what material is acting as the flux?
- A. Scientist 1; iron
  - B. Scientist 2; iron
  - C. Scientist 1; CO<sub>2</sub>
  - D. Scientist 2; CO<sub>2</sub>

## Passage VI

Gene expression in eukaryotes is controlled by *regulatory DNA sequences* (RSs). RSs determine whether, for a particular type of cell, the expression of a gene is turned on or turned off.

Figure 1 shows the coding region of Gene X and shows 3 RSs (RS1–RS3) that are thought to be associated with Gene X. Figure 1 also shows the known expression pattern of Gene X across 6 types of mammalian cells (cell types A–F).

Scientists did 2 experiments to study how RS1, RS2, and RS3 control the expression of Gene X in each of cell types A–F. In each experiment, they prepared *GFP reporter genes*. GFP is a protein that emits green light when viewed with a certain microscope. Reporter genes are DNA molecules that contain RSs of interest and the coding region for an easily detectable protein.

## Experiment 1

GFP reporter genes that contained RS1–RS3 and the coding region for GFP were prepared (see Figure 2). The reporter genes were then *transfected* (delivered) into cells of each of cell types A–F. Then, 48 hr after transfection, the cells were viewed with the microscope to determine if the GFP reporter genes were expressed. Figure 2 also shows the expression pattern of the GFP reporter gene across cell types A–F.

## Experiment 2

Experiment 1 was repeated except that 5 types of GFP reporter genes were prepared. Each type of reporter gene contained either 0, 1, or 2 of the RSs and the coding region for GFP (see Figure 3). Figure 3 also shows the expression patterns of the 5 types of GFP reporter genes across cell types A–F.

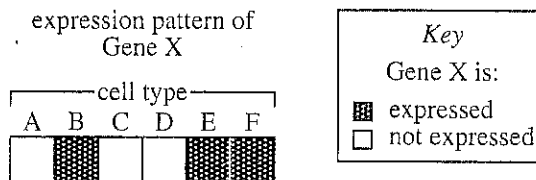
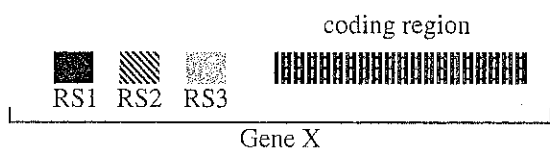


Figure 1

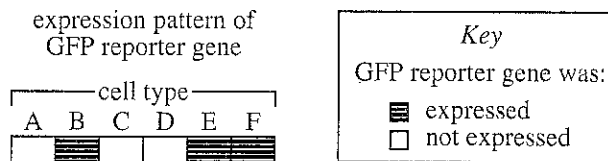
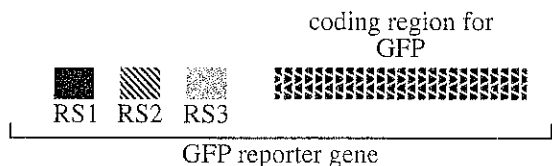


Figure 2

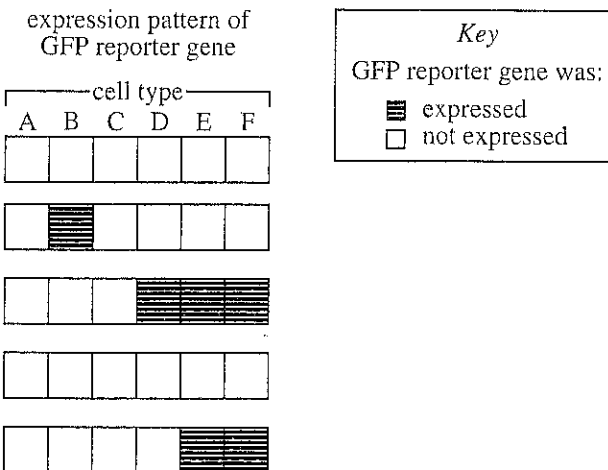
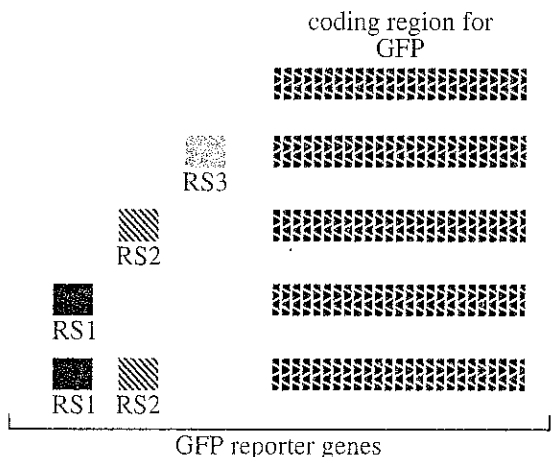
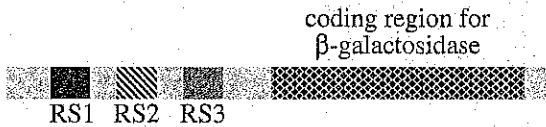


Figure 3

Figures adapted from Bruce Alberts et al., *Molecular Biology of the Cell*, 5th ed. ©2008 by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.

34. Based on the results of Experiment 2, RS2 turns on the expression of the GFP reporter gene in which of the cell types?  
 F. Cell type B only  
 G. Cell types E and F only  
 H. Cell types A, B, and C only  
 J. Cell types D, E, and F only
35. According to the results of Experiments 1 and 2, when the cells were viewed with the microscope, green light was NEVER observed for which of the cell types?  
 A. Cell type A only  
 B. Cell type C only  
 C. Cell types A and C only  
 D. Cell types A, C, and D only
36. The gene that codes for the enzyme  $\beta$ -galactosidase is a common reporter gene. Consider the combination of RSs in the reporter gene shown below.



Which of the following patterns of  $\beta$ -galactosidase enzymatic activity would most likely result from transfecting the cells of cell types A–F with the above reporter gene?

enzymatic activity of  
 $\beta$ -galactosidase in

	cell type:					
	A	B	C	D	E	F
F.	□	□	□	□	□	■
G.	□	□	□	■	■	■
H.	□	■	□	□	□	■
J.	□	■	□	□	■	■

Key

■ has enzymatic activity

□ does not have enzymatic activity

37. Based on the results of Experiment 2, the expression of the GFP reporter genes in cell type F was turned on by which of the 3 RSs?  
 A. RS1 only  
 B. RS2 only  
 C. RS3 only  
 D. RS1 and RS2 only
38. What is the most likely reason that reporter genes were used in Experiments 1 and 2?  
 F. The protein product of Gene X could be more easily observed than could the protein product of the reporter genes.  
 G. The protein product of the reporter genes could be more easily observed than could the protein product of Gene X.  
 H. RS1–RS3 cannot control the expression of Gene X in the cell types studied.  
 J. RS1–RS3 cannot control the expression of the reporter genes in the cell types studied.
39. Consider the expression pattern of the GFP reporter gene in Experiment 2 that contained only RS1 and RS2. What is the most likely reason that the GFP reporter gene was NOT expressed in cell type D? In cell type D, gene expression was turned:  
 A. on by RS1.  
 B. on by RS2.  
 C. off by RS1.  
 D. off by RS2.
40. Do the results of Experiments 1 and 2 indicate that the expression of Gene X is controlled by each of RS1–RS3?  
 F. No; only 1 of the 3 RSs appeared to affect the expression of the GFP reporter gene in all of the cell types.  
 G. No; only 2 of the 3 RSs appeared to affect the expression of the GFP reporter gene in all of the cell types.  
 H. Yes; each of the 3 RSs appeared to affect the expression of the GFP reporter gene in all of the cell types.  
 J. Yes; each of the 3 RSs appeared to affect the expression of the GFP reporter gene in at least 1, but not all, of the cell types.

**END OF TEST 4**

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

### Scoring Keys for Form A11

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

#### Test 1: English—Scoring Key

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

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

**\*Reporting Categories**

POW = Production of Writing

KLA = Knowledge of Language

CSE = Conventions of Standard English

Number Correct (Raw Score) for:	
Production of Writing (POW)	_____ (23)
Knowledge of Language (KLA)	_____ (12)
Conventions of Standard English (CSE)	_____ (40)
Total Number Correct for English Test (POW + KLA + CSE)	_____ (75)

Test 2: Mathematics—Scoring Key

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

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

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

**\*Reporting Categories**

PHM = Preparing for Higher Math

N = Number & Quantity

A = Algebra

F = Functions

G = Geometry

S = Statistics & Probability

IES = Integrating Essential Skills

MDL = Modeling

Number Correct (Raw Score) for:	
Preparing for Higher Math (PHM) (N + A + F + G + S)	(35)
Integrating Essential Skills (IES)	(25)
Total Number Correct for Mathematics Test (PHM + IES)	(60)
Modeling (MDL) (Not included in total number correct for mathematics test raw score)	(30)

**Test 3: Reading—Scoring Key**

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

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

**\*Reporting Categories**

KID = Key Ideas & Details

CS = Craft & Structure

IKI = Integration of Knowledge & Ideas

Number Correct (Raw Score) for:	
Key Ideas & Details (KID)	_____
	(23)
Craft & Structure (CS)	_____
	(11)
Integration of Knowledge & Ideas (IKI)	_____
	(6)
Total Number Correct for Reading Test (KID + CS + IKI)	_____
	(40)

**Test 4: Science—Scoring Key**

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

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

**\*Reporting Categories**

IOD = Interpretation of Data

SIN = Scientific Investigation

EMI = Evaluation of Models,  
Inferences & Experimental Results

Number Correct (Raw Score) for:	
Interpretation of Data (IOD)	_____
	(18)
Scientific Investigation (SIN)	_____
	(9)
Evaluation of Models, Inferences & Experimental Results (EMI)	_____
	(13)
Total Number Correct for Science Test (IOD + SIN + EMI)	_____
	(40)



## Explanation of Procedures Used to Obtain Scale Scores from Raw Scores

On each of the four tests on which you marked any responses, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale scores. For each test, locate and circle your raw score or the range of raw scores that includes it in the table below. Then, read across to either outside column of the table and circle the scale score that corresponds to that raw score. As you determine your scale scores, enter them in the blanks provided on the right. The highest possible scale score for each test is 36. The lowest possible scale score for any test on which you marked any responses is 1.

Next, compute the Composite score by averaging the four scale scores. To do this, add your four scale scores and divide the sum by 4. If the resulting number ends in a fraction, round it off to the nearest whole number. (Round down any fraction less than one-half; round up any fraction that is one-half or more.) Enter this number in the blank. This is your Composite score. The highest possible Composite score is 36. The lowest possible Composite score is 1.

ACT Test A11	Your Scale Score
English	_____
Mathematics	_____
Reading	_____
Science	_____
<b>Sum of scores</b> _____	
<b>Composite score (sum ÷ 4)</b> _____	

NOTE: If you left a test completely blank and marked no items, do not list a scale score for that test. If any test was completely blank, do not calculate a Composite score.

Scale Score	Raw Scores				Scale Score
	Test 1 English	Test 2 Mathematics	Test 3 Reading	Test 4 Science	
36	73-75	59-60	40	39-40	36
35	71-72	57-58	38-39	38	35
34	69-70	56	37	37	34
33	68	54-55	36	36	33
32	67	53	35	35	32
31	66	52	34	34	31
30	65	50-51	33	33	30
29	64	48-49	32	32	29
28	63	45-47	31	31	28
27	61-62	42-44	30	30	27
26	60	39-41	29	29	26
25	57-59	36-38	28	27-28	25
24	55-56	34-35	27	25-26	24
23	52-54	32-33	26	24	23
22	49-51	30-31	24-25	22-23	22
21	46-48	29	23	20-21	21
20	43-45	27-28	21-22	19	20
19	41-42	24-26	20	17-18	19
18	40	22-23	19	16	18
17	37-39	19-21	17-18	14-15	17
16	34-36	15-18	16	13	16
15	30-33	12-14	14-15	12	15
14	27-29	9-11	13	10-11	14
13	25-26	7-8	11-12	9	13
12	23-24	6	9-10	8	12
11	20-22	5	8	7	11
10	17-19	4	7	6	10
9	14-16	3	6	5	9
8	12-13	—	5	4	8
7	10-11	2	4	—	7
6	8-9	—	—	3	6
5	6-7	—	3	2	5
4	5	1	2	—	4
3	3-4	—	—	1	3
2	2	—	1	—	2
1	0-1	0	0	0	1

ITEM NUMBER	1	1111111112	2222222223	3333333334	4444444445	5555555556	6666666667	777777
ENGLISH CORRECT ANSWER YOUR ANSWER		CHDDJTBHF AJDHBJAGAH AJCFBJDHBG AHGJDFAFDG CHBHAGAJDH BJBFBFCHDG BFAHAFCTJBG DJAHK	BF+FAFC+AJ CFCGAFDHDH DH+GC+B+AJ BFBHB+DH+F ++AJC+B+AF +HCJD++JC+ DJCFBH++A+ CH+JB					
MATHEMATICS CORRECT ANSWER YOUR ANSWER		DHCJAHDBG AGCFCKAKAG DJEHCHDJBK CHBKEGCFAK EFAJDKAKDG DHBGDKBFDG	+++++++E+ +++J++B+++ AG+K++++AJ BJ+H+J++++ ++DF+G++CH EJAFAGC++K					
READING CORRECT ANSWER YOUR ANSWER		BFDJBJAJDH DJDHBHCJCF DHAFBJAGCH BFDGCFAHAG	A+++GCJC+++G A+B+++FDGBH B+BJAGBJDF CHA+B+C+BH					
SCIENCE CORRECT ANSWER YOUR ANSWER		BJAHADJCH DFBHBGCJAF CFPDFBGCFBG AHDJCHBGCJ	++++BG+G+G AJ++A+AGDG +G+JAH++++H DF++AFCFBG					

1st Row: Correct responses to the items on the ACT tests.

2nd Row: Your Responses:  
 A plus (+) indicates your response was correct.  
 A letter (A through K) is the response you chose,  
 if your answer was incorrect.  
 A dash (-) indicates you omitted the item.  
 An asterisk (\*) indicates you gridded more than  
 one response.

TO VIEW THE REPORTING CATEGORIES FOR EACH QUESTION, SEE THE  
 ENCLOSED BOOKLET.