Form C03

(December 2019)

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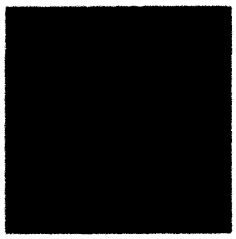


The ACT®

2019|2020

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 scanned 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.

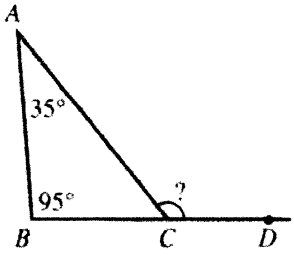
1. Illustrative figures are NOT necessarily drawn to scale.
2. Geometric figures lie in a plane.
3. The word *line* indicates a straight line.
4. The word *average* indicates arithmetic mean.

DO YOUR FIGURING HERE.

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

   A. 0
   B. 10
   C. 19
   D. 24
   E. 28

2. In the figure below, $\angle BAC$ measures 35°, $\angle ABC$ measures 95°, and points B, C, and D are collinear. What is the measure of $\angle ACD$?

   F. 95°
   G. 125°
   H. 130°
   J. 140°
   K. 145°

3. For all nonzero values of x and y, which of the following expressions is equivalent to $-\frac{36x^4y^3}{4xy}$?

   A. $-40x^3y^2$
   B. $-32x^3y^2$
   C. $-9x^5y^4$
   D. $-9x^4y^3$
   E. $-9x^3y^2$

4. At a certain airline company, the cost to transfer mileage points from one person's account to another person's account is \$0.75 for every 100 mileage points transferred plus a onetime \$20 processing fee. What is the cost to transfer 7,000 mileage points from one account to another at that airline company?

   F. \$25.25
   G. \$67.50
   H. \$72.50
   J. \$75.00
   K. \$95.00

DO YOUR FIGURING HERE.

5. For $x = -5$, what is the value of $4x^2 - 11x$?

   A. −155
   B. −84
   C. −45
   D. 84
   E. 155

6. Taho earns his regular pay of \$11 per hour for up to 40 hours of work per week. For each hour over 40 hours of work per week, Taho earns $1\frac{1}{2}$ times his regular pay. How much does Taho earn in a week in which he works 50 hours?

   F. \$550
   G. \$605
   H. \$625
   J. \$750
   K. \$825

7. A science class has 8 juniors and 4 seniors. The teacher will randomly select 2 students, one at a time, to represent the class in a committee at the school. Given that the first student selected is a junior, what is the probability that the second student selected will be a senior?

   A. $\frac{1}{11}$
   B. $\frac{1}{4}$
   C. $\frac{3}{11}$
   D. $\frac{1}{3}$
   E. $\frac{4}{11}$

8. When Tyrone fell asleep one night, the temperature was 24°F. When Tyrone awoke the next morning, the temperature was −12°F. Letting + denote a rise in temperature and − denote a drop in temperature, what was the change in temperature from the time Tyrone fell asleep until the time he awoke?

   F. −36°F
   G. −12°F
   H. +6°F
   J. +12°F
   K. +36°F

9. The total cost of renting a car is \$35.00 for each day the car is rented plus 42.5¢ for each mile the car is driven. What is the total cost of renting the car for 6 days and driving 350 miles?

   (Note: No sales tax is involved.)

   A. \$ 154.75
   B. \$ 224.88
   C. \$ 358.75
   D. \$ 420.00
   E. \$1,697.50

DO YOUR FIGURING HERE.

10. In the standard (x,y) coordinate plane, what is the slope of the line through $(-6,4)$ and $(1,3)$?

F. $-\frac{7}{5}$

G. $-\frac{1}{5}$

H. $-\frac{1}{7}$

J. $\frac{1}{7}$

K. $\frac{1}{5}$

11. One morning at a coffee shop, each customer ordered either decaf or regular coffee, and each ordered it either with milk or without milk. The number of customers who ordered each type of coffee with or without milk is listed in the table below.

Order	Decaf	Regular	Total
With milk	12	8	20
Without milk	6	10	16
Total	18	18	36

A customer will be randomly selected from all 36 customers for a prize. What is the probability that the selected customer will have ordered a regular coffee without milk?

A. $\frac{1}{6}$

B. $\frac{5}{18}$

C. $\frac{5}{13}$

D. $\frac{1}{2}$

E. $\frac{5}{8}$

12. Which of the following inequalities describes the solution set for $3x - 5 < 2x + 1$?

F. $x < -4$

G. $x > -\frac{4}{5}$

H. $x < \frac{6}{5}$

J. $x < 6$

K. $x > 6$

13. Which of the following expressions is equivalent to $4(x + 2) + 3(2x - 1)$?

A. $3x + 8$
B. $5(2x + 1)$
C. $10(x + 1)$
D. $10x + 11$
E. $15x$

DO YOUR FIGURING HERE.

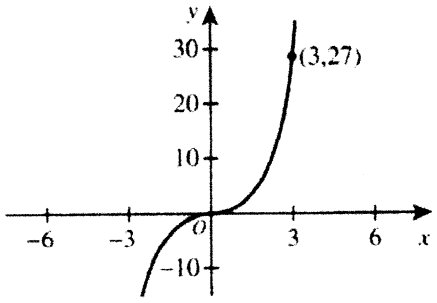
14. What is 4% of 1.36×10^4 ?

F. 340
G. 544
H. 3,400
J. 5,440
K. 54,400

15. What is the least common denominator of the fractions $\frac{4}{35}$, $\frac{1}{77}$, and $\frac{3}{22}$?

A. 110
B. 770
C. 2,695
D. 8,470
E. 59,290

16. The point (3,27) is labeled on the graph of $f(x) = x^3$ in the standard (x,y) coordinate plane below. The graph of $f(x)$ will be translated 3 coordinate units to the left. Which of the following points will be on the image of the graph after the translation?



F. (0,27)
G. (3,24)
H. (3,27)
J. (3,30)
K. (6,27)

17. In the standard (x,y) coordinate plane, what is the midpoint of the line segment that has endpoints (−6,9) and (2,5) ?

A. (−4,−4)

B. (−2, 7)

C. $\left(\frac{3}{2}, \frac{7}{2}\right)$

D. (4,−2)

E. (8,−4)

18. What value of x satisfies the equation $\frac{x^2 + 2x}{x + 2} = 2$?

F. −4
G. −3
H. −2
J. 1
K. 2

DO YOUR FIGURING HERE.

Use the following information to answer questions 19–21.

A large theater complex surveyed 5,000 adults. The results of the survey are shown in the tables below.

Age groups	Number
21–30	2,750
31–40	1,225
41–50	625
51 or older	400

Moviegoer category	Number
Very often	830
Often	1,650
Sometimes	2,320
Rarely	200

Tickets are $9.50 for all regular showings and $7.00 for matinees.

19. Based on the survey results, what was the average number of moviegoers for each of the 4 categories?

A. 610
B. 1,060
C. 1,240
D. 1,250
E. 1,985

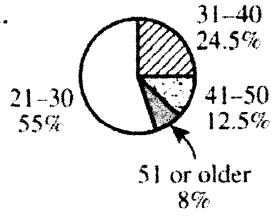
20. Suppose all the adults surveyed happened to attend 1 movie each in one particular week. The total amount spent on tickets by those surveyed in that week was $44,000.00. How many adults attended matinees that week?

F. 500
G. 1,400
H. 2,500
J. 3,600
K. 4,500

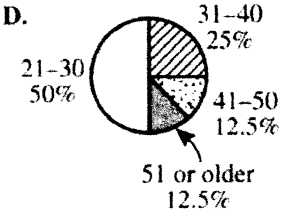
DO YOUR FIGURING HERE.

21. One of the following circle graphs represents the proportion by age group of the adults surveyed. Which one?

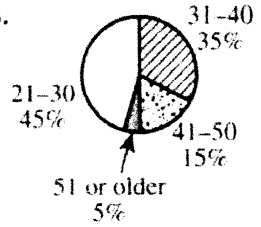
A.



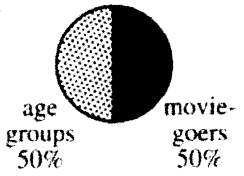
D.



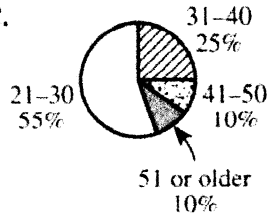
B.



E.



C.



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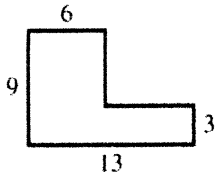
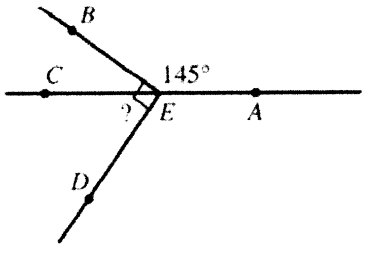
22. In the figure shown below, all angles are right angles, and the side lengths given are in centimeters. What is the area, in square centimeters, of the figure?

F. 42
G. 75
H. 93
J. 99
K. 117



23. In the figure below, E is on $\overline{CA}$, and the measures of $\angle BED$ and $\angle AEB$ are 90° and 145°, respectively. If it can be determined, what is the measure of $\angle CED$?



A. 35°
B. 45°
C. 55°
D. 80°
E. Cannot be determined from the given information

DO YOUR FIGURING HERE.

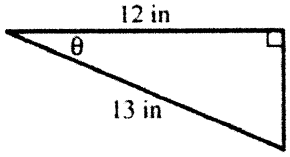
24. In the standard (x,y) coordinate plane, the graph of the function $y = 5\sin(x) - 7$ undergoes a single translation such that the equation of its image is $y = 5\sin(x) - 14$. Which of the following describes this translation?

F. Up 7 coordinate units
G. Down 7 coordinate units
H. Left 7 coordinate units
J. Right 7 coordinate units
K. Right 14 coordinate units

25. What is the value of $\left(9^{\frac{1}{2}} + 16^{\frac{1}{2}}\right)^2$?

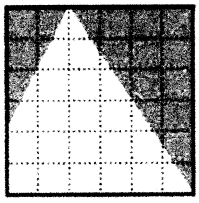
A. 7
B. 25
C. 49
D. 337
E. 625

26. A right triangle is shown in the figure below. What is the value of $\sin\theta$?



F. $\frac{5}{13}$
G. $\frac{5}{12}$
H. $\frac{12}{13}$
J. $\frac{13}{12}$
K. $\frac{13}{5}$

27. A 6-inch-by-6-inch square grid shown below is divided into 36 squares, each with a side length of 1 inch. Each vertex of the 2 shaded triangles lies at an intersection of 2 grid lines. What fractional part of the 6-inch-by-6-inch square is shaded?



A. $\frac{2}{3}$
B. $\frac{4}{5}$
C. $\frac{4}{9}$
D. $\frac{5}{9}$
E. $\frac{8}{9}$

28. All the values in the equation below are exact. What value of c makes the equation true?

$$(4.25 \times 10^{2c+4})(6 \times 10^{7}) = 255$$

F. −7
G. −6.5
H. −5
J. −4.5
K. −4

DO YOUR FIGURING HERE.

29. Which of the following inequalities is true for all positive integers m ?

A. $m \leq \frac{1}{m}$

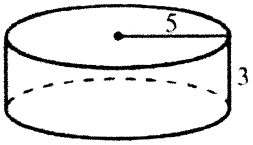
B. $m \leq \sqrt{m}$

C. $m \geq m^2$

D. $m \leq m + 1$

E. $m \geq \sqrt{m + 1}$

30. A formula for the volume, V, of a right circular cylinder is $V = \pi r^2 h$, where r is the radius and h is the height. The cylindrical tank shown below has radius 5 meters and height 3 meters and is filled with water.

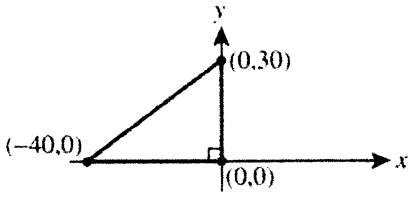


Given that the weight of 1 cubic meter of water is approximately 2,205 pounds, the weight, in pounds, of the water in the tank is:

F. less than 200,000.
G. between 200,000 and 300,000.
H. between 300,000 and 500,000.
J. between 500,000 and 1,000,000.
K. more than 1,000,000.

31. Graphed in the standard (x,y) coordinate plane below is a right triangle with vertices (0,0), (−40,0), and (0,30). What is the length, in coordinate units, of the hypotenuse of the triangle?

A. 30
B. 35
C. 40
D. 50
E. 70



32. Every graph in one of the following categories has a vertical line of symmetry regardless of how it is oriented in the standard (x,y) coordinate plane. Which one?

F. Circles
G. Squares
H. Ellipses
J. Triangles
K. Rectangles

DO YOUR FIGURING HERE.

33. In the standard (x,y) coordinate plane, the graph of $y = 30(x + 17)^2 - 42$ is a parabola. What are the coordinates of the vertex of the parabola?

A. $(-30,-42)$
B. $(-17,-42)$
C. $(17,-42)$
D. $(17, 42)$
E. $(30, 42)$

34. One side of square $ABCD$ has a length of 15 meters. A certain rectangle whose area is equal to the area of $ABCD$ has a width of 10 meters. What is the length, in meters, of the rectangle?

F. 15
G. 20
H. 22.5
J. 25
K. 37.5

35. The average weight of 10 boys is 77.0 pounds. If the youngest boy is excluded, the average weight of the 9 remaining boys is 78.0 pounds. What is the weight, in pounds, of the youngest boy?

A. 62
B. 68
C. 70
D. 78
E. 87

36. The total amount of a certain substance present in a laboratory experiment is given by the formula $A = A_0\left(2^{\frac{h}{5}}\right)$, where A is the total amount of the substance h hours after an initial amount (A_0) of the substance began accumulating. Which of the following expressions gives the number of hours it will take an initial amount of 10 grams of this substance to accumulate to 100 grams?

F. 5
G. 25
H. $\log_2(50)$
J. $5 \log_2(10)$
K. $5 \log_{20}(100)$

DO YOUR FIGURING HERE.

37. For all values of x greater than 3, which of the following expressions is equivalent to $\frac{x^2-x-6}{x^2-9}$?

A. $\frac{-x-6}{-9}$

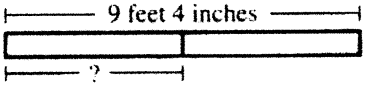
B. $\frac{x-2}{x-3}$

C. $\frac{x-2}{x+3}$

D. $\frac{x+2}{x-3}$

E. $\frac{x+2}{x+3}$

38. Shown below, a board 9 feet 4 inches long is cut into 2 equal parts. What is the length, to the nearest inch, of each part?



F. 4 feet 5 inches
G. 4 feet 7 inches
H. 4 feet 8 inches
J. 5 feet 4 inches
K. 5 feet 5 inches

39. If the positive integers x and y are relatively prime (their greatest common factor is 1) and $\frac{1}{2}+\frac{1}{3}\cdot\frac{1}{4}+\frac{1}{5}=\frac{x}{y}$, then $x+y=$?

A. 23
B. 25
C. 49
D. 91
E. 132

40. What is the 358th digit after the decimal point in the repeating decimal $0.\overline{3178}$?

F. 0
G. 3
H. 1
J. 7
K. 8

41. To promote a new brand of shoes, a shoe store will run a promotion using a jar containing 3 red balls marked "10% off," 2 white balls marked "30% off," and 1 green ball marked "60% off." Each customer will randomly select 1 ball from the jar to determine the discount that the customer will receive on any single pair of the new brand of shoes. Given that the new brand of shoes regularly costs \$60 per pair, what is the average discount amount, in dollars, that the store can expect to give each customer due to this promotion?

A. \$ 6
B. \$10
C. \$15
D. \$20
E. \$25

DO YOUR FIGURING HERE.

Use the following information to answer questions 42–44.

A 500-square-mile national park in Kenya has large and small protected animals. The number of *large* protected animals at the beginning of 2014 is given in the table below.

Large animal	Number
Elephant	600
Rhinoceros	100
Lion	200
Leopard	300
Zebra	400
Giraffe	800
Total	2,400

At the beginning of 2014, the number of *all* protected animals in the park was 10,000. Zoologists predict that for each year from 2015 to 2019, the total number of protected animals in the park at the beginning of the year will be 2% more than the number of protected animals in the park at the beginning of the previous year.

42. At the beginning of 2014, the number of lions in the park was p percent of the total number of *large* animals. Which of the following is closest to the value of p ?

F. 2
G. 8
H. 9
J. 11
K. 12

43. In this park, the average number of gallons of water consumed per day by each elephant, lion, and giraffe is 50, 5, and 10, respectively. Which of the following matrix products yields the average total number of gallons of water consumed per day by all the elephants, lions, and giraffes in the park?

A. $\begin{bmatrix}600 & 200 & 800\end{bmatrix}\begin{bmatrix}50\\5\\10\end{bmatrix}$

B. $\begin{bmatrix}600 & 800 & 200\end{bmatrix}\begin{bmatrix}50\\5\\10\end{bmatrix}$

C. $\begin{bmatrix}600\\200\\800\end{bmatrix}\begin{bmatrix}50 & 5 & 10\end{bmatrix}$

D. $\begin{bmatrix}600\\800\\200\end{bmatrix}\begin{bmatrix}50 & 5 & 10\end{bmatrix}$

E. $\begin{bmatrix}600\\800\\200\end{bmatrix}\begin{bmatrix}50\\5\\10\end{bmatrix}$

DO YOUR FIGURING HERE.

44. Let t be a positive integer less than 6. Based on the zoologists' prediction, which of the following expressions represents the number of protected animals in the park t years after the beginning of 2014 ?

F. $10{,}000 + 0.02t$
G. $10{,}000 + 0.2t$
H. $10{,}000(1 + 0.02^t)$
J. $10{,}000(1 + 0.02)^t$
K. $10{,}000(1 + 0.2)^t$

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45. Anela and Jacob plan to attend a concert in Brady. Anela will drive 375 km to Brady at a constant speed of 75 km/hr, stopping one time for a 30-minute break. Jacob will start 600 km from Brady and will drive at a constant speed of 90 km/hr for 2 hours. He will take a 1-hour break and then drive to Brady at a constant speed of 70 km/hr. To the nearest 0.1 hour, Jacob must leave how much earlier than Anela in order for them to arrive in Brady at the same time?

A. 2.2
B. 2.5
C. 3.1
D. 3.5
E. 4.0

46. Which of the following is equal to $\frac{3x+5}{2x} - \frac{7x-3}{2x}$, for all $x \neq 0$?

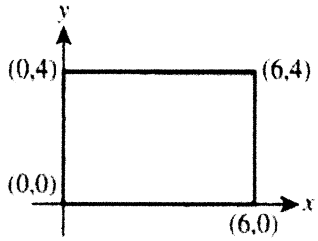
F. $-4x + 8$
G. $-4x + 2$
H. $-2x + 1$
J. $\frac{-2x+4}{x}$
K. 2

47. A rectangular stage is 90 feet long and 30 feet wide. What is the area, in square *yards*, of this stage?

A. $30\sqrt{3}$
B. 300
C. 675
D. 900
E. 2,700

DO YOUR FIGURING HERE.

48. A rectangle, with its vertex coordinates labeled, is graphed in the standard (x,y) coordinate plane below. A *lattice point* is a point with coordinates that are both integers. A lattice point inside but NOT on the rectangle will be chosen at random. What is the probability that the sum of the x-coordinate and the y-coordinate of the chosen lattice point will be odd?



F. $\frac{1}{5}$

G. $\frac{2}{5}$

H. $\frac{7}{15}$

J. $\frac{17}{35}$

K. $\frac{1}{2}$

49. The nth term of an arithmetic progression is given by the formula $a_n = a_1 + (n-1)d$, where d is the common difference and a_1 is the first term. If the third term of an arithmetic progression is $\frac{5}{2}$ and the sixth term is $\frac{1}{4}$, what is the seventh term?

A. $-\frac{1}{2}$

B. 0

C. $\frac{1}{2}$

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

E. 1

50. The probability of Jamie being chosen to bat first in the lineup for his baseball team is $\frac{1}{9}$. What are the odds in favor of Jamie being chosen to bat first?

(Note: The *odds* in favor of an event are defined as the ratio of the probability that the event will happen to the probability that the event will NOT happen.)

F. $\frac{1}{8}$

G. $\frac{1}{9}$

H. $\frac{1}{10}$

J. $\frac{8}{1}$

K. $\frac{9}{1}$

DO YOUR FIGURING HERE.

51. A 120-liter solution that is 5% salt is mixed with an 80-liter solution that is 15% salt. The combined solution is what percent salt?

A. 8%
B. 9%
C. 10%
D. 11%
E. 12%

52. A 50-foot-long rectangular swimming pool with vertical sides is 3 feet deep at the shallow end and 10 feet deep at the deep end. The bottom of the pool slopes downward at a constant angle from horizontal along the length of the pool. Which of the following expressions gives this constant angle?

(Note: For $-\frac{\pi}{2} < x < \frac{\pi}{2}$, $y = \tan x$ if and only if $x = \tan^{-1} y$.)

F. $\tan^{-1}\left(\frac{7}{50}\right)$

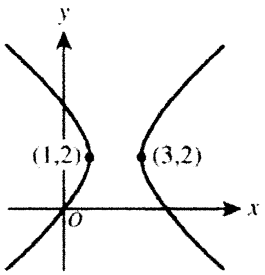
G. $\tan^{-1}\left(\frac{13}{50}\right)$

H. $\tan^{-1}\left(\frac{7}{10}\right)$

J. $\tan^{-1}\left(\frac{50}{13}\right)$

K. $\tan^{-1}\left(\frac{50}{7}\right)$

53. A hyperbola that has vertices (1,2) and (3,2) and that passes through the origin is shown below in the standard (x,y) coordinate plane. The hyperbola has which of the following equations?



A. $\frac{(x-2)^2}{1} - \frac{3(y-2)^2}{4} = 1$

B. $\frac{(x-2)^2}{1} - \frac{4(y-2)^2}{3} = 1$

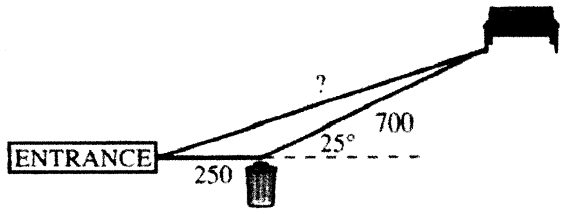
C. $\frac{(x+2)^2}{1} - \frac{3(y+2)^2}{4} = 1$

D. $\frac{(x-2)^2}{1} + \frac{3(y-2)^2}{4} = 1$

E. $\frac{(x+2)^2}{1} + \frac{4(y+2)^2}{3} = 1$

DO YOUR FIGURING HERE.

54. As shown below, Alli walked her dog 250 feet due east from the entrance of a dog park to a trash can and then walked 700 feet in a straight line 25° north of east to a bench. Which of the following expressions is equal to the distance, in feet, between the entrance and the bench?



F. $\frac{950}{\cos 25°}$

G. $\frac{250}{\cos 25°} + 700$

H. $\frac{250}{\sin 155°} + 700$

J. $\sqrt{700^2 + 250^2 - 2(700)(250)\cos 25°}$

K. $\sqrt{700^2 + 250^2 - 2(700)(250)\cos 155°}$

55. For real numbers a, b, and c such that $a > b > c$ and $b > 0$, which of the statements below is(are) *always* true?

I. $|a| > |b|$
II. $|a| > |c|$
III. $|b| > |c|$

A. I only
B. II only
C. I and II only
D. II and III only
E. I, II, and III

56. Kenji and Mary are members of a school committee that will be meeting this afternoon. The 6 members of the committee will be seated randomly around a circular table. What is the probability that Kenji and Mary will NOT sit next to each other at the meeting?

F. $\frac{1}{5}$

G. $\frac{1}{3}$

H. $\frac{2}{5}$

J. $\frac{3}{5}$

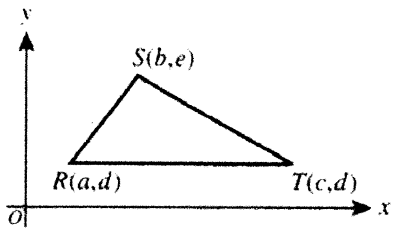
K. $\frac{4}{5}$

57. The digit in the ones place of 2^{88} is 6. What is the digit in the ones place of 2^{90} ?

A. 0
B. 2
C. 4
D. 6
E. 8

DO YOUR FIGURING HERE.

58. Which of the following expressions represents the area, in square coordinate units, of $\triangle RST$ shown in the standard (x,y) coordinate plane below?



F. $\frac{1}{2}(c-a)(e-d)$

G. $\frac{1}{2}c(e-b)$

H. $\frac{1}{2}e(c-a)$

J. $\frac{1}{2}[(e-d)^2+(b-a)^2][(e-d)^2+(b-c)^2]$

K. $\frac{1}{2}\left(\sqrt{(e-d)^2+(b-a)^2}\right)\left(\sqrt{(e-d)^2+(b-c)^2}\right)$

59. In the complex numbers, where $i^2=-1$, what complex number x is a solution to the equation $x(2+3i)=1$?

A. $\frac{2}{13}-\frac{3}{13}i$

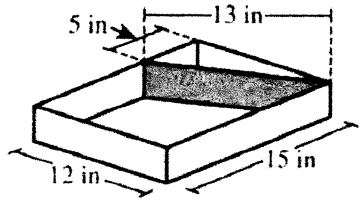
B. $\frac{2}{5}+\frac{3}{5}i$

C. 1

D. -1

E. $-\frac{i}{13}$

60. The rectangular container shown below has a small compartment for water created by a rectangular dividing wall of negligible width. One face of the dividing wall, shown shaded, has an area of 39 square inches. What is the volume, in cubic inches, of the larger compartment?



F. 180
G. 195
H. 390
J. 450
K. 540

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

The *molar volume* of a gas is the volume occupied by 1 mole (mol; 6×10^{23} atoms or molecules) of that gas at a given pressure and temperature.

Table 1 shows how the molar volume, in L, of each of 6 gases—helium (He), neon (Ne), argon (Ar), hydrogen (H_2), nitrogen (N_2), and oxygen (O_2)—varies with pressure, in atmospheres (atm), at a temperature of 273 kelvins (K).

Table 1

Pressure (atm)	Molar volume (L) at 273 K of:					
	He	Ne	Ar	H_2	N_2	O_2
0.500	44.825	44.810	44.774	44.818	44.781	44.773
1.00	22.424	22.409	22.374	22.417	22.380	22.372
5.00	4.503	4.488	4.453	4.496	4.459	4.451
10.0	2.262	2.248	2.213	2.256	2.219	2.211
50.0	0.471	0.456	0.421	0.465	0.430	0.420
100.0	0.247	0.233	0.200	0.242	0.210	0.198

Table 2 shows how the molar volume of each of the 6 gases varies with temperature at a pressure of 1.00 atm.

Table 2

Temperature (K)	Molar volume (L) at 1.00 atm of:					
	He	Ne	Ar	H_2	N_2	O_2
223	18.321	18.304	18.257	18.312	18.263	18.256
323	26.504	26.513	26.486	26.521	26.492	26.485
373	30.670	30.617	30.595	30.625	30.601	30.594
573	47.041	47.031	47.022	47.040	47.028	47.021
773	63.453	63.443	63.440	63.452	63.446	63.440

1. Based on Table 1, for H_2 at 273 K, the absolute value of the difference between the molar volume at 5.00 atm and the molar volume at 10.0 atm is approximately:

   A. 1.8 L.
   B. 2.2 L.
   C. 4.0 L.
   D. 5.0 L.

2. Consider the molar volumes of He, Ar, H_2, and N_2 listed in Table 2 at 323 K. What is the order of these gases from the gas having the smallest molar volume to the gas having the largest molar volume?

   F. Ar, He, N_2, H_2
   G. Ar, N_2, He, H_2
   H. H_2, He, N_2, Ar
   J. H_2, N_2, He, Ar

3. Based on Tables 1 and 2, at any given temperature and pressure, the molar volume of which other gas is most similar to the molar volume of O_2 ?

   A. He
   B. Ar
   C. H_2
   D. N_2

4. An *ideal gas* has a molar volume of 63.429 L at 1.00 atm and 773 K. At 1.00 atm and 773 K, how many of the gases listed in Table 2 have a *smaller* molar volume than that of an ideal gas?

   F. 0
   G. 2
   H. 4
   J. 6

5. In a gas sample, collisions between gas particles are common. The average time a gas particle spends between one collision and the next is called the *mean free time*. In general, mean free time decreases as a sample's volume decreases. Based on Table 1, the mean free time would be *least* for a 1 mol sample of which gas at which pressure?

   A. He at 0.500 atm
   B. O_2 at 0.500 atm
   C. He at 100.0 atm
   D. O_2 at 100.0 atm

6. Consider 2 separate 1 mol samples of O_2, each at a pressure of 1 atm. One sample has a volume of about 18 L, and the other has a volume of about 63 L. Based on Table 2, the average kinetic energy of the O_2 molecules is more likely greater in which sample?

   F. The 18 L sample, because it's at the lower temperature.
   G. The 18 L sample, because it's at the higher temperature.
   H. The 63 L sample, because it's at the lower temperature.
   J. The 63 L sample, because it's at the higher temperature.

Passage II

Scientists conducted 3 experiments to study the transfer of bacteria from one surface to another by 2 species of flies: *Musca domestica* and *Sarcophaga carnaria*.

Experiment 1

A group of 10 *M. domestica* was tested using this procedure:

1. Each fly was placed in a separate enclosure containing *Escherichia coli* (a type of bacteria) and allowed to walk on the *E. coli* for 5 min.
2. Each fly was then immediately placed in a separate petri dish containing sterile nutrient agar. Five minutes later, the flies were removed from the dishes.
3. The dishes were incubated at 37°C for 24 hr so that each *E. coli* cell on the dish divided to form a separate colony, and then the number of *E. coli* colonies on each dish was counted.
4. The average number of colonies per dish was calculated.

This procedure was also used to test a group of 10 *S. carnaria*. The results are shown in Figure 1.

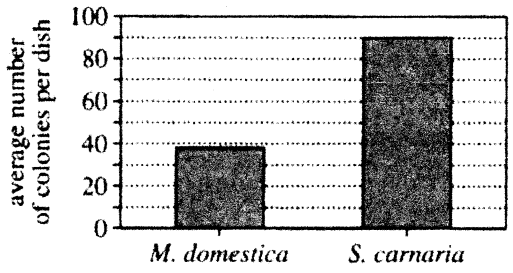


Figure 1

Experiment 2

The procedure from Experiment 1 was repeated with each of 3 groups of 10 *S. carnaria* except that the flies in each group were allowed to walk on the *E. coli* for a different period of time—5 min, 30 min, or 60 min—before each fly was placed in a separate petri dish containing nutrient agar. The results are shown in Figure 2.

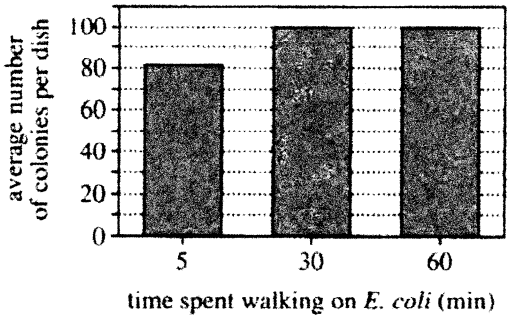


Figure 2

Experiment 3

The procedure from Experiment 1 was repeated with each of 3 groups of 10 *S. carnaria* except that, after Step 1, the flies in each group were allowed a different period of time—0 min, 30 min, or 60 min—to clean themselves before each fly was placed in a separate petri dish containing sterile nutrient agar. The results are shown in Figure 3.

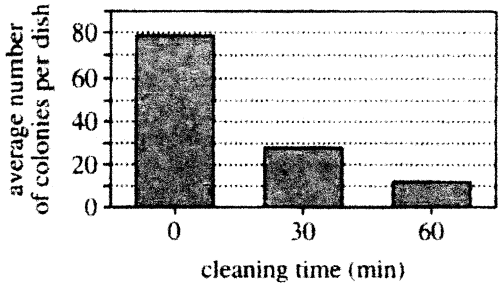


Figure 3

Figures adapted from Julie J. Shaffer, Kasey Jo Warner, and W. Wyatt Hoback, "Filthy Flies? Experiments to Test Flies as Vectors of Bacterial Disease." ©2007 by National Association of Biology Teachers.

7. As the amount of cleaning time increased, the average number of colonies per dish:
   - **A.** increased only.
   - **B.** decreased only.
   - **C.** increased and then decreased.
   - **D.** decreased and then increased.

8. What was the total number of flies tested in Experiment 3 ?
   - **F.** 5
   - **G.** 10
   - **H.** 24
   - **J.** 30

9. A scientist claimed that some species of flies spread bacterial diseases. Are the results of Experiment 1 consistent with this claim?
   - **A.** Yes; based on Figure 1, the flies transferred bacteria from one surface to another.
   - **B.** Yes; based on Figure 1, *M. domestica* transferred bacteria to *S. carnaria*.
   - **C.** No; based on Figure 1, the flies did not transfer bacteria from one surface to another.
   - **D.** No; based on Figure 1, *M. domestica* did not transfer bacteria to *S. carnaria*.

10. In the experiments, why was it necessary for the nutrient agar in the petri dishes to be sterile until the flies were placed in the dishes?

F. To ensure that any colonies that formed came from bacteria present in the nutrient agar before the flies were placed in the dishes
G. To ensure that any colonies that formed came from bacteria transferred to the nutrient agar by the flies
H. To ensure that the nutrient agar contained all the nutrients necessary for the flies to reproduce
J. To ensure that the nutrient agar contained all the nutrients necessary for the bacteria to reproduce

11. A student claimed that Species X flies would transfer more *E. coli* cells to a petri dish containing nutrient agar than would either *M. domestica* or *S. carnaria*. Which of the following experiments would best test the student's claim?

A. Repeat Experiment 1 except include a group of 10 Species X flies.
B. Repeat Experiment 1 except with a different species of bacteria.
C. Repeat Experiment 2 except include a group of 10 Species X flies.
D. Repeat Experiment 2 except with a different species of bacteria.

12. Which of the following statements gives the most likely hypothesis for Experiment 3 ?

F. *S. carnaria* remove bacteria when they clean themselves.
G. The longer *S. carnaria* are exposed to bacteria, the more bacteria they transfer between surfaces.
H. *M. domestica* transfer more bacteria between surfaces than do *S. carnaria*.
J. *M. domestica* are better at removing bacteria during cleaning than are *S. carnaria*.

13. Which of the following is the most likely reason that the average number of colonies per dish for *S. carnaria* shown in Figure 1 was different from the average number of colonies per dish for the flies that spent 5 min walking on the *E. coli* in Experiment 2 ?

A. By chance, the *M. domestica* in Experiment 2 transferred, on average, fewer *E. coli* than did the *S. carnaria* in Experiment 1.
B. By chance, the *S. carnaria* in Experiment 2 transferred, on average, fewer *E. coli* than did the *S. carnaria* in Experiment 1.
C. The *M. domestica* in Experiment 2 walked on the *E. coli* for a shorter period of time than did the *S. carnaria* in Experiment 1.
D. The *S. carnaria* in Experiment 2 walked on the *E. coli* for a shorter period of time than did the *S. carnaria* in Experiment 1.

Passage III

Forest fires require oxygen (O_2) to burn. Figure 1 shows the number of *paleowildfires* (large forest fires known from the rock record) for each 10-million-year interval of the *Mesozoic era* (250–65 million years ago, mya). Figure 1 also shows a model of the percent O_2 by volume ($\%O_2$) in Earth's atmosphere from 250 mya to 70 mya.

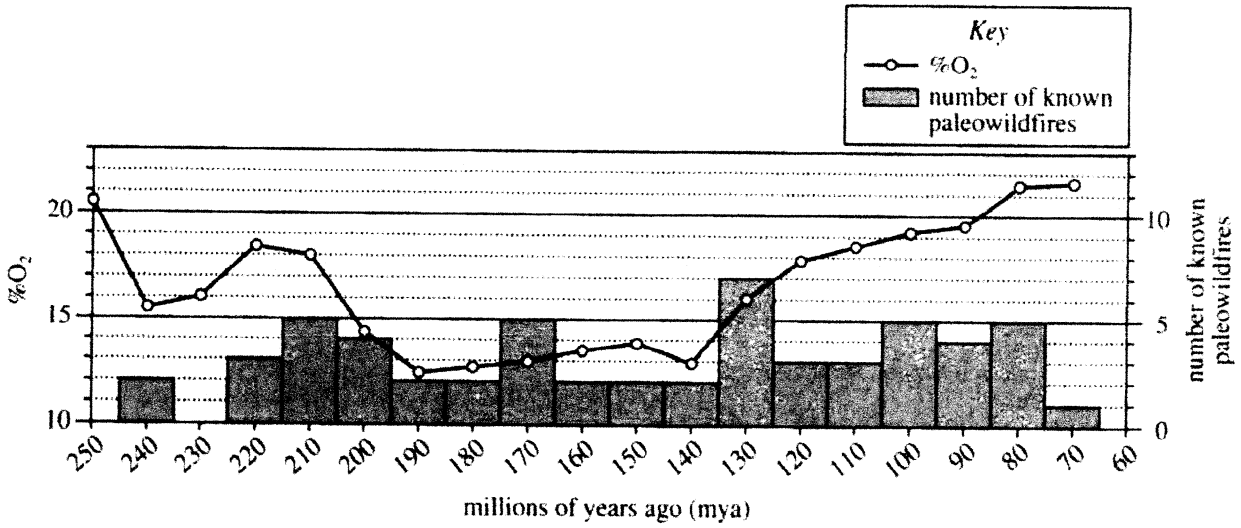
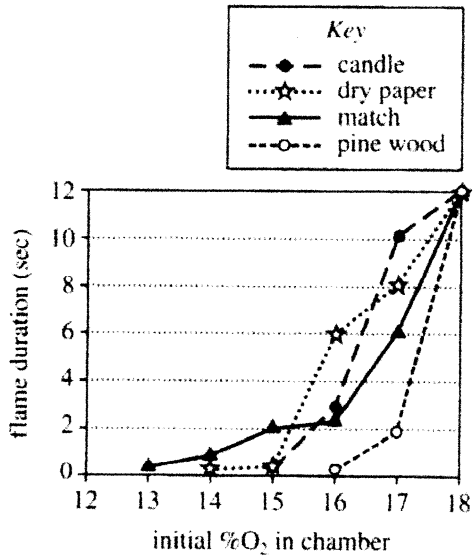


Figure 1

To study how $\%O_2$ affects burning, scientists attempted to ignite 7 samples of each of 4 different materials, 1 sample at a time, in a chamber. For each set of samples of the same material, the initial $\%O_2$ in the chamber ranged from 12% to 18%. Figure 2 shows, for each sample that ignited, the duration of the sample's flame.



Note: At an initial $\%O_2$ of 18, all samples burned to ash in 12 seconds.

Figure 2

Figures adapted from C. M. Belcher and J. C. McElwain, "Limits for Combustion in Low O_2 Redefine Paleoatmospheric Predictions for the Mesozoic." ©2008 by American Association for the Advancement of Science.

14. The $\%O_2$ in Earth's atmosphere today is about 21. According to Figure 1, at which of the following times during the Mesozoic era was the $\%O_2$ in Earth's atmosphere closest to the $\%O_2$ in Earth's atmosphere today?

F. 250 mya
G. 200 mya
H. 150 mya
J. 100 mya

15. According to Figure 2, at an initial $\%O_2$ of 17, approximately how many seconds greater was the flame duration for dry paper than the flame duration for pine wood?

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

16. A scientist claimed that paleowildfires could only have occurred when the $\%O_2$ was higher than 15. For which of the following time intervals during the Mesozoic era are the data in Figure 1 *inconsistent* with this claim?

F. 250–230 mya
G. 180–160 mya
H. 120–100 mya
J. 90–70 mya

17. According to Figure 2, what is the order of the 4 materials tested, from the material that required the highest initial $\%O_2$ to ignite to the material that required the lowest initial $\%O_2$ to ignite?

A. Match, pine wood, dry paper, candle
B. Match, dry paper, pine wood, candle
C. Pine wood, candle, dry paper, match
D. Pine wood, dry paper, candle, match

18. According to Figure 1, how many paleowildfires are known from the rock record between 95 mya and 85 mya ?

F. 4
G. 9
H. 14
J. 19

19. According to Figure 2, at an initial $\%O_2$ of 16, which of the 4 materials sustained a flame the longest?

A. Candle
B. Dry paper
C. Match
D. Pine wood

Passage IV

Four students observed that in a population of land plants, Population A, a plant could have a green stem or a purple stem. Each student proposed an explanation for this observation.

Student 1

All plants in Population A produce the green pigment chlorophyll. If a plant receives 8 hr or more of sunlight each day, it also produces a purple pigment, causing its stem to be purple. If a plant receives less than 8 hr of sunlight each day, it does not produce this purple pigment, so its stem is green. All plants in Population A are genetically identical, so they all have the ability to produce both pigments.

Student 2

All plants in Population A produce the green pigment chlorophyll. If a plant receives too little *phosphorus* (a nutrient), it also produces a purple pigment, causing its stem to be purple. If a plant receives enough phosphorus, it does not produce this purple pigment, so its stem is green. All plants in Population A are genetically identical, so they all have the ability to produce both pigments. The amount of sunlight received by a plant does not affect stem color.

Student 3

All plants in Population A produce the green pigment chlorophyll. The production of purple pigment is determined by Gene Q, which has 2 alleles (*Q* and *q*) and 3 possible genotypes (*QQ*, *Qq*, and *qq*). A plant with either the Gene Q genotype *QQ* or the Gene Q genotype *Qq* produces the purple pigment, causing its stem to be purple. A plant with the Gene Q genotype *qq* does not produce this purple pigment, so its stem is green. The amount of sunlight or nutrients received by a plant does not affect stem color.

Student 4

All plants in Population A produce the green pigment chlorophyll. The production of purple pigment is determined by Gene Q, which has 2 alleles (*Q* and *q*) and 3 possible genotypes (*QQ*, *Qq*, and *qq*). A plant with the Gene Q genotype *qq* produces the purple pigment, causing its stem to be purple. A plant with either the Gene Q genotype *QQ* or the Gene Q genotype *Qq* does not produce this purple pigment, so its stem is green. The amount of sunlight or nutrients received by a plant does not affect stem color.

20. Which student would be the most likely to agree that the soil in which a Population A plant is grown will influence its stem color?

F. Student 1
G. Student 2
H. Student 3
J. Student 4

21. Suppose it were found that the presence of the purple pigment in some plant tissues protects those tissues from being damaged by sunlight. Would this finding better support the explanation of Student 1 or the explanation of Student 2?

A. Student 1, because Student 1 indicated that the plants receiving the most sunlight will have purple stems.
B. Student 1, because Student 1 indicated that the plants receiving the most sunlight will have green stems.
C. Student 2, because Student 2 indicated that the plants receiving the most sunlight will have purple stems.
D. Student 2, because Student 2 indicated that the plants receiving the most sunlight will have green stems.

22. All 4 of the students' explanations are consistent with which of the following statements? In Population A:

F. both green-stemmed plants and purple-stemmed plants produce a pigment that can be used for photosynthesis.
G. only green-stemmed plants produce a pigment that can be used for photosynthesis.
H. only purple-stemmed plants produce a pigment that can be used for photosynthesis.
J. neither green-stemmed plants nor purple-stemmed plants produce a pigment that can be used for photosynthesis.

23. Which of the students, if any, would be likely to agree that providing a purple-stemmed plant from Population A with additional sunlight will cause its stem to become green?

A. Student 1 only
B. Students 1 and 3 only
C. Students 3 and 4 only
D. None of the students

24. Suppose 2 of the purple-stemmed plants in the population were crossed and 52 purple-stemmed and 15 green-stemmed offspring were produced. If all the parents and offspring in the cross were grown under the same conditions, these results would best support the explanation of which student?

F. Student 1
G. Student 2
H. Student 3
J. Student 4

25. Based on Student 4's explanation, if a purple-stemmed plant and a green-stemmed plant from Population A are crossed and they produce both purple-stemmed offspring and green-stemmed offspring, the Gene Q genotype of the parent with the:

A. purple stem must be QQ.
B. purple stem must be Qq.
C. green stem must be QQ.
D. green stem must be Qq.

26. Which of the students would be likely to agree that a plant receiving 9 hr of sunlight each day could have either a purple stem or a green stem?

F. Student 1 only
G. Student 2 only
H. Students 3 and 4 only
J. Students 2, 3, and 4 only

Passage V

Liquid H_2O can be broken down into hydrogen gas (H_2) and oxygen gas (O_2) by *electrolysis* according to the following chemical equation:

$$2H_2O \rightarrow 2H_2 + O_2$$

A scientist performed an experiment to study the electrolysis of H_2O using electricity generated from sunlight.

Experiment

Steps 1–5 were performed daily for 12 months:

1. A tank fitted with 2 electrodes—an *anode* (where O_2 would be produced) and a *cathode* (where H_2 would be produced)—was assembled. Each electrode was suspended in an inverted plastic tube, and each tube was marked to allow gas volume to be measured.

2. Four liters (4.0 L) of a 25% by mass aqueous solution of sodium hydroxide (NaOH) was added to the tank. As a result, the tubes were completely filled with the solution.

3. At 8:00 a.m., a rectangular solar cell was attached to the electrodes and placed next to a particular south-facing window for 8 hr. (Figure 1 shows the apparatus at the initiation of electrolysis.)

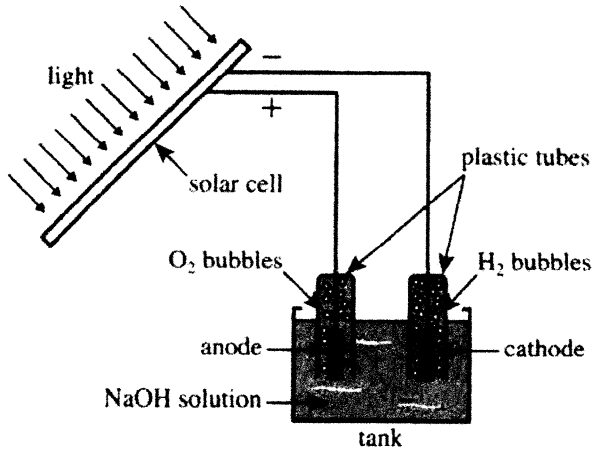


Figure 1

4. Eight hours later, the solar cell was detached from the electrodes, and the amount of H_2 that had been produced was measured.

5. The tank, tubes, and electrodes were cleaned and dried for reuse.

Figure 2 shows the total volume of H_2 produced (in L) in each month of the experiment. Table 1 shows the average *solar irradiance* (power per unit area), in watts per square meter (W/m^2), at the location of the solar cell during each month of the experiment.

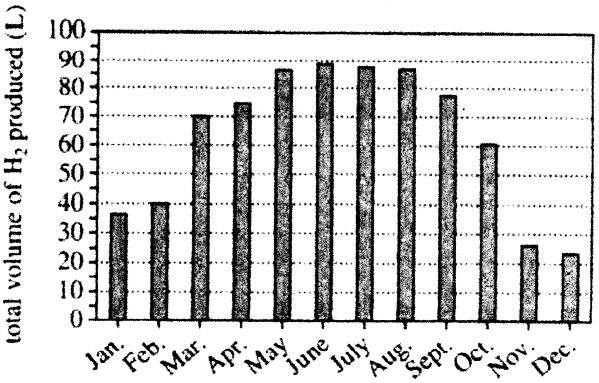


Figure 2

Table 1

Month	Average solar irradiance (W/m^2)
January	77.8
February	106.4
March	153.8
April	170.7
May	197.5
June	213.1
July	206.4
August	198.7
September	183.1
October	137.1
November	59.9
December	52.3

Figures and table adapted from Sergii Bespalko, "Hydrogen Production by Water Electrochemical Photolysis Using PV-Module." ©2011 by Sergii Bespalko.

27. Based on Figure 2 and Table 1, during the month in which a total of 70 L of H_2 was produced, the average solar irradiance was:

A. 77.8 W/m^2.
B. 153.8 W/m^2.
C. 197.5 W/m^2.
D. 206.4 W/m^2.

28. Based on the description of the experiment, at 4:00 p.m. on each day, did the scientist measure the amount of gas produced at the anode or the cathode?

F. The anode, because the anode is where H_2 was produced.
G. The anode, because the anode is where O_2 was produced.
H. The cathode, because the cathode is where H_2 was produced.
J. The cathode, because the cathode is where O_2 was produced.

29. Consider the percent by mass of NaOH in the solution added to the tank in Step 2. Approximately what mass of NaOH was in 200 g of this solution?

A. 25 g
B. 50 g
C. 200 g
D. 225 g

30. Based on the chemical equation and Figure 2, approximately how many liters of O_2 (NOT H_2) were produced in February?

F. 20 L
G. 40 L
H. 80 L
J. 100 L

31. Based on the description of the experiment, in the month of June how many total liters of NaOH solution were added to the tank?

A. 4.0 L, because Step 2 was performed once in June, on June 1.
B. 8.0 L, because Step 2 was performed twice in June, once on June 1 and once on June 30.
C. 120 L, because Step 2 was performed 30 times in June, once each day.
D. 240 L, because Step 2 was performed 60 times in June, twice each day.

32. Based on Table 1, on May 11, was the solar irradiance of the solar cell less than, equal to, or greater than 197.5 W/m^2 ?

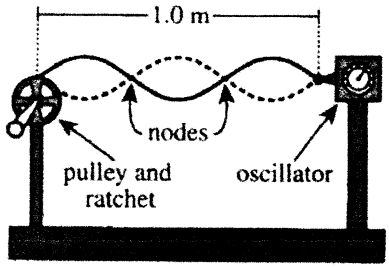
F. Less
G. Equal
H. Greater
J. Cannot be determined from the given information

33. Suppose the experiment was repeated, except that the scientist added only pure liquid H_2O to the tank in Step 2. Based on the description of the experiment, would this change have more likely resulted in more H_2 being produced or less H_2 being produced?

A. More H_2; pure liquid H_2O has more ions and thus higher electrical conductivity than does an aqueous NaOH solution.
B. More H_2; pure liquid H_2O has fewer ions and thus lower electrical conductivity than does an aqueous NaOH solution.
C. Less H_2; pure liquid H_2O has more ions and thus higher electrical conductivity than does an aqueous NaOH solution.
D. Less H_2; pure liquid H_2O has fewer ions and thus lower electrical conductivity than does an aqueous NaOH solution.

Passage VI

A *standing wave* on a taut string is a wave that appears to vibrate without traveling along the string. Such waves are called the string's *harmonics*. Each harmonic has a characteristic number of *nodes*: locations between the ends of the string that do not move (the ends of the string do not count as nodes). Figure 1 illustrates a harmonic and also the apparatus that a student used to perform 2 experiments on standing waves.



Note: Figure not drawn to scale.

Figure 1

A string having a mass per unit length of μ was attached on one end to an *oscillator* (a motor that vibrates) and on the other end to a pulley and ratchet. The student could select the frequency, f (the number of cycles per second), of the oscillator's vibration. By cranking the ratchet, the student could vary the force of tension, T, in the string.

Experiment 1

With 0.10 newtons (N) of tension in String X (μ = 0.02 g/cm), the student varied f. She noted that standing waves occurred only at certain values of f. The student sketched the first 5 harmonics and recorded f (in hertz, Hz) for each. She repeated this procedure for String Y (μ = 0.08 g/cm) and for String Z (μ = 0.16 g/cm). See Table 1.

Table 1

Harmonic	Sketch	f (Hz) for String: X	Y	Z
1st		11.2	5.59	3.95
2nd		22.4	11.2	7.91
3rd		33.5	16.8	11.9
4th		44.7	22.4	15.8
5th		55.9	28.0	19.8

Experiment 2

Beginning again with String X, the student set the oscillator to vibrate at f = 25.0 Hz. She then varied T, and noted that standing waves occurred only at certain values of T. The student recorded T for the first 5 harmonics. She repeated this procedure for Strings Y and Z. See Table 2.

Table 2

Harmonic	T (N) in String: X	Y	Z
1st	0.50	2.00	4.00
2nd	0.13	0.50	1.00
3rd	0.06	0.22	0.44
4th	0.03	0.13	0.25
5th	0.02	0.08	0.16

34. Based on the sketches made in Experiment 1, the string shown in Figure 1 is vibrating in which harmonic?

F. 1st
G. 2nd
H. 3rd
J. 4th

35. In a new trial, the student made the following sketch of a standing wave on String Z.

Based on the results of Experiments 1 and 2, this standing wave occurred at which approximate values of f and T ?

A. $f = 0.10$ Hz and $T = 0.11$ N
B. $f = 0.10$ Hz and $T = 23.7$ N
C. $f = 25.0$ Hz and $T = 0.11$ N
D. $f = 25.0$ Hz and $T = 23.7$ N

36. A piece of String Y that is 1 cm in length would have the same mass as a piece of:

F. String X that is 1 cm in length.
G. String X that is 4 cm in length.
H. String Z that is 1 cm in length.
J. String Z that is 4 cm in length.

37. The student reported the data in Table 1 with how many *significant digits* ?

A. Some data were reported with 1 significant digit, and some were reported with 2 significant digits.
B. Some data were reported with 2 significant digits, and some were reported with 3 significant digits.
C. All data were reported with 2 significant digits.
D. All data were reported with 3 significant digits.

38. For a string at constant tension, let f_n represent the frequency of the nth harmonic (f_1 is the frequency of the 1st harmonic, f_2 is the frequency of the 2nd harmonic, f_3 is the frequency of the 3rd harmonic, and so on). Which of the following equations for f_n is consistent with the results of Experiment 1 for String X ?

F. $f_n = n + f_1$
G. $f_n = n - f_1$
H. $f_n = n \times f_1$
J. $f_n = n + f_1$

39. Suppose that a string having a mass per unit length of 0.32 g/cm had been tested in Experiment 2. The 4th harmonic of this string would most likely have occurred at a tension:

A. less than 0.03 N.
B. between 0.03 N and 0.13 N.
C. between 0.13 N and 0.25 N.
D. greater than 0.25 N.

40. Based on the results of Experiments 1 and 2, for a given harmonic, as μ increased, did f increase or decrease, and did T increase or decrease?

	f	T
F.	increased	increased
G.	increased	decreased
H.	decreased	increased
J.	decreased	decreased

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.

Test 2: Mathematics—Scoring Key

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

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

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)	____ (18)

Test 3: Reading—Scoring Key

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

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

***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)	___ (12)
Integration of Knowledge & Ideas (IKI)	___ (5)
Total Number Correct for Reading Test (KID + CS + IKI)	___ (40)

Test 4: Science—Scoring Key

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

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

***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)	___ (12)
Evaluation of Models, Inferences & Experimental Results (EMI)	___ (10)
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 C03	Your Scale Score
English	_____
Mathematics	_____
Reading	_____
Science	_____
Sum of scores	_____
Composite score (sum ÷ 4)	_____

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