



SAT[®] DECEMBER 2016 U.S.A

IMPORTANT REMINDERS:

1

A No. 2 pencil is required for the test. Do not use a mechanical pencil or pen.

2

Sharing any questions with anyone is a violation of the SAT[®] Program's Test Security and Fairness policies and may result in your scores being canceled.

3

Requests to cancel scores must be received in writing by the Wednesday following the test date.



Math Test – No Calculator

25 MINUTES, 20 QUESTIONS

Turn to Section 3 of your answer sheet to answer the questions in this section.

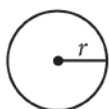
DIRECTIONS

For questions 1-15, solve each problem, choose the best answer from the choices provided, and fill in the corresponding circle on your answer sheet. For questions 16-20, solve the problem and enter your answer in the grid on the answer sheet. Please refer to the directions before question 16 on how to enter your answers in the grid. You may use any available space in your test booklet for scratch work.

NOTES

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3. Figures provided in this test are drawn to scale unless otherwise indicated.
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5. Unless otherwise indicated, the domain of a given function f is the set of all real numbers x for which $f(x)$ is a real number.

REFERENCE

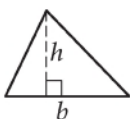


$$A = \pi r^2$$

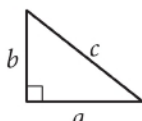
$$C = 2\pi r$$



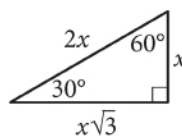
$$A = \ell w$$



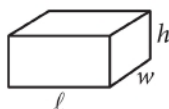
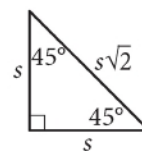
$$A = \frac{1}{2}bh$$



$$c^2 = a^2 + b^2$$



Special Right Triangles



$$V = \ell wh$$



$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}\ell wh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is 2π .

The sum of the measures in degrees of the angles of a triangle is 180.



1

Temperature in degrees Celsius($^{\circ}\text{C}$)	Physical state of granite
1,100	solid
1,200	solid
1,300	liquid
1,400	liquid
1,500	liquid

The table above shows the physical state of granite at various temperatures T , measured in degrees Celsius ($^{\circ}\text{C}$). Which of the following inequalities could describe the set of temperatures for which granite is in a solid state?

- A) $T < 1,250^{\circ}\text{C}$
- B) $T < 1350^{\circ}\text{C}$
- C) $T > 1,450^{\circ}\text{C}$
- D) $T > 1,550^{\circ}\text{C}$

2

Which of the following is equivalent to the expression $4x(x^2 + 3) - 5(x^2 + 3)$?

- A) $4x^5 - 5x^4 + 36x - 45$
- B) $16x^4 + 60x^3 - 20x^2 - 75x$
- C) $4x^3 - 5x^2 + 12x - 15$
- D) $4x^3 - 5x^2 + 4x + 15$

3

$$8x - 12 = 48$$

If x is the solution of the equation above, what is the value of $2x - 3$?

- A) 4
- B) 8
- C) 12
- D) 24

4

If $(2a + 4b)^2 = 100$, which of the following is a possible value of $a + 2b$?

- A) 5
- B) 12.5
- C) 25
- D) 50

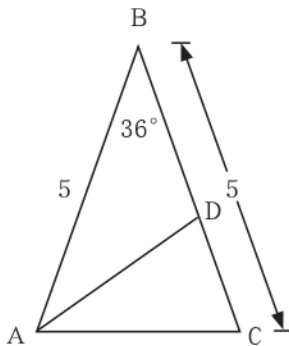


5

Dan bought some apples and oranges. The apples cost \$0.90 per pound, and the oranges cost \$1.30 per pound. If Dan spent \$8.85 in total and bought 3 pounds of oranges, how many pounds of apples did Dan buy?

- A) 4.5
- B) 5
- C) 5.5
- D) 6

6



For isosceles triangle ABC shown above, $AB = BC = 5$ and the measure of angle ABC is 36° . If $\angle BAC$ is bisected by \overline{AD} , which of the following statements must be true?

- A) $AB = AC = BC$
- B) $AD = BD = AC$
- C) $BD = CD = AC$
- D) $AB = BD = AD$

7

$$x^2 - 10x - 9 = -25$$

The solutions of the equation above are t and u . If $t > u$, what is the value of $t - u$?

- A) 4
- B) 6
- C) 8
- D) 10

8

If Jessica runs at a constant speed of 12 miles every 2 hours, which of the following functions represents the number of miles, m , Jessica runs in t hours?

- A) $m(t) = 24t$
- B) $m(t) = 12t$
- C) $m(t) = 6t$
- D) $m(t) = 2t$

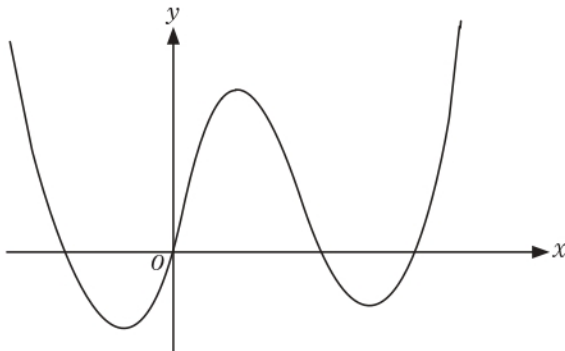


9

The manager of a small catering business prepares c cups of punch for a party of n people, where $c = 3n + 5$. According to the equation, how many additional cups of punch does the manager prepare for each additional person at the party?

- A) 1
- B) 3
- C) 5
- D) 8

10



Which of the following could be an equation of the graph above?

- A) $y = x(x-1.1)(x-1)(x-3)$
- B) $y = x(x-29)(x-20)(x+10)$
- C) $y = x(x-70)(x+20)(x+25)$
- D) $y = (x-500)(x-100)(x+175)(x+150)$

11

$$\frac{x^2-2x-15}{x^2-9} \cdot \frac{x-3}{x}; x \neq -3, 0, 3$$

Which of the following expressions is equivalent to the one above?

- A) $\frac{x-5}{x}$
- B) $\frac{x+5}{x}$
- C) $\frac{x^2-5x}{x^2-6x+9}$
- D) $\frac{x^2-2x-15}{x^2-3x}$

12

Jim has a savings account into which he made an initial deposit of a dollars and has made no deposits or withdrawals since then. The amount of money, P , in the account t years after the initial deposit is given by the equation below.

$$P = a(1.01)^t$$

By what percent did the amount of money in the account grow from the beginning of year 2 to the beginning of year 4?

- A) 0.01%
- B) 1.00%
- C) 2.01%
- D) 3.03%



13

The organizer of an event can spend up to \$815 on prizes. Each prize costs either \$25 or \$50, and she must purchase a minimum of 20 prizes. What is the maximum number of \$50 prizes she could purchase?

- A) 12
- B) 16
- C) 20
- D) 32

14

$$y-4 = \frac{1}{3}(x-1)$$

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

One solution, (x,y) , of this system of equations is $(1,4)$. What is the y -value of the other solution?

- A) 2
- B) 3
- C) $\frac{11}{3}$
- D) $\frac{13}{3}$

15

$$\sqrt{3+x} = \frac{1}{3}x + \frac{3}{2}$$

What is the sum of the solutions of the equations above?

- A) 4
- B) 2
- C) 0
- D) -2



DIRECTIONS

For questions 16-20, solve the problem and enter your answer in the grid, as described below, on the answer sheet.

- Although not required, it is suggested that you write your answer in the boxes at the top of the columns to help you fill in the circles accurately. You will receive credit only if the circles are filled in correctly.
- Mark no more than one circle in any column.
- No question has a negative answer.
- Some problems may have more than one correct answer. In such cases, grid only one answer.
- Mixed numbers** such as $3\frac{1}{2}$ must be gridded as 3.5 or $7/2$. (If

is entered into the grid, it will be

interpreted as $\frac{31}{2}$, not $3\frac{1}{2}$.)

- Decimal answers:** If you obtain a decimal answer with more digits than the grid can accommodate, it may be either rounded or truncated, but it must fill the entire grid.

Write answer in boxes. →

Answer: $\frac{7}{12}$

	7	/	1	2	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	
○	○	○	○	○	

← Fraction line

Grid in result.

Answer: 2.5

	2	.	5	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	

← Decimal point

Acceptable ways to grid $\frac{2}{3}$ are:

	2	/	3	
○	○	○	○	
○	○	○	○	
○	○	○	○	
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○	○	○	○	
○	○	○	○	

.	6	6	6	
○	○	○	○	
○	○	○	○	
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○	○	○	○	
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○	○	○	○	

.	6	6	7	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
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○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	

Answer: 201 – either position is correct

	2	0	1	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	
○	○	○	○	

2	0	1		
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○

NOTE: You may start your answers in any column, space permitting. Columns you don't need to use should be left blank.



16

Abel and Cedric will share a total of \$180. Abel will receive half as much as Cedric. What amount, in dollars, will Cedric receive (Disregard the \$ sign when gridding your answer.)

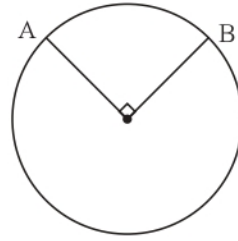
17

If $f(x) = 2x^2 - 3x + 7$, what is the y -intercept of the graph of $g(x) = 3 \cdot f(x)$ in the xy -plane?

18

If $x + 2y = 500$ and $3x - 4y = 875$, what is the value of y ?

19



In the circle above, O is the center and $OB = 4$. If the length of arc \widehat{AB} is $a\pi$, where a is a constant, what is the value of a ?

20

If $\sin 36^\circ = \cos x^\circ$, where $0 < x < 360$, what is a possible value of x ?

STOP

If you finish before time is called, you may check your work on this section only.
Do not turn to any other section.



Math Test – Calculator

55 MINUTES, 38 QUESTIONS

Turn to Section 4 of your answer sheet to answer the questions in this section.

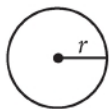
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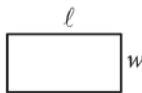
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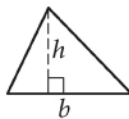


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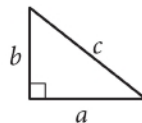
$$C = 2\pi r$$



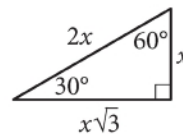
$$A = \ell w$$



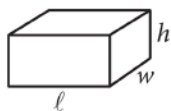
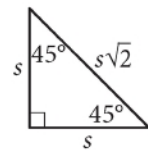
$$A = \frac{1}{2}bh$$



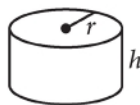
$$c^2 = a^2 + b^2$$



Special Right Triangles



$$V = \ell wh$$



$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}\ell wh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is 2π .

The sum of the measures in degrees of the angles of a triangle is 180.



1

Rodrigo has read 135 pages of a novel that contains 330 pages. If Rodrigo continues to read at a rate of 15 pages per day, how many days will it take him to read the rest of the novel?

- A) 9
- B) 13
- C) 18
- D) 22

2

If $a=7$, how much greater than $2a - 1$ is $6a-5$?

- A) 0
- B) 22
- C) 24
- D) 43

3

Malique had x dollars and bought y stamps that cost \$0.45 each. Which of the following expressions represents the amount of money, in dollars, Malique had left after he bought the stamps?

- A) $x-0.45y$
- B) $x+0.45y$
- C) $100x-4.5y$
- D) $100x-45y$

4

Lucy can fill an empty container with spring water for \$8.75 when springwater cost \$1.75 per gallon. How much will it cost Lucy to fill the same empty container with spring water that cost \$2.00 per gallon?

- A) \$9.00
- B) \$10.00
- C) \$11.00
- D) \$12.00



5

Emma works in a coffee shop where she is paid at the same hourly rate each day. She was paid \$71.25 for working 7.5 hours on Monday. If she worked 6 hours on Tuesday, how much was she paid on Tuesday?

- A) \$51.00
- B) \$57.00
- C) \$63.00
- O) \$69.00

6

If 8 minus y is equal to 6, what is the value of y ?

- A) -6
- B) -2
- C) 2
- D) 14

7

Joth's bank charges 2% interest on his credit card balance each month. The balance on his credit card last month was \$1,450. How much interest did the bank charge on the balance that month?

- A) \$0.29
- B) \$2.90
- C) \$14.50
- D) \$29.00

8

To determine if age and gender are related to pet ownership at his school, Mark selected a random sample of 50 male 14- to 15-year-old students from the school and a random sample of 60 female 17- to 18-year-old students from the school. For each student, he recorded the student's age, gender, and whether the student owned a pet. Which of the following provides the best explanation for why Mark cannot draw a valid conclusion from this study?

- A) The sample sizes are too small.
- B) The two samples are not of equal size.
- C) Mark will be unable to tell whether a difference in pet ownership is related to age because the two age groups are too close in age.
- D) Mark will be unable to tell whether a difference in pet ownership is related to gender because of the difference in age. Similarly, he will be unable to tell whether a difference in pet ownership related to age.



9

Which of the following ordered pairs (x,y) satisfies both of the equations $y=x^2-8x+11$ and $y=-2x+6$?

- A) $(-1,8)$
- B) $(0,11)$
- C) $(1,-4)$
- D) $(5,-4)$

10

Which of the following expressions is

equivalent to $\left(4x^{\frac{1}{2}}y^{\frac{1}{3}}\right)^3$?

- A) $4x^{\frac{3}{2}}y$
- B) $64x^{\frac{3}{2}}y$
- C) $4x^{\frac{1}{8}}y^{\frac{1}{27}}$
- D) $64x^{\frac{1}{2}}y^{\frac{1}{3}}$

11

Students classify a rock collection according to the predominant color of each rock and type of rock. The number of rocks in each classification is shown below.

Rock classifications

Rock color	Igneous	Metamorphic	Sedimentary	Total
Black	16	3	1	20
Brown	8	11	45	64
Gray	14	0	38	52
Red	22	0	6	28
Pink	9	0	0	9
Tan	0	7	1	8
White	4	14	19	37
Total	73	35	110	218

A student selects a rock at random and notices it is gray. Given this information, which of the following is closest to the probability that the selected rock is sedimentary?

- A) 0.17
- B) 0.24
- C) 0.35
- D) 0.73



12

A total of 180 space walks, with a combined durations of 1,130 hours, were required to assemble the International Space Station. In which of the following equations does x represent the average (arithmetic mean) duration, in hours, of the 180 space walks?

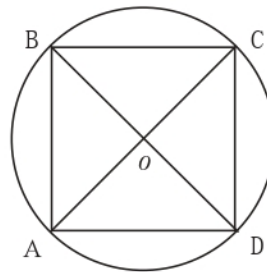
- A) $1,130 = 180x$
- B) $180 = 1,130x$
- C) $x = (180)(1,130)$
- D) $x = 180 + 1,130$

13

A circle in the xy -plane has center $(-5, -6)$, and the point with coordinates $(-8, -10)$ is on the circle. What is the diameter of the circle?

- A) 5
- B) 10
- C) 15
- D) 25

14



In the figure above, square ABCD is inscribed in the circle with center O and radius 3. What is the length of \overline{AB} ?

- A) 6
- B) $3\sqrt{2}$
- C) $6\sqrt{2}$
- D) $3\sqrt{3}$

15

A snack company advertises that their bags of pretzels contain, on average, 1 pound of pretzels. To test this, Sam selected at random 50 bags of pretzels produced by the company and weighed the contents of each bag. Based on his measurements, Sam estimated that the average weight of a bag of pretzels produced by the company is 0.95 pounds, with a margin of error of 0.13 pounds. Which of the following is the most plausible conclusion about the true average weight w , in pounds, of a bag of pretzels produced by the company?

- A) $w = 0.95$
- B) $0.82 \leq w \leq 0.95$
- C) $0.82 \leq w \leq 1.08$
- D) $0.95 \leq w \leq 1.08$



Questions 16-18 refer to the following information.

Estimated Total Daily Water Usage, in Millions of Gallons, for New Jersey in 2005

Type	Source	
	Groundwater	Surface water
Fresh	592.00	1,340
Saline	0.01	5,460

The table above shows the estimated water usage, in millions of gallons per day, by source and type, for New Jersey in 2005. In 2005, New Jersey had an estimated population of 8,720,000.

16

Which of the following is closest to the proportion of estimated daily usage of surface water that was fresh?

- A) 0.20
- B) 0.25
- C) 0.69
- D) 0.80

17

Approximately what percent of the estimated daily water usage was both groundwater and fresh?

- A) 8%
- B) 18%
- C) 20%
- D) 34%

18

Which of the following best approximates the estimated water usage of groundwater in acre-feet per year?

(1 million gallons = 3.07 acre-feet)

- A) 0.05
- B) 1.19
- C) 11.21
- D) 121.40

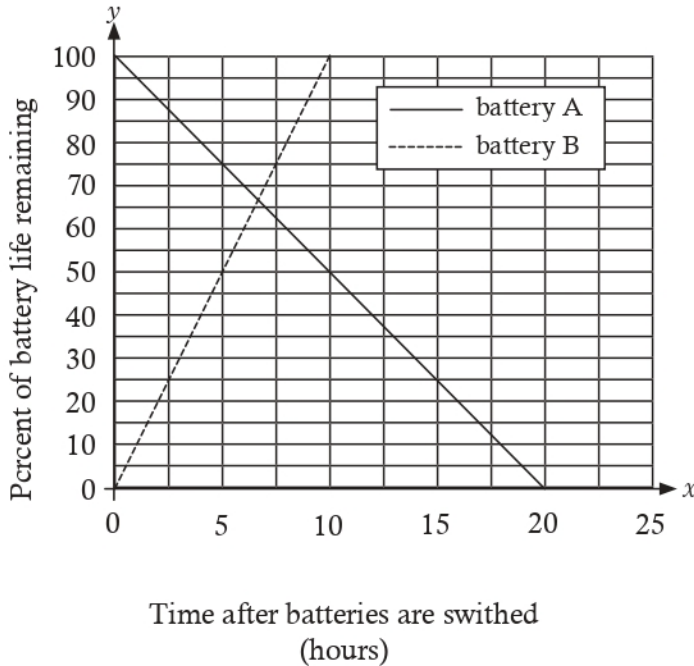
19

The value of x is more than the value of y . The sum of $3x$ and $4y$ is 20 less than the value of $8x$. What is the value of x ?

- A) 5
- B) 6
- C) 8
- D) 12



Questions 16-18 refer to the following information.



Dennis has two batteries for his mobile phone. When battery B is drained, he places it in a charger and puts battery A into the phone. The graph above relates the percent of battery life remaining for the two batteries to the time, in hours, after they are switched.

20

Which of the following gives the percent of battery life remaining, y , for battery A in terms of the number of hours, x , after battery A and battery B are switched?

- A) $y = -5x + 20$
- B) $y = -5x + 100$
- C) $y = -10x + 100$
- D) $y = -20x + 100$

21

Which of the following can be concluded from comparing the line representing battery A to the line representing battery B?

- A) The rate at which battery A discharges is greater than the rate at which battery B discharges.
- B) The rate at which battery A charges is greater than the rate at which battery B discharges.
- C) The rate at which battery B charges is greater than the rate at which battery A discharges.
- D) The rate at which battery B discharges is greater than the rate at which battery A charges.



22

In economics, Okun's law states that the percentage change in the unemployment rate, Δr , from one quarter to the next is related to the quarterly percentage change in the gross domestic product (GDP), ΔG , as defined by the equation below.

$$\Delta G = 0.856 - 1.827(\Delta r)$$

- A) The quarterly percentage change in the GDP for every 1% change in the unemployment rate
- B) The quarterly percentage change in the GDP to maintain the same unemployment rate
- C) The percentage change in the unemployment rate if the change in the GDP is 0%
- D) The percentage change in the unemployment rate for every 1% change in the GDP

23

Which of the following is equivalent to $\frac{x^2-2}{x-2}$

- A) $x + 2$
- B) $x + 4$
- C) $x + 2 + \frac{2}{x-2}$
- D) $x + 2 + \frac{2}{x^2-2}$



Questions 24 and 25 refer to the following information.

$$F = \frac{mv^2}{r}$$

The formula above relates the centripetal force F , in newtons, acting on an object traveling in a circular path to the object's mass m , its velocity v and the radius r of its path.

24

If the velocity of the object is doubled, which of the following equations expresses the new centripetal force, N of the object, in terms of the original centripetal force F ?

- A) $N = 4F$
- B) $N = 2F$
- C) $N = \frac{1}{2}F$
- D) $N = \frac{1}{2}F$

25

Of the following equations, which is NOT equivalent to the formula for centripetal force?

- A) $Fr = mv^2$
- B) $\frac{v^2}{F} = \frac{m}{r}$
- C) $\frac{Fr}{m^2} = \frac{v^2}{m}$
- D) $r = \frac{mv^2}{F}$



26

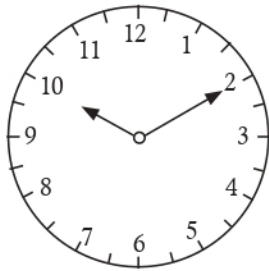
In 2015, XYZ Railroad made a plan to reduce the number of railroad cars in service by 12 cars per year for each of the next 15 years. Which of the following types of expressions could be used to model the number of cars XYZ Railroad has in service n years after 2015, where n is an integer from 1 to 15?

- A) $a + bn$, where a is a positive constant and b is a negative constant
- B) $a + bn$, where a is a negative constant and b is a positive constant
- C) $a(b)^n$, where a is a positive constant and b is a constant such that $b > 1$
- D) $a(b)^n$, where a is a positive constant and b is a constant such that $0 < b < 1$

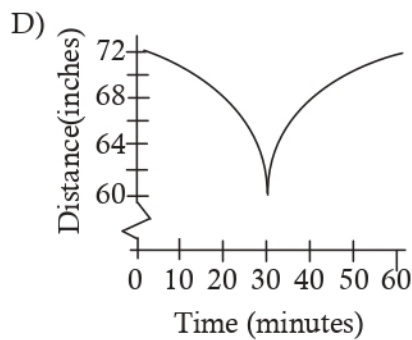
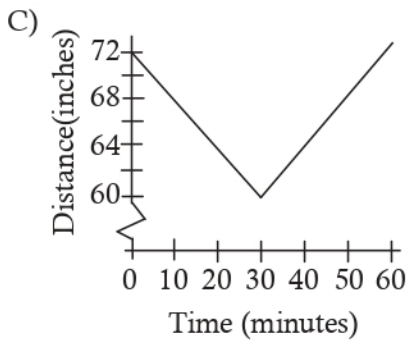
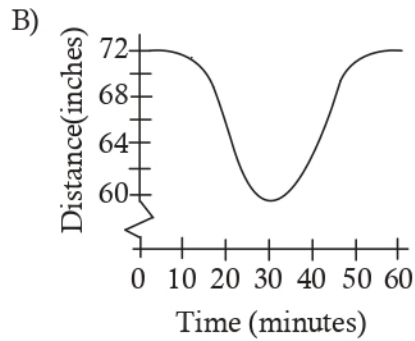
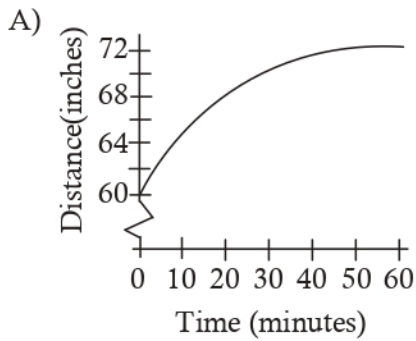
27

A piece of jewelry is initially valued at \$100. Every month the value of the piece of jewelry increases by 1% of its value the previous month. Which of the following represents the value $Q(t)$, in dollars, of the piece of jewelry at the end of t months?

- A) $Q(t) = 100\left(1 + \frac{t}{100}\right)$
- B) $Q(t) = 100(1 + .01)^t$
- C) $Q(t) = 100\left(1 + \frac{.01}{12}\right)^t$
- D) $Q(t) = 100(1 + (.01)^t)$



The circular dock shown above has diameter 14 inches, and its minute hand has length 6 inches. It is placed on the wall so that the center of the clock is 66 inches above the ground. Which of the following graphs could represent the distance from the tip of the arrow of the minute hand to the ground with respect to time from 10 a.m. to 11 a.m.?





29

Larry plans to make at least 10 pounds of a snack mix that will consist of almonds and dried fruit. If he wants the snack mix to be at least 60% almonds by weight, which of the following systems of inequalities represents, a , and the number of pounds of dried fruit, f ?

A) $a + f \leq 10$

$$0.6a \leq f$$

B) $a + f \geq 10$

$$0.6f \leq a$$

C) $a + f \geq 10$

$$1.5f \leq a$$

D) $a + f \leq 10$

$$1.5a \geq f$$

30

The speed of light in a vacuum is 3.00×10^8 meters per second. Given that 1 kilometer is equal in approximately 0.62 miles, which of the following is closest to the speed of light in a vacuum, in miles per hour?

A) 1.12×10^7

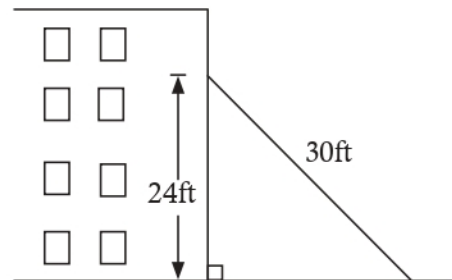
B) 1.86×10^3

C) 1.86×10^8

D) 6.70×10^8

31

A 30-foot-long ladder is leaning against a building, as shown below.

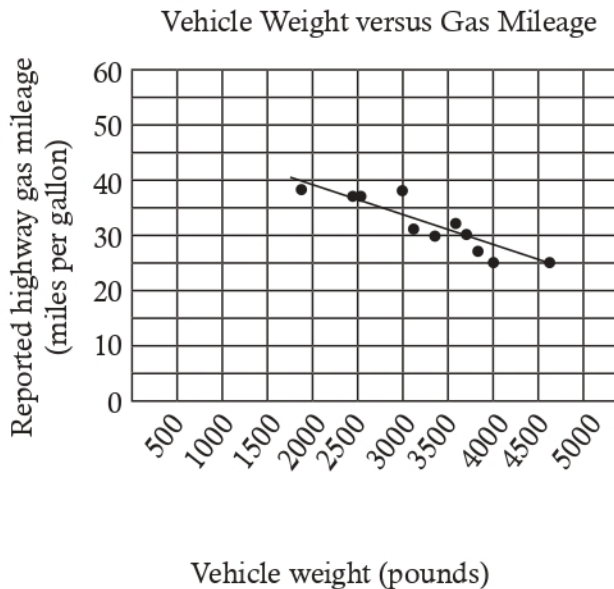


The top of the ladder is resting on the building at a point 24 feet above the ground. How many feet from the base of the building is the bottom of the ladder?



32

The scatterplot below represents the weights of several vehicles and their reported highway gas mileages. A line of best fit for the data is also shown.



How much greater is the reported highway gas mileage, in miles per gallon, for the vehicle weighing 3000 pounds than what is predicted by the line of best fit?

33

A teacher determines a student's course grade by computing the mean of 4 scores, 3 unit test scores and the final exam score. If a student misses a unit test, the final exam score is used once as the final exam score and once in place of the missing unit test score. What is the course grade for a student who receives scores of 76 and 80 on 2 unit tests, misses 1 unit test, and earns a score of 72 on the final exam?

34

A refrigerator that was originally priced at \$2500 had its price reduced by 40 percent. If an additional 15 percent was taken off the reduced price, what was the price, in dollars, of the refrigerator after the two reductions were applied? (Disregard the 5 sign when gridding your answer.)

35

Katia designed a wilder headset that she intends to sell. She uses the inequality $100,000 \leq x \leq 300,000$ to estimate the profit x , in dollars, she could make from selling 20,000 headsets. What is the maximum profit, in dollars, she could expect to make per headset sold? (Disregard the \$ sign when gridding your answer.)



36

The function $f(x) = 158x^2 - 770x + 1000$, where x represents the number of years after 1970, can be used to model the number of college-bound students, $f(x)$, who take a test to receive college credit for a biology course. Based on the model, how many more students took the test in 2004 than in 2003?

37

On May 20, 2012, Victor's tenth grandchild was born, and the average (arithmetic mean) age of his other 9 grandchildren was 10 years. What will be the average age, in years, of Victor's 10 grandchildren on May 20, 2013?

38

$$2y + 7x = 2c$$

$$3y + 9x = c$$

In the system of linear equations above, c is a nonzero constant. The graphs of the equations are two lines in the xy -plane that intersect at $(k, -44)$. What is the value of k ?

STOP

If you finish before time is called, you may check your work on this section only.
Do not turn to any other section.

