



Telegram t.me/SAT\_pdf

PART I



## BASIC CONCEPTS

## QUESTION 1



$$|2x + 1| = 5$$

If  $a$  and  $b$  are the solutions to the equation above, what is the value of  $|a - b|$ ?

## QUESTION 2



Which of the following expressions is equal to 0 for some value of  $x$ ?

- A)  $|x - 1| - 1$
- B)  $|x + 1| + 1$
- C)  $|1 - x| + 1$
- D)  $|x - 1| + 1$

## QUESTION 3



For what value of  $n$  is  $|n - 1| + 1$  equal to 0?

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- A) 0
- B) 1
- C) 2
- D) There is no such value of  $n$ .

## QUESTION 4



Two different points on a number line are both 3 units from the point with coordinate  $-4$ . The solution to which of the following equations gives the coordinates of both points?

- A)  $|x + 4| = 3$
- B)  $|x - 4| = 3$
- C)  $|x + 3| = 4$
- D)  $|x - 3| = 4$

## PART I: HEART OF ALGEBRA

## LINEAR EQUATIONS

## QUESTION 5



If  $\frac{x-1}{3} = k$  and  $k = 3$ , what is the value of  $x$ ?

- A) 2
- B) 4
- C) 9
- D) 10

## QUESTION 6



On Saturday afternoon, Armand sent  $m$  text messages each hour for 5 hours, and Tyrone sent  $p$  text messages each hour for 4 hours. Which of the following represents the total number of messages sent by Armand and Tyrone on Saturday afternoon?

- A)  $9mp$
- B)  $20mp$
- C)  $5m + 4p$
- D)  $4m + 5p$

## QUESTION 7



Kathy is a repair technician for a phone company. Each week, she receives a batch of phones that need repairs. The number of phones that she has left to fix at the end of each day can be estimated with the equation  $P = 108 - 23d$ , where  $P$  is the number of phones left and  $d$  is the number of days she has worked that week. What is the meaning of the value 108 in this equation?

- A) Kathy will complete the repairs within 108 days.
- B) Kathy starts each week with 108 phones to fix.
- C) Kathy repairs phones at a rate of 108 per hour.
- D) Kathy repairs phones at a rate of 108 per day.

## QUESTION 8



$$h = 3a + 28.6$$

A pediatrician uses the model above to estimate the height  $h$  of a boy, in inches, in terms of the boy's age  $a$ , in years, between the ages of 2 and 5. Based on the model, what is the estimated increase, in inches, of a boy's height each year?

- A) 3
- B) 5.7
- C) 9.5
- D) 14.3

## LINEAR EQUATIONS

## QUESTION 9



If  $\frac{a}{b} = 2$ , what is the value of  $\frac{4b}{a}$  ?

- A) 0
- B) 1
- C) 2
- D) 4

## QUESTION 10



A line in the  $xy$ -plane passes through the origin and has a slope of  $\frac{1}{7}$ . Which of the following points lies on the line?

- A) (0, 7)
- B) (1, 7)
- C) (7, 7)
- D) (14, 2)

## QUESTION 11



If  $y = kx$ , where  $k$  is a constant, and  $y = 24$  when  $x = 6$ , what is the value of  $y$  when  $x = 5$  ?

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- A) 6
- B) 15
- C) 20
- D) 23

## QUESTION 12



If  $16 + 4x$  is 10 more than 14, what is the value of  $8x$  ?

- A) 2
- B) 6
- C) 16
- D) 80

## LINEAR EQUATIONS

QUESTION 13

QUESTION 14



$$a = 1,052 + 1.08t$$

The speed of a sound wave in air depends on the air temperature. The formula above shows the relationship between  $a$ , the speed of a sound wave, in feet per second, and  $t$ , the air temperature, in degrees Fahrenheit ( $^{\circ}\text{F}$ ).

Which of the following expresses the air temperature in terms of the speed of a sound wave?

A)  $t = \frac{a - 1,052}{1.08}$

B)  $t = \frac{a + 1,052}{1.08}$

C)  $t = \frac{1,052 - a}{1.08}$

D)  $t = \frac{1.08}{a + 1,052}$

At which of the following air temperatures will the speed of a sound wave be closest to 1,000 feet per second?

A)  $-46^{\circ}\text{F}$

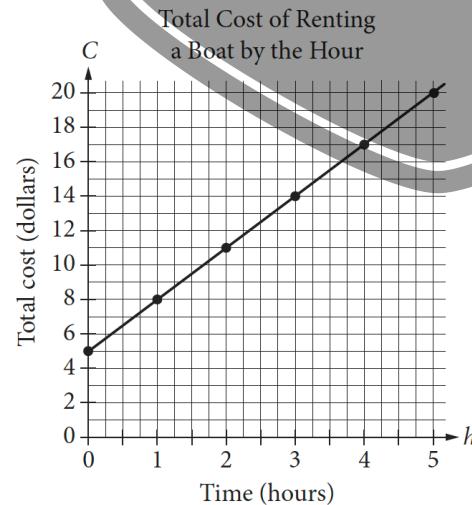
B)  $-48^{\circ}\text{F}$

C)  $-49^{\circ}\text{F}$

D)  $-50^{\circ}\text{F}$

QUESTION 15

QUESTION 16



The graph above displays the total cost  $C$ , in dollars, of renting a boat for  $h$  hours.

What does the  $C$ -intercept represent in the graph?

A) The initial cost of renting the boat

B) The total number of boats rented

C) The total number of hours the boat is rented

D) The increase in cost to rent the boat for each additional hour

Which of the following represents the relationship between  $h$  and  $C$ ?

A)  $C = 5h$

B)  $C = \frac{3}{4}h + 5$

C)  $C = 3h + 5$

D)  $h = 3C$

## LINEAR EQUATIONS

QUESTION 17



Katarina is a botanist studying the production of pears by two types of pear trees. She noticed that Type A trees produced 20 percent more pears than Type B trees did. Based on Katarina's observation, if the Type A trees produced 144 pears, how many pears did the Type B trees produce?

- A) 115
- B) 120
- C) 124
- D) 173

QUESTION 18



Alma bought a laptop computer at a store that gave a 20 percent discount off its original price. The total amount she paid to the cashier was  $p$  dollars, including an 8 percent sales tax on the discounted price. Which of the following represents the original price of the computer in terms of  $p$  ?

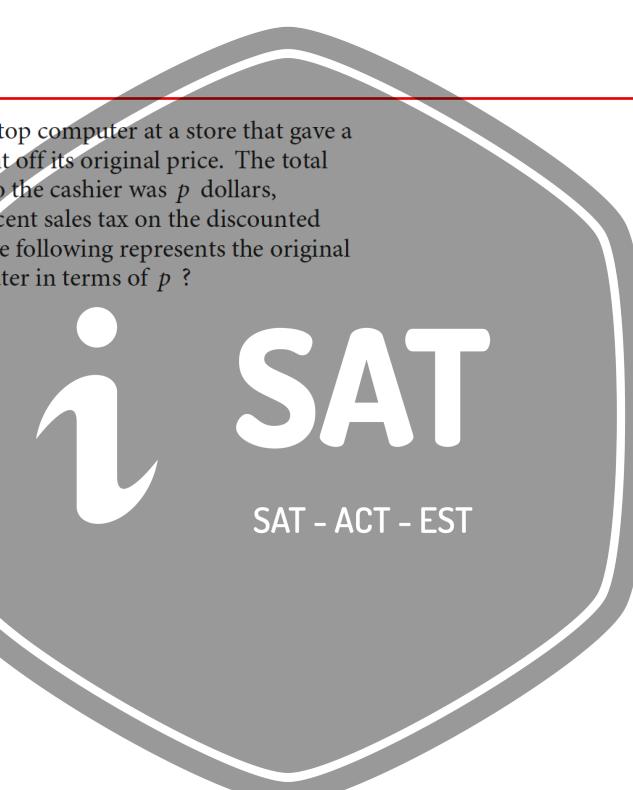
- A)  $0.88p$
- B)  $\frac{p}{0.88}$
- C)  $(0.8)(1.08)p$
- D)  $\frac{p}{(0.8)(1.08)}$

QUESTION 19



If  $5x + 6 = 10$ , what is the value of  $10x + 3$  ?

- A) 4
- B) 9
- C) 11
- D) 20



## LINEAR EQUATIONS

QUESTION 20



A landscaping company estimates the price of a job, in dollars, using the expression  $60 + 12nh$ , where  $n$  is the number of landscapers who will be working and  $h$  is the total number of hours the job will take using  $n$  landscapers. Which of the following is the best interpretation of the number 12 in the expression?

- A) The company charges \$12 per hour for each landscaper.
- B) A minimum of 12 landscapers will work on each job.
- C) The price of every job increases by \$12 every hour.
- D) Each landscaper works 12 hours a day.

QUESTION 21



The graph of a line in the  $xy$ -plane has slope 2 and contains the point  $(1, 8)$ . The graph of a second line passes through the points  $(1, 2)$  and  $(2, 1)$ . If the two lines intersect at the point  $(a, b)$ , what is the value of  $a + b$ ?

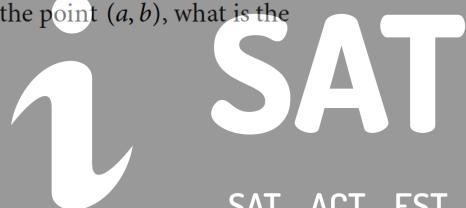
- A) 4
- B) 3
- C) -1
- D) -4

QUESTION 22



A musician has a new song available for downloading or streaming. The musician earns \$0.09 each time the song is downloaded and \$0.002 each time the song is streamed. Which of the following expressions represents the amount, in dollars, that the musician earns if the song is downloaded  $d$  times and streamed  $s$  times?

- A)  $0.002d + 0.09s$
- B)  $0.002d - 0.09s$
- C)  $0.09d + 0.002s$
- D)  $0.09d - 0.002s$



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## LINEAR EQUATIONS

QUESTION 23



$$\ell = 24 + 3.5m$$

One end of a spring is attached to a ceiling. When an object of mass  $m$  kilograms is attached to the other end of the spring, the spring stretches to a length of  $\ell$  centimeters as shown in the equation above. What is  $m$  when  $\ell$  is 73?

- A) 14
- B) 27.7
- C) 73
- D) 279.5

QUESTION 24



When 4 times the number  $x$  is added to 12, the result is 8. What number results when 2 times  $x$  is added to 7?

- A) -1
- B) 5
- C) 8
- D) 9

QUESTION 25



In a video game, each player starts the game with  $k$  points and loses 2 points each time a task is not completed. If a player who gains no additional points and fails to complete 100 tasks has a score of 200 points, what is the value of  $k$ ?

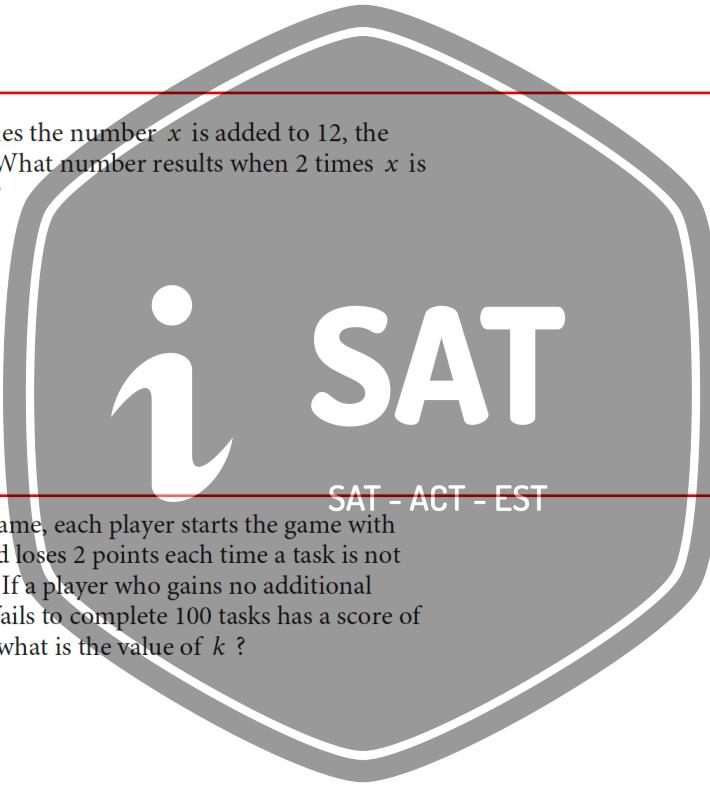
- A) 0
- B) 150
- C) 250
- D) 400

QUESTION 26



The atomic weight of an unknown element, in atomic mass units (amu), is approximately 20% less than that of calcium. The atomic weight of calcium is 40 amu. Which of the following best approximates the atomic weight, in amu, of the unknown element?

- A) 8
- B) 20
- C) 32
- D) 48



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## LINEAR EQUATIONS

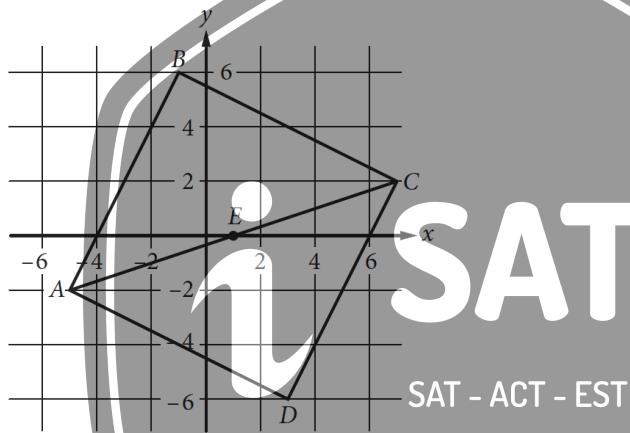
QUESTION 27



The graph of the linear function  $f$  has intercepts at  $(a, 0)$  and  $(0, b)$  in the  $xy$ -plane. If  $a + b = 0$  and  $a \neq b$ , which of the following is true about the slope of the graph of  $f$ ?

- A) It is positive.
- B) It is negative.
- C) It equals zero.
- D) It is undefined.

QUESTION 28



In the  $xy$ -plane above,  $ABCD$  is a square and point  $E$  is the center of the square. The coordinates of points  $C$  and  $E$  are  $(7, 2)$  and  $(1, 0)$ , respectively. Which of the following is an equation of the line that passes through points  $B$  and  $D$ ?

A)  $y = -3x - 1$

B)  $y = -3(x - 1)$

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

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

## LINEAR EQUATIONS

QUESTION 29



$$a = 18t + 15$$

Jane made an initial deposit to a savings account. Each week thereafter she deposited a fixed amount to the account. The equation above models the amount  $a$ , in dollars, that Jane has deposited after  $t$  weekly deposits. According to the model, how many dollars was Jane's initial deposit? (Disregard the \$ sign when gridding your answer.)

QUESTION 30



A painter will paint  $n$  walls with the same size and shape in a building using a specific brand of paint. The painter's fee can be calculated by the expression  $nK\ell h$ , where  $n$  is the number of walls,  $K$  is a constant with units of dollars per square foot,  $\ell$  is the length of each wall in feet, and  $h$  is the height of each wall in feet. If the customer asks the painter to use a more expensive brand of paint, which of the factors in the expression would change?

- A)  $h$
- B)  $\ell$
- C)  $K$
- D)  $n$

QUESTION 31



If  $3r = 18$ , what is the value of  $6r + 3$ ?

- A) 6
- B) 27
- C) 36
- D) 39

## LINEAR EQUATIONS

QUESTION 32



The number of states that joined the United States between 1776 and 1849 is twice the number of states that joined between 1850 and 1900. If 30 states joined the United States between 1776 and 1849 and  $x$  states joined between 1850 and 1900, which of the following equations is true?

- A)  $30x = 2$
- B)  $2x = 30$
- C)  $\frac{x}{2} = 30$
- D)  $x + 30 = 2$

QUESTION 33



If  $\frac{5}{x} = \frac{15}{x + 20}$ , what is the value of  $\frac{x}{5}$ ?

- A) 10
- B) 5
- C) 2
- D)  $\frac{1}{2}$

QUESTION 34



The line  $y = kx + 4$ , where  $k$  is a constant, is graphed in the  $xy$ -plane. If the line contains the point  $(c, d)$ , where  $c \neq 0$  and  $d \neq 0$ , what is the slope of the line in terms of  $c$  and  $d$ ?

- A)  $\frac{d - 4}{c}$
- B)  $\frac{c - 4}{d}$
- C)  $\frac{4 - d}{c}$
- D)  $\frac{4 - c}{d}$

## LINEAR EQUATIONS

QUESTION 35



$$C = \frac{5}{9}(F - 32)$$

The equation above shows how a temperature  $F$ , measured in degrees Fahrenheit, relates to a temperature  $C$ , measured in degrees Celsius. Based on the equation, which of the following must be true?

- I. A temperature increase of 1 degree Fahrenheit is equivalent to a temperature increase of  $\frac{5}{9}$  degree Celsius.
- II. A temperature increase of 1 degree Celsius is equivalent to a temperature increase of 1.8 degrees Fahrenheit.
- III. A temperature increase of  $\frac{5}{9}$  degree Fahrenheit is equivalent to a temperature increase of 1 degree Celsius.

- A) I only
- B) II only
- C) III only
- D) I and II only

QUESTION 36



If  $\frac{7}{9}x - \frac{4}{9}x = \frac{1}{4} + \frac{5}{12}$ , what is the value of  $x$ ?

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QUESTION 37



$n$	1	2	3	4
$f(n)$	-2	1	4	7

The table above shows some values of the linear function  $f$ . Which of the following defines  $f$ ?

- A)  $f(n) = n - 3$
- B)  $f(n) = 2n - 4$
- C)  $f(n) = 3n - 5$
- D)  $f(n) = 4n - 6$

## PART I: HEART OF ALGEBRA

## LINEAR EQUATIONS

QUESTION 38



If  $\frac{3}{5}w = \frac{4}{3}$ , what is the value of  $w$ ?

- A)  $\frac{9}{20}$
- B)  $\frac{4}{5}$
- C)  $\frac{5}{4}$
- D)  $\frac{20}{9}$

QUESTION 39



The average number of students per classroom at Central High School from 2000 to 2010 can be modeled by the equation  $y = 0.56x + 27.2$ , where  $x$  represents the number of years since 2000, and  $y$  represents the average number of students per classroom. Which of the following best describes the meaning of the number 0.56 in the equation?

- A) The total number of students at the school in 2000
- B) The average number of students per classroom in 2000
- C) The estimated increase in the average number of students per classroom each year
- D) The estimated difference between the average number of students per classroom in 2010 and in 2000

QUESTION 40



The cost of using a telephone in a hotel meeting room is \$0.20 per minute. Which of the following equations represents the total cost  $c$ , in dollars, for  $h$  hours of phone use?

A)  $c = 0.20(60h)$

B)  $c = 0.20h + 60$

C)  $c = \frac{60h}{0.20}$

D)  $c = \frac{0.20h}{60}$

## LINEAR EQUATIONS

QUESTION 41



In the  $xy$ -plane, the line determined by the points  $(2, k)$  and  $(k, 32)$  passes through the origin. Which of the following could be the value of  $k$ ?

- A) 0
- B) 4
- C) 8
- D) 16

QUESTION 42



$$f(x) = \frac{3}{2}x + b$$

In the function above,  $b$  is a constant. If  $f(6) = 7$ , what is the value of  $f(-2)$ ?

- A) -5
- B) -2
- C) 1
- D) 7

QUESTION 43



If  $f(x) = -2x + 5$ , what is  $f(-3x)$  equal to?

- A)  $-6x - 5$
- B)  $6x + 5$
- C)  $6x - 5$
- D)  $6x^2 - 15x$

## PART I: HEART OF ALGEBRA

## LINEAR EQUATIONS

## QUESTION 44



If  $\frac{a-b}{b} = \frac{3}{7}$ , which of the following must also be true?

- A)  $\frac{a}{b} = -\frac{4}{7}$
- B)  $\frac{a}{b} = \frac{10}{7}$
- C)  $\frac{a+b}{b} = \frac{10}{7}$
- D)  $\frac{a-2b}{b} = -\frac{11}{7}$

## QUESTION 45



While preparing to run a marathon, Amelia created a training schedule in which the distance of her longest run every week increased by a constant amount. If Amelia's training schedule requires that her longest run in week 4 is a distance of 8 miles and her longest run in week 16 is a distance of 26 miles, which of the following best describes how the distance Amelia runs changes between week 4 and week 16 of her training schedule?

- A) Amelia increases the distance of her longest run by 0.5 miles each week.
- B) Amelia increases the distance of her longest run by 2 miles each week.
- C) Amelia increases the distance of her longest run by 2 miles every 3 weeks.
- D) Amelia increases the distance of her longest run by 1.5 miles each week.

## QUESTION 46



Which of the following equations represents a line that is parallel to the line with equation  $y = -3x + 4$ ?

- A)  $6x + 2y = 15$
- B)  $3x - y = 7$
- C)  $2x - 3y = 6$
- D)  $x + 3y = 1$

## LINEAR EQUATIONS

QUESTION 47



If  $\frac{t+5}{t-5} = 10$ , what is the value of  $t$ ?

A)  $\frac{45}{11}$

B) 5

C)  $\frac{11}{2}$

D)  $\frac{55}{9}$

QUESTION 48



Ken and Paul each ordered a sandwich at a restaurant. The price of Ken's sandwich was  $x$  dollars, and the price of Paul's sandwich was \$1 more than the price of Ken's sandwich. If Ken and Paul split the cost of the sandwiches evenly and each paid a 20% tip, which of the following expressions represents the amount, in dollars, each of them paid? (Assume there is no sales tax.)

A)  $0.2x + 0.2$

B)  $0.5x + 0.1$

C)  $1.2x + 0.6$

D)  $2.4x + 1.2$

QUESTION 49



The mesosphere is the layer of Earth's atmosphere between 50 kilometers and 85 kilometers above Earth's surface. At a distance of 50 kilometers from Earth's surface, the temperature in the mesosphere is  $-5^\circ$  Celsius, and at a distance of 80 kilometers from Earth's surface, the temperature in the mesosphere is  $-80^\circ$  Celsius. For every additional 10 kilometers from Earth's surface, the temperature in the mesosphere decreases by  $k^\circ$  Celsius, where  $k$  is a constant. What is the value of  $k$ ?

## LINEAR EQUATIONS

QUESTION 50



The monthly membership fee for an online television and movie service is \$9.80. The cost of viewing television shows online is included in the membership fee, but there is an additional fee of \$1.50 to rent each movie online. For one month, Jill's membership and movie rental fees were \$12.80. How many movies did Jill rent online that month?

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

QUESTION 51



One of the requirements for becoming a court reporter is the ability to type 225 words per minute. Donald can currently type 180 words per minute, and believes that with practice he can increase his typing speed by 5 words per minute each month. Which of the following represents the number of words per minute that Donald believes he will be able to type  $m$  months from now?

- A)  $5 + 180m$   
B)  $225 + 5m$   
C)  $180 + 5m$   
D)  $180 - 5m$

QUESTION 52



Line  $\ell$  in the  $xy$ -plane contains points from each of Quadrants II, III, and IV, but no points from Quadrant I. Which of the following must be true?

- A) The slope of line  $\ell$  is undefined.  
B) The slope of line  $\ell$  is zero.  
C) The slope of line  $\ell$  is positive.  
D) The slope of line  $\ell$  is negative.

QUESTION 53



The normal systolic blood pressure  $P$ , in millimeters of mercury, for an adult male  $x$  years old can be modeled by the equation  $P = \frac{x + 220}{2}$ . According to the model, for every increase of 1 year in age, by how many millimeters of mercury will the normal systolic blood pressure for an adult male increase?

## LINEAR EQUATIONS

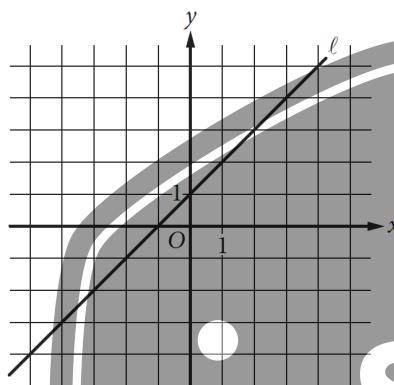
QUESTION 54



At a restaurant,  $n$  cups of tea are made by adding  $t$  tea bags to hot water. If  $t = n + 2$ , how many additional tea bags are needed to make each additional cup of tea?

- A) None
- B) One
- C) Two
- D) Three

QUESTION 55



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Which of the following is an equation of line  $\ell$  in the  $xy$ -plane above?

- A)  $x = 1$
- B)  $y = 1$
- C)  $y = x$
- D)  $y = x + 1$

QUESTION 56



In air, the speed of sound  $S$ , in meters per second, is a linear function of the air temperature  $T$ , in degrees Celsius, and is given by  $S(T) = 0.6T + 331.4$ . Which of the following statements is the best interpretation of the number 331.4 in this context?

- A) The speed of sound, in meters per second, at  $0^\circ\text{C}$
- B) The speed of sound, in meters per second, at  $0.6^\circ\text{C}$
- C) The increase in the speed of sound, in meters per second, that corresponds to an increase of  $1^\circ\text{C}$
- D) The increase in the speed of sound, in meters per second, that corresponds to an increase of  $0.6^\circ\text{C}$

## PART I: HEART OF ALGEBRA

## LINEAR EQUATIONS

QUESTION 57



$$2(p + 1) + 8(p - 1) = 5p$$

What value of  $p$  is the solution of the equation above?

QUESTION 58



$x$	$f(x)$
1	5
3	13
5	21

Some values of the linear function  $f$  are shown in the table above. Which of the following defines  $f$ ?

- A)  $f(x) = 2x + 3$
- B)  $f(x) = 3x + 2$
- C)  $f(x) = 4x + 1$
- D)  $f(x) = 5x$

QUESTION 59



If  $3(c + d) = 5$ , what is the value of  $c + d$ ?

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- A)  $\frac{3}{5}$
- B)  $\frac{5}{3}$
- C) 3
- D) 5

QUESTION 60



$$9ax + 9b - 6 = 21$$

Based on the equation above, what is the value of  $ax + b$ ?

- A) 3
- B) 6
- C) 8
- D) 12

## LINEAR EQUATIONS

QUESTION 61

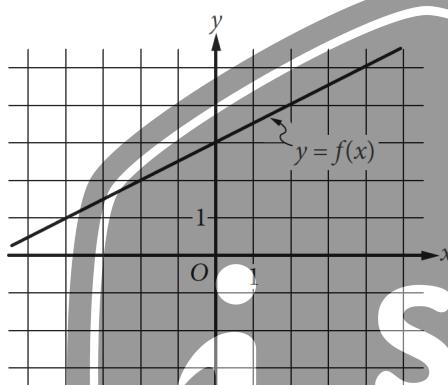


$$-2x + 3y = 6$$

In the  $xy$ -plane, the graph of which of the following equations is perpendicular to the graph of the equation above?

- A)  $3x + 2y = 6$
- B)  $3x + 4y = 6$
- C)  $2x + 4y = 6$
- D)  $2x + 6y = 3$

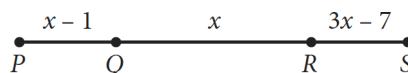
QUESTION 62


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The graph of the linear function  $f$  is shown in the  $xy$ -plane above. The slope of the graph of the linear function  $g$  is 4 times the slope of the graph of  $f$ . If the graph of  $g$  passes through the point  $(0, -4)$ , what is the value of  $g(9)$ ?

- A) 5
- B) 9
- C) 14
- D) 18

QUESTION 63



Note: Figure not drawn to scale.

On  $\overline{PS}$  above,  $PQ = RS$ . What is the length of  $\overline{PS}$ ?

## LINEAR EQUATIONS

QUESTION 64



Salim wants to purchase tickets from a vendor to watch a tennis match. The vendor charges a one-time service fee for processing the purchase of the tickets. The equation  $T = 15n + 12$  represents the total amount  $T$ , in dollars, Salim will pay for  $n$  tickets. What does 12 represent in the equation?

- A) The price of one ticket, in dollars
- B) The amount of the service fee, in dollars
- C) The total amount, in dollars, Salim will pay for one ticket
- D) The total amount, in dollars, Salim will pay for any number of tickets

QUESTION 65



A gardener buys two kinds of fertilizer. Fertilizer A contains 60% filler materials by weight and Fertilizer B contains 40% filler materials by weight. Together, the fertilizers bought by the gardener contain a total of 240 pounds of filler materials. Which equation models this relationship, where  $x$  is the number of pounds of Fertilizer A and  $y$  is the number of pounds of Fertilizer B?

- A)  $0.4x + 0.6y = 240$
- B)  $0.6x + 0.4y = 240$
- C)  $40x + 60y = 240$
- D)  $60x + 40y = 240$

QUESTION 66



If  $x = \frac{2}{3}y$  and  $y = 18$ , what is the value of  $2x - 3$ ?

- A) 21
- B) 15
- C) 12
- D) 10

QUESTION 67



$$\frac{2}{3}t = \frac{5}{2}$$

What value of  $t$  is the solution of the equation above?

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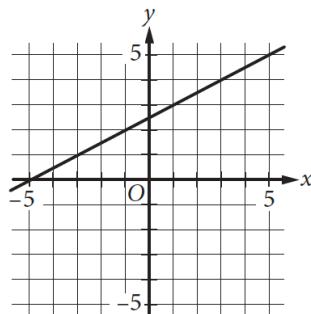
## LINEAR EQUATIONS

QUESTION 68

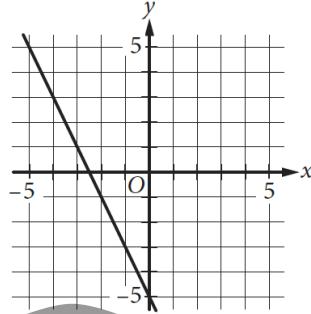


Which of the following is the graph of the equation  $y = 2x - 5$  in the  $xy$ -plane?

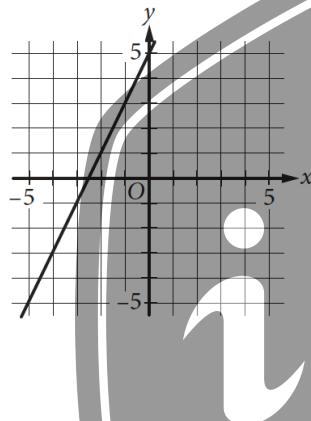
A)



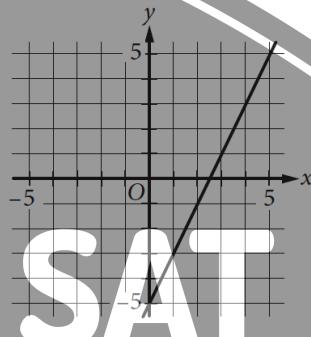
B)



C)



D)



QUESTION 69



A website-hosting service charges businesses a onetime setup fee of \$350 plus  $d$  dollars for each month. If a business owner paid \$1,010 for the first 12 months, including the setup fee, what is the value of  $d$  ?

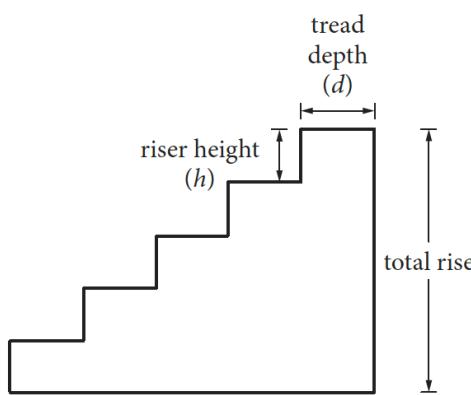
- A) 25
- B) 35
- C) 45
- D) 55

## LINEAR EQUATIONS

QUESTION 70

QUESTION 71

QUESTION 72



Note: Figure not drawn to scale.

When designing a stairway, an architect can use the riser-tread formula  $2h + d = 25$ , where  $h$  is the riser height, in inches, and  $d$  is the tread depth, in inches. For any given stairway, the riser heights are the same and the tread depths are the same for all steps in that stairway.

The number of steps in a stairway is the number of its risers. For example, there are 5 steps in the stairway in the figure above. The total rise of a stairway is the sum of the riser heights as shown in the figure.

Which of the following expresses the riser height in terms of the tread depth?

- A)  $h = \frac{1}{2}(25 + d)$
- B)  $h = \frac{1}{2}(25 - d)$
- C)  $h = -\frac{1}{2}(25 + d)$
- D)  $h = -\frac{1}{2}(25 - d)$

Some building codes require that, for indoor stairways, the tread depth must be at least 9 inches and the riser height must be at least 5 inches. According to the riser-tread formula, which of the following inequalities represents the set of all possible values for the riser height that meets this code requirement?

- A)  $0 \leq h \leq 5$
- B)  $h \geq 5$
- C)  $5 \leq h \leq 8$
- D)  $8 \leq h \leq 16$

An architect wants to use the riser-tread formula to design a stairway with a total rise of 9 feet, a riser height between 7 and 8 inches, and an odd number of steps. With the architect's constraints, which of the following must be the tread depth, in inches, of the stairway? (1 foot = 12 inches)

- A) 7.2
- B) 9.5
- C) 10.6
- D) 15

## LINEAR EQUATIONS

QUESTION 73



$x$	$f(x)$
0	-2
2	4
6	16

Some values of the linear function  $f$  are shown in the table above. What is the value of  $f(3)$  ?

- A) 6  
B) 7  
C) 8  
D) 9

QUESTION 74



$$2(5x - 20) - (15 + 8x) = 7$$

What value of  $x$  satisfies the equation above?

QUESTION 75



The line with the equation  $\frac{4}{5}x + \frac{1}{3}y = 1$  is graphed in the  $xy$ -plane. SAT - ACT - EST

What is the  $x$ -coordinate of the  $x$ -intercept of the line?

QUESTION 76



	Masses (kilograms)					
Andrew	2.4	2.5	3.6	3.1	2.5	2.7
Maria	$x$	3.1	2.7	2.9	3.3	2.8

Andrew and Maria each collected six rocks, and the masses of the rocks are shown in the table above. The mean of the masses of the rocks Maria collected is 0.1 kilogram greater than the mean of the masses of the rocks Andrew collected. What is the value of  $x$  ?

## LINEAR EQUATIONS

QUESTION 77



$$x + y = 75$$

The equation above relates the number of minutes,  $x$ , Maria spends running each day and the number of minutes,  $y$ , she spends biking each day. In the equation, what does the number 75 represent?

- A) The number of minutes spent running each day
- B) The number of minutes spent biking each day
- C) The total number of minutes spent running and biking each day
- D) The number of minutes spent biking for each minute spent running

QUESTION 78



Which of the following is equivalent to  $3(x + 5) - 6$ ?

- A)  $3x - 3$
- B)  $3x - 1$
- C)  $3x + 9$
- D)  $15x - 6$

QUESTION 79



If  $2x + 8 = 16$ , what is the value of  $x + 4$ ?

i SAT  
SAT - ACT - EST

QUESTION 80



The graph of a line in the  $xy$ -plane passes through the point  $(1, 4)$  and crosses the  $x$ -axis at the point  $(2, 0)$ . The line crosses the  $y$ -axis at the point  $(0, b)$ . What is the value of  $b$ ?

## LINEAR EQUATIONS

QUESTION 81



$$y = 19.99 + 1.50x$$

The equation above models the total cost  $y$ , in dollars, that a company charges a customer to rent a truck for one day and drive the truck  $x$  miles. The total cost consists of a flat fee plus a charge per mile driven. When the equation is graphed in the  $xy$ -plane, what does the  $y$ -intercept of the graph represent in terms of the model?

- A) A flat fee of \$19.99
- B) A charge per mile of \$1.50
- C) A charge per mile of \$19.99
- D) Total daily charges of \$21.49

QUESTION 82

QUESTION 83



Energy per Gram of Typical Macronutrients

Macronutrient	Food calories	Kilojoules
Protein	4.0	16.7
Fat	9.0	37.7
Carbohydrate	4.0	16.7

The table above gives the typical amounts of energy per gram, expressed in both food calories and kilojoules, of the three macronutrients in food.

If  $x$  food calories is equivalent to  $k$  kilojoules of the following, which best represents the relationship between  $x$  and  $k$ ?

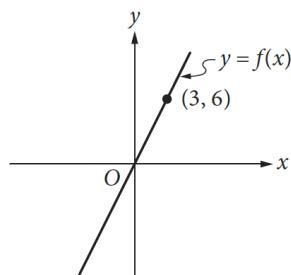
- A)  $k = 0.24x$
- B)  $k = 4.2x$
- C)  $x = 4.2k$
- D)  $xk = 4.2$

If the 180 food calories in a granola bar come entirely from  $p$  grams of protein,  $f$  grams of fat, and  $c$  grams of carbohydrate, which of the following expresses  $f$  in terms of  $p$  and  $c$ ?

- A)  $f = 20 + \frac{4}{9}(p + c)$
- B)  $f = 20 - \frac{4}{9}(p + c)$
- C)  $f = 20 - \frac{4}{9}(p - c)$
- D)  $f = 20 + \frac{9}{4}(p + c)$

## LINEAR EQUATIONS

QUESTION 84



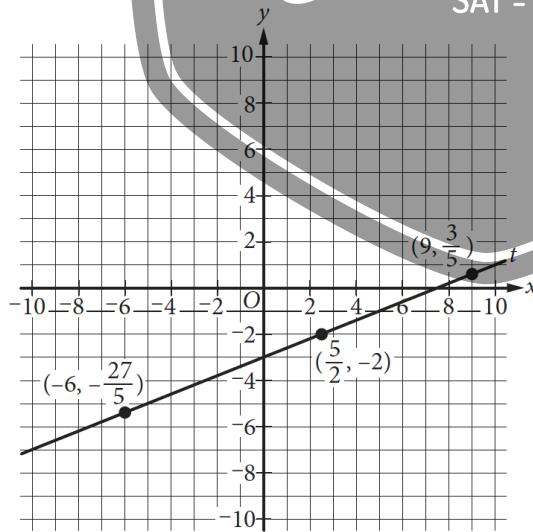
In the  $xy$ -plane above, a point (not shown) with coordinates  $(s, t)$  lies on the graph of the linear function  $f$ . If  $s$  and  $t$  are positive integers, what is the ratio of  $t$  to  $s$ ?

- A) 1 to 3
- B) 1 to 2
- C) 2 to 1
- D) 3 to 1

QUESTION 85



Line  $t$  is shown in the  $xy$ -plane below.



What is the slope of line  $t$ ?



## LINEAR EQUATIONS

QUESTION 86



$$3x + x + x + x - 3 - 2 = 7 + x + x$$

In the equation above, what is the value of  $x$ ?

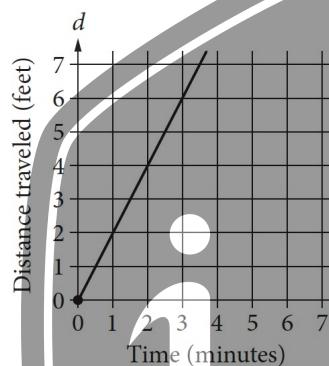
A)  $-\frac{5}{7}$

B) 1

C)  $\frac{12}{7}$

D) 3

QUESTION 87



SAT - ACT - EST

The graph above shows the distance traveled  $d$ , in feet, by a product on a conveyor belt  $m$  minutes after the product is placed on the belt. Which of the following equations correctly relates  $d$  and  $m$ ?

A)  $d = 2m$

B)  $d = \frac{1}{2}m$

C)  $d = m + 2$

D)  $d = 2m + 2$

QUESTION 88



If  $\frac{2n}{5} = 10$ , what is the value of  $2n - 1$ ?

A) 24

B) 49

C) 50

D) 99

## LINEAR EQUATIONS

QUESTION 89



The formula below is often used by project managers to compute  $E$ , the estimated time to complete a job, where  $O$  is the shortest completion time,  $P$  is the longest completion time, and  $M$  is the most likely completion time.

$$E = \frac{O + 4M + P}{6}$$

Which of the following correctly gives  $P$  in terms of  $E$ ,  $O$ , and  $M$ ?

- A)  $P = 6E - O - 4M$   
 B)  $P = -6E + O + 4M$   
 C)  $P = \frac{O + 4M + E}{6}$   
 D)  $P = \frac{O + 4M - E}{6}$

QUESTION 90



If  $\frac{2a}{b} = \frac{1}{2}$ , what is the value of  $\frac{b}{a}$ ?

- A)  $\frac{1}{8}$   
 B)  $\frac{1}{4}$   
 C) 2  
 D) 4



QUESTION 91



Oil and gas production in a certain area dropped from 4 million barrels in 2000 to 1.9 million barrels in 2013. Assuming that the oil and gas production decreased at a constant rate, which of the following linear functions  $f$  best models the production, in millions of barrels,  $t$  years after the year 2000?

- A)  $f(t) = \frac{21}{130}t + 4$   
 B)  $f(t) = \frac{19}{130}t + 4$   
 C)  $f(t) = -\frac{21}{130}t + 4$   
 D)  $f(t) = -\frac{19}{130}t + 4$



## LINEAR EQUATIONS

QUESTION 92



A start-up company opened with 8 employees. The company's growth plan assumes that 2 new employees will be hired each quarter (every 3 months) for the first 5 years. If an equation is written in the form  $y = ax + b$  to represent the number of employees,  $y$ , employed by the company  $x$  quarters after the company opened, what is the value of  $b$ ?

QUESTION 93



In the  $xy$ -plane, the graph of which of the following equations is a line with a slope of 3?

- A)  $y = \frac{1}{3}x$
- B)  $y = x - 3$
- C)  $y = 3x + 2$
- D)  $y = 6x + 3$

QUESTION 94



Population of Greenleaf, Idaho

Year	Population
2000	862
2010	846

The table above shows the population of Greenleaf, Idaho, for the years 2000 and 2010. If the relationship between population and year is linear, which of the following functions  $P$  models the population of Greenleaf  $t$  years after 2000?

- A)  $P(t) = 862 - 1.6t$
- B)  $P(t) = 862 - 16t$
- C)  $P(t) = 862 + 16(t - 2,000)$
- D)  $P(t) = 862 - 1.6(t - 2,000)$

## LINEAR EQUATIONS

QUESTION 95



In the  $xy$ -plane, the point  $(p, r)$  lies on the line with equation  $y = x + b$ , where  $b$  is a constant. The point with coordinates  $(2p, 5r)$  lies on the line with equation  $y = 2x + b$ . If  $p \neq 0$ , what is the value of  $\frac{r}{p}$ ?

A)  $\frac{2}{5}$

B)  $\frac{3}{4}$

C)  $\frac{4}{3}$

D)  $\frac{5}{2}$

QUESTION 96



$x - \frac{1}{2}a = 0$   
If  $x = 1$  in the equation above, what is the value of  $a$ ?

QUESTION 97



If  $h$  hours and 30 minutes is equal to 450 minutes, what is the value of  $h$ ?

QUESTION 98



Which of the following statements is true about the graph of the equation  $2y - 3x = -4$  in the  $xy$ -plane?

- A) It has a negative slope and a positive  $y$ -intercept.
- B) It has a negative slope and a negative  $y$ -intercept.
- C) It has a positive slope and a positive  $y$ -intercept.
- D) It has a positive slope and a negative  $y$ -intercept.

## LINEAR EQUATIONS

QUESTION 99



The front of a roller-coaster car is at the bottom of a hill and is 15 feet above the ground. If the front of the roller-coaster car rises at a constant rate of 8 feet per second, which of the following equations gives the height  $h$ , in feet, of the front of the roller-coaster car  $s$  seconds after it starts up the hill?

A)  $h = 8s + 15$

B)  $h = 15s + \frac{335}{8}$

C)  $h = 8s + \frac{335}{15}$

D)  $h = 15s + 8$

QUESTION 100



If  $\frac{8}{x} = 160$ , what is the value of  $x$ ?

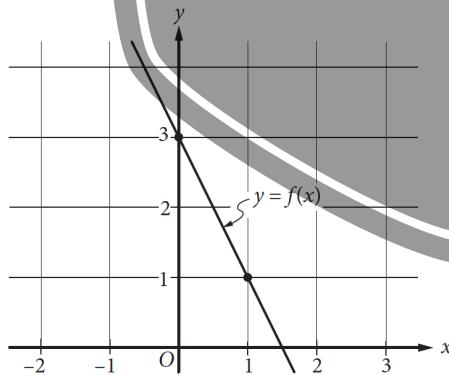
A) 1,280

B) 80

C) 20

D) 0.05

QUESTION 101



SAT - ACT - EST

The graph of the linear function  $f$  is shown in the  $xy$ -plane above. The graph of the linear function  $g$  (not shown) is perpendicular to the graph of  $f$  and passes through the point  $(1, 3)$ . What is the value of  $g(0)$ ?

## LINEAR EQUATIONS

QUESTION 102



$$4x + 2 = 4$$

If  $x$  satisfies the equation above, what is the value of  $2x + 1$ ?

QUESTION 103



What value of  $x$  satisfies the equation  $3x + 3 = 27$ ?

- A) 3
- B) 8
- C) 10
- D) 27

QUESTION 104



A company purchased a machine valued at \$120,000. The value of the machine depreciates by the same amount each year so that after 10 years the value will be \$30,000. Which of the following equations gives the value,  $v$ , of the machine, in dollars,  $t$  years after it was purchased for  $0 \leq t \leq 10$ ?

- A)  $v = 30,000 - 9,000t$
- B)  $v = 120,000 - 9,000t$
- C)  $v = 120,000 + 9,000t$
- D)  $v = 120,000 - 30,000t$

QUESTION 105



In the  $xy$ -plane, line  $\ell$  has a  $y$ -intercept of  $-13$  and is perpendicular to the line with equation  $y = -\frac{2}{3}x$ . If the point  $(10, b)$  is on line  $\ell$ , what is the value of  $b$ ?

## LINEAR EQUATIONS

QUESTION 106



Line  $m$  in the  $xy$ -plane contains the points  $(2, 4)$  and  $(0, 1)$ . Which of the following is an equation of line  $m$ ?

- A)  $y = 2x + 3$   
 B)  $y = 2x + 4$   
 C)  $y = \frac{3}{2}x + 3$   
 D)  $y = \frac{3}{2}x + 1$

QUESTION 107



$2z + 1 = z$   
 What value of  $z$  satisfies the equation above?

- A)  $-2$   
 B)  $-1$   
 C)  $\frac{1}{2}$   
 D)  $1$

QUESTION 108

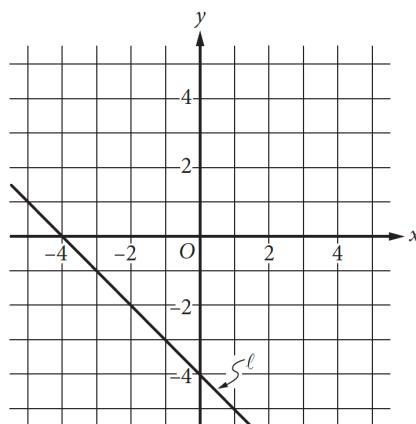


A television with a price of \$300 is to be purchased with an initial payment of \$60 and weekly payments of \$30. Which of the following equations can be used to find the number of weekly payments,  $w$ , required to complete the purchase, assuming there are no taxes or fees?

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- A)  $300 = 30w - 60$   
 B)  $300 = 30w$   
 C)  $300 = 30w + 60$   
 D)  $300 = 60w - 30$

QUESTION 109



Which of the following is an equation of line  $\ell$  in the  $xy$ -plane above?

- A)  $x - y = -4$   
 B)  $x - y = 4$   
 C)  $x + y = -4$   
 D)  $x + y = 4$

## LINEAR EQUATIONS

## QUESTION II0



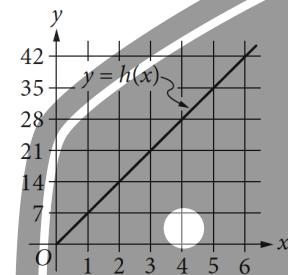
## Shipping Charges

Merchandise weight (pounds)	Shipping charge
5	\$16.94
10	\$21.89
20	\$31.79
40	\$51.59

- A)  $f(x) = 0.99x$   
 B)  $f(x) = 0.99x + 11.99$   
 C)  $f(x) = 3.39x$   
 D)  $f(x) = 3.39x + 16.94$

The table above shows shipping charges for an online retailer that sells sporting goods. There is a linear relationship between the shipping charge and the weight of the merchandise. Which function can be used to determine the total shipping charge  $f(x)$ , in dollars, for an order with a merchandise weight of  $x$  pounds?

## QUESTION III



SAT

SAT - ACT - EST

The line in the  $xy$ -plane above represents the relationship between the height  $h(x)$ , in feet, and the base diameter  $x$ , in feet, for cylindrical Doric columns in ancient Greek architecture. How much greater is the height of a Doric column that has a base diameter of 5 feet than the height of a Doric column that has a base diameter of 2 feet?

- A) 7 feet  
 B) 14 feet  
 C) 21 feet  
 D) 24 feet

## QUESTION II2



$$T = 5c + 12f$$

A manufacturer shipped units of a certain product to two locations. The equation above shows the total shipping cost  $T$ , in dollars, for shipping  $c$  units to the closer location and shipping  $f$  units to the farther location. If the total shipping cost was \$47,000 and 3000 units were shipped to the farther location, how many units were shipped to the closer location?

## LINEAR EQUATIONS

QUESTION II3



A helicopter, initially hovering 40 feet above the ground, begins to gain altitude at a rate of 21 feet per second. Which of the following functions represents the helicopter's altitude above the ground  $y$ , in feet,  $t$  seconds after the helicopter begins to gain altitude?

- A)  $y = 40 + 21$   
 B)  $y = 40 + 21t$   
 C)  $y = 40 - 21t$   
 D)  $y = 40t + 21$

QUESTION II4



If  $20 - x = 15$ , what is the value of  $3x$ ?

- A) 5  
 B) 10  
 C) 15  
 D) 35

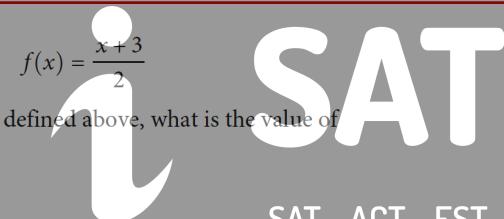
QUESTION II5



For the function  $f$  defined above, what is the value of  $f(-1)$ ?

- A) -2  
 B) -1  
 C) 1  
 D) 2

QUESTION II6



$x$	$a$	$3a$	$5a$
$y$	0	$-a$	$-2a$

Some values of  $x$  and their corresponding values of  $y$  are shown in the table above, where  $a$  is a constant.

If there is a linear relationship between  $x$  and  $y$ , which of the following equations represents the relationship?

- A)  $x + 2y = a$   
 B)  $x + 2y = 5a$   
 C)  $2x - y = -5a$   
 D)  $2x - y = 7a$

## PART I: HEART OF ALGEBRA

## LINEAR EQUATIONS

QUESTION 117



$$\frac{2}{3}(9x - 6) - 4 = 9x - 6$$

Based on the equation above, what is the value of  $3x - 2$ ?

- A) -4
- B)  $-\frac{4}{5}$
- C)  $-\frac{2}{3}$
- D) 4

QUESTION 118



$$H = 1.88L + 32.01$$

The formula above can be used to approximate the height  $H$ , in inches, of an adult male based on the length  $L$ , in inches, of his femur. What is the meaning of 1.88 in this context?

- A) The approximate femur length, in inches, for a man with a height of 32.01 inches
- B) The approximate increase in a man's femur length, in inches, for each increase of 32.01 inches in his height
- C) The approximate increase in a man's femur length, in inches, for each one-inch increase in his height
- D) The approximate increase in a man's height, in inches, for each one-inch increase in his femur length

QUESTION 119



$$a(x + b) = 4x + 10$$

In the equation above,  $a$  and  $b$  are constants. If the equation has infinitely many solutions for  $x$ , what is the value of  $b$ ?

QUESTION 120



Lynne has \$8.00 to spend on apples and oranges. Apples cost \$0.65 each, and oranges cost \$0.75 each. If there is no tax on this purchase and she buys 5 apples, what is the maximum number of whole oranges she can buy?

1.3

## PART I: HEART OF ALGEBRA

## INEQUALITIES

QUESTION 121



Which of the following numbers is NOT a solution of the inequality  $3x - 5 \geq 4x - 3$ ?

- A) -1
- B) -2
- C) -3
- D) -5

QUESTION 122



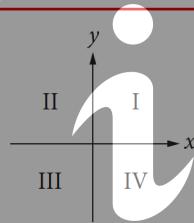
$$y < -x + a$$

$$y > x + b$$

In the  $xy$ -plane, if  $(0, 0)$  is a solution to the system of inequalities above, which of the following relationships between  $a$  and  $b$  must be true?

- A)  $a > b$
- B)  $b > a$
- C)  $|a| > |b|$
- D)  $a = -b$

QUESTION 123



# SAT

SAT - ACT - EST

If the system of inequalities  $y \geq 2x + 1$  and

$y > \frac{1}{2}x - 1$  is graphed in the  $xy$ -plane above, which

quadrant contains no solutions to the system?

- A) Quadrant II
- B) Quadrant III
- C) Quadrant IV
- D) There are solutions in all four quadrants.

QUESTION 124



The posted weight limit for a covered wooden bridge in Pennsylvania is 6000 pounds. A delivery truck that is carrying  $x$  identical boxes each weighing 14 pounds will pass over the bridge. If the combined weight of the empty delivery truck and its driver is 4500 pounds, what is the maximum possible value for  $x$  that will keep the combined weight of the truck, driver, and boxes below the bridge's posted weight limit?

## INEQUALITIES

QUESTION 125



The sales manager of a company awarded a total of \$3000 in bonuses to the most productive salespeople. The bonuses were awarded in amounts of \$250 or \$750. If at least one \$250 bonus and at least one \$750 bonus were awarded, what is one possible number of \$250 bonuses awarded?

QUESTION 126



On January 1, 2000, there were 175,000 tons of trash in a landfill that had a capacity of 325,000 tons. Each year since then, the amount of trash in the landfill increased by 7,500 tons. If  $y$  represents the time, in years, after January 1, 2000, which of the following inequalities describes the set of years where the landfill is at or above capacity?

- A)  $325,000 - 7,500 \leq y$
- B)  $325,000 \leq 7,500y$
- C)  $150,000 \geq 7,500y$
- D)  $175,000 + 7,500y \geq 325,000$

QUESTION 127



Tickets for a school talent show cost \$2 for students and \$3 for adults. If Chris spends at least \$11 but no more than \$14 on  $x$  student tickets and 1 adult ticket, what is one possible value of  $x$ ?

## INEQUALITIES

QUESTION 128



A project manager estimates that a project will take  $x$  hours to complete, where  $x > 100$ . The goal is for the estimate to be within 10 hours of the time it will actually take to complete the project. If the manager meets the goal and it takes  $y$  hours to complete the project, which of the following inequalities represents the relationship between the estimated time and the actual completion time?

- A)  $x + y < 10$
- B)  $y > x + 10$
- C)  $y < x - 10$
- D)  $-10 < y - x < 10$

QUESTION 129



$$\begin{aligned}y &\leq -15x + 3000 \\y &\leq 5x\end{aligned}$$

In the  $xy$ -plane, if a point with coordinates  $(a, b)$  lies in the solution set of the system of inequalities above, what is the maximum possible value of  $b$ ?

QUESTION 130



If  $3p - 2 \geq 1$ , what is the least possible value of  $3p + 2$ ?

- A) 5
- B) 3
- C) 2
- D) 1

QUESTION 131



Let  $x$  and  $y$  be numbers such that  $-y < x < y$ . Which of the following must be true?

- I.  $|x| < y$
  - II.  $x > 0$
  - III.  $y > 0$
- A) I only
  - B) I and II only
  - C) I and III only
  - D) I, II, and III

## I.3

## PART I: HEART OF ALGEBRA

## INEQUALITIES

QUESTION 132



Maria plans to rent a boat. The boat rental costs \$60 per hour, and she will also have to pay for a water safety course that costs \$10. Maria wants to spend no more than \$280 for the rental and the course. If the boat rental is available only for a whole number of hours, what is the maximum number of hours for which Maria can rent the boat?

QUESTION 133



A psychologist set up an experiment to study the tendency of a person to select the first item when presented with a series of items. In the experiment, 300 people were presented with a set of five pictures arranged in random order. Each person was asked to choose the most appealing picture. Of the first 150 participants, 36 chose the first picture in the set. Among the remaining 150 participants,  $p$  people chose the first picture in the set. If more than 20% of all participants chose the first picture in the set, which of the following inequalities best describes the possible values of  $p$ ?

- A)  $p > 0.20(300 - 36)$ , where  $p \leq 150$
- B)  $p > 0.20(300 + 36)$ , where  $p \leq 150$
- C)  $p - 36 > 0.20(300)$ , where  $p \leq 150$
- D)  $p + 36 > 0.20(300)$ , where  $p \leq 150$

QUESTION 134



$$6x - 9y > 12$$

Which of the following inequalities is equivalent to the inequality above?

- A)  $x - y > 2$
- B)  $2x - 3y > 4$
- C)  $3x - 2y > 4$
- D)  $3y - 2x > 2$

## I.3

## PART I: HEART OF ALGEBRA

## INEQUALITIES

## QUESTION 135



Jaime is preparing for a bicycle race. His goal is to bicycle an average of at least 280 miles per week for 4 weeks. He bicycled 240 miles the first week, 310 miles the second week, and 320 miles the third week. Which inequality can be used to represent the number of miles,  $x$ , Jaime could bicycle on the 4th week to meet his goal?

- A)  $\frac{240 + 310 + 320}{3} + x \geq 280$
- B)  $240 + 310 + 320 \geq x(280)$
- C)  $\frac{240}{4} + \frac{310}{4} + \frac{320}{4} + x \geq 280$
- D)  $240 + 310 + 320 + x \geq 4(280)$

## QUESTION 136



A shipping service restricts the dimensions of the boxes it will ship for a certain type of service. The restriction states that for boxes shaped like rectangular prisms, the sum of the perimeter of the base of the box and the height of the box cannot exceed 130 inches. The perimeter of the base is determined using the width and length of the box. If a box has a height of 60 inches and its length is 2.5 times the width, which inequality shows the allowable width  $x$ , in inches, of the box?

- A)  $0 < x \leq 10$
- B)  $0 < x \leq 11\frac{2}{3}$
- C)  $0 < x \leq 17\frac{1}{2}$
- D)  $0 < x \leq 20$

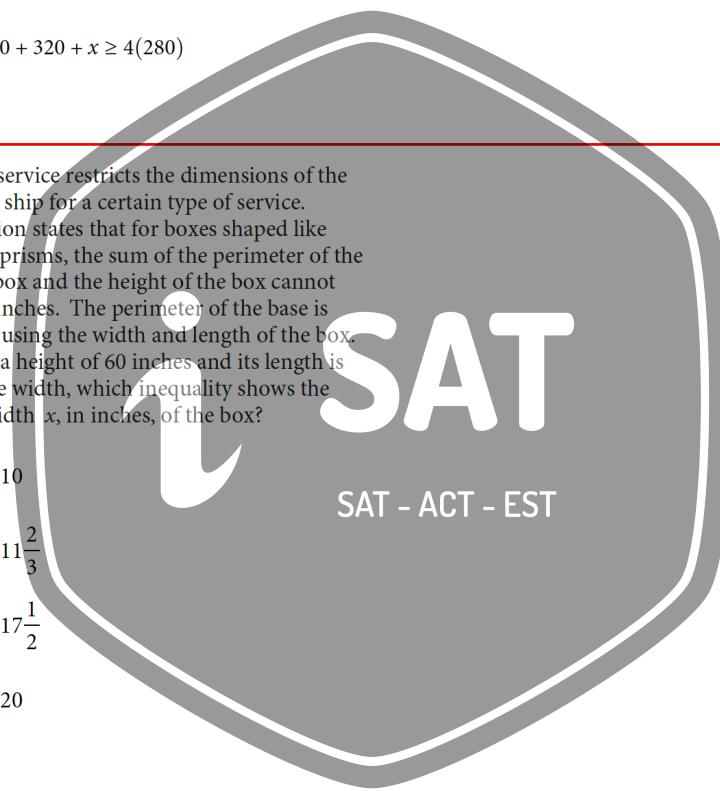
## QUESTION 137



Which of the following ordered pairs  $(x, y)$  satisfies the inequality  $5x - 3y < 4$ ?

- I.  $(1, 1)$   
 II.  $(2, 5)$   
 III.  $(3, 2)$
- A) I only  
 B) II only  
 C) I and II only  
 D) I and III only

SAT - ACT - EST



## INEQUALITIES

## QUESTION 138



The average annual energy cost for a certain home is \$4,334. The homeowner plans to spend \$25,000 to install a geothermal heating system. The homeowner estimates that the average annual energy cost will then be \$2,712. Which of the following inequalities can be solved to find  $t$ , the number of years after installation at which the total amount of energy cost savings will exceed the installation cost?

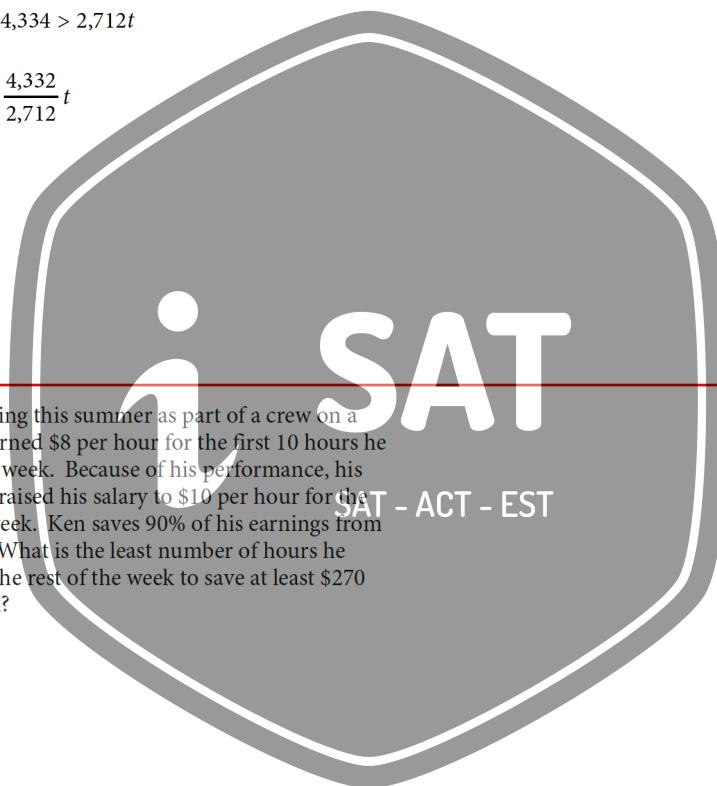
- A)  $25,000 > (4,334 - 2,712)t$
- B)  $25,000 < (4,334 - 2,712)t$
- C)  $25,000 - 4,334 > 2,712t$
- D)  $25,000 > \frac{4,332}{2,712}t$

## QUESTION 139



Ken is working this summer as part of a crew on a farm. He earned \$8 per hour for the first 10 hours he worked this week. Because of his performance, his crew leader raised his salary to \$10 per hour for the rest of the week. Ken saves 90% of his earnings from each week. What is the least number of hours he must work the rest of the week to save at least \$270 for the week?

- A) 38
- B) 33
- C) 22
- D) 16



## LINEAR SYSTEMS

QUESTION 140



$$\begin{aligned}3x + 4y &= -23 \\2y - x &= -19\end{aligned}$$

What is the solution  $(x, y)$  to the system of equations above?

- A)  $(-5, -2)$
- B)  $(3, -8)$
- C)  $(4, -6)$
- D)  $(9, -6)$

QUESTION 141



$$\begin{aligned}b &= 2.35 + 0.25x \\c &= 1.75 + 0.40x\end{aligned}$$

In the equations above,  $b$  and  $c$  represent the price per pound, in dollars, of beef and chicken, respectively,  $x$  weeks after July 1 during last summer. What was the price per pound of beef when it was equal to the price per pound of chicken?

- A) \$2.60
- B) \$2.85
- C) \$2.95
- D) \$3.35

QUESTION 142



$$\begin{aligned}x + y &= -9 \\x + 2y &= -25\end{aligned}$$

According to the system of equations above, what is the value of  $x$ ?

QUESTION 143



A food truck sells salads for \$6.50 each and drinks for \$2.00 each. The food truck's revenue from selling a total of 209 salads and drinks in one day was \$836.50. How many salads were sold that day?

- A) 77
- B) 93
- C) 99
- D) 105

QUESTION 144



$$\begin{aligned}ax + by &= 12 \\2x + 8y &= 60\end{aligned}$$

In the system of equations above,  $a$  and  $b$  are constants. If the system has infinitely many solutions, what is the value of  $\frac{a}{b}$ ?

## LINEAR SYSTEMS

QUESTION 145



$$\begin{aligned}x + y &= 0 \\3x - 2y &= 10\end{aligned}$$

Which of the following ordered pairs  $(x, y)$  satisfies the system of equations above?

- A)  $(3, -2)$
- B)  $(2, -2)$
- C)  $(-2, 2)$
- D)  $(-2, -2)$

QUESTION 146



In one semester, Doug and Laura spent a combined 250 hours in the tutoring lab. If Doug spent 40 more hours in the lab than Laura did, how many hours did Laura spend in the lab?

QUESTION 147



$$\begin{aligned}2x - 3y &= -14 \\3x - 2y &= -6\end{aligned}$$

SAT - ACT - EST

If  $(x, y)$  is a solution to the system of equations above, what is the value of  $x - y$ ?

- A)  $-20$
- B)  $-8$
- C)  $-4$
- D)  $8$

QUESTION 148



At a lunch stand, each hamburger has 50 more calories than each order of fries. If 2 hamburgers and 3 orders of fries have a total of 1700 calories, how many calories does a hamburger have?

## LINEAR SYSTEMS

QUESTION 149



$$kx - 3y = 4$$

$$4x - 5y = 7$$

In the system of equations above,  $k$  is a constant and  $x$  and  $y$  are variables. For what value of  $k$  will the system of equations have no solution?

A)  $\frac{12}{5}$

B)  $\frac{16}{7}$

C)  $-\frac{16}{7}$

D)  $-\frac{12}{5}$

QUESTION 150

QUESTION 151



$$S(P) = \frac{1}{2}P + 40$$

$$D(P) = 220 - P$$

The quantity of a product supplied and the quantity of the product demanded in an economic market are functions of the price of the product. The functions above are the estimated supply and demand functions for a certain product. The function  $S(P)$  gives the quantity of the product supplied to the market when the price is  $P$  dollars, and the function  $D(P)$  gives the quantity of the product demanded by the market when the price is  $P$  dollars.

**SAT - ACT - EST**

How will the quantity of the product supplied to the market change if the price of the product is increased by \$10?

- A) The quantity supplied will decrease by 5 units.
- B) The quantity supplied will increase by 5 units.
- C) The quantity supplied will increase by 10 units.
- D) The quantity supplied will increase by 50 units.

At what price will the quantity of the product supplied to the market equal the quantity of the product demanded by the market?

- A) \$90
- B) \$120
- C) \$133
- D) \$155

## 1.4

## PART I: HEART OF ALGEBRA

## LINEAR SYSTEMS

QUESTION 152



$$\begin{aligned}3x + b &= 5x - 7 \\3y + c &= 5y - 7\end{aligned}$$

In the equations above,  $b$  and  $c$  are constants.

If  $b$  is  $c$  minus  $\frac{1}{2}$ , which of the following is true?

- A)  $x$  is  $y$  minus  $\frac{1}{4}$ .
- B)  $x$  is  $y$  minus  $\frac{1}{2}$ .
- C)  $x$  is  $y$  minus 1.
- D)  $x$  is  $y$  plus  $\frac{1}{2}$ .

QUESTION 153



$$\begin{aligned}-3x + 4y &= 20 \\6x + 3y &= 15\end{aligned}$$

If  $(x, y)$  is the solution to the system of equations above, what is the value of  $x$ ?

QUESTION 154



Last week Raul worked 11 more hours than Angelica. If they worked a combined total of 59 hours, how many hours did Angelica work last week?

- A) 24
- B) 35
- C) 40
- D) 48

QUESTION 155



$$\begin{aligned}\frac{1}{2}(2x + y) &= \frac{21}{2} \\y &= 2x\end{aligned}$$

The system of equations above has solution  $(x, y)$ . What is the value of  $x$ ?

## LINEAR SYSTEMS

QUESTION 156



An online bookstore sells novels and magazines. Each novel sells for \$4, and each magazine sells for \$1. If Sadie purchased a total of 11 novels and magazines that have a combined selling price of \$20, how many novels did she purchase?

- A) 2
- B) 3
- C) 4
- D) 5

QUESTION 157



Between 1497 and 1500, Amerigo Vespucci embarked on two voyages to the New World. According to Vespucci's letters, the first voyage lasted 43 days longer than the second voyage, and the two voyages combined lasted a total of 1,003 days. How many days did the second voyage last?

- A) 460
- B) 480
- C) 520
- D) 540

QUESTION 158



$$\begin{aligned}\frac{1}{2}y &= 4 \\ x - \frac{1}{2}y &= 2\end{aligned}$$

The system of equations above has solution  $(x, y)$ . What is the value of  $x$ ?

- A) 3
- B)  $\frac{7}{2}$
- C) 4
- D) 6



## LINEAR SYSTEMS

QUESTION 159



$$\begin{aligned} 7x + 3y &= 8 \\ 6x - 3y &= 5 \end{aligned}$$

For the solution  $(x, y)$  to the system of equations above, what is the value of  $x - y$ ?

- A)  $-\frac{4}{3}$
- B)  $\frac{2}{3}$
- C)  $\frac{4}{3}$
- D)  $\frac{22}{3}$

QUESTION 160



$$x = y - 3$$

$$\frac{x}{2} + 2y = 6$$

Which ordered pair  $(x, y)$  satisfies the system of equations shown above?

- A)  $(-3, 0)$
- B)  $(0, 3)$
- C)  $(6, -3)$
- D)  $(36, -6)$

QUESTION 161



A software company is selling a new game in a standard edition and a collector's edition. The box for the standard edition has a volume of 20 cubic inches, and the box for the collector's edition has a volume of 30 cubic inches. The company receives an order for 75 copies of the game, and the total volume of the order to be shipped is 1,870 cubic inches. Which of the following systems of equations can be used to determine the number of standard edition games,  $s$ , and collector's edition games,  $c$ , that were ordered?

- A)  $75 - s = c$   
 $20s + 30c = 1,870$
- B)  $75 - s = c$   
 $30s + 20c = 1,870$
- C)  $s - c = 75$   
 $25(s + c) = 1,870$
- D)  $s - c = 75$   
 $30s + 20c = 1,870$

## PART I: HEART OF ALGEBRA

## LINEAR SYSTEMS

## QUESTION 162



A group of 202 people went on an overnight camping trip, taking 60 tents with them. Some of the tents held 2 people each, and the rest held 4 people each. Assuming all the tents were filled to capacity and every person got to sleep in a tent, exactly how many of the tents were 2-person tents?

- A) 30
- B) 20
- C) 19
- D) 18

## QUESTION 163



$$\begin{aligned}-x + y &= -3.5 \\ x + 3y &= 9.5\end{aligned}$$

If  $(x, y)$  satisfies the system of equations above, what is the value of  $y$ ?

## QUESTION 164



Two types of tickets were sold for a concert held at an amphitheater. Tickets to sit on a bench during the concert cost \$75 each, and tickets to sit on the lawn during the concert cost \$40 each. Organizers of the concert announced that 350 tickets had been sold and that \$19,250 had been raised through ticket sales alone. Which of the following systems of equations could be used to find the number of tickets for bench seats,  $B$ , and the number of tickets for lawn seats,  $L$ , that were sold for the concert?

- A)  $(75B)(40L) = 1,950$   
 $B + L = 350$
- B)  $40B + 75L = 19,250$   
 $B + L = 350$
- C)  $75B + 40L = 350$   
 $B + L = 19,250$
- D)  $75B + 40L = 19,250$   
 $B + L = 350$

## QUESTION 165



In the  $xy$ -plane, the equations  $x + 2y = 10$  and  $3x + 6y = c$  represent the same line for some constant  $c$ . What is the value of  $c$ ?

SAT - ACT - EST

## LINEAR SYSTEMS

QUESTION 166



$$2x - y = 8$$

$$x + 2y = 4$$

For the system of equations above, what is the value of  $x + y$ ?

- A) -1
- B) 4
- C) 5
- D) 20

QUESTION 167



If  $2w + 4t = 14$  and  $4w + 5t = 25$ , what is the value of  $2w + 3t$ ?

- A) 6
- B) 10
- C) 13
- D) 17

QUESTION 168



$$\frac{3}{4}x - \frac{1}{2}y = 12$$

**SAT**  
SAT - ACT - EST

The system of equations above has no solutions. If  $a$

and  $b$  are constants, what is the value of  $\frac{a}{b}$ ?

QUESTION 169



$$-3x + y = 6$$

$$ax + 2y = 4$$

In the system of equations above,  $a$  is a constant. For which of the following values of  $a$  does the system have no solution?

- A) -6
- B) -3
- C) 3
- D) 6

## LINEAR SYSTEMS

QUESTION 170



$$\begin{aligned}2x + 3y &= 1200 \\3x + 2y &= 1300\end{aligned}$$

Based on the system of equations above, what is the value of  $5x + 5y$ ?

QUESTION 171



$$\begin{aligned}2.4x - 1.5y &= 0.3 \\1.6x + 0.5y &= -1.3\end{aligned}$$

The system of equations above is graphed in the  $xy$ -plane. What is the  $x$ -coordinate of the intersection point  $(x, y)$  of the system?

- A) -0.5
- B) -0.25
- C) 0.8
- D) 1.75

QUESTION 172



The sum of three numbers is 855. One of the numbers,  $x$ , is 50% more than the sum of the other two numbers. What is the value of  $x$ ?

- A) 570
- B) 513
- C) 214
- D) 155

QUESTION 173



Mr. Kohl has a beaker containing  $n$  milliliters of solution to distribute to the students in his chemistry class. If he gives each student 3 milliliters of solution, he will have 5 milliliters left over. In order to give each student 4 milliliters of solution, he will need an additional 21 milliliters. How many students are in the class?

- A) 16
- B) 21
- C) 23
- D) 26

## LINEAR SYSTEMS

QUESTION 174

QUESTION 175



Mr. Martinson is building a concrete patio in his backyard and deciding where to buy the materials and rent the tools needed for the project. The table below shows the materials' cost and daily rental costs for three different stores.

Store	Materials' Cost, $M$ (dollars)	Rental cost of wheelbarrow, $W$ (dollars per day)	Rental cost of concrete mixer, $K$ (dollars per day)
A	750	15	65
B	600	25	80
C	700	20	70

The total cost,  $y$ , for buying the materials and renting the tools in terms of the number of days,  $x$ , is given by

$$y = M + (W + K)x.$$

For what number of days,  $x$ , will the total cost of buying the materials and renting the tools from Store B be less than or equal to the total cost of buying the materials and renting the tools from Store A?

- A)  $x \leq 6$
- B)  $x \geq 6$
- C)  $x \leq 7.3$
- D)  $x \geq 7.3$

If the relationship between the total cost,  $y$ , of buying the materials and renting the tools at Store C and the number of days,  $x$ , for which the tools are rented is graphed in the  $xy$ -plane, what does the slope of the line represent?

- A) The total cost of the project
- B) The total cost of the materials
- C) The total daily cost of the project
- D) The total daily rental costs of the tools

QUESTION 176



If  $a - b = 12$  and  $\frac{b}{2} = 10$ , what is the value of  $a + b$ ?

- A) 2
- B) 12
- C) 32
- D) 52



SAT ACT - EST

## LINEAR SYSTEMS

QUESTION 177



The score on a trivia game is obtained by subtracting the number of incorrect answers from twice the number of correct answers. If a player answered 40 questions and obtained a score of 50, how many questions did the player answer correctly?

QUESTION 178



$$C = 75h + 125$$

The equation above gives the amount  $C$ , in dollars, an electrician charges for a job that takes  $h$  hours. Ms. Sanchez and Mr. Roland each hired this electrician. The electrician worked 2 hours longer on Ms. Sanchez's job than on Mr. Roland's job. How much more did the electrician charge Ms. Sanchez than Mr. Roland?

- A) \$75
- B) \$125
- C) \$150
- D) \$275

QUESTION 179



$$2ax - 15 = 3(x + 5) + 5(x - 1)$$

In the equation above,  $a$  is a constant. If no value of  $x$  satisfies the equation, what is the value of  $a$ ?

**SAT - ACT - EST**

- A) 1
- B) 2
- C) 4
- D) 8

QUESTION 180



A cargo helicopter delivers only 100-pound packages and 120-pound packages. For each delivery trip, the helicopter must carry at least 10 packages, and the total weight of the packages can be at most 1,100 pounds. What is the maximum number of 120-pound packages that the helicopter can carry per trip?

- A) 2
- B) 4
- C) 5
- D) 6

## LINEAR SYSTEMS

QUESTION 181



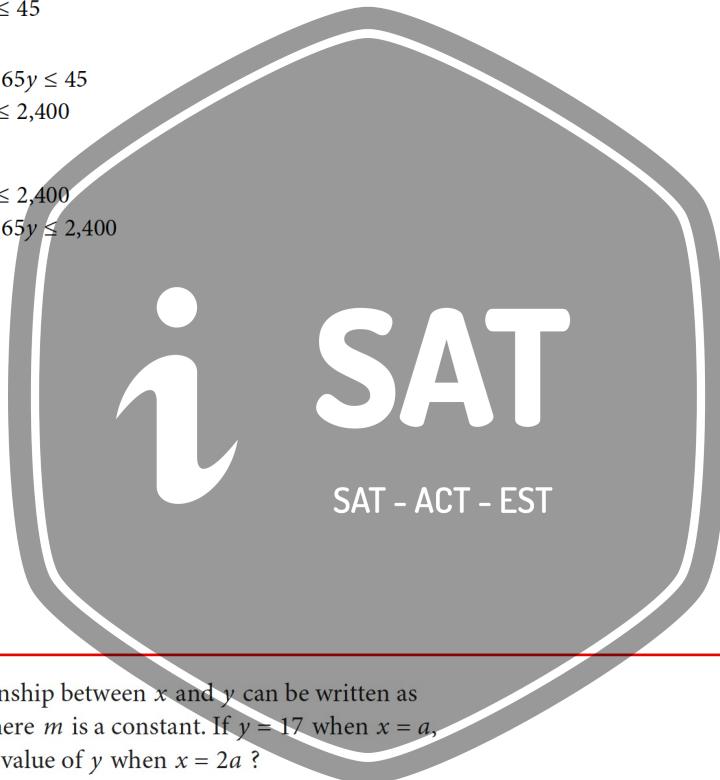
A worker uses a forklift to move boxes that weigh either 40 pounds or 65 pounds each. Let  $x$  be the number of 40-pound boxes and  $y$  be the number of 65-pound boxes. The forklift can carry up to either 45 boxes or a weight of 2,400 pounds. Which of the following systems of inequalities represents this relationship?

A)  $\begin{cases} 40x + 65y \leq 2,400 \\ x + y \leq 45 \end{cases}$

B)  $\begin{cases} \frac{x}{40} + \frac{y}{65} \leq 2,400 \\ x + y \leq 45 \end{cases}$

C)  $\begin{cases} 40x + 65y \leq 45 \\ x + y \leq 2,400 \end{cases}$

D)  $\begin{cases} x + y \leq 2,400 \\ 40x + 65y \leq 2,400 \end{cases}$



QUESTION 182



The relationship between  $x$  and  $y$  can be written as  $y = mx$ , where  $m$  is a constant. If  $y = 17$  when  $x = a$ , what is the value of  $y$  when  $x = 2a$ ?

## LINEAR SYSTEMS

QUESTION 183



Jackie has two summer jobs. She works as a tutor, which pays \$12 per hour, and she works as a lifeguard, which pays \$9.50 per hour. She can work no more than 20 hours per week, but she wants to earn at least \$220 per week. Which of the following systems of inequalities represents this situation in terms of  $x$  and  $y$ , where  $x$  is the number of hours she tutors and  $y$  is the number of hours she works as a lifeguard?

- A)  $12x + 9.5y \leq 220$   
 $x + y \geq 20$
- B)  $12x + 9.5y \leq 220$   
 $x + y \leq 20$
- C)  $12x + 9.5y \geq 220$   
 $x + y \leq 20$
- D)  $12x + 9.5y \geq 220$   
 $x + y \geq 20$

QUESTION 184



$$\begin{aligned}y &\leq 3x + 1 \\x - y &> 1\end{aligned}$$

SAT - ACT - EST

Which of the following ordered pairs  $(x, y)$  satisfies the system of inequalities above?

- A)  $(-2, -1)$
- B)  $(-1, 3)$
- C)  $(1, 5)$
- D)  $(2, -1)$

## LINEAR SYSTEMS

QUESTION 185



Marisa needs to hire at least 10 staff members for an upcoming project. The staff members will be made up of junior directors, who will be paid \$640 per week, and senior directors, who will be paid \$880 per week. Her budget for paying the staff members is no more than \$9,700 per week. She must hire at least 3 junior directors and at least 1 senior director. Which of the following systems of inequalities represents the conditions described if  $x$  is the number of junior directors and  $y$  is the number of senior directors?

A)  $640x + 880y \geq 9,700$

$x + y \leq 10$

$x \geq 3$

$y \geq 1$

B)  $640x + 880y \leq 9,700$

$x + y \geq 10$

$x \geq 3$

$y \geq 1$

C)  $640x + 880y \geq 9,700$

$x + y \geq 10$

$x \leq 3$

$y \leq 1$

D)  $640x + 880y \leq 9,700$

$x + y \leq 10$

$x \leq 3$

$y \leq 1$

QUESTION 186



Which of the following consists of the  $y$ -coordinates of all the points that satisfy the system of inequalities above?

A)  $y > 6$

B)  $y > 4$

C)  $y > \frac{5}{2}$

D)  $y > \frac{3}{2}$

$$\begin{aligned} y &> 2x - 1 \\ 2x &> 5 \end{aligned}$$



SAT - ACT - EST

## LINEAR SYSTEMS

QUESTION 187



A laundry service is buying detergent and fabric softener from its supplier. The supplier will deliver no more than 300 pounds in a shipment. Each container of detergent weighs 7.35 pounds, and each container of fabric softener weighs 6.2 pounds. The service wants to buy at least twice as many containers of detergent as containers of fabric softener. Let  $d$  represent the number of containers of detergent, and let  $s$  represent the number of containers of fabric softener, where  $d$  and  $s$  are nonnegative integers. Which of the following systems of inequalities best represents this situation?

- A)  $7.35d + 6.2s \leq 300$   
 $d \geq 2s$
- B)  $7.35d + 6.2s \leq 300$   
 $2d \geq s$
- C)  $14.7d + 6.2s \leq 300$   
 $d \geq 2s$
- D)  $14.7d + 6.2s \leq 300$   
 $2d \geq s$

QUESTION 188



Roberto is an insurance agent who sells two types of policies: a \$50,000 policy and a \$100,000 policy. Last month, his goal was to sell at least 57 insurance policies. While he did not meet his goal, the total value of the policies he sold was over \$3,000,000. Which of the following systems of inequalities describes  $x$ , the possible number of \$50,000 policies, and  $y$ , the possible number of \$100,000 policies, that Roberto sold last month?

- A)  $x + y < 57$   
 $50,000x + 100,000y < 3,000,000$
- B)  $x + y > 57$   
 $50,000x + 100,000y > 3,000,000$
- C)  $x + y < 57$   
 $50,000x + 100,000y > 3,000,000$
- D)  $x + y > 57$   
 $50,000x + 100,000y < 3,000,000$

## LINEAR SYSTEMS

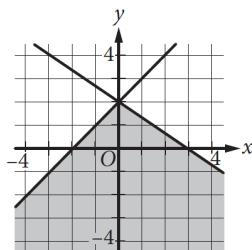
QUESTION 189



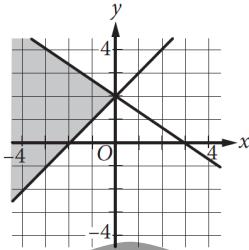
$$\begin{aligned}y &\geq x + 2 \\2x + 3y &\leq 6\end{aligned}$$

In which of the following does the shaded region represent the solution set in the  $xy$ -plane to the system of inequalities above?

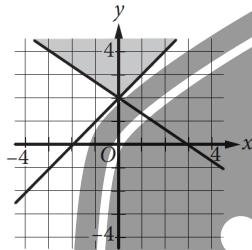
A)



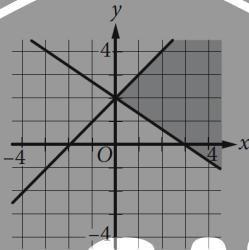
B)



C)



D)



i SAT  
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## PART II

# PROBLEMSAT AND DATA ANALYSIS

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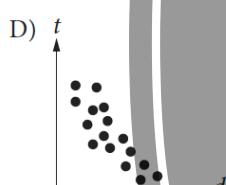
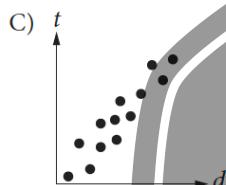
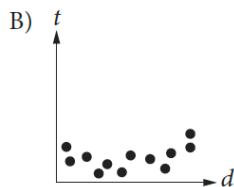
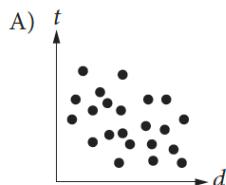


## DATA ANALYSIS

QUESTION 190



Which of the following graphs best shows a strong negative association between  $d$  and  $t$ ?



QUESTION 191



A market researcher selected 200 people at random from a group of people who indicated that they liked a certain book. The 200 people were shown a movie based on the book and then asked whether they liked or disliked the movie. Of those surveyed, 95% said they disliked the movie. Which of the following inferences can appropriately be drawn from this survey result?

- A) At least 95% of people who go see movies will dislike this movie.
- B) At least 95% of people who read books will dislike this movie.
- C) Most people who dislike this book will like this movie.
- D) Most people who like this book will dislike this movie.



## DATA ANALYSIS

QUESTION 192



Lengths of Fish (in inches)						
8	9	9	9	10	10	11
11	12	12	12	12	13	13
13	14	14	15	15	16	24

The table above lists the lengths, to the nearest inch, of a random sample of 21 brown bullhead fish. The outlier measurement of 24 inches is an error. Of the mean, median, and range of the values listed, which will change the most if the 24-inch measurement is removed from the data?

- A) Mean
- B) Median
- C) Range
- D) They will all change by the same amount.

QUESTION 193



The maximum value of a data set consisting of 25 positive integers is 84. A new data set consisting of 26 positive integers is created by including 96 in the original data set. Which of the following measures must be 12 greater for the new data set than for the original data set?

- A) The mean
- B) The median
- C) The range
- D) The standard deviation

QUESTION 194



A survey was taken of the value of homes in a county, and it was found that the mean home value was \$165,000 and the median home value was \$125,000. Which of the following situations could explain the difference between the mean and median home values in the county?

- A) The homes have values that are close to each other.
- B) There are a few homes that are valued much less than the rest.
- C) There are a few homes that are valued much more than the rest.
- D) Many of the homes have values between \$125,000 and \$165,000.

2.I

# PART II: PROBLEM SOLVING AND DATA ANALYSIS

## DATA ANALYSIS

**QUESTION 195**  
**QUESTION 196**



A sociologist chose 300 students at random from each of two schools and asked each student how many siblings he or she has. The results are shown in the table below.

Students' Sibling Survey

Number of siblings	Lincoln School	Washington School
0	120	140
1	80	110
2	60	30
3	30	10
4	10	10

There are a total of 2,400 students at Lincoln School and 3,300 students at Washington School.

What is the median number of siblings for all the students surveyed?

- A) 0
- B) 1
- C) 2
- D) 3

Based on the survey data, which of the following most accurately compares the expected total number of students with 4 siblings at the two schools?

- A) The total number of students with 4 siblings is expected to be equal at the two schools.
- B) The total number of students with 4 siblings at Lincoln School is expected to be 30 more than at Washington School.
- C) The total number of students with 4 siblings at Washington School is expected to be 30 more than at Lincoln School.
- D) The total number of students with 4 siblings at Washington School is expected to be 900 more than at Lincoln School.

**QUESTION 197**



An online store receives customer satisfaction ratings between 0 and 100, inclusive. In the first 10 ratings the store received, the average (arithmetic mean) of the ratings was 75. What is the least value the store can receive for the 11th rating and still be able to have an average of at least 85 for the first 20 ratings?

## DATA ANALYSIS

QUESTION 198



Ages of the First 12 United States Presidents at the Beginning of Their Terms in Office

President	Age (years)	President	Age (years)
Washington	57	Jackson	62
Adams	62	Van Buren	55
Jefferson	58	Harrison	68
Madison	58	Tyler	51
Monroe	59	Polk	50
Adams	58	Taylor	65

The table above lists the ages of the first 12 United States presidents when they began their terms in office. According to the table, what was the mean age, in years, of these presidents at the beginning of their terms? (Round your answer to the nearest tenth.)

QUESTION 199

QUESTION 200



International Tourist Arrivals, in millions

Country	2012	2013
France	83.0	84.7
United States	66.7	69.8
Spain	57.5	60.7
China	57.7	55.7
Italy	46.4	47.7
Turkey	35.7	37.8
Germany	30.4	31.5
United Kingdom	26.3	32.2
Russia	24.7	28.4

SAT - ACT - EST

The table above shows the number of international tourist arrivals, rounded to the nearest tenth of a million, to the top nine tourist destinations in both 2012 and 2013.

Based on the information given in the table, how much greater, in millions, was the median number of international tourist arrivals to the top nine tourist destinations in 2013 than the median number in 2012, to the nearest tenth of a million?

The number of international tourist arrivals in Russia in 2012 was 13.5% greater than in 2011. The number of international tourist arrivals in Russia was  $k$  million more in 2012 than in 2011. What is the value of  $k$  to the nearest integer?

2.1

## PART II: PROBLEM SOLVING AND DATA ANALYSIS

### DATA ANALYSIS

QUESTION 201



The tables below give the distribution of high temperatures in degrees Fahrenheit ( $^{\circ}\text{F}$ ) for City A and City B over the same 21 days in March.

City A

Temperature ( $^{\circ}\text{F}$ )	Frequency
80	3
79	14
78	2
77	1
76	1

City B

Temperature ( $^{\circ}\text{F}$ )	Frequency
80	6
79	3
78	2
77	4
76	6

Which of the following is true about the data shown for these 21 days?

- A) The standard deviation of temperatures in City A is larger.
- B) The standard deviation of temperatures in City B is larger.
- C) The standard deviation of temperatures in City A is the same as that of City B.
- D) The standard deviation of temperatures in these cities cannot be calculated with the data provided.

QUESTION 202



If  $x$  is the average (arithmetic mean) of  $m$  and 9,  $y$  is the average of  $2m$  and 15, and  $z$  is the average of  $3m$  and 18, what is the average of  $x$ ,  $y$ , and  $z$  in terms of  $m$ ?

- A)  $m + 6$
- B)  $m + 7$
- C)  $2m + 14$
- D)  $3m + 21$

## DATA ANALYSIS

QUESTION 203



A researcher conducted a survey to determine whether people in a certain large town prefer watching sports on television to attending the sporting event. The researcher asked 117 people who visited a local restaurant on a Saturday, and 7 people refused to respond. Which of the following factors makes it least likely that a reliable conclusion can be drawn about the sports-watching preferences of all people in the town?

- A) Sample size
- B) Population size
- C) The number of people who refused to respond
- D) Where the survey was given

QUESTION 204



The members of a city council wanted to assess the opinions of all city residents about converting an open field into a dog park. The council surveyed a sample of 500 city residents who own dogs. The survey showed that the majority of those sampled were in favor of the dog park. Which of the following is true about the city council's survey?

- A) It shows that the majority of city residents are in favor of the dog park.
- B) The survey sample should have included more residents who are dog owners.
- C) The survey sample should have consisted entirely of residents who do not own dogs.
- D) The survey sample is biased because it is not representative of all city residents.

QUESTION 205



A study was done on the weights of different types of fish in a pond. A random sample of fish were caught and marked in order to ensure that none were weighed more than once. The sample contained 150 largemouth bass, of which 30% weighed more than 2 pounds. Which of the following conclusions is best supported by the sample data?

- A) The majority of all fish in the pond weigh less than 2 pounds.
- B) The average weight of all fish in the pond is approximately 2 pounds.
- C) Approximately 30% of all fish in the pond weigh more than 2 pounds.
- D) Approximately 30% of all largemouth bass in the pond weigh more than 2 pounds.

## DATA ANALYSIS

QUESTION 206

700, 1200, 1600, 2000,  $x$ 

If the mean of the five numbers above is 1600, what is the value of  $x$ ?

QUESTION 207



The mean score of 8 players in a basketball game was 14.5 points. If the highest individual score is removed, the mean score of the remaining 7 players becomes 12 points. What was the highest score?

- A) 20
- B) 24
- C) 32
- D) 36

QUESTION 208



Number of States with 10 or More Electoral Votes in 2008

Electoral votes	Frequency
10	4
11	4
12	1
13	1
15	3
17	1
20	1
21	2
27	1
31	1
34	1
55	1

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In 2008, there were 21 states with 10 or more electoral votes, as shown in the table above. Based on the table, what was the median number of electoral votes for the 21 states?

- A) 13
- B) 15
- C) 17
- D) 20

## DATA ANALYSIS

QUESTION 209



List A	1	2	3	4	5	6
List B	2	3	3	4	4	5

The table above shows two lists of numbers. Which of the following is a true statement comparing list A and list B?

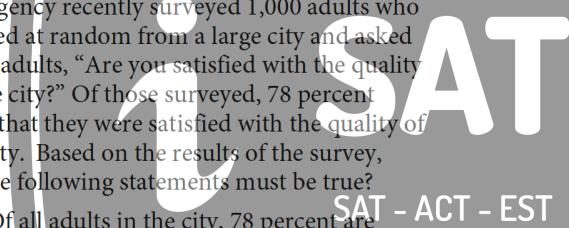
- A) The means are the same, and the standard deviations are different.
- B) The means are the same, and the standard deviations are the same.
- C) The means are different, and the standard deviations are different.
- D) The means are different, and the standard deviations are the same.

QUESTION 210



A polling agency recently surveyed 1,000 adults who were selected at random from a large city and asked each of the adults, “Are you satisfied with the quality of air in the city?” Of those surveyed, 78 percent responded that they were satisfied with the quality of air in the city. Based on the results of the survey, which of the following statements must be true?

- I. Of all adults in the city, 78 percent are satisfied with the quality of air in the city.
  - II. If another 1,000 adults selected at random from the city were surveyed, 78 percent of them would report they are satisfied with the quality of air in the city.
  - III. If 1,000 adults selected at random from a different city were surveyed, 78 percent of them would report they are satisfied with the quality of air in the city.
- A) None
  - B) II only
  - C) I and II only
  - D) I and III only



2.I

# PART II: PROBLEM SOLVING AND DATA ANALYSIS

## DATA ANALYSIS

QUESTION 2II



Percent of Residents Who Earned a Bachelor's Degree or Higher

State	Percent of residents
State A	21.9%
State B	27.9%
State C	25.9%
State D	19.5%
State E	30.1%
State F	36.4%
State G	35.5%

A survey was given to residents of all 50 states asking if they had earned a bachelor's degree or higher.

The results from 7 of the states are given in the table above. The median percent of residents who earned a bachelor's degree or higher for all 50 states was 26.95%. What is the difference between the median percent of residents who earned a bachelor's degree or higher for these 7 states and the median for all 50 states?

- A) 0.05%
- B) 0.95%
- C) 1.22%
- D) 7.45%

QUESTION 2I2



A researcher surveyed a random sample of students from a large university about how often they see movies. Using the sample data, the researcher estimated that 23% of the students in the population saw a movie at least once per month. The margin of error for this estimation is 4%. Which of the following is the most appropriate conclusion about all students at the university, based on the given estimate and margin of error?

- A) It is unlikely that less than 23% of the students see a movie at least once per month.
- B) At least 23%, but no more than 25%, of the students see a movie at least once per month.
- C) The researcher is between 19% and 27% sure that most students see a movie at least once per month.
- D) It is plausible that the percentage of students who see a movie at least once per month is between 19% and 27%.

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# PART II: PROBLEM SOLVING AND DATA ANALYSIS

## DATA ANALYSIS

QUESTION 213

QUESTION 214



Number of Contestants by Score and Day

	5 out of 5	4 out of 5	3 out of 5	2 out of 5	1 out of 5	0 out of 5	Total
Day 1	2	3	4	6	2	3	20
Day 2	2	3	5	5	4	1	20
Day 3	3	3	4	5	3	2	20
Total	7	9	13	16	9	6	60

The same 20 contestants, on each of 3 days, answered 5 questions in order to win a prize. Each contestant received 1 point for each correct answer. The number of contestants receiving a given score on each day is shown in the table above.

What was the mean score of the contestants on Day 1?

No contestant received the same score on two different days. If a contestant is selected at random, what is the probability that the selected contestant received a score of 5 on Day 2 or Day 3, given that the contestant received a score of 5 on one of the three days?

QUESTION 215



Ages of 20 Students Enrolled in a College Class

Age	Frequency
18	6
19	5
20	4
21	2
22	1
23	1
30	1

The table above shows the distribution of ages of the 20 students enrolled in a college class. Which of the following gives the correct order of the mean, median, and mode of the ages?

- A) mode < median < mean
- B) mode < mean < median
- C) median < mode < mean
- D) mean < mode < median

## DATA ANALYSIS

QUESTION 216



For the finale of a TV show, viewers could use either social media or a text message to vote for their favorite of two contestants. The contestant receiving more than 50% of the vote won. An estimated 10% of the viewers voted, and 30% of the votes were cast on social media. Contestant 2 earned 70% of the votes cast using social media and 40% of the votes cast using a text message. Based on this information, which of the following is an accurate conclusion?

- A) If all viewers had voted, Contestant 2 would have won.
- B) Viewers voting by social media were likely to be younger than viewers voting by text message.
- C) If all viewers who voted had voted by social media instead of by text message, Contestant 2 would have won.
- D) Viewers voting by social media were more likely to prefer Contestant 2 than were viewers voting by text message.



QUESTION 217



To determine the mean number of children per household in a community, Tabitha surveyed 20 families at a playground. For the 20 families surveyed, the mean number of children per household was 2.4. Which of the following statements must be true?

- A) The mean number of children per household in the community is 2.4.
- B) A determination about the mean number of children per household in the community should not be made because the sample size is too small.
- C) The sampling method is flawed and may produce a biased estimate of the mean number of children per household in the community.
- D) The sampling method is not flawed and is likely to produce an unbiased estimate of the mean number of children per household in the community.

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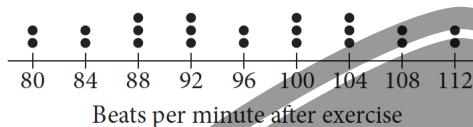
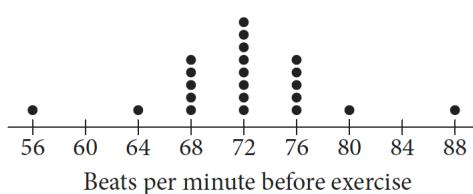
# PART II: PROBLEM SOLVING AND DATA ANALYSIS

## DATA ANALYSIS

QUESTION 218



The 22 students in a health class conducted an experiment in which they each recorded their pulse rates, in beats per minute, before and after completing a light exercise routine. The dot plots below display the results.



Let  $s_1$  and  $r_1$  be the standard deviation and range, respectively, of the data before exercise, and let  $s_2$  and  $r_2$  be the standard deviation and range, respectively, of the data after exercise. Which of the following is true?

- A)  $s_1 = s_2$  and  $r_1 = r_2$
- B)  $s_1 < s_2$  and  $r_1 < r_2$
- C)  $s_1 > s_2$  and  $r_1 > r_2$
- D)  $s_1 \neq s_2$  and  $r_1 = r_2$

QUESTION 219



A retail company has 50 large stores located in different areas throughout a state. A researcher for the company believes that employee job satisfaction varies greatly from store to store. Which of the following sampling methods is most appropriate to estimate the proportion of all employees of the company who are satisfied with their job?

- A) Selecting one of the 50 stores at random and then surveying each employee at that store
- B) Selecting 10 employees from each store at random and then surveying each employee selected
- C) Surveying the 25 highest-paid employees and the 25 lowest-paid employees
- D) Creating a website on which employees can express their opinions and then using the first 50 responses



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## PART II: PROBLEM SOLVING AND DATA ANALYSIS

### DATA ANALYSIS

QUESTION 220



In order to determine if treatment X is successful in improving eyesight, a research study was conducted. From a large population of people with poor eyesight, 300 participants were selected at random. Half of the participants were randomly assigned to receive treatment X, and the other half did not receive treatment X. The resulting data showed that participants who received treatment X had significantly improved eyesight as compared to those who did not receive treatment X. Based on the design and results of the study, which of the following is an appropriate conclusion?

- A) Treatment X is likely to improve the eyesight of people who have poor eyesight.
- B) Treatment X improves eyesight better than all other available treatments.
- C) Treatment X will improve the eyesight of anyone who takes it.
- D) Treatment X will cause a substantial improvement in eyesight.

Near the end of a US cable news show, the host invited viewers to respond to a poll on the show's website that asked, "Do you support the new federal policy discussed during the show?" At the end of the show, the host reported that 28% responded "Yes," and 70% responded "No." Which of the following best explains why the results are unlikely to represent the sentiments of the population of the United States?

- A) The percentages do not add up to 100%, so any possible conclusions from the poll are invalid.
- B) Those who responded to the poll were not a random sample of the population of the United States.
- C) There were not 50% "Yes" responses and 50% "No" responses.
- D) The show did not allow viewers enough time to respond to the poll.

QUESTION 221



The weights, in pounds, for 15 horses in a stable were reported, and the mean, median, range, and standard deviation for the data were found. The horse with the lowest reported weight was found to actually weigh 10 pounds less than its reported weight. What value remains unchanged if the four values are reported using the corrected weight?

- A) Mean
- B) Median
- C) Range
- D) Standard deviation

## RATES AND RATIOS

QUESTION 223



Two units of length used in ancient Egypt were cubits and palms, where 1 cubit is equivalent to 7 palms. The Great Sphinx statue in Giza is approximately 140 cubits long. Which of the following best approximates the length, in palms, of the Great Sphinx statue?

- A) 0.05
- B) 20
- C) 140
- D) 980

QUESTION 224



$$\begin{aligned}1 \text{ decagram} &= 10 \text{ grams} \\1,000 \text{ milligrams} &= 1 \text{ gram}\end{aligned}$$

A hospital stores one type of medicine in 2-decagram containers. Based on the information given in the box above, how many 1-milligram doses are there in one 2-decagram container?

- A) 0.002
- B) 200
- C) 2,000
- D) 20,000

QUESTION 225



Horsepower and watts are units of measure of power. They are directly proportional such that 5 horsepower is equal to 3730 watts. How much power, in watts, is equal to 2 horsepower?

QUESTION 226



Biologists found a new species of pale shrimp at the world's deepest undersea vent, the Beebe Vent Field. The vent is 3.1 miles below the sea's surface. Approximately how many kilometers below the sea's surface is the vent? (1 kilometer  $\approx$  0.6214 miles)

- A) 2
- B) 3
- C) 4
- D) 5

## RATES AND RATIOS

QUESTION 227



The *pes*, a Roman measure of length, is approximately equal to 11.65 inches. It is also equivalent to 16 smaller Roman units called digits. Based on these relationships, 75 Roman digits is equivalent to how many feet, to the nearest hundredth? (12 inches = 1 foot)

QUESTION 228



To make a bakery's signature chocolate muffins, a baker needs 2.5 ounces of chocolate for each muffin. How many pounds of chocolate are needed to make 48 signature chocolate muffins? (1 pound = 16 ounces)

- A) 7.5
- B) 10
- C) 50.5
- D) 120

QUESTION 229



In the 1908 Olympic Games, the Olympic marathon was lengthened from 40 kilometers to approximately 42 kilometers. Of the following, which is closest to the increase in the distance of the Olympic marathon, in miles? (1 mile is approximately 1.6 kilometers.)

- A) 1.00
- B) 1.25
- C) 1.50
- D) 1.75

## RATES AND RATIOS

## QUESTION 230



If a 3-pound pizza is sliced in half and each half is sliced into thirds, what is the weight, in ounces, of each of the slices? (1 pound = 16 ounces)

- A) 4
- B) 6
- C) 8
- D) 16

## QUESTION 231



A local television station sells time slots for programs in 30-minute intervals. If the station operates 24 hours per day, every day of the week, what is the total number of 30-minute time slots the station can sell for Tuesday and Wednesday?

## QUESTION 232



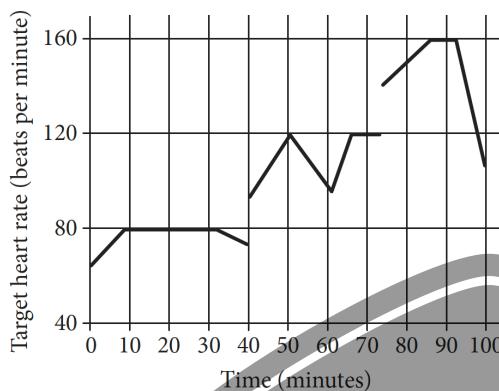
In 1854, during the California gold rush, each ounce of gold was worth \$20, and the largest known mass of gold found in California was worth \$62,400 in that year. What was the weight, in pounds, of this mass of gold? (16 ounces = 1 pound)

## RATES AND RATIOS

QUESTION 233



John runs at different speeds as part of his training program. The graph shows his target heart rate at different times during his workout. On which interval is the target heart rate strictly increasing then strictly decreasing?



- A) Between 0 and 30 minutes
- B) Between 40 and 60 minutes
- C) Between 50 and 65 minutes
- D) Between 70 and 90 minutes

QUESTION 234



Number of hours Tony plans to read the novel per day	SAT <sup>2</sup> 8
Number of parts in the novel	239
Number of chapters in the novel	239
Number of words Tony reads per minute	250
Number of pages in the novel	1,078
Number of words in the novel	349,168

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Tony is planning to read a novel. The table above shows information about the novel, Tony's reading speed, and the amount of time he plans to spend reading the novel each day. If Tony reads at the rates given in the table, which of the following is closest to the number of days it would take Tony to read the entire novel?

- A) 6
- B) 8
- C) 23
- D) 324

## RATES AND RATIOS

QUESTION 235

QUESTION 236



Annual Budgets for Different Programs in Kansas, 2007 to 2010

Program	Year			
	2007	2008	2009	2010
Agriculture/natural resources	373,904	358,708	485,807	488,106
Education	2,164,607	2,413,984	2,274,514	3,008,036
General government	14,347,325	12,554,845	10,392,107	14,716,155
Highways and transportation	1,468,482	1,665,636	1,539,480	1,773,893
Human resources	4,051,050	4,099,067	4,618,444	5,921,379
Public safety	263,463	398,326	355,935	464,233

The table above lists the annual budget, in thousands of dollars, for each of six different state programs in Kansas from 2007 to 2010.

Which of the following best approximates the average rate of change in the annual budget for agriculture/natural resources in Kansas from 2008 to 2010?

- A) \$50,000,000 per year
- B) \$65,000,000 per year
- C) \$75,000,000 per year
- D) \$130,000,000 per year

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Of the following, which program's ratio of its 2007 budget to its 2010 budget is closest to the human resources program's ratio of its 2007 budget to its 2010 budget?

- A) Agriculture/natural resources
- B) Education
- C) Highways and transportation
- D) Public safety

QUESTION 237




Wyatt can husk at least 12 dozen ears of corn per hour and at most 18 dozen ears of corn per hour. Based on this information, what is a possible amount of time, in hours, that it could take Wyatt to husk 72 dozen ears of corn?

## RATES AND RATIOS

QUESTION 238



A quality control manager at a factory selects 7 lightbulbs at random for inspection out of every 400 lightbulbs produced. At this rate, how many lightbulbs will be inspected if the factory produces 20,000 lightbulbs?

- A) 300
- B) 350
- C) 400
- D) 450

QUESTION 239



The distance traveled by Earth in one orbit around the Sun is about 580,000,000 miles. Earth makes one complete orbit around the Sun in one year. Of the following, which is closest to the average speed of Earth, in miles per hour, as it orbits the Sun?

- A) 66,000
- B) 93,000
- C) 210,000
- D) 420,000

QUESTION 240



Nate walks 25 meters in 13.7 seconds. If he walks at this same rate, which of the following is closest to the distance he will walk in 4 minutes?

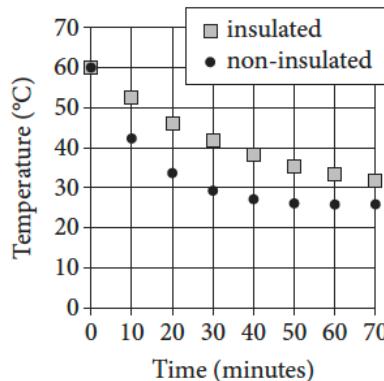
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- A) 150 meters
- B) 450 meters
- C) 700 meters
- D) 1,400 meters

A coastal geologist estimates that a certain country's beaches are eroding at a rate of 1.5 feet per year. According to the geologist's estimate, how long will it take, in years, for the country's beaches to erode by 21 feet?

## RATES AND RATIOS

QUESTION 242



Two samples of water of equal mass are heated to 60 degrees Celsius (°C). One sample is poured into an insulated container, and the other sample is poured into a non-insulated container. The samples are then left for 70 minutes to cool in a room having a temperature of 25°C. The graph above shows the temperature of each sample at 10-minute intervals. Which of the following statements correctly compares the average rates at which the temperatures of the two samples change?

- SAT - ACT - EST
- A) In every 10-minute interval, the magnitude of the rate of change of temperature of the insulated sample is greater than that of the non-insulated sample.
  - B) In every 10-minute interval, the magnitude of the rate of change of temperature of the non-insulated sample is greater than that of the insulated sample.
  - C) In the intervals from 0 to 10 minutes and from 10 to 20 minutes, the rates of change of temperature of the insulated sample are of greater magnitude, whereas in the intervals from 40 to 50 minutes and from 50 to 60 minutes, the rates of change of temperature of the non-insulated sample are of greater magnitude.
  - D) In the intervals from 0 to 10 minutes and from 10 to 20 minutes, the rates of change of temperature of the non-insulated sample are of greater magnitude, whereas in the intervals from 40 to 50 minutes and from 50 to 60 minutes, the rates of change of temperature of the insulated sample are of greater magnitude.

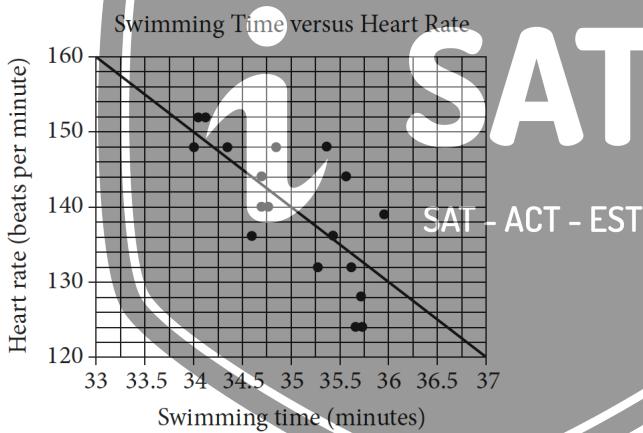
## RATES AND RATIOS

QUESTION 243



Graphene, which is used in the manufacture of integrated circuits, is so thin that a sheet weighing one ounce can cover up to 7 football fields. If a football field has an area of approximately  $1\frac{1}{3}$  acres, about how many acres could 48 ounces of graphene cover?

- A) 250
- B) 350
- C) 450
- D) 1,350



Michael swam 2,000 yards on each of eighteen days. The scatterplot above shows his swim time for and corresponding heart rate after each swim. The line of best fit for the data is also shown. For the swim that took 34 minutes, Michael's actual heart rate was about how many beats per minutes less than the rate predicted by the line of best fit?

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

QUESTION 244



## RATES AND RATIOS

QUESTION 245



A partially filled pool contains 600 gallons of water. A hose is turned on, and water flows into the pool at the rate of 8 gallons per minute. How many gallons of water will be in the pool after 70 minutes?

QUESTION 246  
QUESTION 247

If shoppers enter a store at an average rate of  $r$  shoppers per minute and each stays in the store for an average time of  $T$  minutes, the average number of shoppers in the store,  $N$ , at any one time is given by the formula  $N = rT$ . This relationship is known as Little's law.

The owner of the Good Deals Store estimates that during business hours, an average of 3 shoppers per minute enter the store and that each of them stays an average of 15 minutes. The store owner uses Little's law to estimate that there are 45 shoppers in the store at any time.

Little's law can be applied to any part of the store, such as a particular department or the checkout lines. The store owner determines that, during business hours, approximately 84 shoppers per hour make a purchase and each of these shoppers spends an average of 5 minutes in the checkout line. At any time during business hours, about how many shoppers, on average, are waiting in the checkout line to make a purchase at the Good Deals Store?

The owner of the Good Deals Store opens a new store across town. For the new store, the owner estimates that, during business hours, an average of 90 shoppers per hour enter the store and each of them stays an average of 12 minutes. The average number of shoppers in the new store at any time is what percent less than the average number of shoppers in the original store at any time? (Note: Ignore the percent symbol when entering your answer. For example, if the answer is 42.1%, enter 42.1)

## RATES AND RATIOS

QUESTION 248



$$q = \frac{1}{2} n v^2$$

The dynamic pressure  $q$  generated by a fluid moving with velocity  $v$  can be found using the formula above, where  $n$  is the constant density of the fluid. An aeronautical engineer uses the formula to find the dynamic pressure of a fluid moving with velocity  $v$  and the same fluid moving with velocity  $1.5v$ . What is the ratio of the dynamic pressure of the faster fluid to the dynamic pressure of the slower fluid?

QUESTION 249



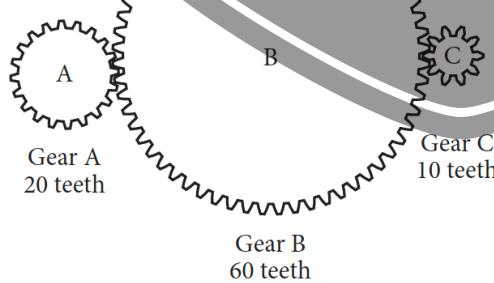
The total area of a coastal city is 92.1 square miles, of which 11.3 square miles is water. If the city had a population of 621,000 people in the year 2010, which of the following is closest to the population density, in people per square mile of land area, of the city at that time?

- A) 6,740
- B) 7,690
- C) 55,000
- D) 76,000

QUESTION 250



A gear ratio  $r:s$  is the ratio of the number of teeth of two connected gears. The ratio of the number of revolutions per minute (rpm) of two gear wheels is  $s:r$ . In the diagram below, Gear A is turned by a motor. The turning of Gear A causes Gears B and C to turn as well.



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If Gear A is rotated by the motor at a rate of 100 rpm, what is the number of revolutions per minute for Gear C?

- A) 50
- B) 110
- C) 200
- D) 1,000

## RATES AND RATIOS

QUESTION 251



A certain package requires 3 centimeters of tape to be closed securely. What is the maximum number of packages of this type that can be secured with 6 meters of tape? (1 meter = 100 cm)

- A) 100
- B) 150
- C) 200
- D) 300

QUESTION 252



If 50 one-cent coins were stacked on top of each other in a column, the column would be approximately  $3\frac{7}{8}$  inches tall. At this rate, which of the following is closest to the number of one-cent coins it would take to make an 8-inch-tall column?

- A) 75
- B) 100
- C) 200
- D) 390

QUESTION 253



One pound of grapes costs \$2. At this rate, how many dollars will  $c$  pounds of grapes cost?

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- A)  $2c$
- B)  $2 + c$
- C)  $\frac{2}{c}$
- D)  $\frac{c}{2}$

QUESTION 254



A company that makes wildlife videos purchases camera equipment for \$32,400. The equipment depreciates in value at a constant rate for 12 years, after which it is considered to have no monetary value. How much is the camera equipment worth 4 years after it is purchased?

- A) \$10,800
- B) \$16,200
- C) \$21,600
- D) \$29,700

## RATES AND RATIOS

QUESTION 255



In a random sample of 200 cars of a particular model, 3 have a manufacturing defect. At this rate, how many of 10,000 cars of the same model will have a manufacturing defect?

- A) 150
- B) 200
- C) 250
- D) 300

QUESTION 256



There are two atoms of hydrogen and one atom of oxygen in one molecule of water. How many atoms of hydrogen are there in 51 molecules of water?

QUESTION 257



On April 18, 1775, Paul Revere set off on his midnight ride from Charlestown to Lexington. If he had ridden straight to Lexington without stopping, he would have traveled 11 miles in 26 minutes. In such a ride, what would the average speed of his horse have been, to the nearest tenth of a mile per hour?

QUESTION 258



Plant A is currently 20 centimeters tall, and Plant B is currently 12 centimeters tall. The ratio of the heights of Plant A to Plant B is equal to the ratio of the heights of Plant C to Plant D. If Plant C is 54 centimeters tall, what is the height of Plant D, in centimeters?

- A) 32.4
- B) 44.0
- C) 62.0
- D) 90.0

## RATES AND RATIOS

QUESTION 259

The peregrine falcon can reach speeds of up to 200 miles per hour while diving to catch prey, making it the fastest animal on the planet when in a dive.



QUESTION 260

What is a peregrine falcon's maximum speed while diving to catch prey, in feet per second? (Round your answer to the nearest whole number.  
1 mile = 5280 feet)

If a peregrine falcon dove at its maximum speed for half a mile to catch prey, how many seconds would the dive take? (Round your answer to the nearest second.)


QUESTION 261



Alan drives an average of 100 miles each week. His car can travel an average of 25 miles per gallon of gasoline. Alan would like to reduce his weekly expenditure on gasoline by \$5. Assuming gasoline costs \$4 per gallon, which equation can Alan use to determine how many fewer average miles,  $m$ , he should drive each week?

A)  $\frac{25}{4}m = 95$

B)  $\frac{25}{4}m = 5$

C)  $\frac{4}{25}m = 95$

D)  $\frac{4}{25}m = 5$

--

## PERCENTAGES AND PROPORTIONS

QUESTION 262



At Lincoln High School, approximately 7 percent of enrolled juniors and 5 percent of enrolled seniors were inducted into the National Honor Society last year. If there were 562 juniors and 602 seniors enrolled at Lincoln High School last year, which of the following is closest to the total number of juniors and seniors at Lincoln High School last year who were inducted into the National Honor Society?

- A) 140  
B) 69  
C) 39  
D) 30

QUESTION 263



Movies with Greatest Ticket Sales in 2012

MPAA rating	Type of movie				
	Action	Animated	Comedy	Drama	Total
PG	2	7	0	2	11
PG-13	10	0	4	8	22
R	6	0	5	6	17
Total	18	7	9	16	50

The table above represents the 50 movies that had the greatest ticket sales in 2012, categorized by movie type and Motion Picture Association of America (MPAA) rating. What proportion of the movies are comedies with a PG-13 rating?

- A)  $\frac{2}{25}$   
B)  $\frac{9}{50}$   
C)  $\frac{2}{11}$   
D)  $\frac{11}{25}$

QUESTION 264



In a study of bat migration habits, 240 male bats and 160 female bats have been tagged. If 100 more female bats are tagged, how many more male bats must be tagged so that  $\frac{3}{5}$  of the total number of bats in the study are male?

## PERCENTAGES AND PROPORTIONS

QUESTION 265



The painting *The Starry Night* by Vincent van Gogh is rectangular in shape with height 29 inches and width 36.25 inches. If a reproduction was made where each dimension is  $\frac{1}{3}$  the corresponding original dimension, what is the height of the reproduction, in inches?

QUESTION 266



The weight of an object on Venus is approximately  $\frac{9}{10}$  of its weight on Earth. The weight of an object on Jupiter is approximately  $\frac{23}{10}$  of its weight on Earth. If an object weighs 100 pounds on Earth, approximately how many more pounds does it weigh on Jupiter than it weighs on Venus?

- A) 90
- B) 111
- C) 140
- D) 230

QUESTION 267



In State X, Mr. Camp's eighth-grade class consisting of 26 students was surveyed and 34.6 percent of the students reported that they had at least two siblings. The average eighth-grade class size in the state is 26. If the students in Mr. Camp's class are representative of students in the state's eighth-grade classes and there are 1,800 eighth-grade classes in the state, which of the following best estimates the number of eighth-grade students in the state who have fewer than two siblings?

- A) 16,200
- B) 23,400
- C) 30,600
- D) 46,800

QUESTION 268



How many liters of a 25% saline solution must be added to 3 liters of a 10% saline solution to obtain a 15% saline solution?

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## PERCENTAGES AND PROPORTIONS

QUESTION 269



Where Do People Get Most of Their Medical Information?

Source	Percent of those surveyed
Doctor	63%
Internet	13%
Magazines/brochures	9%
Pharmacy	6%
Television	2%
Other/none of the above	7%

The table above shows a summary of 1,200 responses to a survey question. Based on the table, how many of those surveyed get most of their medical information from either a doctor or the Internet?

- A) 865
- B) 887
- C) 912
- D) 926

QUESTION 270



Ice Cream and Topping Selections

Topping	Flavor	
	Vanilla	Chocolate
Hot fudge	8	6
Caramel	5	6

The table above shows the flavors of ice cream and the toppings chosen by the people at a party. Each person chose one flavor of ice cream and one topping. Of the people who chose vanilla ice cream, what fraction chose hot fudge as a topping?

- A)  $\frac{8}{25}$
- B)  $\frac{5}{13}$
- C)  $\frac{13}{25}$
- D)  $\frac{8}{13}$

## PERCENTAGES AND PROPORTIONS

QUESTION 271



A customer's monthly water bill was \$75.74. Due to a rate increase, her monthly bill is now \$79.86. To the nearest tenth of a percent, by what percent did the amount of the customer's water bill increase?

- A) 4.1%
- B) 5.1%
- C) 5.2%
- D) 5.4%

QUESTION 272



A school district is forming a committee to discuss plans for the construction of a new high school. Of those invited to join the committee, 15% are parents of students, 45% are teachers from the current high school, 25% are school and district administrators, and the remaining 6 individuals are students. How many more teachers were invited to join the committee than school and district administrators?

QUESTION 273



Feeding Information for Boarded Pets

	Fed only dry food	Fed both wet and dry food	Total
Cats	5	11	16
Dogs	2	23	25
Total	7	34	41

The table above shows the kinds of foods that are fed to the cats and dogs currently boarded at a pet care facility. What fraction of the dogs are fed only dry food?

- A)  $\frac{2}{41}$
- B)  $\frac{2}{25}$
- C)  $\frac{7}{41}$
- D)  $\frac{2}{7}$

QUESTION 274



Lani spent 15% of her 8-hour workday in meetings. How many minutes of her workday did she spend in meetings?

- A) 1.2
- B) 15
- C) 48
- D) 72

## PERCENTAGES AND PROPORTIONS

QUESTION 275



A customer paid \$53.00 for a jacket after a 6 percent sales tax was added. What was the price of the jacket before the sales tax was added?

- A) \$47.60
- B) \$50.00
- C) \$52.60
- D) \$52.84

QUESTION 276



Gisela would owe \$15,500 in taxes each year if she were not eligible for any tax deductions. This year, Gisela is eligible for tax deductions that reduce the amount of taxes she owes by \$2,325.00. If these tax deductions reduce the taxes Gisela owes this year by  $d\%$ , what is the value of  $d$ ?

QUESTION 277



Year	Subscriptions sold
2012	5,600
2013	5,880

The manager of an online news service received the report above on the number of subscriptions sold by the service. The manager estimated that the percent increase from 2012 to 2013 would be double the percent increase from 2013 to 2014. How many subscriptions did the manager expect would be sold in 2014?

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- A) 6,020
- B) 6,027
- C) 6,440
- D) 6,468

QUESTION 278



$$0.10x + 0.20y = 0.18(x + y)$$

Clayton will mix  $x$  milliliters of a 10% by mass saline solution with  $y$  milliliters of a 20% by mass saline solution in order to create an 18% by mass saline solution. The equation above represents this situation. If Clayton uses 100 milliliters of the 20% by mass saline solution, how many milliliters of the 10% by mass saline solution must he use?

- A) 5
- B) 25
- C) 50
- D) 100

## PERCENTAGES AND PROPORTIONS

QUESTION 279



A book was on sale for 40% off its original price. If the sale price of the book was \$18.00, what was the original price of the book? (Assume there is no sales tax.)

- A) \$7.20
- B) \$10.80
- C) \$30.00
- D) \$45.00

QUESTION 280



Number of Adults Contracting Colds

	Cold	No cold	Total
Vitamin C	21	129	150
Sugar pill	33	117	150
Total	54	246	300

The table shows the results of a research study that investigated the therapeutic value of vitamin C in preventing colds. A random sample of 300 adults received either a vitamin C pill or a sugar pill each day during a 2-week period, and the adults reported whether they contracted a cold during that time period. What proportion of adults who received a sugar pill reported contracting a cold?

- A)  $\frac{11}{18}$
- B)  $\frac{11}{50}$
- C)  $\frac{9}{50}$
- D)  $\frac{11}{100}$

QUESTION 281



In 2015 the populations of City X and City Y were equal. From 2010 to 2015, the population of City X increased by 20% and the population of City Y decreased by 10%. If the population of City X was 120,000 in 2010, what was the population of City Y in 2010?

- A) 60,000
- B) 90,000
- C) 160,000
- D) 240,000

## PERCENTAGES AND PROPORTIONS

QUESTION 282



Juan purchased an antique that had a value of \$200 at the time of purchase. Each year, the value of the antique is estimated to increase 10% over its value the previous year. The estimated value of the antique, in dollars, 2 years after purchase can be represented by the expression  $200a$ , where  $a$  is a constant. What is the value of  $a$ ?

QUESTION 283

QUESTION 284



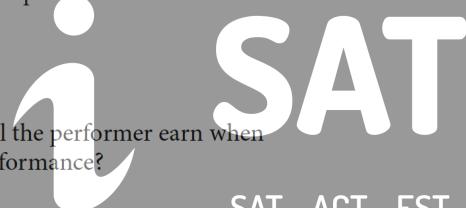
The amount of money a performer earns is directly proportional to the number of people attending the performance. The performer earns \$120 at a performance where 8 people attend.

How much money will the performer earn when 20 people attend a performance?

- A) \$960
- B) \$480
- C) \$300
- D) \$240

The performer uses 43% of the money earned to pay the costs involved in putting on each performance. The rest of the money earned is the performer's profit. What is the profit the performer makes at a performance where 8 people attend?

- A) \$51.60
- B) \$57.00
- C) \$68.40
- D) \$77.00



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## PERCENTAGES AND PROPORTIONS

QUESTION 285



Nick surveyed a random sample of the freshman class of his high school to determine whether the Fall Festival should be held in October or November. Of the 90 students surveyed, 25.6% preferred October. Based on this information, about how many students in the entire 225-person class would be expected to prefer having the Fall Festival in October?

- A) 50
- B) 60
- C) 75
- D) 80

QUESTION 286



Washington High School randomly selected freshman, sophomore, junior, and senior students

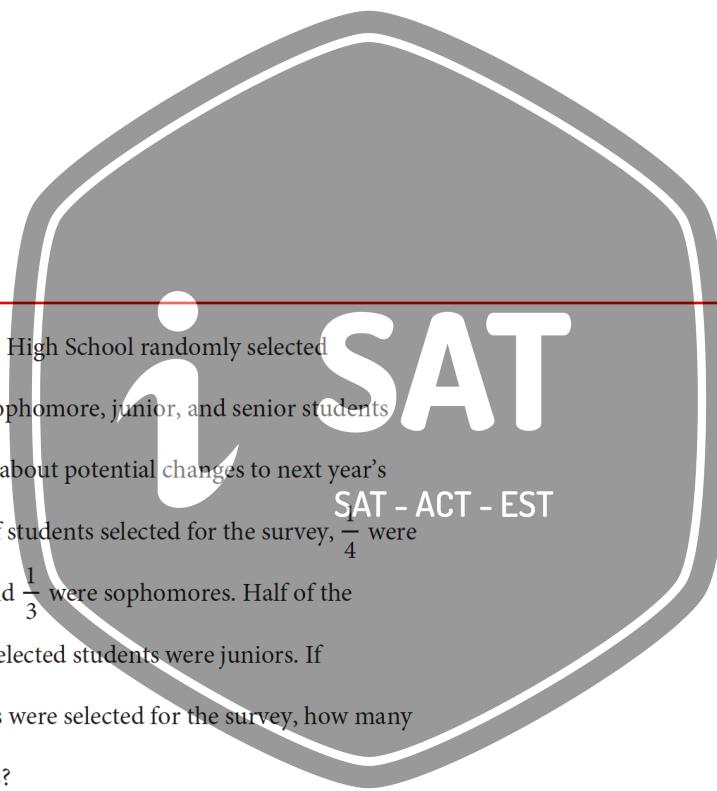
for a survey about potential changes to next year's  
schedule. Of students selected for the survey,  $\frac{1}{4}$  were

freshmen and  $\frac{1}{3}$  were sophomores. Half of the

remaining selected students were juniors. If

336 students were selected for the survey, how many  
were seniors?

- A) 240
- B) 140
- C) 120
- D) 70



## PROBABILITIES

QUESTION 287



Dreams Recalled during One Week

	None	1 to 4	5 or more	Total
Group X	15	28	57	100
Group Y	21	11	68	100
Total	36	39	125	200

The data in the table above were produced by a sleep researcher studying the number of dreams people recall when asked to record their dreams for one week. Group X consisted of 100 people who observed early bedtimes, and Group Y consisted of 100 people who observed later bedtimes. If a person is chosen at random from those who recalled at least 1 dream, what is the probability that the person belonged to Group Y?

- A)  $\frac{68}{100}$   
 B)  $\frac{79}{100}$   
 C)  $\frac{79}{164}$   
 D)  $\frac{164}{200}$

QUESTION 288



Results on the Bar Exam of Law School Graduates

	Passed bar exam	Did not pass bar exam
Took review course	18	82
Did not take review course	7	93

The table above summarizes the results of 200 law school graduates who took the bar exam. If one of the surveyed graduates who passed the bar exam is chosen at random for an interview, what is the probability that the person chosen did not take the review course?

- A)  $\frac{18}{25}$   
 B)  $\frac{7}{25}$   
 C)  $\frac{25}{200}$   
 D)  $\frac{7}{200}$

## 2.4

## PART II: PROBLEM SOLVING AND DATA ANALYSIS

## PROBABILITIES

QUESTION 289



Gender	Age		Total
	Under 40	40 or older	
Male	12	2	14
Female	8	3	11
Total	20	5	25

The table above shows the distribution of age and gender for 25 people who entered a contest. If the contest winner will be selected at random, what is the probability that the winner will be either a female under age 40 or a male age 40 or older?

- A)  $\frac{4}{25}$   
 B)  $\frac{10}{25}$   
 C)  $\frac{11}{25}$   
 D)  $\frac{16}{25}$

QUESTION 290



Gender	Handedness	
	Left	Right
Female		
Male		
Total	18	122

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The incomplete table above summarizes the number of left-handed students and right-handed students by gender for the eighth-grade students at Keisel Middle School. There are 5 times as many right-handed female students as there are left-handed female students, and there are 9 times as many right-handed male students as there are left-handed male students. If there is a total of 18 left-handed students and 122 right-handed students in the school, which of the following is closest to the probability that a right-handed student selected at random is female? (Note: Assume that none of the eighth-grade students are both right-handed and left-handed.)

- A) 0.410  
 B) 0.357  
 C) 0.333  
 D) 0.250

## 2.4

## PART II: PROBLEM SOLVING AND DATA ANALYSIS

## PROBABILITIES

QUESTION 291

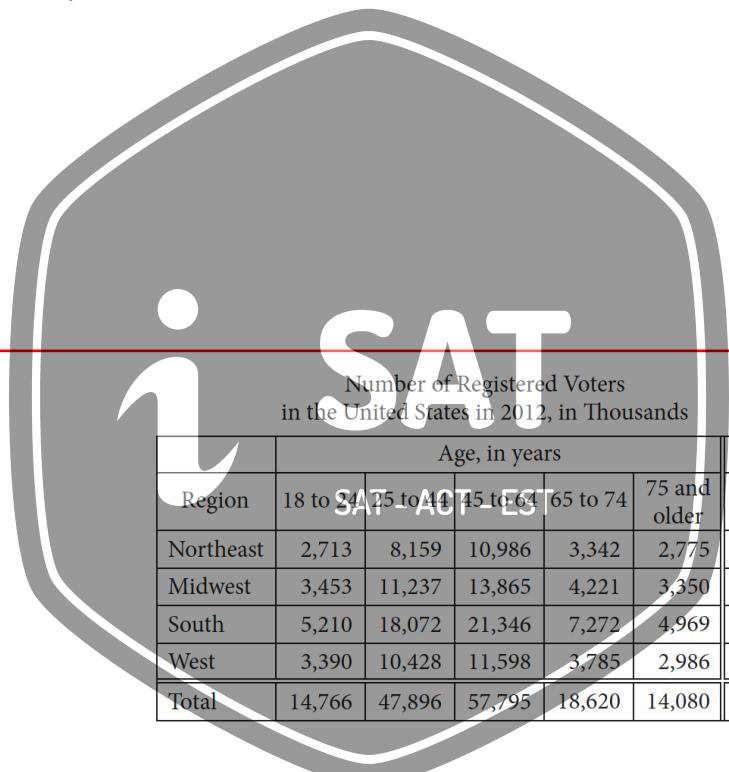


Type of surgeon	Major professional activity		Total
	Teaching	Research	
General	258	156	414
Orthopedic	119	74	193
Total	377	230	607

In a survey, 607 general surgeons and orthopedic surgeons indicated their major professional activity. The results are summarized in the table above. If one of the surgeons is selected at random, which of the following is closest to the probability that the selected surgeon is an orthopedic surgeon whose indicated professional activity is research?

- A) 0.122
- B) 0.196
- C) 0.318
- D) 0.379

QUESTION 292



The table above shows the number of registered voters in 2012, in thousands, in four geographic regions and five age groups. Based on the table, if a registered voter who was 18 to 44 years old in 2012 is chosen at random, which of the following is closest to the probability that the registered voter was from the Midwest region?

- A) 0.10
- B) 0.25
- C) 0.40
- D) 0.75

2.4

## PART II: PROBLEM SOLVING AND DATA ANALYSIS

## PROBABILITIES

QUESTION 293



		Blood type			
Rhesus factor		A	B	AB	O
+	33	9	3	37	
-	7	2	1		x

Human blood can be classified into four common blood types—A, B, AB, and O. It is also characterized by the presence (+) or absence (−) of the rhesus factor. The table above shows the distribution of blood type and rhesus factor for a group of people. If one of these people who is rhesus negative (−) is chosen at random, the probability that the person has blood type B is  $\frac{1}{9}$ . What is the value of  $x$ ?

QUESTION 294



Survey Results	
Answer	Percent
Never	31.3%
Rarely	24.3%
Often	13.5%
Always	30.9%

SAT - ACT - EST

The table above shows the results of a survey in which tablet users were asked how often they would watch video advertisements in order to access streaming content for free. Based on the table, which of the following is closest to the probability that a tablet user answered “Always,” given that the tablet user did not answer “Never”?

- A) 0.31
- B) 0.38
- C) 0.45
- D) 0.69

## PROBABILITIES

QUESTION 295



Customer Purchases at a Gas Station

	Beverage purchased	Beverage not purchased	Total
Gasoline purchased	60	25	85
Gasoline not purchased	35	15	50
Total	95	40	135

On Tuesday, a local gas station had 135 customers. The table above summarizes whether or not the customers on Tuesday purchased gasoline, a beverage, both, or neither. Based on the data in the table, what is the probability that a gas station customer selected at random on that day did not purchase gasoline?

- A)  $\frac{15}{50}$
- B)  $\frac{15}{40}$
- C)  $\frac{35}{50}$
- D)  $\frac{50}{135}$

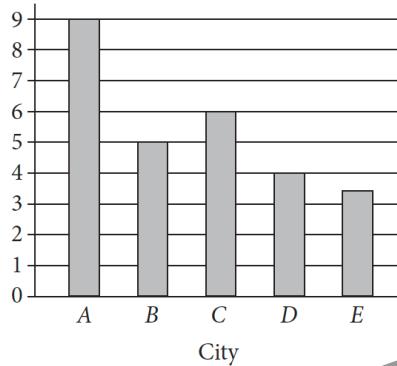


## TABLES AND GRAPHS

QUESTION 296



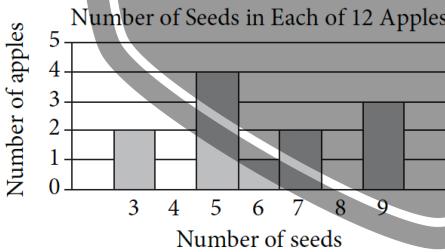
Rooftop Solar Panel Installations in Five Cities



The number of rooftops with solar panel installations in 5 cities is shown in the graph above. If the total number of installations is 27,500, what is an appropriate label for the vertical axis of the graph?

- A) Number of installations (in tens)
- B) Number of installations (in hundreds)
- C) Number of installations (in thousands)
- D) Number of installations (in tens of thousands)

QUESTION 297



Based on the histogram above, of the following, which is closest to the average (arithmetic mean) number of seeds per apple?

- A) 4
- B) 5
- C) 6
- D) 7

## TABLES AND GRAPHS

QUESTION 298



Gender		Course			Total
		Algebra I	Geometry	Algebra II	
Female		35	53	62	150
Male		44	59	57	160
Total		79	112	119	310

A group of tenth-grade students responded to a survey that asked which math course they were currently enrolled in. The survey data were broken down as shown in the table above. Which of the following categories accounts for approximately 19 percent of all the survey respondents?

- A) Females taking Geometry
- B) Females taking Algebra II
- C) Males taking Geometry
- D) Males taking Algebra I

QUESTION 299



A square field measures 10 meters by 10 meters. Ten students each mark off a randomly selected region of the field; each region is square and has side lengths of 1 meter, and no two regions overlap. The students count the earthworms contained in the soil to a depth of 5 centimeters beneath the ground's surface in each region. The results are shown in the table below.

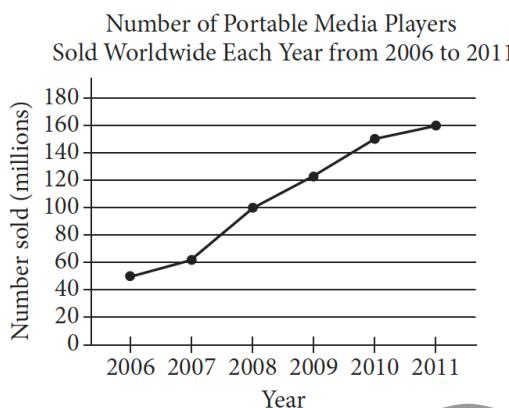
Region	Number of earthworms	Region	Number of earthworms
A	107	F	141
B	147	G	150
C	146	H	154
D	135	I	176
E	149	J	166

Which of the following is a reasonable approximation of the number of earthworms to a depth of 5 centimeters beneath the ground's surface in the entire field?

- A) 150
- B) 1,500
- C) 15,000
- D) 150,000

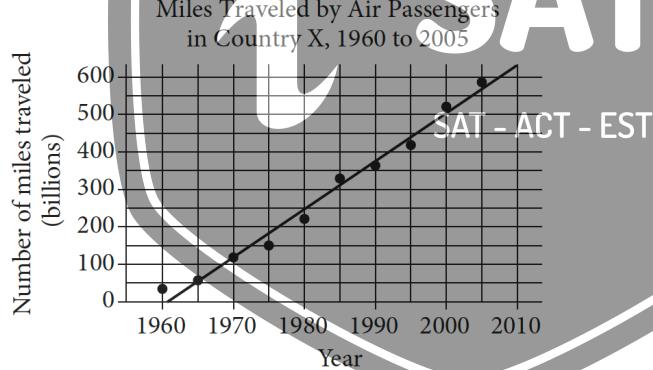
## TABLES AND GRAPHS

QUESTION 300



According to the line graph above, the number of portable media players sold in 2008 is what fraction of the number sold in 2011?

QUESTION 301

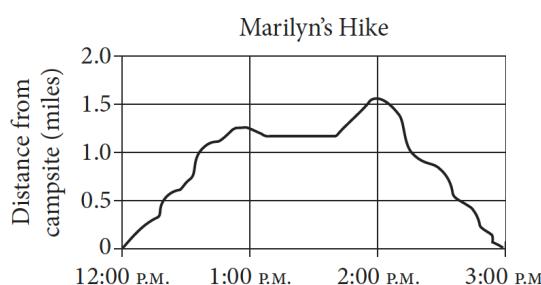


According to the line of best fit in the scatterplot above, which of the following best approximates the year in which the number of miles traveled by air passengers in Country X was estimated to be 550 billion?

- A) 1997
- B) 2000
- C) 2003
- D) 2008

## TABLES AND GRAPHS

QUESTION 302



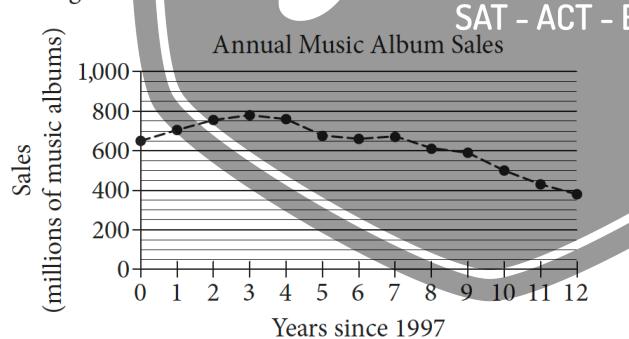
The graph above shows Marilyn’s distance from her campsite during a 3-hour hike. She stopped for 30 minutes during her hike to have lunch. Based on the graph, which of the following is closest to the time she finished lunch and continued her hike?

- A) 12:40 P.M.
- B) 1:10 P.M.
- C) 1:40 P.M.
- D) 2:00 P.M.

QUESTION 303



The graph below shows the total number of music album sales, in millions, each year from 1997 through 2009.



Based on the graph, which of the following best describes the general trend in music album sales from 1997 through 2009?

- A) Sales generally increased each year since 1997.
- B) Sales generally decreased each year since 1997.
- C) Sales increased until 2000 and then generally decreased.
- D) Sales generally remained steady from 1997 through 2009.

## TABLES AND GRAPHS

QUESTION 304

QUESTION 305



Planet	Acceleration due to gravity $\left(\frac{\text{m}}{\text{sec}^2}\right)$
Mercury	3.6
Venus	8.9
Earth	9.8
Mars	3.8
Jupiter	26.0
Saturn	11.1
Uranus	10.7
Neptune	14.1

The chart above shows approximations of the acceleration due to gravity in meters per second squared  $\left(\frac{\text{m}}{\text{sec}^2}\right)$  for the eight planets in our solar system. The weight of an object on a given planet can be found by using the formula  $W = mg$ , where  $W$  is the weight of the object measured in newtons,  $m$  is the mass of the object measured in kilograms, and  $g$  is the acceleration due to gravity on the planet measured in  $\frac{\text{m}}{\text{sec}^2}$ .

What is the weight, in newtons, of an object on Mercury with a mass of 90 kilograms?

- A) 25
- B) 86
- C) 101
- D) 324

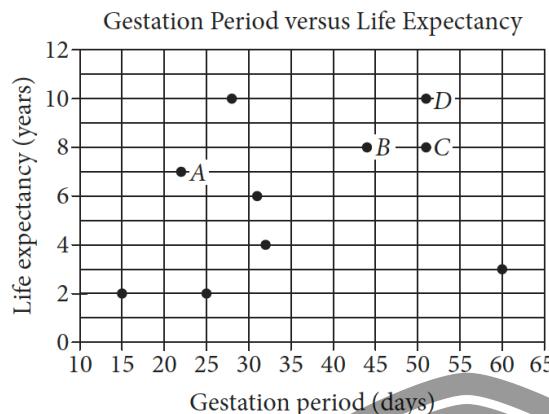
An object on Earth has a weight of 150 newtons. On which planet would the same object have an approximate weight of 170 newtons?

- A) Venus
- B) Saturn
- C) Uranus
- D) Neptune

## TABLES AND GRAPHS

QUESTION 306

QUESTION 307



A curator at a wildlife society created the scatterplot above to examine the relationship between the gestation period and life expectancy of 10 species of animals.

What is the life expectancy, in years, of the animal that has the longest gestation period?

- A) 3
- B) 4
- C) 8
- D) 10

Of the labeled points, which represents the animal for which the ratio of life expectancy to gestation period is greatest?

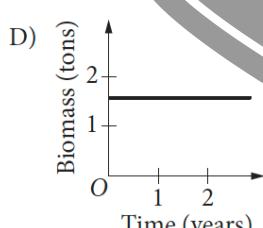
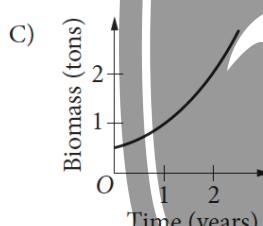
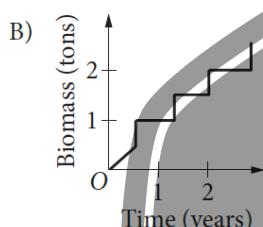
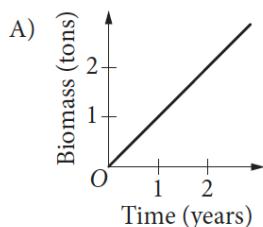
- A) A
- B) B
- C) C
- D) D


## TABLES AND GRAPHS

QUESTION 308



The mass of living organisms in a lake is defined to be the biomass of the lake. If the biomass in a lake doubles each year, which of the following graphs could model the biomass in the lake as a function of time? (Note: In each graph below, O represents  $(0, 0)$ .)

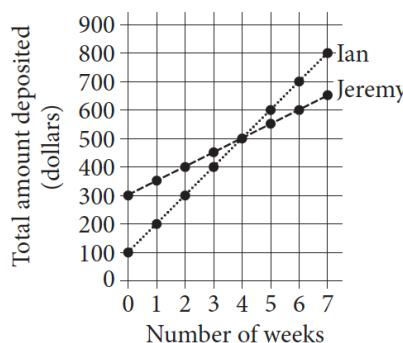


i SAT

SAT - ACT - EST

## TABLES AND GRAPHS

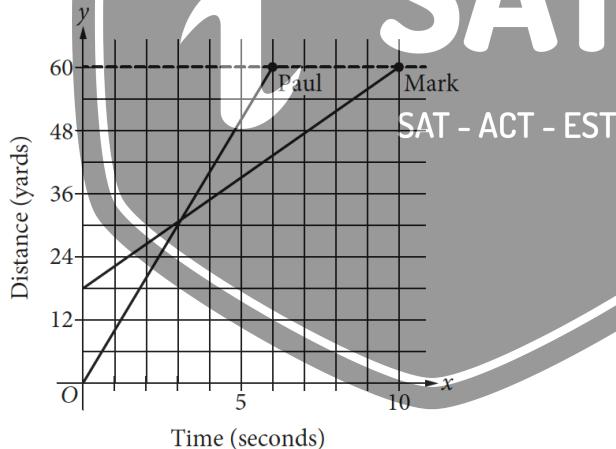
QUESTION 309



The two graphs above show the total amounts of money that Ian and Jeremy each have deposited into their savings accounts for the first seven weeks after opening their accounts. After they made their initial deposits, how much more did Ian deposit each week than Jeremy?

- A) \$200  
 B) \$100  
 C) \$50  
 D) \$25

QUESTION 310



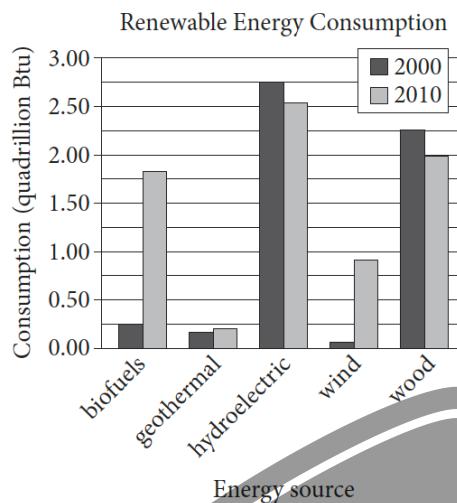
The graph above shows the positions of Paul and Mark during a race. Paul and Mark each ran at a constant rate, and Mark was given a head start to shorten the distance he needed to run. Paul finished the race in 6 seconds, and Mark finished the race in 10 seconds. According to the graph, Mark was given a head start of how many yards?

- A) 3  
 B) 12  
 C) 18  
 D) 24

2.5

## PART II: PROBLEM SOLVING AND DATA ANALYSIS

## TABLES AND GRAPHS

QUESTION 311  
QUESTION 312

The bar graph above shows renewable energy consumption in quadrillions of British thermal units (Btu) in the United States, by energy source, for several energy sources in the years 2000 and 2010.

In a scatterplot of this data, where renewable energy consumption in the year 2000 is plotted along the  $x$ -axis and renewable energy consumption in the year 2010 is plotted along the  $y$ -axis for each of the given energy sources, how many data points would be above the line  $y = x$ ?

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

Of the following, which best approximates the percent decrease in consumption of wood power in the United States from 2000 to 2010?

- A) 6%
- B) 11%
- C) 21%
- D) 26%

2.5

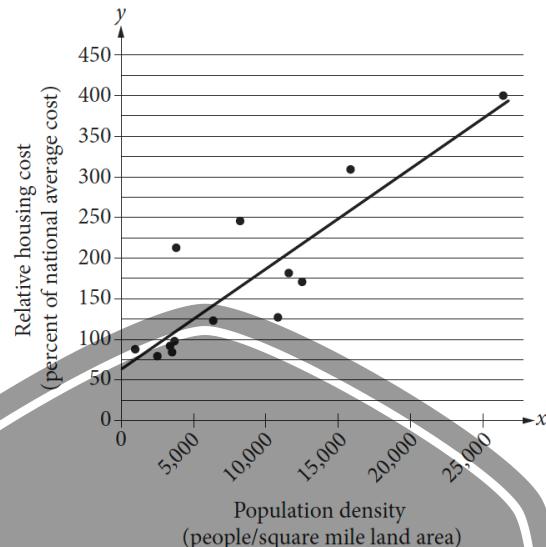
## PART II: PROBLEM SOLVING AND DATA ANALYSIS

## TABLES AND GRAPHS

QUESTION 313



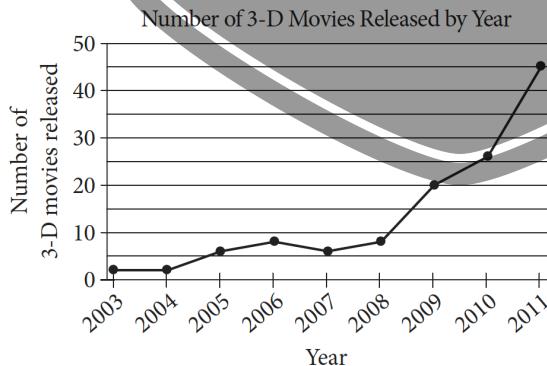
The relative housing cost for a US city is defined to be the ratio  $\frac{\text{average housing cost for the city}}{\text{national average housing cost}}$ , expressed as a percent.



The scatterplot above shows the relative housing cost and the population density for several large US cities in the year 2005. The line of best fit is also shown and has equation  $y = 0.0125x + 61$ . Which of the following best explains how the number 61 in the equation relates to the scatterplot?

- A) In 2005, the lowest housing cost in the United States was about \$61 per month.
- B) In 2005, the lowest housing cost in the United States was about 61% of the highest housing cost.
- C) In 2005, even in cities with low population densities, housing costs were never below 61% of the national average.
- D) In 2005, even in cities with low population densities, housing costs were likely at least 61% of the national average.

QUESTION 314



According to the line graph above, between which two consecutive years was there the greatest change in the number of 3-D movies released?

- A) 2003–2004
- B) 2008–2009
- C) 2009–2010
- D) 2010–2011

## TABLES AND GRAPHS

QUESTION 315

QUESTION 316

QUESTION 317

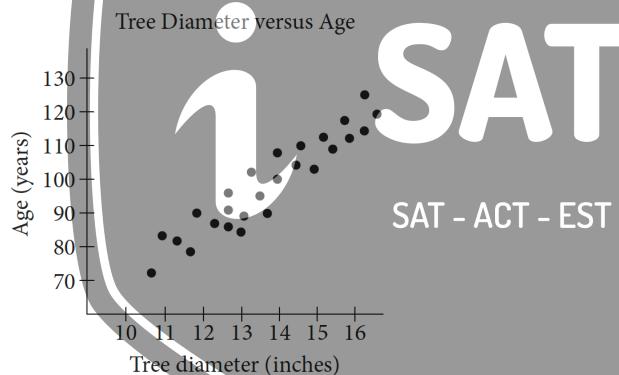


Species of tree	Growth factor
Red maple	4.5
River birch	3.5
Cottonwood	2.0
Black walnut	4.5
White birch	5.0
American elm	4.0
Pin oak	3.0
Shagbark hickory	7.5

One method of calculating the approximate age, in years, of a tree of a particular species is to multiply the diameter of the tree, in inches, by a constant called the growth factor for that species. The table above gives the growth factors for eight species of trees.

According to the information in the table, what is the approximate age of an American elm tree with a diameter of 12 inches?

- A) 24 years
- B) 36 years
- C) 40 years
- D) 48 years



The scatterplot above gives the tree diameter plotted against age for 26 trees of a single species. The growth factor of this species is closest to that of which of the following species of tree?

- A) Red maple
- B) Cottonwood
- C) White birch
- D) Shagbark hickory

If a white birch tree and a pin oak tree each now have a diameter of 1 foot, which of the following will be closest to the difference, in inches, of their diameters 10 years from now? (1 foot = 12 inches)

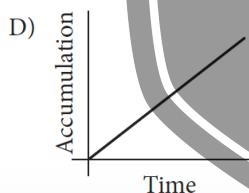
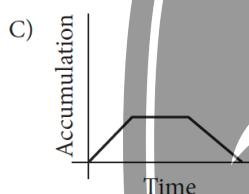
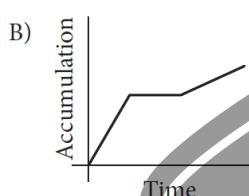
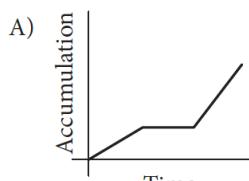
- A) 1.0
- B) 1.2
- C) 1.3
- D) 1.4

## TABLES AND GRAPHS

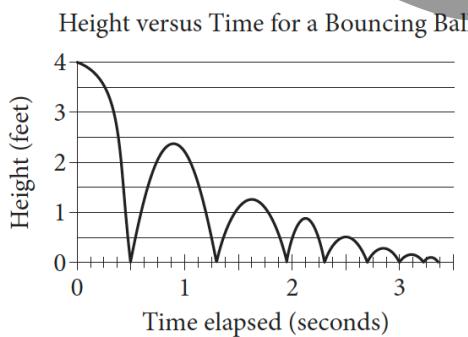
QUESTION 318



Snow fell and then stopped for a time. When the snow began to fall again, it fell at a faster rate than it had initially. Assuming that none of the snow melted during the time indicated, which of the following graphs could model the total accumulation of snow versus time?



QUESTION 319



As part of an experiment, a ball was dropped and allowed to bounce repeatedly off the ground until it came to rest. The graph above represents the relationship between the time elapsed after the ball was dropped and the height of the ball above the ground. After it was dropped, how many times was the ball at a height of 2 feet?

- A) One
- B) Two
- C) Three
- D) Four

## TABLES AND GRAPHS

QUESTION 320

QUESTION 321



Townsend Realty Group Investments		
Property address	Purchase price (dollars)	Monthly rental price (dollars)
Clearwater Lane	128,000	950
Driftwood Drive	176,000	1,310
Edgemont Street	70,000	515
Glenview Street	140,000	1,040
Hamilton Circle	450,000	3,365

The Townsend Realty Group invested in the five different properties listed in the table above. The table shows the amount, in dollars, the company paid for each property and the corresponding monthly rental price, in dollars, the company charges for the property at each of the five locations.

The relationship between the monthly rental price  $r$ , in dollars, and the property's purchase price  $p$ , in thousands of dollars, can be represented by a linear function. Which of the following functions represents the relationship?

- A)  $r(p) = 2.5p - 870$   
 B)  $r(p) = 5p + 165$   
 C)  $r(p) = 6.5p + 440$   
 D)  $r(p) = 7.5p - 10$

Townsend Realty purchased the Glenview Street property and received a 40% discount off the original price along with an additional 20% off the discounted price for purchasing the property in cash. Which of the following best approximates the original price, in dollars, of the Glenview Street property?

- A) \$350,000  
 B) \$291,700  
 C) \$233,300  
 D) \$175,000


## TABLES AND GRAPHS

QUESTION 322

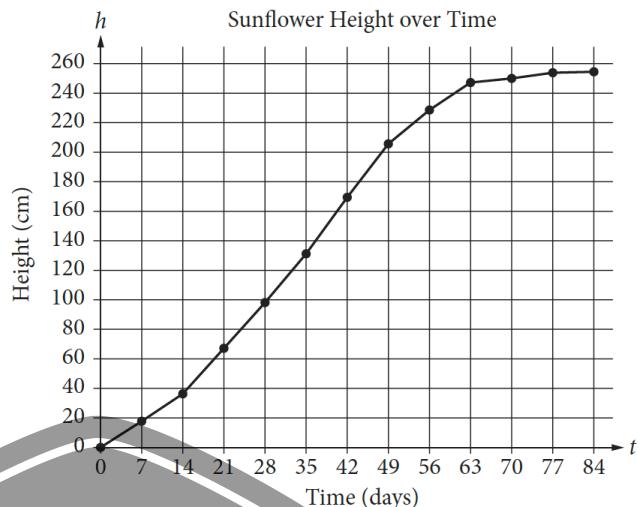
QUESTION 323

QUESTION 324



Sunflower Growth

Day	Height (cm)
0	0.00
7	17.93
14	36.36
21	67.76
28	98.10
35	131.00
42	169.50
49	205.50
56	228.30
63	247.10
70	250.50
77	253.80
84	254.50



In 1919, H. S. Reed and R. H. Holland published a paper on the growth of sunflowers. Included in the paper were the table and graph above, which show the height  $h$ , in centimeters, of a sunflower  $t$  days after the sunflower begins to grow.

Over which of the following time periods is the average growth rate of the sunflower least?

- A) Day 0 to Day 21
- B) Day 21 to Day 42
- C) Day 42 to Day 63
- D) Day 63 to Day 84

The function  $h$ , defined by  $h(t) = at + b$ , where  $a$  and  $b$  are constants, models the height, in centimeters, of the sunflower after  $t$  days of growth during a time period in which the growth is approximately linear. What does  $a$  represent?

- A) The predicted number of centimeters the sunflower grows each day during the period
- B) The predicted height, in centimeters, of the sunflower at the beginning of the period
- C) The predicted height, in centimeters, of the sunflower at the end of the period
- D) The predicted total increase in the height of the sunflower, in centimeters, during the period

The growth rate of the sunflower from day 14 to day 35 is nearly constant. On this interval, which of the following equations best models the height  $h$ , in centimeters, of the sunflower  $t$  days after it begins to grow?

- A)  $h = 2.1t - 15$
- B)  $h = 4.5t - 27$
- C)  $h = 6.8t - 12$
- D)  $h = 13.2t - 18$

SAT

SAT - ACT - EST


2.5

## PART II: PROBLEM SOLVING AND DATA ANALYSIS

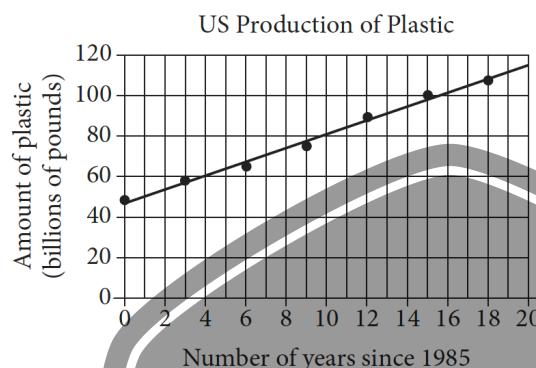
## TABLES AND GRAPHS

QUESTION 325

QUESTION 326



Between 1985 and 2003, data were collected every three years on the amount of plastic produced annually in the United States, in billions of pounds. The graph below shows the data and a line of best fit. The equation of the line of best fit is  $y = 3.39x + 46.89$ , where  $x$  is the number of years since 1985 and  $y$  is the amount of plastic produced annually, in billions of pounds.



Which of the following is the best interpretation of the number 3.39 in the context of the problem?

- SAT - ACT - EST**
- A) The amount of plastic, in billions of pounds, produced in the United States during the year 1985
  - B) The number of years it took the United States to produce 1 billion pounds of plastic
  - C) The average annual plastic production, in billions of pounds, in the United States from 1985 to 2003
  - D) The average annual increase, in billions of pounds, of plastic produced per year in the United States from 1985 to 2003

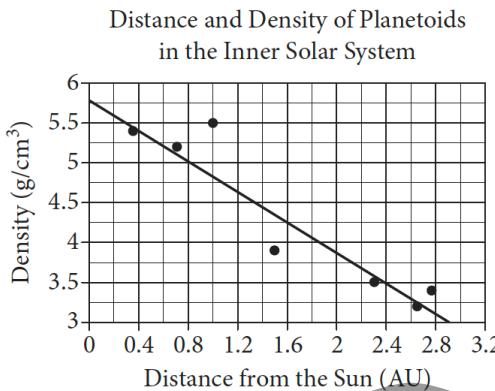
Which of the following is closest to the percent increase in the billions of pounds of plastic produced in the United States from 2000 to 2003?

- A) 10%
- B) 44%
- C) 77%
- D) 110%

## TABLES AND GRAPHS

QUESTION 327

QUESTION 328



The scatterplot above shows the densities of 7 planetoids, in grams per cubic centimeter, with respect to their average distances from the Sun in astronomical units (AU). The line of best fit is also shown.

According to the scatterplot, which of the following statements is true about the relationship between a planetoid's average distance from the Sun and its density?

- A) Planetoids that are more distant from the Sun tend to have lesser densities.
- B) Planetoids that are more distant from the Sun tend to have greater densities.
- C) The density of a planetoid that is twice as far from the Sun as another planetoid is half the density of that other planetoid.
- D) The distance from a planetoid to the Sun is unrelated to its density.

An astronomer has discovered a new planetoid about 1.2 AU from the Sun. According to the line of best fit, which of the following best approximates the density of the planetoid, in grams per cubic centimeter?

- A) 3.6
- B) 4.1
- C) 4.6
- D) 5.5

## TABLES AND GRAPHS

QUESTION 329

QUESTION 330



Ms. Simon's Workday Morning Drive

Segment of drive	Distance (miles)	Average driving speed with no traffic delay (mph)
From home to freeway entrance	0.6	25
From freeway entrance to freeway exit	15.4	50
From freeway exit to workplace	1.4	35

Ms. Simon drives her car from her home to her workplace every workday morning. The table above shows the distance, in miles, and her average driving speed, in miles per hour (mph), when there is no traffic delay, for each segment of her drive.

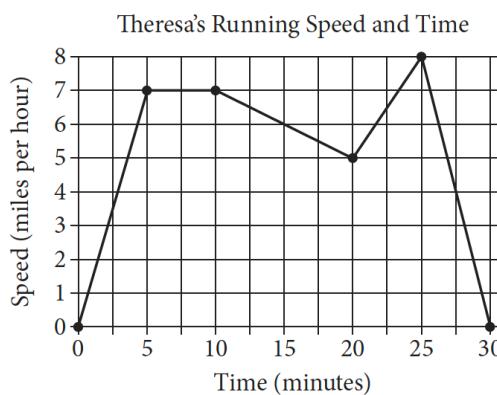
One morning, Ms. Simon drove directly from her home to her workplace in 24 minutes. What was her average speed, in miles per hour, during her drive that morning?

SAT - ACT - EST

If Ms. Simon starts her drive at 6:30 a.m., she can drive at her average driving speed with no traffic delay for each segment of the drive. If she starts her drive at 7:00 a.m., the travel time from the freeway entrance to the freeway exit increases by 33% due to slower traffic, but the travel time for each of the other two segments of her drive does not change. Based on the table, how many more minutes does Ms. Simon take to arrive at her workplace if she starts her drive at 7:00 a.m. than if she starts her drive at 6:30 a.m.? (Round your answer to the nearest minute.)

## TABLES AND GRAPHS

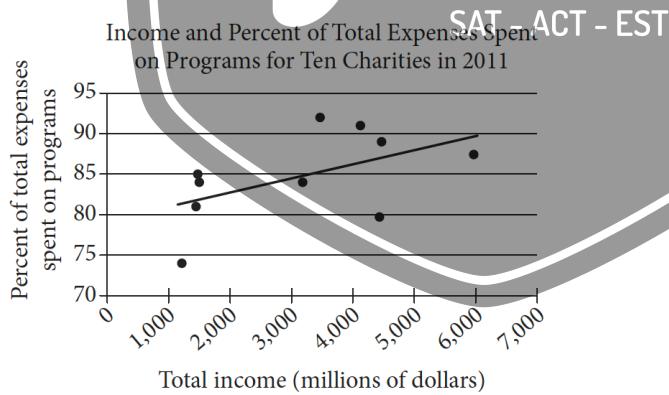
QUESTION 331



Theresa ran on a treadmill for thirty minutes, and her time and speed are shown on the graph above. According to the graph, which of the following statements is NOT true concerning Theresa's run?

- A) Theresa ran at a constant speed for five minutes.
- B) Theresa's speed was increasing for a longer period of time than it was decreasing.
- C) Theresa's speed decreased at a constant rate during the last five minutes.
- D) Theresa's speed reached its maximum during the last ten minutes.

QUESTION 332

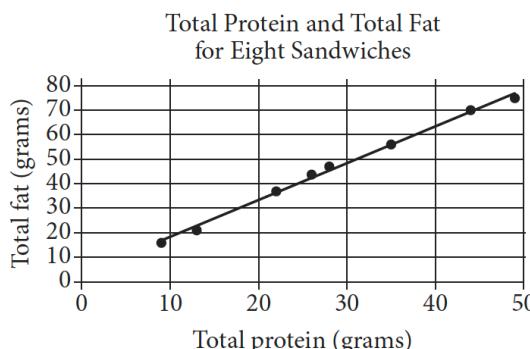


The scatterplot above shows data for ten charities along with the line of best fit. For the charity with the greatest percent of total expenses spent on programs, which of the following is closest to the difference of the actual percent and the percent predicted by the line of best fit?

- A) 10%
- B) 7%
- C) 4%
- D) 1%

## TABLES AND GRAPHS

QUESTION 333



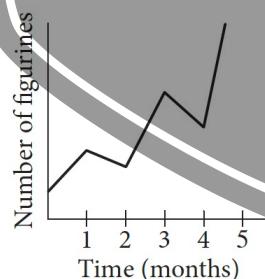
The scatterplot above shows the numbers of grams of both total protein and total fat for eight sandwiches on a restaurant menu. The line of best fit for the data is also shown. According to the line of best fit, which of the following is closest to the predicted increase in total fat, in grams, for every increase of 1 gram in total protein?

- A) 2.5
- B) 2.0
- C) 1.5
- D) 1.0

QUESTION 334



Tracy collects, sells, and trades figurines, and she tracks the number of figurines in her collection on the graph below.



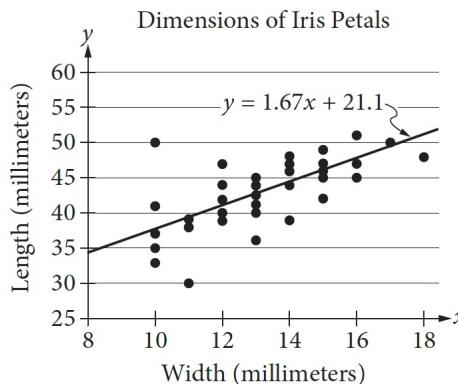
On what interval did the number of figurines decrease the fastest?

- A) Between 1 and 2 months
- B) Between 2 and 3 months
- C) Between 3 and 4 months
- D) Between 4 and 5 months



## TABLES AND GRAPHS

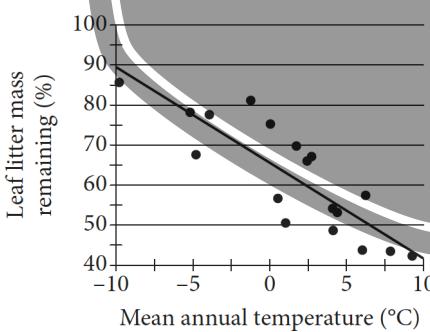
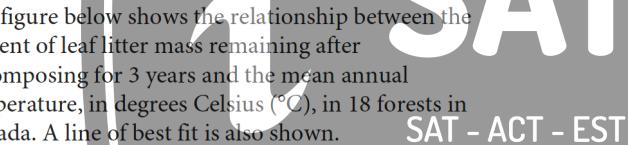
QUESTION 335



The scatterplot above shows data collected on the lengths and widths of *Iris setosa* petals. A line of best fit for the data is also shown. Based on the line of best fit, if the width of an *Iris setosa* petal is 19 millimeters, what is the predicted length, in millimeters, of the petal?

- A) 21.10
- B) 31.73
- C) 52.83
- D) 55.27

QUESTION 336



A particular forest in Canada, whose data is not included in the figure, had a mean annual temperature of  $-2^{\circ}\text{C}$ . Based on the line of best fit, which of the following is closest to the predicted percent of leaf litter mass remaining in this particular forest after decomposing for 3 years?

- A) 50%
- B) 63%
- C) 70%
- D) 82%

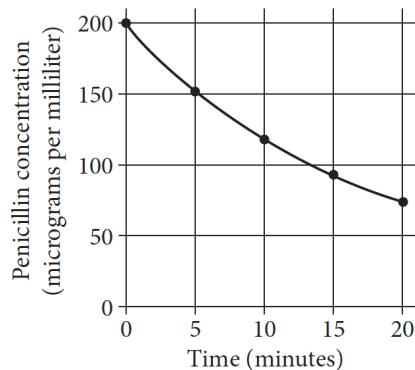
## TABLES AND GRAPHS

QUESTION 337

QUESTION 338



Minutes after injection	Penicillin concentration (micrograms per milliliter)
0	200
5	152
10	118
15	93
20	74



When a patient receives a penicillin injection, the kidneys begin removing the penicillin from the body. The table and graph above show the penicillin concentration in a patient's bloodstream at 5-minute intervals for the 20 minutes immediately following a one-time penicillin injection.

According to the table, how many more micrograms of penicillin are present in 10 milliliters of blood drawn from the patient 5 minutes after the injection than are present in 8 milliliters of blood drawn 10 minutes after the injection?

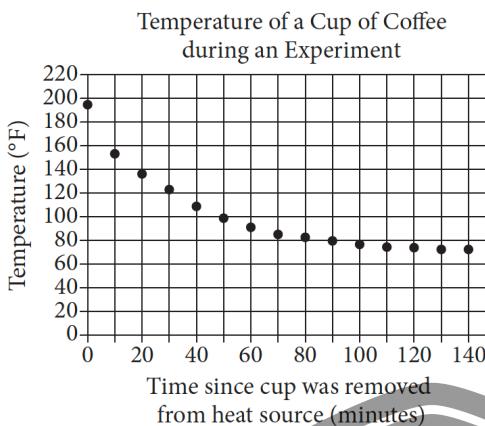
SAT - ACT - EST

The penicillin concentration, in micrograms per milliliter, in the patient's bloodstream  $t$  minutes after the penicillin injection is modeled by the function  $P$  defined by  $P(t) = 200b^{\frac{t}{5}}$ . If  $P$  approximates the values in the table to within 10 micrograms per milliliter, what is the value of  $b$ , rounded to the nearest tenth?

## TABLES AND GRAPHS

QUESTION 339

QUESTION 340



In an experiment, a heated cup of coffee is removed from a heat source, and the cup of coffee is then left in a room that is kept at a constant temperature. The graph above shows the temperature, in degrees Fahrenheit ( $^{\circ}\text{F}$ ), of the coffee immediately after being removed from the heat source and at 10-minute intervals thereafter.

Of the following, which best approximates the temperature, in degrees Fahrenheit, of the coffee when it is first removed from the heat source?

- SAT - ACT - EST
- A) 75
  - B) 100
  - C) 155
  - D) 195

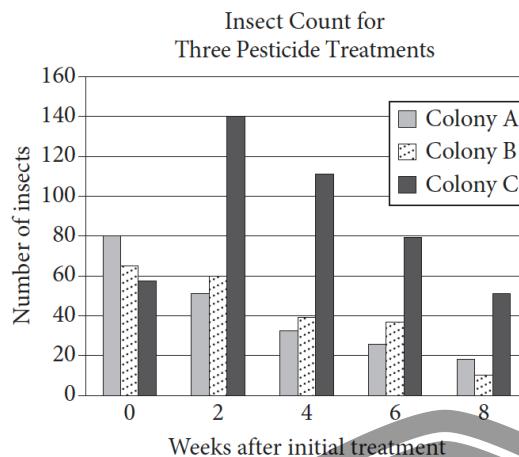
During which of the following 10-minute intervals does the temperature of the coffee decrease at the greatest average rate?

- A) Between 0 and 10 minutes
- B) Between 30 and 40 minutes
- C) Between 50 and 60 minutes
- D) Between 90 and 100 minutes

## TABLES AND GRAPHS

QUESTION 341

QUESTION 342



Three colonies of insects were each treated with a different pesticide over an 8-week period to test the effectiveness of the three pesticides. Colonies A, B, and C were treated with Pesticides A, B, and C, respectively. Each pesticide was applied every 2 weeks to one of the three colonies over the 8-week period. The bar graph above shows the insect counts for each of the three colonies 0, 2, 4, 6, and 8 weeks after the initial treatment.

Which of the following colonies showed a decrease in size every two weeks after the initial treatment with pesticide?

- I. Colony A
  - II. Colony B
  - III. Colony C
- A) I only  
B) III only  
C) I and II only  
D) I, II, and III

Of the following, which is closest to the ratio of the total number of insects in all three colonies in week 8 to the total number of insects at the time of initial treatment?

- A) 2 to 5  
B) 1 to 4  
C) 3 to 5  
D) 1 to 2

**SAT**

SAT - ACT - EST

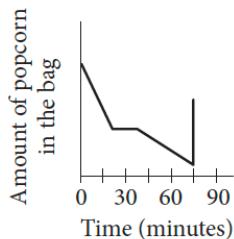
## TABLES AND GRAPHS

QUESTION 343

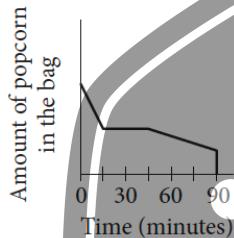


Jake buys a bag of popcorn at a movie theater. He eats half of the popcorn during the 15 minutes of previews. After eating half of the popcorn, he stops eating for the next 30 minutes. Then he gradually eats the popcorn until he accidentally spills all of the remaining popcorn. Which of the following graphs could represent the situation?

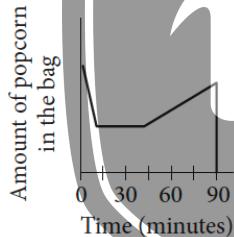
A)



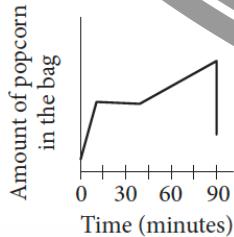
B)



C)



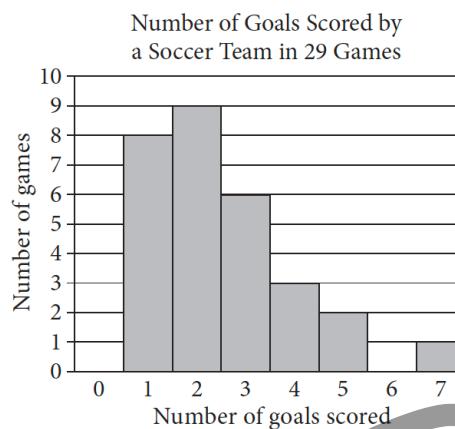
D)

 SAT

SAT - ACT - EST

## TABLES AND GRAPHS

QUESTION 344

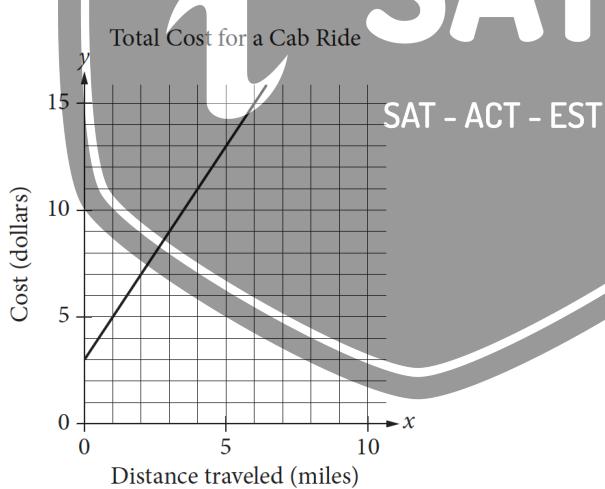


Based on the graph above, in how many of the games played did the soccer team score goals equal to the median number of goals for the 29 games?

QUESTION 345



The line graphed in the  $xy$ -plane below models the total cost, in dollars, for a cab ride,  $y$ , in a certain city during nonpeak hours based on the number of miles traveled,  $x$ .

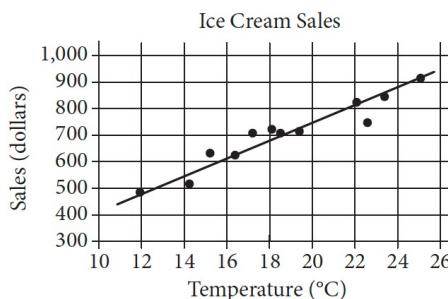


According to the graph, what is the cost for each additional mile traveled, in dollars, of a cab ride?

- A) \$2.00
- B) \$2.60
- C) \$3.00
- D) \$5.00

## TABLES AND GRAPHS

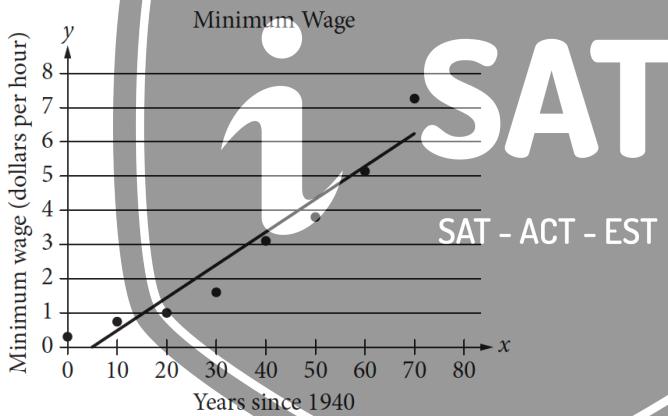
QUESTION 346



The scatterplot above shows a company's ice cream sales  $d$ , in dollars, and the high temperature  $t$ , in degrees Celsius ( $^{\circ}\text{C}$ ), on 12 different days. A line of best fit for the data is also shown. Which of the following could be an equation of the line of best fit?

- A)  $d = 0.03t + 402$
- B)  $d = 10t + 402$
- C)  $d = 33t + 300$
- D)  $d = 33t + 84$

QUESTION 347

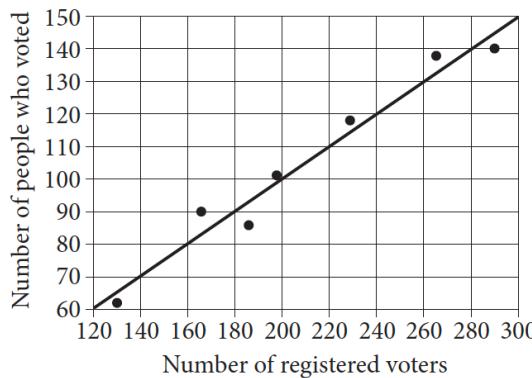


The scatterplot above shows the federal-mandated minimum wage every 10 years between 1940 and 2010. A line of best fit is shown, and its equation is  $y = 0.096x - 0.488$ . What does the line of best fit predict about the increase in the minimum wage over the 70-year period?

- A) Each year between 1940 and 2010, the average increase in minimum wage was 0.096 dollars.
- B) Each year between 1940 and 2010, the average increase in minimum wage was 0.49 dollars.
- C) Every 10 years between 1940 and 2010, the average increase in minimum wage was 0.096 dollars.
- D) Every 10 years between 1940 and 2010, the average increase in minimum wage was 0.488 dollars.

## TABLES AND GRAPHS

QUESTION 348



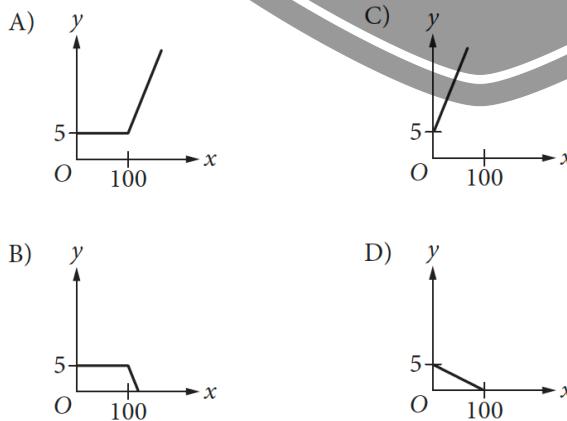
The scatterplot above shows the number of registered voters,  $x$ , and the number of people who voted in the last election,  $y$ , for seven districts in a town. A line of best fit for the data is also shown. Which of the following could be the equation of the line of best fit?

- A)  $y = -0.5x$
- B)  $y = 0.5x$
- C)  $y = -2x$
- D)  $y = 2x$

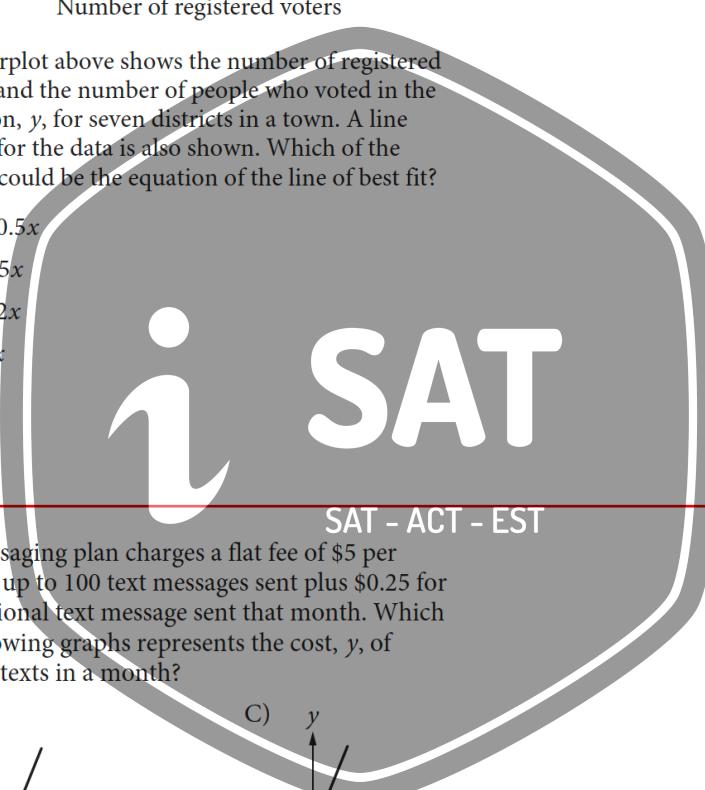
QUESTION 349



A text messaging plan charges a flat fee of \$5 per month for up to 100 text messages sent plus \$0.25 for each additional text message sent that month. Which of the following graphs represents the cost,  $y$ , of sending  $x$  texts in a month?



SAT - ACT - EST



# PART III



Telegram t.me/SAT\_pdf

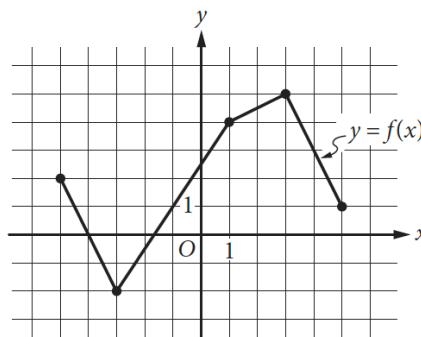


## 3.I

## PART III: PASSPORT TO ADVANCED MATH

## FUNCTIONS

QUESTION 350



The complete graph of the function  $f$  is shown in the  $xy$ -plane above. For what value of  $x$  is the value of  $f(x)$  at its minimum?

- A) -5
- B) -3
- C) -2
- D) 3

QUESTION 351



$$h(x) = \frac{1}{(x-5)^2 + 4(x-5) + 4}$$

i SAT  
SAT - ACT - EST

For what value of  $x$  is the function  $h$  above undefined?

QUESTION 352



A function  $f$  satisfies  $f(2) = 3$  and  $f(3) = 5$ . A function  $g$  satisfies  $g(3) = 2$  and  $g(5) = 6$ . What is the value of  $f(g(3))$ ?

- A) 2
- B) 3
- C) 5
- D) 6

QUESTION 353

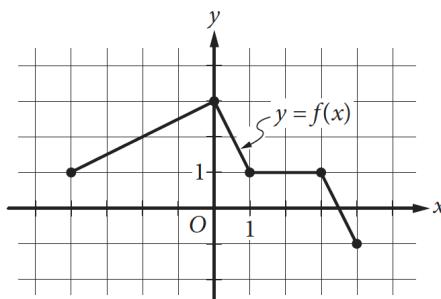


In the  $xy$ -plane, the graph of function  $f$  has  $x$ -intercepts at  $-3$ ,  $-1$ , and  $1$ . Which of the following could define  $f$ ?

- A)  $f(x) = (x-3)(x-1)(x+1)$
- B)  $f(x) = (x-3)(x-1)^2$
- C)  $f(x) = (x-1)(x+1)(x+3)$
- D)  $f(x) = (x+1)^2(x+3)$

## FUNCTIONS

QUESTION 354



The complete graph of the function  $f$  is shown in the  $xy$ -plane above. Which of the following are equal to 1?

- I.  $f(-4)$
  - II.  $f\left(\frac{3}{2}\right)$
  - III.  $f(3)$
- A) III only  
 B) I and III only  
 C) II and III only  
 D) I, II, and III

QUESTION 355



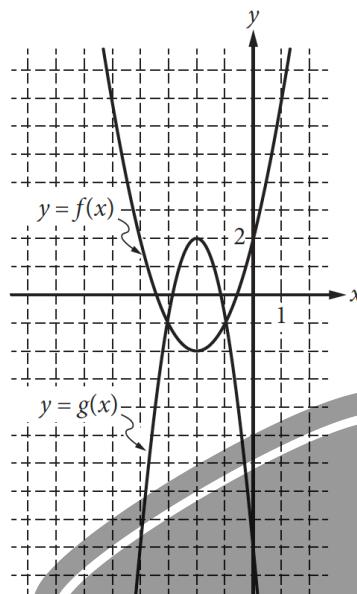
If the function  $f$  has five distinct zeros, which of the following could represent the complete graph of  $f$  in the  $xy$ -plane?

- SAT ACT - EST
- A)   
 B)   
 C)   
 D)

i SAT

## FUNCTIONS

QUESTION 356



Graphs of the functions  $f$  and  $g$  are shown in the  $xy$ -plane above. For which of the following values of  $x$  does  $f(x) + g(x) = 0$ ?

- A)  $-3$
- B)  $-2$
- C)  $-1$
- D)  $0$

QUESTION 357



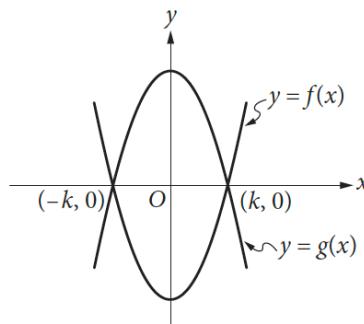
The world's population has grown at an average rate of 1.9 percent per year since 1945. There were approximately 4 billion people in the world in 1975. Which of the following functions represents the world's population  $P$ , in billions of people,  $t$  years since 1975? (1 billion = 1,000,000,000)

- A)  $P(t) = 4(1.019)^t$
- B)  $P(t) = 4(1.9)^t$
- C)  $P(t) = 1.19t + 4$
- D)  $P(t) = 1.019t + 4$

**i SAT**  
SAT - ACT - EST

## FUNCTIONS

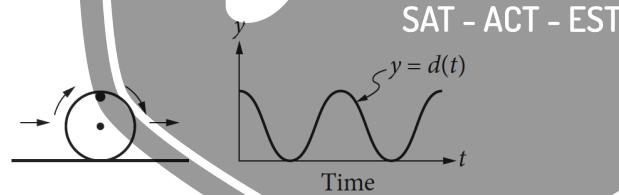
QUESTION 358



The functions  $f$  and  $g$ , defined by  $f(x) = 8x^2 - 2$  and  $g(x) = -8x^2 + 2$ , are graphed in the  $xy$ -plane above. The graphs of  $f$  and  $g$  intersect at the points  $(k, 0)$  and  $(-k, 0)$ . What is the value of  $k$ ?

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

QUESTION 359



The figure on the left above shows a wheel with a mark on its rim. The wheel is rolling on the ground at a constant rate along a level straight path from a starting point to an ending point. The graph of  $y = d(t)$  on the right could represent which of the following as a function of time from when the wheel began to roll?

- A) The speed at which the wheel is rolling
- B) The distance of the wheel from its starting point
- C) The distance of the mark on the rim from the center of the wheel
- D) The distance of the mark on the rim from the ground

## FUNCTIONS

QUESTION 360



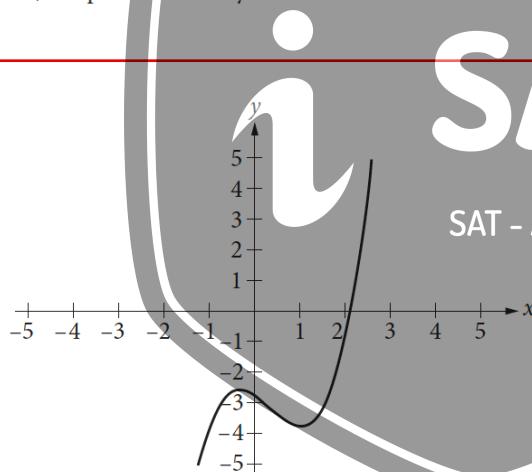
The population of mosquitoes in a swamp is estimated over the course of twenty weeks, as shown in the table.

Time (weeks)	Population
0	100
5	1,000
10	10,000
15	100,000
20	1,000,000

Which of the following best describes the relationship between time and the estimated population of mosquitoes during the twenty weeks?

- A) Increasing linear
- B) Decreasing linear
- C) Exponential growth
- D) Exponential decay

QUESTION 361



SAT

SAT - ACT - EST

The function  $f(x) = x^3 - x^2 - x - \frac{11}{4}$  is graphed in

the  $xy$ -plane above. If  $k$  is a constant such that the equation  $f(x) = k$  has three real solutions, which of the following could be the value of  $k$ ?

- A) 2
- B) 0
- C) -2
- D) -3

## 3.I

## PART III: PASSPORT TO ADVANCED MATH

## FUNCTIONS

## QUESTION 362



Which of the following is an example of a function whose graph in the  $xy$ -plane has no  $x$ -intercepts?

- A) A linear function whose rate of change is not zero
- B) A quadratic function with real zeros
- C) A quadratic function with no real zeros
- D) A cubic polynomial with at least one real zero

## QUESTION 363



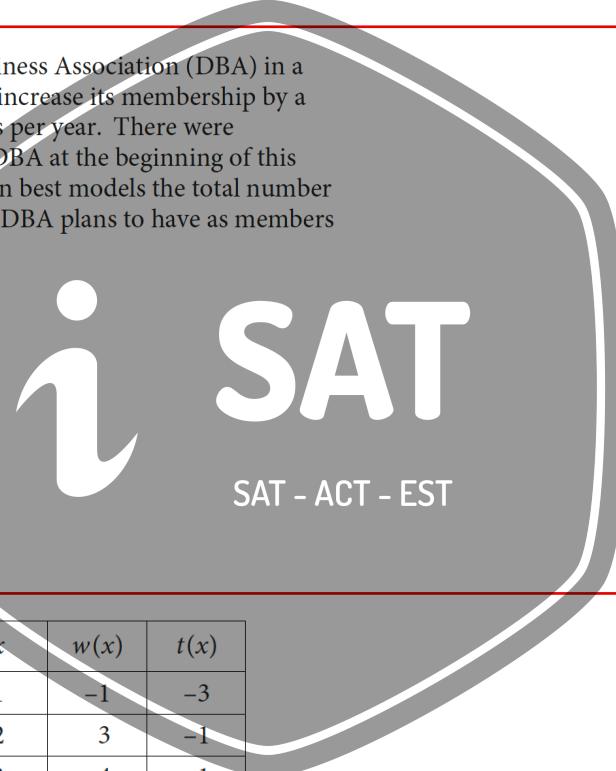
The Downtown Business Association (DBA) in a certain city plans to increase its membership by a total of  $n$  businesses per year. There were  $b$  businesses in the DBA at the beginning of this year. Which function best models the total number of businesses,  $y$ , the DBA plans to have as members  $x$  years from now?

- A)  $y = nx + b$
- B)  $y = nx - b$
- C)  $y = b(n)^x$
- D)  $y = n(b)^x$

## QUESTION 364



$x$	$w(x)$	$t(x)$
1	-1	-3
2	3	-1
3	4	1
4	3	3
5	-1	5

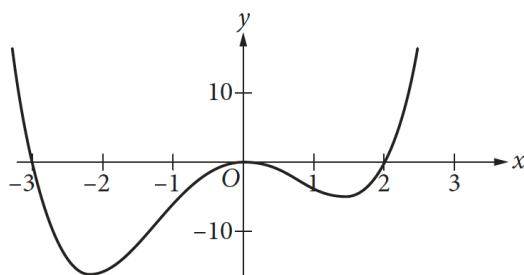


The table above shows some values of the functions  $w$  and  $t$ . For which value of  $x$  is  $w(x) + t(x) = x$ ?

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

## FUNCTIONS

QUESTION 365



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

- A)  $y = x(x - 2)(x + 3)$
- B)  $y = x^2(x - 2)(x + 3)$
- C)  $y = x(x + 2)(x - 3)$
- D)  $y = x^2(x + 2)(x - 3)$

QUESTION 366



$x$	1	2	3	4	5
$y$	$\frac{11}{4}$	$\frac{25}{4}$	$\frac{39}{4}$	$\frac{53}{4}$	$\frac{67}{4}$

Which of the following equations relates  $y$  to  $x$  for the values in the table above?

- A)  $y = \frac{1}{2} \cdot \left(\frac{5}{2}\right)^x$
- B)  $y = 2 \cdot \left(\frac{3}{4}\right)^x$
- C)  $y = \frac{3}{4}x + 2$
- D)  $y = \frac{7}{2}x - \frac{3}{4}$

## FUNCTIONS

QUESTION 367



$$g(x) = 2x - 1$$
$$h(x) = 1 - g(x)$$

The functions  $g$  and  $h$  are defined above. What is the value of  $h(0)$ ?

- A) -2
- B) 0
- C) 1
- D) 2

QUESTION 368



Which of the following is a value of  $x$  for which the

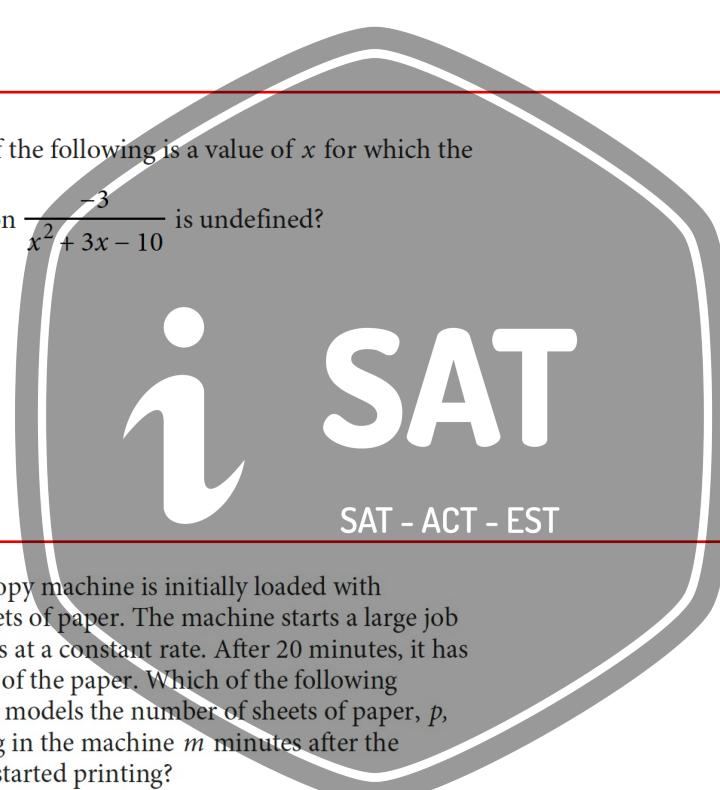
$$\text{expression } \frac{-3}{x^2 + 3x - 10} \text{ is undefined?}$$

- A) -3
- B) -2
- C) 0
- D) 2

QUESTION 369



A photocopy machine is initially loaded with 5,000 sheets of paper. The machine starts a large job and copies at a constant rate. After 20 minutes, it has used 30% of the paper. Which of the following equations models the number of sheets of paper,  $p$ , remaining in the machine  $m$  minutes after the machine started printing?



- A)  $p = 5,000 - 20m$
- B)  $p = 5,000 - 75m$
- C)  $p = 5,000(0.3)^{\frac{m}{20}}$
- D)  $p = 5,000(0.7)^{\frac{m}{20}}$

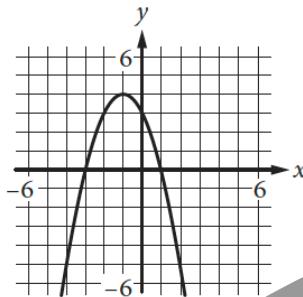
## FUNCTIONS

QUESTION 370

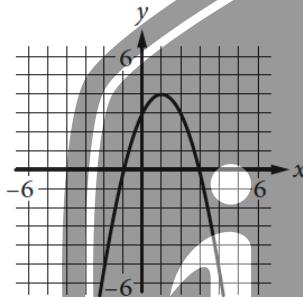


The range of the polynomial function  $f$  is the set of real numbers less than or equal to 4. If the zeros of  $f$  are  $-3$  and  $1$ , which of the following could be the graph of  $y = f(x)$  in the  $xy$ -plane?

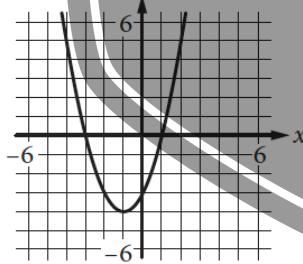
A)



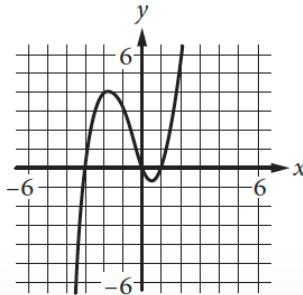
B)



C)



D)

  
SAT

SAT - ACT - EST

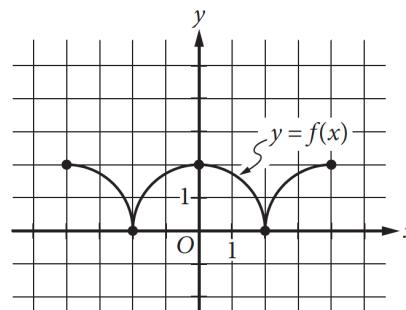


## 3.I

## PART III: PASSPORT TO ADVANCED MATH

## FUNCTIONS

QUESTION 371



The figure above shows the complete graph of the function  $f$  in the  $xy$ -plane. The function  $g$  (not shown) is defined by  $g(x) = f(x) + 6$ . What is the maximum value of the function  $g$ ?

QUESTION 372



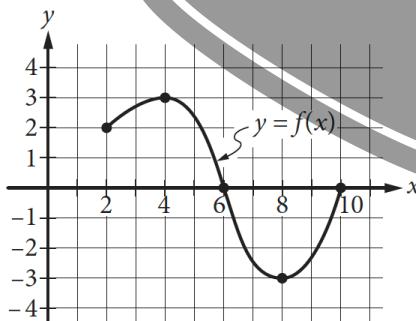
In the  $xy$ -plane, the graph of the polynomial function  $f$  crosses the  $x$ -axis at exactly two points,  $(a, 0)$  and  $(b, 0)$ , where  $a$  and  $b$  are both positive. Which of the following could define  $f$ ?

- A)  $f(x) = (x - a)(x - b)$
- B)  $f(x) = (x + a)(x + b)$
- C)  $f(x) = (x - a)(x + b)$
- D)  $f(x) = x(x - a)(x - b)$

SAT

SAT - ACT - EST

QUESTION 373



$x$	$g(x)$
-2	1
-1	2
0	3
1	4
2	5
3	6
4	7

The complete graph of the function  $f$  and a table of values for the function  $g$  are shown above. The maximum value of  $f$  is  $k$ . What is the value of  $g(k)$ ?

- A) 7
- B) 6
- C) 3
- D) 0

## FUNCTIONS

QUESTION 374

QUESTION 375

QUESTION 376



Jennifer bought a box of Crunchy Grain cereal. The nutrition facts on the box state that a serving size of the cereal is  $\frac{3}{4}$  cup and provides 210 calories, 50 of which are calories from fat. In addition, each serving of the cereal provides 180 milligrams of potassium, which is 5% of the daily allowance for adults.

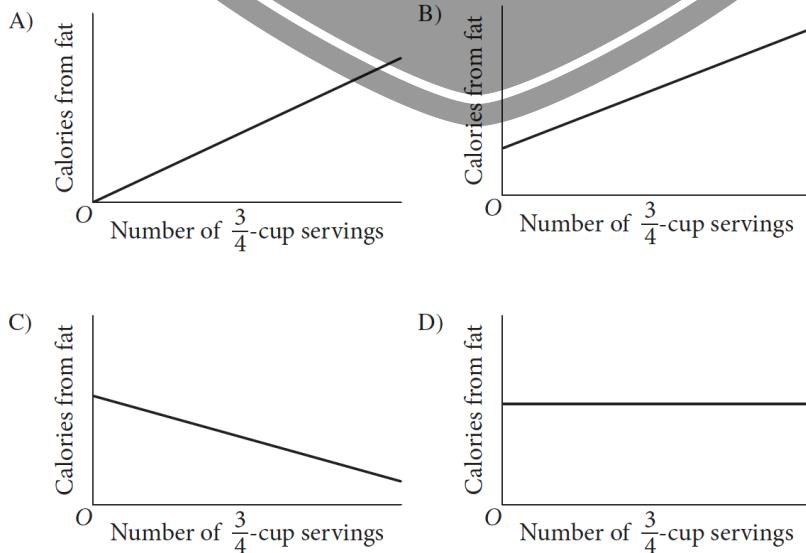
If  $p$  percent of an adult's daily allowance of potassium is provided by  $x$  servings of Crunchy Grain cereal per day, which of the following expresses  $p$  in terms of  $x$ ?

- A)  $p = 0.5x$
- B)  $p = 5x$
- C)  $p = (0.05)^x$
- D)  $p = (1.05)^x$

On Tuesday, Jennifer will mix Crunchy Grain cereal with Super Grain cereal for her breakfast. Super Grain cereal provides 240 calories per cup. If the total number of calories in one cup of Jennifer's mixture is 270, how much Super Grain cereal is in one cup of the mixture?

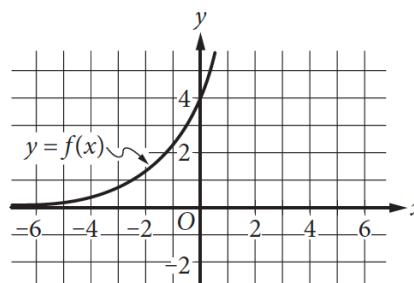
- A)  $\frac{1}{8}$  cup
- B)  $\frac{1}{4}$  cup
- C)  $\frac{1}{3}$  cup
- D)  $\frac{1}{2}$  cup

Which of the following could be the graph of the number of calories from fat in Crunchy Grain cereal as a function of the number of  $\frac{3}{4}$ -cup servings of the cereal?




## FUNCTIONS

QUESTION 377



The graph of  $y = f(x)$  is shown in the  $xy$ -plane.

What is the value of  $f(0)$ ?

- A) 0
- B) 2
- C) 3
- D) 4

QUESTION 378



The first year Eleanor organized a fund-raising event, she invited 30 people. For each of the next 5 years, she invited double the number of people she had invited the previous year. If  $f(n)$  is the number of people invited to the fund-raiser  $n$  years after Eleanor began organizing the event, which of the following statements best describes the function  $f$ ?

- A) The function  $f$  is a decreasing linear function.
- B) The function  $f$  is an increasing linear function.
- C) The function  $f$  is a decreasing exponential function.
- D) The function  $f$  is an increasing exponential function.

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 379



$$g(x) = ax^2 + 24$$

For the function  $g$  defined above,  $a$  is a constant and  $g(4) = 8$ . What is the value of  $g(-4)$ ?

- A) 8
- B) 0
- C) -1
- D) -8

QUESTION 380



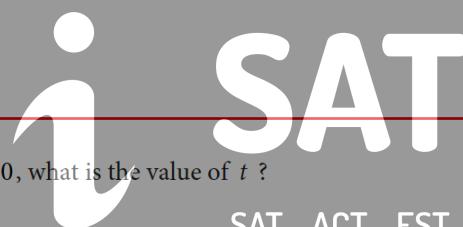
If  $(ax + 2)(bx + 7) = 15x^2 + cx + 14$  for all values of  $x$ , and  $a + b = 8$ , what are the two possible values for  $c$ ?

- A) 3 and 5
- B) 6 and 35
- C) 10 and 21
- D) 31 and 41

QUESTION 381



If  $t > 0$  and  $t^2 - 4 = 0$ , what is the value of  $t$ ?



SAT - ACT - EST

QUESTION 382



$$h = -4.9t^2 + 25t$$

The equation above expresses the approximate height  $h$ , in meters, of a ball  $t$  seconds after it is launched vertically upward from the ground with an initial velocity of 25 meters per second. After approximately how many seconds will the ball hit the ground?

- A) 3.5
- B) 4.0
- C) 4.5
- D) 5.0

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 383



What is the sum of all values of  $m$  that satisfy

$$2m^2 - 16m + 8 = 0 ?$$

- A) -8
- B)  $-4\sqrt{3}$
- C)  $4\sqrt{3}$
- D) 8

QUESTION 384



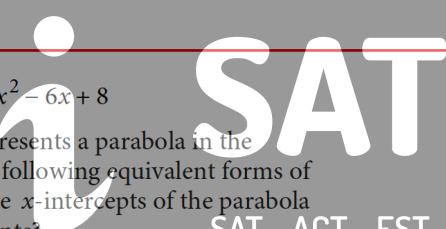
$$2x(3x + 5) + 3(3x + 5) = ax^2 + bx + c$$

In the equation above,  $a$ ,  $b$ , and  $c$  are constants. If the equation is true for all values of  $x$ , what is the value of  $b$ ?

QUESTION 385



$$y = x^2 - 6x + 8$$

  
SAT

SAT - ACT - EST

The equation above represents a parabola in the  $xy$ -plane. Which of the following equivalent forms of the equation displays the  $x$ -intercepts of the parabola as constants or coefficients?

- A)  $y - 8 = x^2 - 6x$
- B)  $y + 1 = (x - 3)^2$
- C)  $y = x(x - 6) + 8$
- D)  $y = (x - 2)(x - 4)$

QUESTION 386



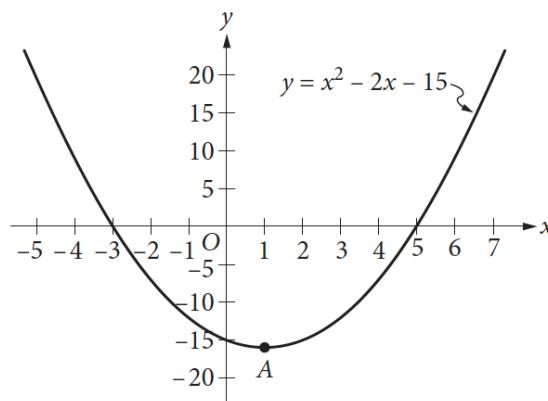
In the  $xy$ -plane, the point  $(3, 6)$  lies on the graph of the function  $f(x) = 3x^2 - bx + 12$ . What is the value of  $b$ ?

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

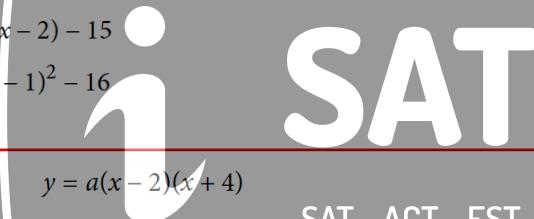
QUESTION 387



Which of the following is an equivalent form of the equation of the graph shown in the  $xy$ -plane above, from which the coordinates of vertex A can be identified as constants in the equation?

- A)  $y = (x + 3)(x - 5)$
- B)  $y = (x - 3)(x + 5)$
- C)  $y = x(x - 2) - 15$
- D)  $y = (x - 1)^2 - 16$

QUESTION 388



SAT - ACT - EST

In the quadratic equation above,  $a$  is a nonzero constant. The graph of the equation in the  $xy$ -plane is a parabola with vertex  $(c, d)$ . Which of the following is equal to  $d$ ?

- A)  $-9a$
- B)  $-8a$
- C)  $-5a$
- D)  $-2a$

QUESTION 389



$$(-3x^2 + 5x - 2) - 2(x^2 - 2x - 1)$$

If the expression above is rewritten in the form  $ax^2 + bx + c$ , where  $a$ ,  $b$ , and  $c$  are constants, what is the value of  $b$ ?

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 390



$$x^2 - \frac{k}{2}x = 2p$$

In the quadratic equation above,  $k$  and  $p$  are constants. What are the solutions for  $x$ ?

- A)  $x = \frac{k}{4} \pm \frac{\sqrt{k^2 + 2p}}{4}$
- B)  $x = \frac{k}{4} \pm \frac{\sqrt{k^2 + 32p}}{4}$
- C)  $x = \frac{k}{2} \pm \frac{\sqrt{k^2 + 2p}}{2}$
- D)  $x = \frac{k}{2} \pm \frac{\sqrt{k^2 + 32p}}{4}$

QUESTION 391



What are the solutions to  $3x^2 + 12x + 6 = 0$ ?

- A)  $x = -2 \pm \sqrt{2}$
- B)  $x = -2 \pm \frac{\sqrt{30}}{3}$
- C)  $x = -6 \pm \sqrt{2}$
- D)  $x = -6 \pm 6\sqrt{2}$

QUESTION 392



$$f(x) = (x + 6)(x - 4)$$

Which of the following is an equivalent form of the function  $f$  above in which the minimum value of  $f$  appears as a constant or coefficient?

- A)  $f(x) = x^2 - 24$
- B)  $f(x) = x^2 + 2x - 24$
- C)  $f(x) = (x - 1)^2 - 21$
- D)  $f(x) = (x + 1)^2 - 25$

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 393



What are the solutions of the quadratic equation

$$4x^2 - 8x - 12 = 0 ?$$

- A)  $x = -1$  and  $x = -3$
- B)  $x = -1$  and  $x = 3$
- C)  $x = 1$  and  $x = -3$
- D)  $x = 1$  and  $x = 3$

QUESTION 394



$$4x^2 - 9 = (px + t)(px - t)$$

In the equation above,  $p$  and  $t$  are constants.  
Which of the following could be the value of  $p$ ?

- A) 2
- B) 3
- C) 4
- D) 9

QUESTION 395



$$y = x^2 - a$$

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In the equation above,  $a$  is a positive constant  
and the graph of the equation in the  $xy$ -plane is a  
parabola. Which of the following is an equivalent  
form of the equation?

- A)  $y = (x + a)(x - a)$
- B)  $y = (x + \sqrt{a})(x - \sqrt{a})$
- C)  $y = \left(x + \frac{a}{2}\right)\left(x - \frac{a}{2}\right)$
- D)  $y = (x + a)^2$

QUESTION 396



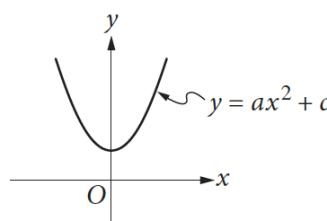
In the  $xy$ -plane, the point  $(2, 5)$  lies on the graph of  
the function  $f$ . If  $f(x) = k - x^2$ , where  $k$  is a  
constant, what is the value of  $k$ ?

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 397



The vertex of the parabola in the  $xy$ -plane above is  $(0, c)$ . Which of the following is true about the parabola with the equation  $y = -a(x - b)^2 + c$ ?

- A) The vertex is  $(b, c)$  and the graph opens upward.
- B) The vertex is  $(b, c)$  and the graph opens downward.
- C) The vertex is  $(-b, c)$  and the graph opens upward.
- D) The vertex is  $(-b, c)$  and the graph opens downward.

QUESTION 398



$$2x^2 - 4x = t$$

In the equation above,  $t$  is a constant. If the equation has no real solutions, which of the following could be the value of  $t$ ?

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

QUESTION 399



What is the sum of the solutions to  $(x - 6)(x + 0.7) = 0$ ?

- A) -6.7
- B) -5.3
- C) 5.3
- D) 6.7

## QUADRATIC EXPRESSIONS

QUESTION 400



If  $f(x) = \frac{x^2 - 6x + 3}{x - 1}$ , what is  $f(-1)$ ?

- A) -5
- B) -2
- C) 2
- D) 5

QUESTION 401



$$x^2 + 6x + 4$$

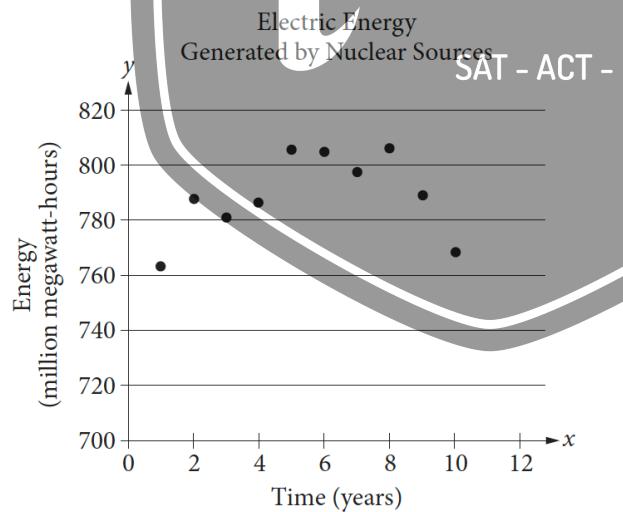
Which of the following is equivalent to the expression above?

- A)  $(x + 3)^2 + 5$
- B)  $(x + 3)^2 - 5$
- C)  $(x - 3)^2 + 5$
- D)  $(x - 3)^2 - 5$

QUESTION 402



The scatterplot below shows the amount of electric energy generated, in millions of megawatt-hours, by nuclear sources over a 10-year period.



Of the following equations, which best models the data in the scatterplot?

- A)  $y = 1.674x^2 + 19.76x - 745.73$
- B)  $y = -1.674x^2 - 19.76x - 745.73$
- C)  $y = 1.674x^2 + 19.76x + 745.73$
- D)  $y = -1.674x^2 + 19.76x + 745.73$

## QUADRATIC EXPRESSIONS

QUESTION 403



The expression  $\frac{1}{3}x^2 - 2$  can be rewritten as

$\frac{1}{3}(x - k)(x + k)$ , where  $k$  is a positive constant.

What is the value of  $k$ ?

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

QUESTION 404



$$(7532 + 100y^2) + 10(10y^2 - 110)$$

The expression above can be written in the form  $ay^2 + b$ , where  $a$  and  $b$  are constants. What is the value of  $a + b$ ?

QUESTION 405



In the  $xy$ -plane, the graph of  $y = 3x^2 - 14x$  intersects the graph of  $y = x$  at the points  $(0, 0)$  and  $(a, a)$ . What is the value of  $a$ ?

QUESTION 406



$$(x^2 - 3) - (-3x^2 + 5)$$

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

- A)  $4x^2 - 8$
- B)  $4x^2 - 2$
- C)  $-2x^2 - 8$
- D)  $-2x^2 - 2$

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 407



$$x^2 + x - 12 = 0$$

If  $a$  is a solution of the equation above and  $a > 0$ , what is the value of  $a$ ?

QUESTION 408



In the equation  $(ax + 3)^2 = 36$ ,  $a$  is a constant. If  $x = -3$  is one solution to the equation, what is a possible value of  $a$ ?

- A) -11
- B) -5
- C) -1
- D) 0

QUESTION 409



$$h(t) = -16t^2 + 110t + 72$$

The function above models the height  $h$ , in feet, of an object above ground  $t$  seconds after being launched straight up in the air. What does the number 72 represent in the function?

- A) The initial height, in feet, of the object
- B) The maximum height, in feet, of the object
- C) The initial speed, in feet per second, of the object
- D) The maximum speed, in feet per second, of the object

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

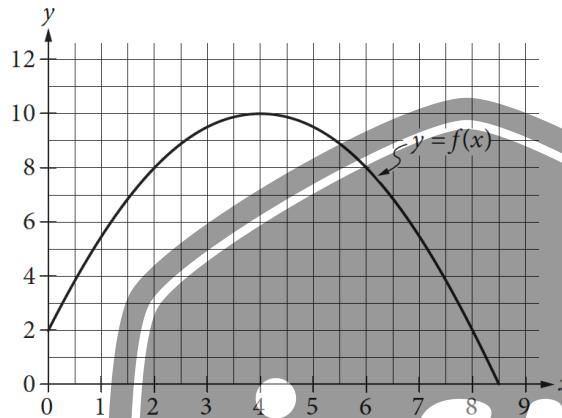
## QUADRATIC EXPRESSIONS

## QUESTION 410



The sum of  $-2x^2 + x + 31$  and  $3x^2 + 7x - 8$  can be written in the form  $ax^2 + bx + c$ , where  $a$ ,  $b$ , and  $c$  are constants. What is the value of  $a + b + c$ ?

## QUESTION 411



The graph of the function  $f$ , defined by

$$f(x) = -\frac{1}{2}(x - 4)^2 + 10, \text{ is shown in the } xy\text{-plane}$$

above. If the function  $g$  (not shown) is defined by

$g(x) = -x + 10$ , what is one possible value of  $a$  such

that  $f(a) = g(a)$ ?

## QUESTION 412



Which of the following is equivalent to

$$2(x^2 - x) + 3(x^2 - x) ?$$

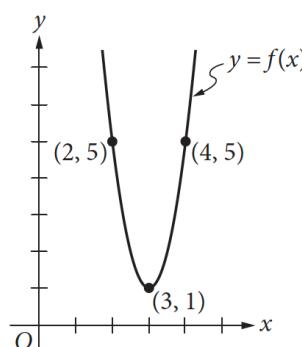
- A)  $5x^2 - 5x$
- B)  $5x^2 + 5x$
- C)  $5x$
- D)  $5x^2$

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 413



The graph of the function  $f$  in the  $xy$ -plane above is a parabola. Which of the following defines  $f$ ?

- A)  $f(x) = 4(x - 3)^2 + 1$
- B)  $f(x) = 4(x + 3)^2 + 1$
- C)  $f(x) = (x - 3)^2 + 1$
- D)  $f(x) = 3(x + 3)^2 + 1$

QUESTION 414



$$(4x + 4)(ax - 1) - x^2 + 4$$

In the expression above,  $a$  is a constant. If the expression is equivalent to  $bx$ , where  $b$  is a constant, what is the value of  $b$ ?

- A) -5
- B) -3
- C) 0
- D) 12

QUESTION 415



If  $f(x) = 5x^2 - 3$  and  $f(x + a) = 5x^2 + 30x + 42$ , what is the value of  $a$ ?

- A) -30
- B) -3
- C) 3
- D) 30

## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 416



$$h(x) = -16x^2 + 100x + 10$$

The quadratic function above models the height above the ground  $h$ , in feet, of a projectile  $x$  seconds after it had been launched vertically. If  $y = h(x)$  is graphed in the  $xy$ -plane, which of the following represents the real-life meaning of the positive  $x$ -intercept of the graph?

- A) The initial height of the projectile
- B) The maximum height of the projectile
- C) The time at which the projectile reaches its maximum height
- D) The time at which the projectile hits the ground

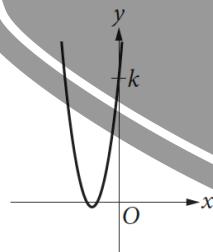
QUESTION 417



If  $y = 3x^2 + 6x + 2$  is graphed in the  $xy$ -plane, which of the following characteristics of the graph is displayed as a constant or coefficient in the equation?

- A)  $y$ -coordinate of the vertex
- B)  $x$ -intercept(s)
- C)  $y$ -intercept
- D)  $x$ -intercept of the line of symmetry

QUESTION 418



The graph of  $y = 2x^2 + 10x + 12$  is shown. If the graph crosses the  $y$ -axis at the point  $(0, k)$ , what is the value of  $k$ ?

- A) 2
- B) 6
- C) 10
- D) 12

## QUADRATIC EXPRESSIONS

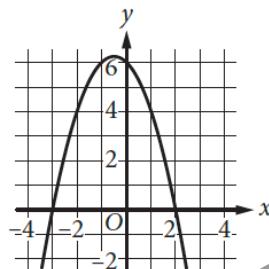
QUESTION 419



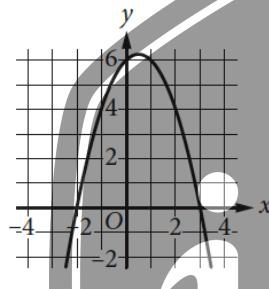
$$f(x) = (x + 3)(x - k)$$

The function  $f$  is defined above. If  $k$  is a positive integer, which of the following could represent the graph of  $y = f(x)$  in the  $xy$ -plane?

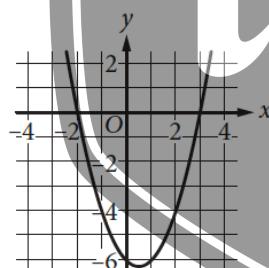
A)



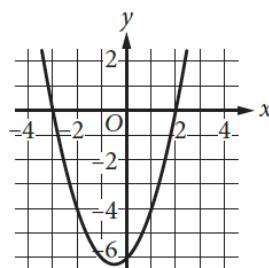
B)



C)



D)



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## 3.2

## PART III: PASSPORT TO ADVANCED MATH

## QUADRATIC EXPRESSIONS

QUESTION 420



In the  $xy$ -plane, the graph of the function  $f(x) = x^2 + 5x + 4$  has two  $x$ -intercepts. What is the distance between the  $x$ -intercepts?

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

QUESTION 421



$$y = -(x - 3)^2 + a$$

In the equation above,  $a$  is a constant. The graph of the equation in the  $xy$ -plane is a parabola. Which of the following is true about the parabola?

- A) Its minimum occurs at  $(-3, a)$ .
- B) Its minimum occurs at  $(3, a)$ .
- C) Its maximum occurs at  $(-3, a)$ .
- D) Its maximum occurs at  $(3, a)$ .

  
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QUESTION 422



The function  $f$  is defined by  $f(x) = (x + 3)(x + 1)$ . The graph of  $f$  in the  $xy$ -plane is a parabola. Which of the following intervals contains the  $x$ -coordinate of the vertex of the graph of  $f$ ?

- A)  $-4 < x < -3$
- B)  $-3 < x < 1$
- C)  $1 < x < 3$
- D)  $3 < x < 4$

## HIGHER ORDER EQUATIONS AND OPERATIONS

QUESTION 423



$$(x^2y - 3y^2 + 5xy^2) - (-x^2y + 3xy^2 - 3y^2)$$

Which of the following is equivalent to the expression above?

- A)  $4x^2y^2$
- B)  $8xy^2 - 6y^2$
- C)  $2x^2y + 2xy^2$
- D)  $2x^2y + 8xy^2 - 6y^2$

QUESTION 424



For a polynomial  $p(x)$ , the value of  $p(3)$  is  $-2$ . Which of the following must be true about  $p(x)$ ?

- A)  $x - 5$  is a factor of  $p(x)$ .
- B)  $x - 2$  is a factor of  $p(x)$ .
- C)  $x + 2$  is a factor of  $p(x)$ .
- D) The remainder when  $p(x)$  is divided by  $x - 3$  is  $-2$ .

QUESTION 425



$$9a^4 + 12a^2b^2 + 4b^4$$

Which of the following is equivalent to the expression shown above?

- A)  $(3a^2 + 2b^2)^2$
- B)  $(3a + 2b)^4$
- C)  $(9a^2 + 4b^2)^2$
- D)  $(9a + 4b)^4$

QUESTION 426



$$x^3(x^2 - 5) = -4x$$

If  $x > 0$ , what is one possible solution to the equation above?

## HIGHER ORDER EQUATIONS AND OPERATIONS

QUESTION 427



$x$	$f(x)$
0	3
2	1
4	0
5	-2

The function  $f$  is defined by a polynomial. Some values of  $x$  and  $f(x)$  are shown in the table above. Which of the following must be a factor of  $f(x)$ ?

- A)  $x - 2$
- B)  $x - 3$
- C)  $x - 4$
- D)  $x - 5$

QUESTION 428



QUESTION 429



$$3(2x + 1)(4x + 1)$$

Which of the following is equivalent to the expression above?

- A)  $45x$
- B)  $24x^2 + 3$
- C)  $24x^2 + 18x + 3$
- D)  $18x^2 + 6$



$$\begin{aligned} 3x^2 - 5x + 2 \\ 5x^2 - 2x - 6 \end{aligned}$$

Which of the following is the sum of the two polynomials shown above?

- A)  $8x^2 - 7x - 4$
- B)  $8x^2 + 7x - 4$
- C)  $8x^4 - 7x^2 - 4$
- D)  $8x^4 + 7x^2 - 4$

3.3

## PART III: PASSPORT TO ADVANCED MATH

## HIGHER ORDER EQUATIONS AND OPERATIONS

QUESTION 430



Which of the following is equivalent to the sum of the expressions  $a^2 - 1$  and  $a + 1$ ?

- A)  $a^2 + a$
- B)  $a^3 - 1$
- C)  $2a^2$
- D)  $a^3$

QUESTION 431



$$x^3 - 5x^2 + 2x - 10 = 0$$

For what real value of  $x$  is the equation above true?

QUESTION 432



$$f(x) = 2x^3 + 6x^2 + 4x$$

$$g(x) = x^2 + 3x + 2$$

The polynomials  $f(x)$  and  $g(x)$  are defined above. Which of the following polynomials is divisible by  $2x + 3$ ?

- A)  $h(x) = f(x) + g(x)$
- B)  $p(x) = f(x) + 3g(x)$
- C)  $r(x) = 2f(x) + 3g(x)$
- D)  $s(x) = 3f(x) + 2g(x)$

QUESTION 433

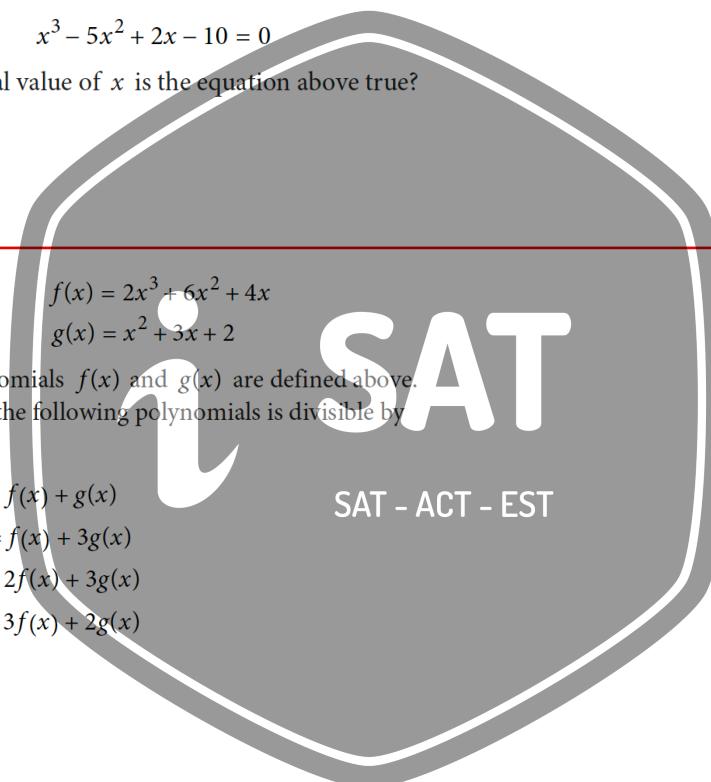


If  $a^2 + b^2 = z$  and  $ab = y$ , which of the following is equivalent to  $4z + 8y$ ?

- A)  $(a + 2b)^2$
- B)  $(2a + 2b)^2$
- C)  $(4a + 4b)^2$
- D)  $(4a + 8b)^2$

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## HIGHER ORDER EQUATIONS AND OPERATIONS

QUESTION 434



Which of the following is equivalent to  $\left(a + \frac{b}{2}\right)^2$ ?

- A)  $a^2 + \frac{b^2}{2}$
- B)  $a^2 + \frac{b^2}{4}$
- C)  $a^2 + \frac{ab}{2} + \frac{b^2}{2}$
- D)  $a^2 + ab + \frac{b^2}{4}$

QUESTION 435



Which of the following is an equivalent form of  $(1.5x - 2.4)^2 - (5.2x^2 - 6.4)$ ?

- A)  $-2.2x^2 + 1.6$
- B)  $-2.2x^2 + 11.2$
- C)  $-2.95x^2 - 7.2x + 12.16$
- D)  $-2.95x^2 - 7.2x + 0.64$

QUESTION 436



Which expression is equivalent to  $(2x^2 - 4) - (-3x^2 + 2x - 7)$ ?

- A)  $5x^2 - 2x + 3$
- B)  $5x^2 + 2x - 3$
- C)  $-x^2 - 2x - 11$
- D)  $-x^2 + 2x - 11$

## 3.3

## PART III: PASSPORT TO ADVANCED MATH

## HIGHER ORDER EQUATIONS AND OPERATIONS

QUESTION 437



$$ax^3 + bx^2 + cx + d = 0$$

In the equation above,  $a$ ,  $b$ ,  $c$ , and  $d$  are constants.

If the equation has roots  $-1$ ,  $-3$ , and  $5$ , which of the

following is a factor of  $ax^3 + bx^2 + cx + d$ ?

- A)  $x - 1$
- B)  $x + 1$
- C)  $x - 3$
- D)  $x + 5$

QUESTION 438



$$(ax + 3)(5x^2 - bx + 4) = 20x^3 - 9x^2 - 2x + 12$$

The equation above is true for all  $x$ , where  $a$  and  $b$  are constants. What is the value of  $ab$ ?

- A) 18
- B) 20
- C) 24
- D) 40

QUESTION 439



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

- A)  $-4x^2$
- B)  $3x^3 - x^2$
- C)  $2x^3 - 3x$
- D)  $2x^3 - 6x^2$

QUESTION 440



If  $u + t = 5$  and  $u - t = 2$ , what is the value of  $(u - t)(u^2 - t^2)$ ?

## EXPONENTS AND RADICALS

QUESTION 441



If  $3x - y = 12$ , what is the value of  $\frac{8^x}{2^y}$ ?

- A)  $2^{12}$
- B)  $4^4$
- C)  $8^2$
- D) The value cannot be determined from the information given.

QUESTION 442



If  $a = 5\sqrt{2}$  and  $2a = \sqrt{2x}$ , what is the value of  $x$ ?

QUESTION 443

QUESTION 444



Jessica opened a bank account that earns 2 percent interest compounded annually. Her initial deposit was \$100, and she uses the expression  $\$100(x)^t$  to find the value of the account after  $t$  years.

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What is the value of  $x$  in the expression?

Jessica's friend Tyshaun found an account that earns 2.5 percent interest compounded annually. Tyshaun made an initial deposit of \$100 into this account at the same time Jessica made a deposit of \$100 into her account. After 10 years, how much more money will Tyshaun's initial deposit have earned than Jessica's initial deposit? (Round your answer to the nearest cent and ignore the dollar sign when gridding your response.)

## EXPONENTS AND RADICALS

QUESTION 445



$$\sqrt{2k^2 + 17} - x = 0$$

If  $k > 0$  and  $x = 7$  in the equation above, what is the value of  $k$ ?

- A) 2
- B) 3
- C) 4
- D) 5

QUESTION 446



If  $\frac{x^{a^2}}{x^{b^2}} = x^{16}$ ,  $x > 1$ , and  $a + b = 2$ , what is the value of  $a - b$ ?

- A) 8
- B) 14
- C) 16
- D) 18

QUESTION 447



A radioactive substance decays at an annual rate of 13 percent. If the initial amount of the substance is 325 grams, which of the following functions models the remaining amount of the substance, in grams,  $t$  years later?

- A)  $f(t) = 325(0.87)^t$
- B)  $f(t) = 325(0.13)^t$
- C)  $f(t) = 0.87(325)^t$
- D)  $f(t) = 0.13(325)^t$

QUESTION 448



$$\sqrt{x-a} = x-4$$

If  $a = 2$ , what is the solution set of the equation above?

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

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## PART III: PASSPORT TO ADVANCED MATH

## EXPONENTS AND RADICALS

QUESTION 449



Which of the following is equal to  $a^{\frac{2}{3}}$ , for all values of  $a$ ?

A)  $\sqrt{a^{\frac{1}{3}}}$

B)  $\sqrt{a^3}$

C)  $\sqrt[3]{a^{\frac{1}{2}}}$

D)  $\sqrt[3]{a^2}$

Of the following four types of savings account plans, which option would yield exponential growth of the money in the account?

- A) Each successive year, 2% of the initial savings is added to the value of the account.
- B) Each successive year, 1.5% of the initial savings and \$100 is added to the value of the account.
- C) Each successive year, 1% of the current value is added to the value of the account.
- D) Each successive year, \$100 is added to the value of the account.

In planning maintenance for a city's infrastructure, a civil engineer estimates that, starting from the present, the population of the city will decrease by 10 percent every 20 years. If the present population of the city is 50,000, which of the following expressions represents the engineer's estimate of the population of the city  $t$  years from now?

A)  $50,000(0.1)^{20t}$

B)  $50,000(0.1)^{\frac{t}{20}}$

C)  $50,000(0.9)^{20t}$

D)  $50,000(0.9)^{\frac{t}{20}}$

QUESTION 450



- Of the following four types of savings account plans, which option would yield exponential growth of the money in the account?
- A) Each successive year, 2% of the initial savings is added to the value of the account.
  - B) Each successive year, 1.5% of the initial savings and \$100 is added to the value of the account.
  - C) Each successive year, 1% of the current value is added to the value of the account.
  - D) Each successive year, \$100 is added to the value of the account.

QUESTION 451



In planning maintenance for a city's infrastructure, a civil engineer estimates that, starting from the present, the population of the city will decrease by 10 percent every 20 years. If the present population of the city is 50,000, which of the following expressions represents the engineer's estimate of the population of the city  $t$  years from now?

A)  $50,000(0.1)^{20t}$

B)  $50,000(0.1)^{\frac{t}{20}}$

C)  $50,000(0.9)^{20t}$

D)  $50,000(0.9)^{\frac{t}{20}}$

SAT

SAT - ACT - EST

## EXPONENTS AND RADICALS

QUESTION 452



$$1,000 \left(1 + \frac{r}{1,200}\right)^{12}$$

The expression above gives the amount of money, in dollars, generated in a year by a \$1,000 deposit in a bank account that pays an annual interest rate of  $r\%$ , compounded monthly. Which of the following expressions shows how much additional money is generated at an interest rate of 5% than at an interest rate of 3%?

A)  $1,000 \left(1 + \frac{5 - 3}{1,200}\right)^{12}$

B)  $1,000 \left(1 + \frac{\frac{5}{3}}{1,200}\right)^{12}$

C)  $\frac{1,000 \left(1 + \frac{5}{1,200}\right)^{12}}{1,000 \left(1 + \frac{3}{1,200}\right)^{12}}$

D)  $1,000 \left(1 + \frac{5}{1,200}\right)^{12} - 1,000 \left(1 + \frac{3}{1,200}\right)^{12}$

QUESTION 453



$$\sqrt{k+2} - x = 0$$

In the equation above,  $k$  is a constant. If  $x = 9$ , what is the value of  $k$ ?

- A) 1
- B) 7
- C) 16
- D) 79

3.4

## PART III: PASSPORT TO ADVANCED MATH

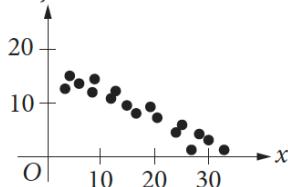
## EXPONENTS AND RADICALS

QUESTION 454

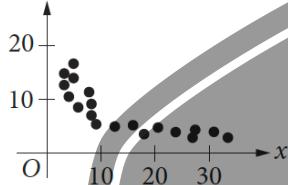


Which of the following scatterplots shows a relationship that is appropriately modeled with the equation  $y = ax^b$ , where  $a$  is positive and  $b$  is negative?

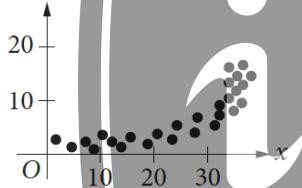
A)



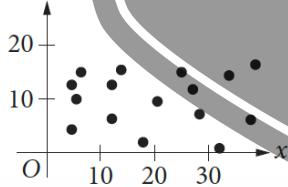
B)



C)



D)



QUESTION 455



Which of the following is equivalent to  $9^{\frac{3}{4}}$ ?

A)  $\sqrt[3]{9}$

B)  $\sqrt[4]{9}$

C)  $\sqrt{3}$

D)  $3\sqrt{3}$

## EXPONENTS AND RADICALS

QUESTION 456



If  $\sqrt{x} + \sqrt{9} = \sqrt{64}$ , what is the value of  $x$ ?

- A)  $\sqrt{5}$
- B) 5
- C) 25
- D) 55

If  $a^{\frac{b}{4}} = 16$  for positive integers  $a$  and  $b$ , what is one possible value of  $b$ ?

QUESTION 458

QUESTION 459



The stock price of one share in a certain company is worth \$360 today. A stock analyst believes that the stock will lose 28 percent of its value each week for the next three weeks. The analyst uses the equation  $V = 360(0.72)^t$  to model the value,  $V$ , of the stock after  $t$  weeks.

What value should the analyst use for  $r$ ?

To the nearest dollar, what does the analyst believe the value of the stock will be at the end of three weeks? (Note: Disregard the \$ sign when gridding your answer.)

QUESTION 460



$$\sqrt{2x+6} + 4 = x + 3$$

What is the solution set of the equation above?

- A)  $\{-1\}$
- B)  $\{5\}$
- C)  $\{-1, 5\}$
- D)  $\{0, -1, 5\}$

## EXPONENTS AND RADICALS

QUESTION 461

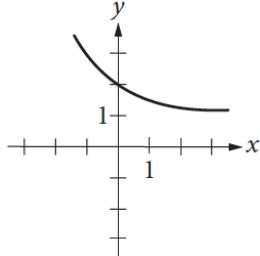


$$f(x) = 2^x + 1$$

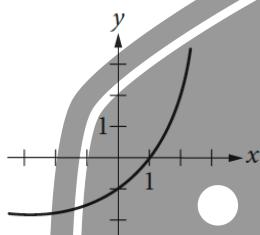
The function  $f$  is defined by the equation above.

Which of the following is the graph of  $y = -f(x)$  in the  $xy$ -plane?

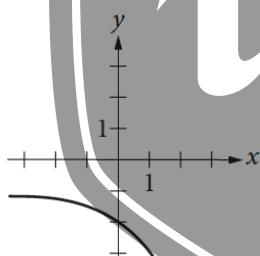
A)



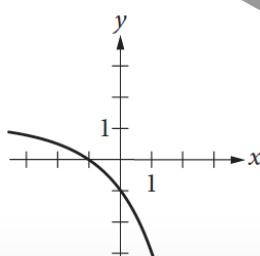
B)



C)



D)



SAT - ACT - EST

3.4

## PART III: PASSPORT TO ADVANCED MATH

### EXONENTS AND RADICALS

QUESTION 462



A motor powers a model car so that after starting from rest, the car travels  $s$  inches in  $t$  seconds, where  $s = 16t\sqrt{t}$ . Which of the following gives the average speed of the car, in inches per second, over the first  $t$  seconds after it starts?

A)  $4\sqrt{t}$

B)  $16\sqrt{t}$

C)  $\frac{16}{\sqrt{t}}$

D)  $16t$

QUESTION 463



If  $a^{-\frac{1}{2}} = x$ , where  $a > 0$ , what is  $a$  in terms of  $x$ ?

A)  $\sqrt{x}$

B)  $-\sqrt{x}$

C)  $\frac{1}{x^2}$

D)  $-\frac{1}{x^2}$

QUESTION 464



What is the set of all solutions to the equation

$$\sqrt{x+2} = -x$$

A)  $\{-1, 2\}$

B)  $\{-1\}$

C)  $\{2\}$

D) There are no solutions to the given equation.

3.4

## PART III: PASSPORT TO ADVANCED MATH

## EXPONENTS AND RADICALS

QUESTION 465



$$M = 1,800(1.02)^t$$

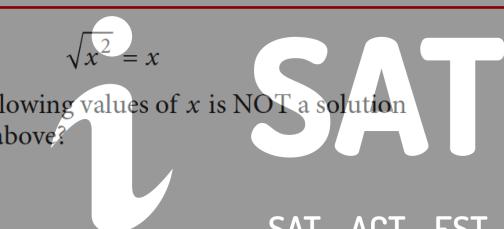
The equation above models the number of members,  $M$ , of a gym  $t$  years after the gym opens. Of the following, which equation models the number of members of the gym  $q$  quarter years after the gym opens?

- A)  $M = 1,800(1.02)^{\frac{q}{4}}$
- B)  $M = 1,800(1.02)^{4q}$
- C)  $M = 1,800(1.005)^{4q}$
- D)  $M = 1,800(1.082)^q$

QUESTION 466



$$\sqrt{x^2} = x$$

  
SAT

SAT - ACT - EST

Which of the following values of  $x$  is NOT a solution to the equation above?

- A)  $-4$
- B)  $0$
- C)  $1$
- D)  $3$

QUESTION 467



$$\sqrt{9x^2}$$

If  $x > 0$ , which of the following is equivalent to the given expression?

- A)  $3x$
- B)  $3x^2$
- C)  $18x$
- D)  $18x^4$

## EXPONENTS AND RADICALS

QUESTION 468



Keith modeled the growth over several hundred years of a tree population by estimating the number of the trees' pollen grains per square centimeter that were deposited each year within layers of a lake's sediment. He estimated there were 310 pollen grains per square centimeter the first year the grains were deposited, with a 1% annual increase in the number of grains per square centimeter thereafter. Which of the following functions models  $P(t)$ , the number of pollen grains per square centimeter  $t$  years after the first year the grains were deposited?

- A)  $P(t) = 310^t$
- B)  $P(t) = 310^{1.01t}$
- C)  $P(t) = 310(0.99)^t$
- D)  $P(t) = 310(1.01)^t$

QUESTION 469



The function  $h$  is defined above. What is  $h(5) - h(3)$ ?

- A) 2
- B) 4
- C) 24
- D) 28

QUESTION 470



$$\sqrt{4x} = x - 3$$

What are all values of  $x$  that satisfy the given equation?

- I. 1
  - II. 9
- A) I only
  - B) II only
  - C) I and II
  - D) Neither I nor II



## EXPONENTS AND RADICALS

QUESTION 471



The expression  $\frac{x^{-2}y^{\frac{1}{2}}}{x^{\frac{1}{3}}y^{-1}}$ , where  $x > 1$  and  $y > 1$ , is

equivalent to which of the following?

A)  $\frac{\sqrt{y}}{\sqrt[3]{x^2}}$

B)  $\frac{y\sqrt{y}}{\sqrt[3]{x^2}}$

C)  $\frac{y\sqrt{y}}{x\sqrt{x}}$

D)  $\frac{y\sqrt{y}}{x^2\sqrt[3]{x}}$

QUESTION 472



Jeremy deposited  $x$  dollars in his investment account on January 1, 2001. The amount of money in the account doubled each year until Jeremy had 480 dollars in his investment account on January 1, 2005. What is the value of  $x$ ?

## RATIONAL EXPRESSIONS

QUESTION 473



The expression  $\frac{5x - 2}{x + 3}$  is equivalent to which of the following?

- A)  $\frac{5 - 2}{3}$
- B)  $5 - \frac{2}{3}$
- C)  $5 - \frac{2}{x + 3}$
- D)  $5 - \frac{17}{x + 3}$

QUESTION 474



$$\frac{a - b}{a} = c$$

In the equation above, if  $a$  is negative and  $b$  is positive, which of the following must be true?

- A)  $c > 1$
- B)  $c = 1$
- C)  $c = -1$
- D)  $c < -1$

QUESTION 475



If  $x > 3$ , which of the following is equivalent

to  $\frac{1}{\frac{1}{x+2} + \frac{1}{x+3}}$  ?

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

## RATIONAL EXPRESSIONS

QUESTION 476



The equation  $\frac{24x^2 + 25x - 47}{ax - 2} = -8x - 3 - \frac{53}{ax - 2}$  is true for all values of  $x \neq \frac{2}{a}$ , where  $a$  is a constant.

What is the value of  $a$ ?

- A) -16
- B) -3
- C) 3
- D) 16

QUESTION 477



$$\frac{2x+6}{(x+2)^2} - \frac{2}{x+2}$$

The expression above is equivalent to  $\frac{a}{(x+2)^2}$ , where  $a$  is a positive constant and  $x \neq -2$ .

What is the value of  $a$ ?

QUESTION 478



Which of the following is equivalent to  $\frac{4x^2 + 6x}{4x + 2}$ ?

- A)  $x$
- B)  $x + 4$
- C)  $x - \frac{2}{4x + 2}$
- D)  $x + 1 - \frac{2}{4x + 2}$

## RATIONAL EXPRESSIONS

QUESTION 479



Which of the following expressions is equivalent to

$$\frac{x^2 - 2x - 5}{x - 3} ?$$

- A)  $x - 5 - \frac{20}{x - 3}$
- B)  $x - 5 - \frac{10}{x - 3}$
- C)  $x + 1 - \frac{8}{x - 3}$
- D)  $x + 1 - \frac{2}{x - 3}$

QUESTION 480



$$\frac{x}{x - 3} = \frac{2x}{2}$$

Which of the following represents all the possible values of  $x$  that satisfy the equation above?

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

QUESTION 481



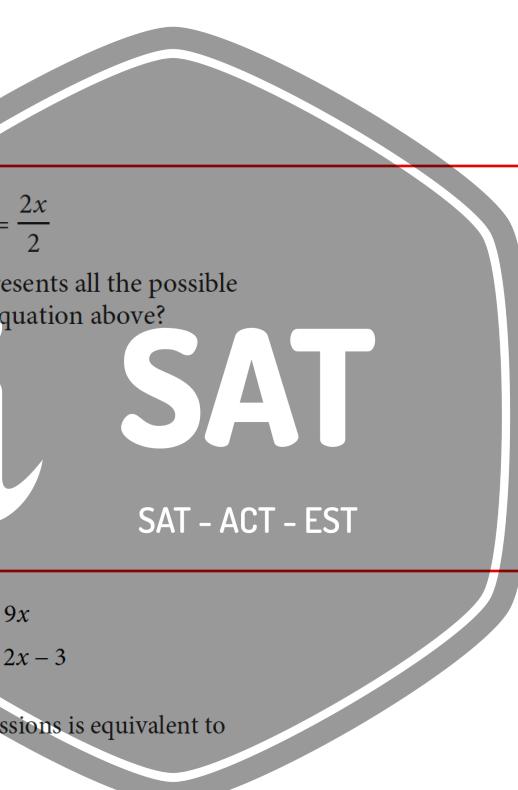
$$f(x) = x^3 - 9x$$

$$g(x) = x^2 - 2x - 3$$

Which of the following expressions is equivalent to

$$\frac{f(x)}{g(x)}, \text{ for } x > 3 ?$$

- A)  $\frac{1}{x + 1}$
- B)  $\frac{x + 3}{x + 1}$
- C)  $\frac{x(x - 3)}{x + 1}$
- D)  $\frac{x(x + 3)}{x + 1}$



3.5

## PART III: PASSPORT TO ADVANCED MATH

## RATIONAL EXPRESSIONS

QUESTION 482



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

In the equation above, which of the following is a possible value of  $x + 1$ ?

- A)  $1 - \sqrt{2}$
- B)  $\sqrt{2}$
- C) 2
- D) 4

QUESTION 483



$$\frac{1}{2x + 1} + 5$$

Which of the following is equivalent to the expression above for  $x > 0$ ?

- A)  $\frac{2x + 5}{2x + 1}$
- B)  $\frac{2x + 6}{2x + 1}$
- C)  $\frac{10x + 5}{2x + 1}$
- D)  $\frac{10x + 6}{2x + 1}$

QUESTION 484



$$\frac{x^2 - 1}{x - 1} = -2$$

What are all values of  $x$  that satisfy the equation above?

- A) -3
- B) 0
- C) 1
- D) -3 and -1

## NON-LINEAR EXPRESSIONS

QUESTION 485



$$m = \frac{\left(\frac{r}{1,200}\right)\left(1 + \frac{r}{1,200}\right)^N}{\left(1 + \frac{r}{1,200}\right)^N - 1} P$$

The formula above gives the monthly payment  $m$  needed to pay off a loan of  $P$  dollars at  $r$  percent annual interest over  $N$  months. Which of the following gives  $P$  in terms of  $m$ ,  $r$ , and  $N$ ?

A)  $P = \frac{\left(\frac{r}{1,200}\right)\left(1 + \frac{r}{1,200}\right)^N}{\left(1 + \frac{r}{1,200}\right)^N - 1} m$

B)  $P = \frac{\left(1 + \frac{r}{1,200}\right)^N - 1}{\left(\frac{r}{1,200}\right)\left(1 + \frac{r}{1,200}\right)^N} m$

C)  $P = \left(\frac{r}{1,200}\right)m$

D)  $P = \left(\frac{1,200}{r}\right)m$

**SAT**  
SAT - ACT - EST

QUESTION 486



Which of the following equations has a graph in the  $xy$ -plane for which  $y$  is always greater than or equal to  $-1$ ?

A)  $y = |x| - 2$

B)  $y = x^2 - 2$

C)  $y = (x - 2)^2$

D)  $y = x^3 - 2$

## NON-LINEAR EXPRESSIONS

QUESTION 487



$$R = \frac{F}{N + F}$$

A website uses the formula above to calculate a seller's rating,  $R$ , based on the number of favorable reviews,  $F$ , and unfavorable reviews,  $N$ . Which of the following expresses the number of favorable reviews in terms of the other variables?

A)  $F = \frac{RN}{R - 1}$

B)  $F = \frac{RN}{1 - R}$

C)  $F = \frac{N}{1 - R}$

D)  $F = \frac{N}{R - 1}$

QUESTION 488

QUESTION 489



A botanist is cultivating a rare species of plant in a controlled environment and currently has 3000 of these plants. The population of this species that the botanist expects to grow next year,  $N_{\text{next year}}$ , can be estimated from the number of plants this year,  $N_{\text{this year}}$ , by the equation below.

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$$N_{\text{next year}} = N_{\text{this year}} + 0.2(N_{\text{this year}}) \left(1 - \frac{N_{\text{this year}}}{K}\right)$$

The constant  $K$  in this formula is the number of plants the environment is able to support.

According to the formula, what will be the number of plants two years from now if  $K = 4000$ ? (Round your answer to the nearest whole number.)

The botanist would like to increase the number of plants that the environment can support so that the population of the species will increase more rapidly. If the botanist's goal is that the number of plants will increase from 3000 this year to 3360 next year, how many plants must the modified environment support?

## NON-LINEAR EXPRESSIONS

QUESTION 490



- In the  $xy$ -plane, the parabola with equation  $y = (x - 11)^2$  intersects the line with equation  $y = 25$  at two points,  $A$  and  $B$ . What is the length of  $\overline{AB}$ ?
- A) 10  
B) 12  
C) 14  
D) 16

QUESTION 491

QUESTION 492



$$I = \frac{P}{4\pi r^2}$$

At a large distance  $r$  from a radio antenna, the intensity of the radio signal  $I$  is related to the power of the signal  $P$  by the formula above.

Which of the following expresses the square of the distance from the radio antenna in terms of the intensity of the radio signal and the power of the signal?

- A)  $r^2 = \frac{IP}{4\pi}$   
 B)  $r^2 = \frac{P}{4\pi I}$   
 C)  $r^2 = \frac{4\pi I}{P}$   
 D)  $r^2 = \frac{I}{4\pi P}$

For the same signal emitted by a radio antenna, Observer A measures its intensity to be 16 times the intensity measured by Observer B. The distance of Observer A from the radio antenna is what fraction of the distance of Observer B from the radio antenna?

- A)  $\frac{1}{4}$   
 B)  $\frac{1}{16}$   
 C)  $\frac{1}{64}$   
 D)  $\frac{1}{256}$

**SAT**  
SAT - ACT - EST

## NON-LINEAR EXPRESSIONS

QUESTION 493



$$y = x^2$$

$$2y + 6 = 2(x + 3)$$

If  $(x, y)$  is a solution of the system of equations above and  $x > 0$ , what is the value of  $xy$ ?

- A) 1
- B) 2
- C) 3
- D) 9

QUESTION 494



$$h = -16t^2 + vt + k$$

The equation above gives the height  $h$ , in feet, of a ball  $t$  seconds after it is thrown straight up with an initial speed of  $v$  feet per second from a height of  $k$  feet. Which of the following gives  $v$  in terms of  $h$ ,  $t$ , and  $k$ ?

- A)  $v = h + k - 16t$
- B)  $v = \frac{h - k + 16}{t}$
- C)  $v = \frac{h + k}{t} - 16t$
- D)  $v = \frac{h - k}{t} + 16t$

QUESTION 495



The density  $d$  of an object is found by dividing the mass  $m$  of the object by its volume  $V$ . Which of the following equations gives the mass  $m$  in terms of  $d$  and  $V$ ?

- A)  $m = dV$
- B)  $m = \frac{d}{V}$
- C)  $m = \frac{V}{d}$
- D)  $m = V + d$

**SAT**  
SAT - ACT - EST

## NON-LINEAR EXPRESSIONS

QUESTION 496



A bricklayer uses the formula  $n = 7\ell h$  to estimate the number of bricks,  $n$ , needed to build a wall that is  $\ell$  feet long and  $h$  feet high. Which of the following correctly expresses  $\ell$  in terms of  $n$  and  $h$ ?

A)  $\ell = \frac{7}{nh}$

B)  $\ell = \frac{h}{7n}$

C)  $\ell = \frac{n}{7h}$

D)  $\ell = \frac{n}{7+h}$

QUESTION 497



$$\begin{aligned}y &= x^2 + 3x - 7 \\y - 5x + 8 &= 0\end{aligned}$$

How many solutions are there to the system of equations above?

- A) There are exactly 4 solutions.
- B) There are exactly 2 solutions.
- C) There is exactly 1 solution.
- D) There are no solutions.

QUESTION 498



$$\begin{aligned}y &= x^2 - 4x + 4 \\y &= 4 - x\end{aligned}$$

If the ordered pair  $(x, y)$  satisfies the system of equations above, what is one possible value of  $x$ ?

QUESTION 499



The graph of the exponential function  $h$  in the  $xy$ -plane, where  $y = h(x)$ , has a  $y$ -intercept of  $d$ , where  $d$  is a positive constant. Which of the following could define the function  $h$ ?

A)  $h(x) = -3(d)^x$

B)  $h(x) = 3(x)d$

C)  $h(x) = d(-x)^3$

D)  $h(x) = d(3)^x$

## NON-LINEAR EXPRESSIONS

QUESTION 500

QUESTION 501



$$\text{Mosteller's formula: } A = \frac{\sqrt{hw}}{60}$$

$$\text{Current's formula: } A = \frac{4 + w}{30}$$

The formulas above are used in medicine to estimate the body surface area  $A$ , in square meters, of infants and children whose weight  $w$  ranges between 3 and 30 kilograms and whose height  $h$  is measured in centimeters.

Based on Current's formula, what is  $w$  in terms of  $A$ ?

- A)  $w = 30A - 4$
- B)  $w = 30A + 4$
- C)  $w = 30(A - 4)$
- D)  $w = 30(A + 4)$

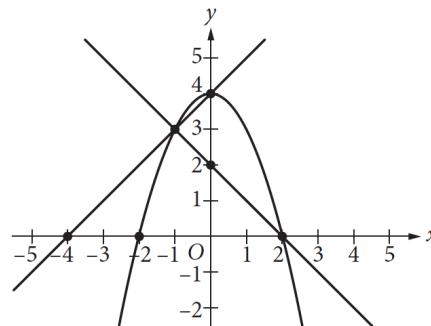


If Mosteller's and Current's formulas give the same estimate for  $A$ , which of the following expressions is equivalent to  $\sqrt{hw}$ ?

- A)  $\frac{4 + w}{2}$
- B)  $\frac{4 + w}{1,800}$
- C)  $2(4 + w)$
- D)  $\frac{(4 + w)^2}{2}$


## NON-LINEAR EXPRESSIONS

QUESTION 502



A system of three equations is graphed in the  $xy$ -plane above. How many solutions does the system have?

- A) None
- B) One
- C) Two
- D) Three

QUESTION 503



The volume of a sphere is given by the formula

$$V = \frac{4}{3}\pi r^3, \text{ where } r \text{ is the radius of the sphere. Which}$$

of the following gives the radius of the sphere in terms of the volume of the sphere?

- A)  $\frac{4\pi}{3V}$
- B)  $\frac{3V}{4\pi}$
- C)  $\sqrt[3]{\frac{4\pi}{3V}}$
- D)  $\sqrt[3]{\frac{3V}{4\pi}}$

QUESTION 504



$$y = 3$$

$$y = ax^2 + b$$

In the system of equations above,  $a$  and  $b$  are constants. For which of the following values of  $a$  and  $b$  does the system of equations have exactly two real solutions?

- A)  $a = -2, b = 2$
- B)  $a = -2, b = 4$
- C)  $a = 2, b = 4$
- D)  $a = 4, b = 3$

## NON-LINEAR EXPRESSIONS

QUESTION 505



A group of friends decided to divide the \$800 cost of a trip equally among themselves. When two of the friends decided not to go on the trip, those remaining still divided the \$800 cost equally, but each friend's share of the cost increased by \$20. How many friends were in the group originally?

QUESTION 506



$$\frac{x}{y} = 6$$

$$4(y + 1) = x$$

If  $(x, y)$  is the solution to the system of equations above, what is the value of  $y$ ?

- A) 2
- B) 4
- C) 12
- D) 24

QUESTION 507



$$x = 2y + 5$$

$$y = (2x - 3)(x + 9)$$

How many ordered pairs  $(x, y)$  satisfy the system of equations shown above?

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- A) 0
- B) 1
- C) 2
- D) Infinitely many

QUESTION 508



In the  $xy$ -plane, a line that has the equation  $y = c$  for some constant  $c$  intersects a parabola at exactly one point. If the parabola has the equation  $y = -x^2 + 5x$ , what is the value of  $c$ ?

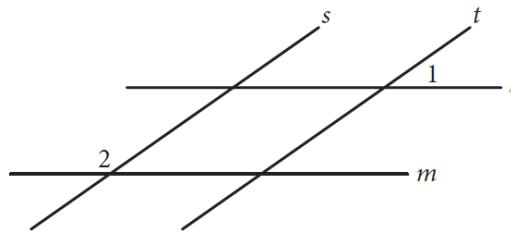
# PART IV

i SAT  
ADDITIONAL TOPICS  
SAT - ACT - EST



## ANGLES AND PARALLEL LINES

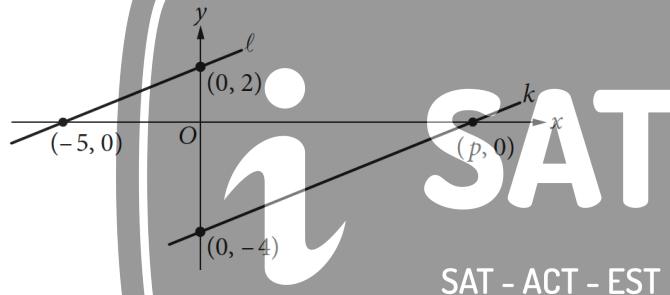
QUESTION 509



In the figure above, lines  $\ell$  and  $m$  are parallel and lines  $s$  and  $t$  are parallel. If the measure of  $\angle 1$  is  $35^\circ$ , what is the measure of  $\angle 2$ ?

- A)  $35^\circ$
- B)  $55^\circ$
- C)  $70^\circ$
- D)  $145^\circ$

QUESTION 510



In the  $xy$ -plane above, line  $\ell$  is parallel to line  $k$ . What is the value of  $p$ ?

- A) 4
- B) 5
- C) 8
- D) 10

QUESTION 511



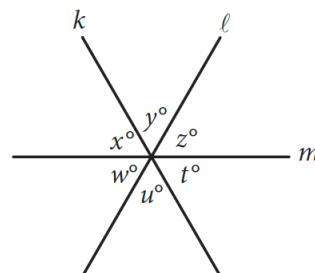
$$nA = 360$$

The measure  $A$ , in degrees, of an exterior angle of a regular polygon is related to the number of sides,  $n$ , of the polygon by the formula above. If the measure of an exterior angle of a regular polygon is greater than  $50^\circ$ , what is the greatest number of sides it can have?

- A) 5
- B) 6
- C) 7
- D) 8

## ANGLES AND PARALLEL LINES

QUESTION 512



Note: Figure not drawn to scale.

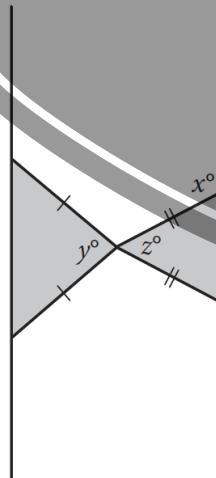
In the figure above, lines  $k$ ,  $\ell$ , and  $m$  intersect at a point. If  $x + y = u + w$ , which of the following must be true?

- I.  $x = z$
  - II.  $y = w$
  - III.  $z = t$
- A) I and II only  
B) I and III only  
C) II and III only  
D) I, II, and III

QUESTION 513



SAT - ACT - EST

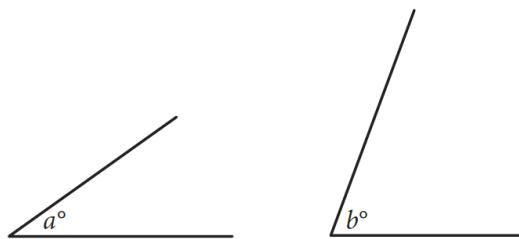


Note: Figure not drawn to scale.

Two isosceles triangles are shown above. If  $180 - z = 2y$  and  $y = 75$ , what is the value of  $x$ ?

## ANGLES AND PARALLEL LINES

QUESTION 514



Note: Figures not drawn to scale.

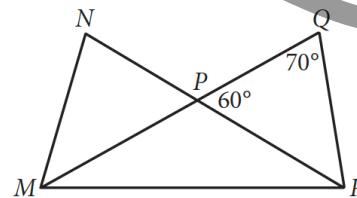
The angles shown above are acute and  $\sin(a^\circ) = \cos(b^\circ)$ . If  $a = 4k - 22$  and  $b = 6k - 13$ , what is the value of  $k$ ?

- A) 4.5
- B) 5.5
- C) 12.5
- D) 21.5

QUESTION 515

Intersecting lines  $r$ ,  $s$ , and  $t$  are shown below.What is the value of  $x$ ?

QUESTION 516



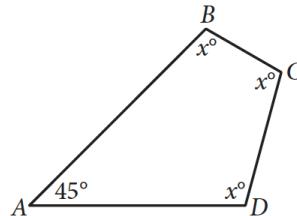
In the figure above,  $\overline{MQ}$  and  $\overline{NR}$  intersect at point  $P$ ,  $NP = QP$ , and  $MP = PR$ . What is the measure, in degrees, of  $\angle QMR$ ? (Disregard the degree symbol when gridding your answer.)

## 4.I

## PART IV: ADDITIONAL TOPICS

## ANGLES AND PARALLEL LINES

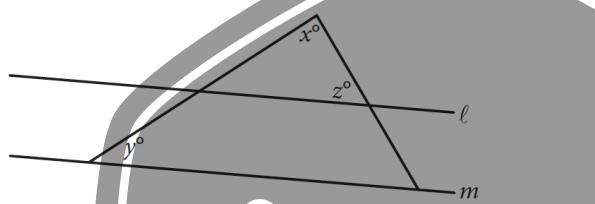
QUESTION 517



In the figure above, what is the value of  $x$ ?

- A) 45
- B) 90
- C) 100
- D) 105

QUESTION 518

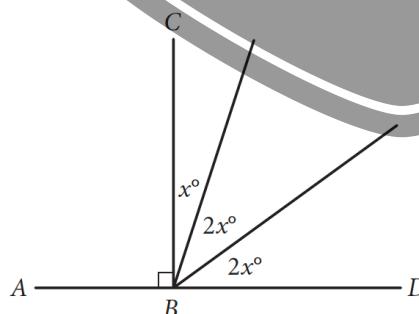


Note: Figure not drawn to scale.

In the figure above, lines  $\ell$  and  $m$  are parallel,  $y = 20$ , and  $z = 60$ . What is the value of  $x$ ?

- A) 120
- B) 100
- C) 90
- D) 80

QUESTION 519



In the figure above, point  $B$  lies on  $\overline{AD}$ . What is the value of  $3x$ ?

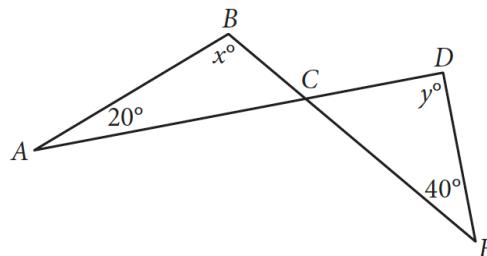
- A) 18
- B) 36
- C) 54
- D) 72

4.1

## PART IV: ADDITIONAL TOPICS

## ANGLES AND PARALLEL LINES

QUESTION 520

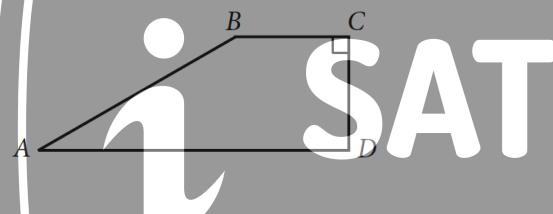


Note: Figure not drawn to scale.

In the figure above,  $\overline{AD}$  intersects  $\overline{BE}$  at  $C$ . If  $x = 100$ , what is the value of  $y$ ?

- A) 100
- B) 90
- C) 80
- D) 60

QUESTION 521



In quadrilateral  $ABCD$  above,  $\overline{AD} \parallel \overline{BC}$  and  $\angle D = 90^\circ$ .

$CD = \frac{1}{2} AB$ . What is the measure of angle  $B$ ?

- A)  $150^\circ$
- B)  $135^\circ$
- C)  $120^\circ$
- D)  $90^\circ$

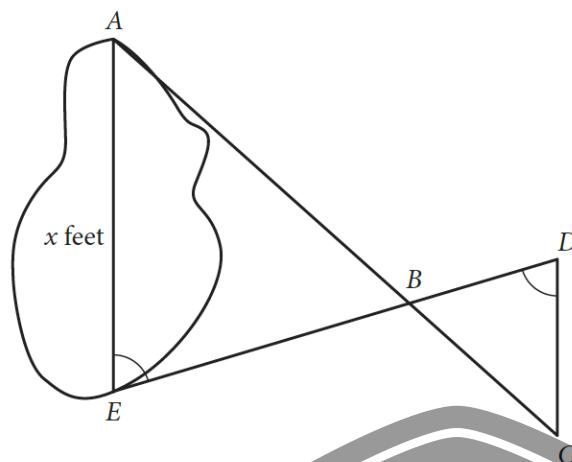
QUESTION 522



The number of radians in a 720-degree angle can be written as  $a\pi$ , where  $a$  is a constant. What is the value of  $a$ ?

## TRIANGLES

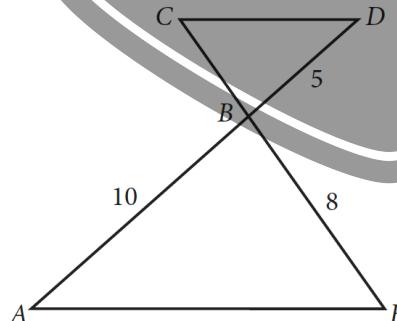
QUESTION 523



A summer camp counselor wants to find a length,  $x$ , in feet, across a lake as represented in the sketch above. The lengths represented by  $AB$ ,  $EB$ ,  $BD$ , and  $CD$  on the sketch were determined to be 1800 feet, 1400 feet, 700 feet, and 800 feet, respectively.

Segments  $AC$  and  $DE$  intersect at  $B$ , and  $\angle AEB$  and  $\angle CDB$  have the same measure. What is the value of  $x$ ?

QUESTION 524



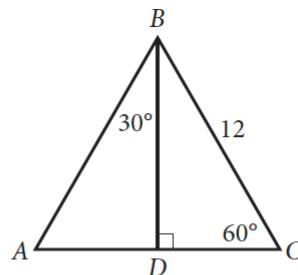
In the figure above,  $\overline{AE} \parallel \overline{CD}$  and segment  $AD$  intersects segment  $CE$  at  $B$ . What is the length of segment  $CE$ ?

## 4.2

## PART IV: ADDITIONAL TOPICS

## TRIANGLES

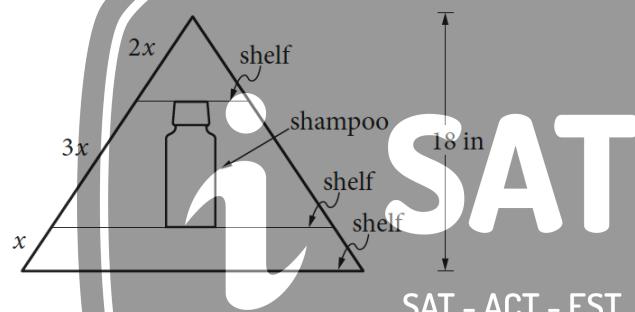
QUESTION 525



In  $\triangle ABC$  above, what is the length of  $\overline{AD}$ ?

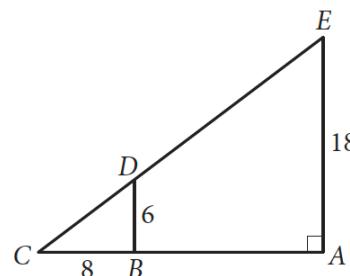
- A) 4  
 B) 6  
 C)  $6\sqrt{2}$   
 D)  $6\sqrt{3}$

QUESTION 526



Jim has a triangular shelf system that attaches to his showerhead. The total height of the system is 18 inches, and there are three parallel shelves as shown above. What is the maximum height, in inches, of a shampoo bottle that can stand upright on the middle shelf?

QUESTION 527



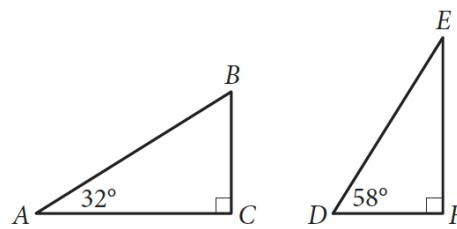
In the figure above,  $\overline{BD}$  is parallel to  $\overline{AE}$ . What is the length of  $\overline{CE}$ ?

4.2

## PART IV: ADDITIONAL TOPICS

## TRIANGLES

QUESTION 528



Triangles  $ABC$  and  $DEF$  are shown above. Which of the following is equal to the ratio  $\frac{BC}{AB}$ ?

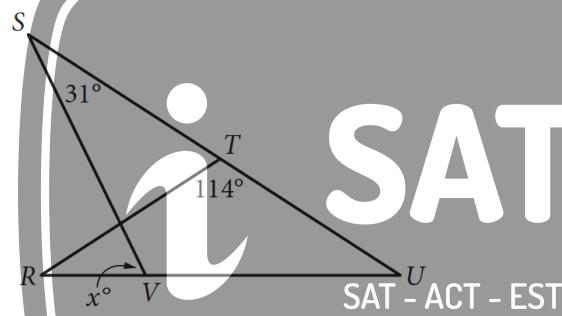
A)  $\frac{DE}{DF}$

B)  $\frac{DF}{DE}$

C)  $\frac{DF}{EF}$

D)  $\frac{EF}{DE}$

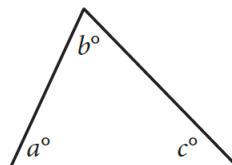
QUESTION 529



In the figure above,  $RT = TU$ . What is the value of  $x$ ?

- A) 72
- B) 66
- C) 64
- D) 58

QUESTION 530



Note: Figure not drawn to scale.

In the triangle above,  $a = 34$ . What is the value of  $b + c$ ?

## CIRCLES

QUESTION 531



Which of the following is an equation of a circle in the  $xy$ -plane with center  $(0, 4)$  and a radius with endpoint  $\left(\frac{4}{3}, 5\right)$ ?

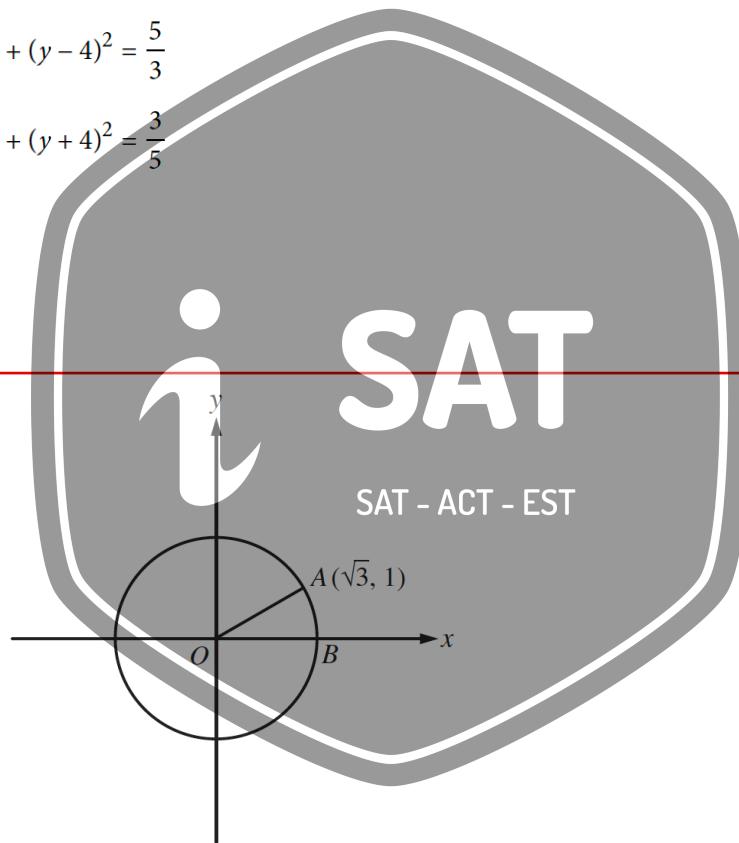
A)  $x^2 + (y - 4)^2 = \frac{25}{9}$

B)  $x^2 + (y + 4)^2 = \frac{25}{9}$

C)  $x^2 + (y - 4)^2 = \frac{5}{3}$

D)  $x^2 + (y + 4)^2 = \frac{3}{5}$

QUESTION 532



In the  $xy$ -plane above,  $O$  is the center of the circle, and the measure of  $\angle AOB$  is  $\frac{\pi}{a}$  radians. What is the value of  $a$ ?

## CIRCLES

QUESTION 533

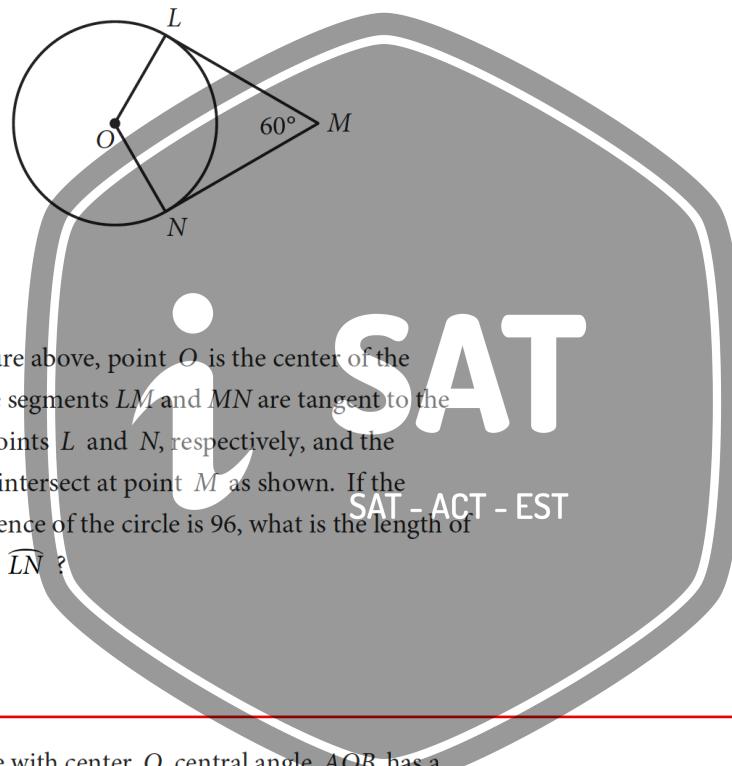


$$x^2 + y^2 + 4x - 2y = -1$$

The equation of a circle in the  $xy$ -plane is shown above. What is the radius of the circle?

- A) 2
- B) 3
- C) 4
- D) 9

QUESTION 534



In the figure above, point  $O$  is the center of the circle, line segments  $LM$  and  $MN$  are tangent to the circle at points  $L$  and  $N$ , respectively, and the segments intersect at point  $M$  as shown. If the circumference of the circle is 96, what is the length of minor arc  $\widehat{LN}$ ?

QUESTION 535



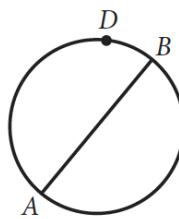
In a circle with center  $O$ , central angle  $AOB$  has a measure of  $\frac{5\pi}{4}$  radians. The area of the sector formed by central angle  $AOB$  is what fraction of the area of the circle?

## 4.3

## PART IV: ADDITIONAL TOPICS

## CIRCLES

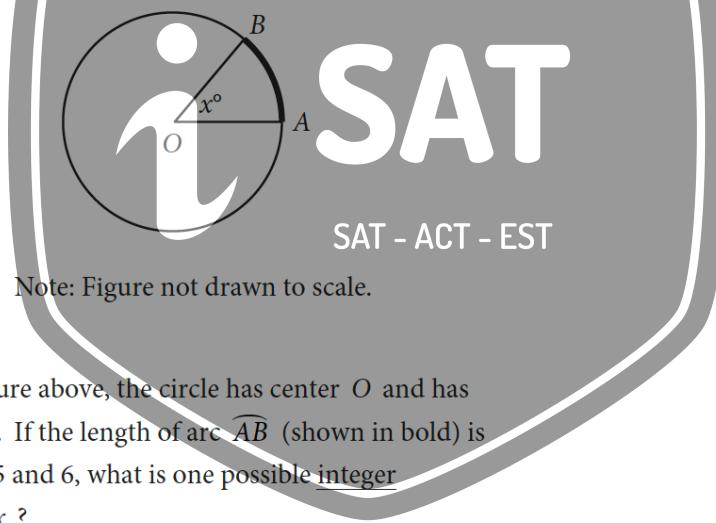
QUESTION 536



In the circle above, segment  $AB$  is a diameter. If the length of arc  $\widehat{ADB}$  is  $8\pi$ , what is the length of the radius of the circle?

- A) 2
- B) 4
- C) 8
- D) 16

QUESTION 537



In the figure above, the circle has center  $O$  and has radius 10. If the length of arc  $\widehat{AB}$  (shown in bold) is between 5 and 6, what is one possible integer value of  $x$ ?

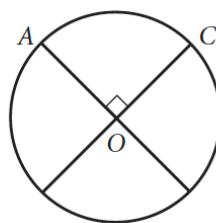
QUESTION 538



$$x^2 + 20x + y^2 + 16y = -20$$

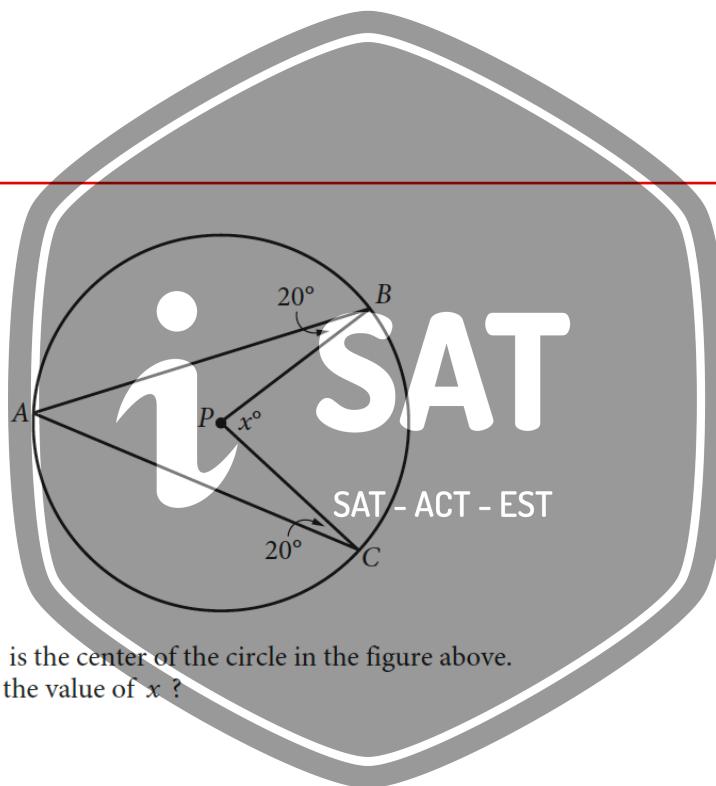
The equation above defines a circle in the  $xy$ -plane. What are the coordinates of the center of the circle?

- A)  $(-20, -16)$
- B)  $(-10, -8)$
- C)  $(10, 8)$
- D)  $(20, 16)$

**4.3****PART IV: ADDITIONAL TOPICS****CIRCLES****QUESTION 539**

The circle above with center  $O$  has a circumference of 36. What is the length of minor arc  $\widehat{AC}$ ?

- A) 9
- B) 12
- C) 18
- D) 36

**QUESTION 540**

Point  $P$  is the center of the circle in the figure above. What is the value of  $x$ ?

**QUESTION 541**

Points  $A$  and  $B$  lie on a circle with radius 1, and arc  $\widehat{AB}$  has length  $\frac{\pi}{3}$ . What fraction of the circumference of the circle is the length of arc  $\widehat{AB}$ ?

4.3

## PART IV: ADDITIONAL TOPICS

## CIRCLES

QUESTION 542



In the  $xy$ -plane, the graph of  $2x^2 - 6x + 2y^2 + 2y = 45$  is a circle. What is the radius of the circle?

- A) 5
- B) 6.5
- C)  $\sqrt{40}$
- D)  $\sqrt{50}$

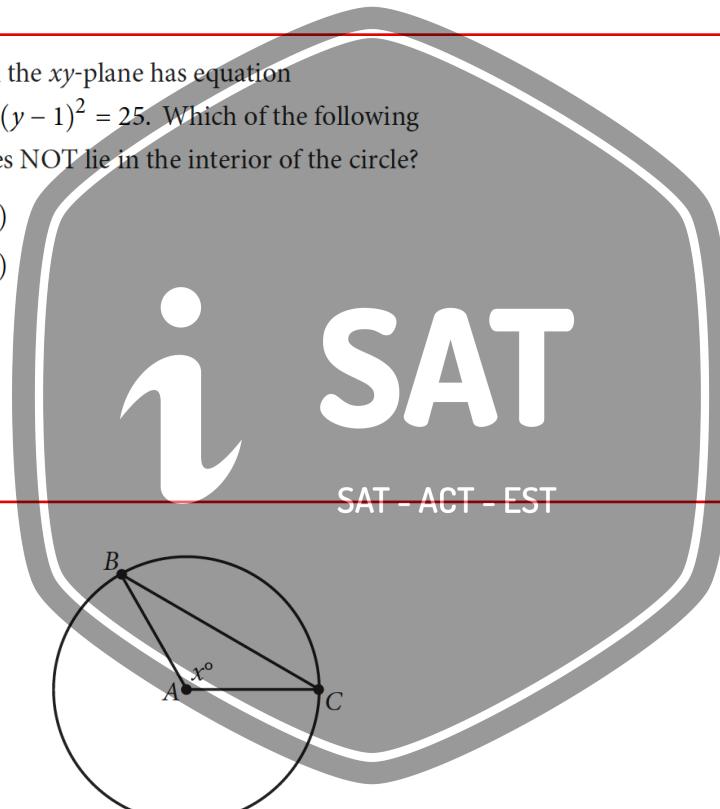
QUESTION 543



A circle in the  $xy$ -plane has equation  $(x + 3)^2 + (y - 1)^2 = 25$ . Which of the following points does NOT lie in the interior of the circle?

- A)  $(-7, 3)$
- B)  $(-3, 1)$
- C)  $(0, 0)$
- D)  $(3, 2)$

QUESTION 544



Note: Figure not drawn to scale.

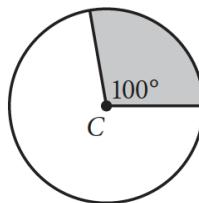
In the circle above, point A is the center and the length of arc  $\widehat{BC}$  is  $\frac{2}{5}$  of the circumference of the circle. What is the value of  $x$ ?

4.3

## PART IV: ADDITIONAL TOPICS

## CIRCLES

QUESTION 545



Point  $C$  is the center of the circle above. What fraction of the area of the circle is the area of the shaded region?

QUESTION 546

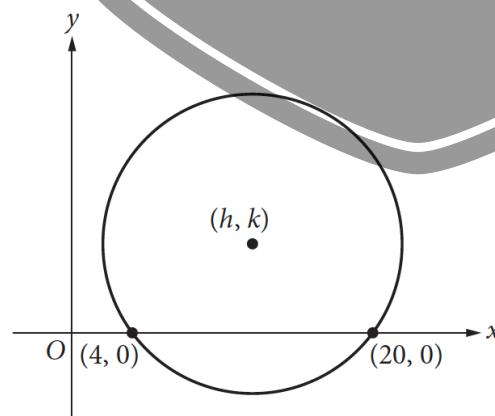


$$(x - 6)^2 + (y + 5)^2 = 16$$

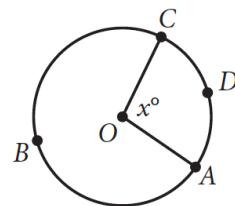
In the  $xy$ -plane, the graph of the equation above is a circle. Point  $P$  is on the circle and has coordinates  $(10, -5)$ . If  $\overline{PQ}$  is a diameter of the circle, what are the coordinates of point  $Q$ ?

- A)  $(2, -5)$
- B)  $(6, -1)$
- C)  $(6, -5)$
- D)  $(6, -9)$

QUESTION 547



In the  $xy$ -plane above, the circle has center  $(h, k)$  and radius 10. What is the value of  $k$ ?

**4.3****PART IV: ADDITIONAL TOPICS****CIRCLES****QUESTION 548**

The circle above has center  $O$ , the length of arc  $\widehat{ADC}$  is  $5\pi$ , and  $x = 100$ . What is the length of arc  $\widehat{ABC}$ ?

- A)  $9\pi$
- B)  $13\pi$
- C)  $18\pi$
- D)  $\frac{13}{2}\pi$

**QUESTION 549**

A circle in the  $xy$ -plane has center  $(5, 7)$  and radius 2. Which of the following is an equation of the circle?

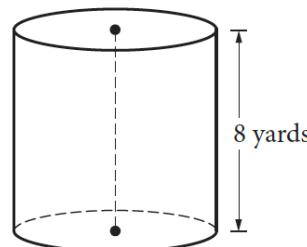
- A)  $(x - 5)^2 + (y - 7)^2 = 4$
- B)  $(x + 5)^2 + (y + 7)^2 = 4$
- C)  $(x - 5)^2 + (y - 7)^2 = 2$
- D)  $(x + 5)^2 + (y + 7)^2 = 2$

## 4.4

## PART IV: ADDITIONAL TOPICS

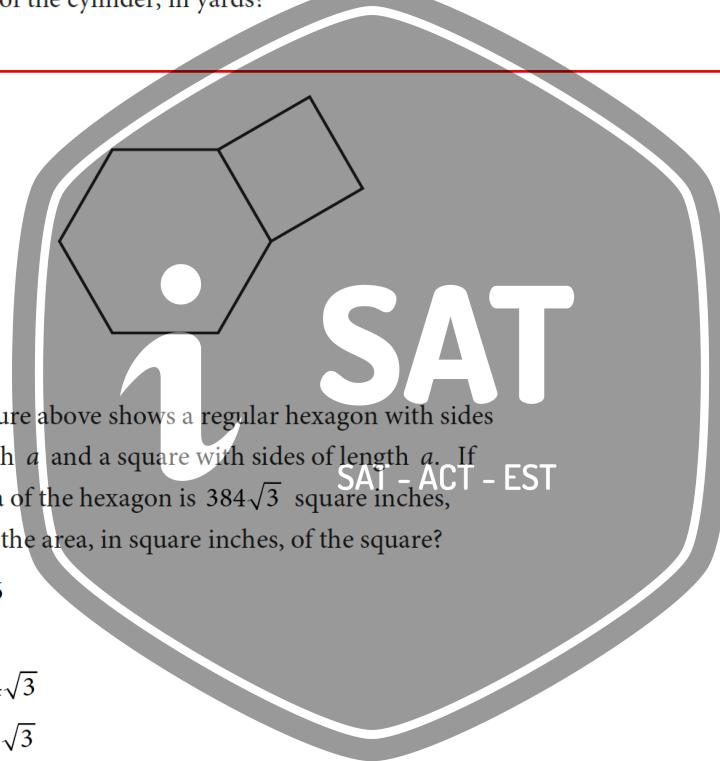
## AREAS AND VOLUMES

QUESTION 550



A dairy farmer uses a storage silo that is in the shape of the right circular cylinder above. If the volume of the silo is  $72\pi$  cubic yards, what is the diameter of the base of the cylinder, in yards?

QUESTION 551



The figure above shows a regular hexagon with sides of length  $a$  and a square with sides of length  $a$ . If the area of the hexagon is  $384\sqrt{3}$  square inches, what is the area, in square inches, of the square?

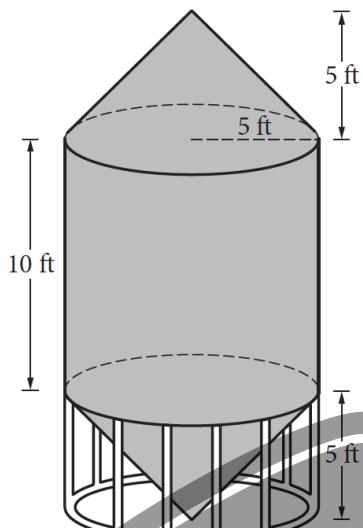
- A) 256
- B) 192
- C)  $64\sqrt{3}$
- D)  $16\sqrt{3}$

QUESTION 552



A rectangle was altered by increasing its length by 10 percent and decreasing its width by  $p$  percent. If these alterations decreased the area of the rectangle by 12 percent, what is the value of  $p$ ?

- A) 12
- B) 15
- C) 20
- D) 22

**4.4****PART IV: ADDITIONAL TOPICS****AREAS AND VOLUMES****QUESTION 553**

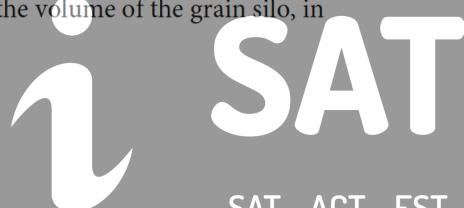
A grain silo is built from two right circular cones and a right circular cylinder with internal measurements represented by the figure above. Of the following, which is closest to the volume of the grain silo, in cubic feet?

- A) 261.8
- B) 785.4
- C) 916.3
- D) 1,047.2

**QUESTION 554**

The surface area of a cube is  $6\left(\frac{a}{4}\right)^2$ , where  $a$  is a positive constant. Which of the following gives the perimeter of one face of the cube?

- A)  $\frac{a}{4}$
- B)  $a$
- C)  $4a$
- D)  $6a$

  
**SAT**  
SAT - ACT - EST

# 4.4

## PART IV: ADDITIONAL TOPICS

### AREAS AND VOLUMES

QUESTION 555



The density of an object is equal to the mass of the object divided by the volume of the object. What is the volume, in milliliters, of an object with a mass of 24 grams and a density of 3 grams per milliliter?

- A) 0.125
- B) 8
- C) 21
- D) 72

QUESTION 556



A landscaper is designing a rectangular garden. The length of the garden is to be 5 feet longer than the width. If the area of the garden will be 104 square feet, what will be the length, in feet, of the garden?

QUESTION 557



A laboratory supply company produces graduated cylinders, each with an internal radius of 2 inches and an internal height between 7.75 inches and 8 inches. What is one possible volume, rounded to the nearest cubic inch, of a graduated cylinder produced by this company?

QUESTION 558



The volume of right circular cylinder A is 22 cubic centimeters. What is the volume, in cubic centimeters, of a right circular cylinder with twice the radius and half the height of cylinder A?

- A) 11
- B) 22
- C) 44
- D) 66

**4.4****PART IV: ADDITIONAL TOPICS****AREAS AND VOLUMES****QUESTION 559**

A cylindrical can containing pieces of fruit is filled to the top with syrup before being sealed. The base of the can has an area of  $75 \text{ cm}^2$ , and the height of the can is 10 cm. If  $110 \text{ cm}^3$  of syrup is needed to fill the can to the top, which of the following is closest to the total volume of the pieces of fruit in the can?

- A)  $7.5 \text{ cm}^3$
- B)  $185 \text{ cm}^3$
- C)  $640 \text{ cm}^3$
- D)  $750 \text{ cm}^3$

**QUESTION 560**

A granite block in the shape of a right rectangular prism has dimensions 30 centimeters by 40 centimeters by 50 centimeters. The block has a density of 2.8 grams per cubic centimeter. What is the mass of the block, in grams? (Density is mass per unit volume.)

- A) 336
- B) 3,360
- C) 16,800
- D) 168,000

**QUESTION 561**

The width of a rectangular dance floor is  $w$  feet. The length of the floor is 6 feet longer than its width. Which of the following expresses the perimeter, in feet, of the dance floor in terms of  $w$ ?

- A)  $2w + 6$
- B)  $4w + 12$
- C)  $w^2 + 6$
- D)  $w^2 + 6w$

4.4

## PART IV: ADDITIONAL TOPICS

## AREAS AND VOLUMES

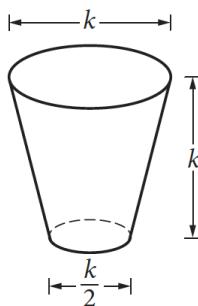
QUESTION 562

QUESTION 563

QUESTION 564



$$\text{Volume} = \frac{7\pi k^3}{48}$$

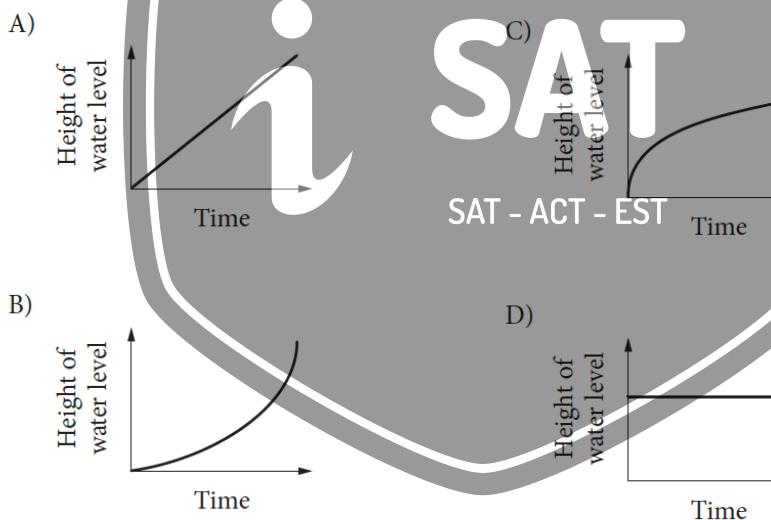


The glass pictured above can hold a maximum volume of 473 cubic centimeters, which is approximately 16 fluid ounces.

What is the value of  $k$ , in centimeters?

- A) 2.52
- B) 7.67
- C) 7.79
- D) 10.11

Water pours into the glass slowly and at a constant rate. Which of the following graphs best illustrates the height of the water level in the glass as it fills?



Jenny has a pitcher that contains 1 gallon of water.

How many times could Jenny completely fill the glass with 1 gallon of water? (1 gallon = 128 fluid ounces)

- A) 16
- B) 8
- C) 4
- D) 3


# 4.4

## PART IV: ADDITIONAL TOPICS

### AREAS AND VOLUMES

QUESTION 565



What is the volume, in cubic centimeters, of a right rectangular prism that has a length of 4 centimeters, a width of 9 centimeters, and a height of 10 centimeters?

QUESTION 566



A right circular cone has a volume of  $24\pi$  cubic inches. If the height of the cone is 2 inches, what is the radius, in inches, of the base of the cone?

- A)  $2\sqrt{3}$
- B) 6
- C) 12
- D) 36

QUESTION 567



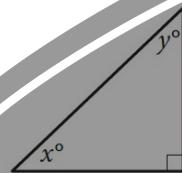
Jim has identical drinking glasses each in the shape of a right circular cylinder with internal diameter of 3 inches. He pours milk from a gallon jug into each glass until it is full. If the height of milk in each glass is about 6 inches, what is the largest number of full milk glasses that he can pour from one gallon of milk? (Note: There are 231 cubic inches in 1 gallon.)

- A) 2
- B) 4
- C) 5
- D) 6

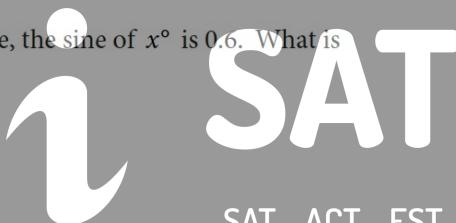
**4.5****PART IV: ADDITIONAL TOPICS****TRIGONOMETRY****QUESTION 568**

In a right triangle, one angle measures  $x^\circ$ , where

$$\sin x^\circ = \frac{4}{5}. \text{ What is } \cos(90^\circ - x^\circ) ?$$

**QUESTION 569**

In the triangle above, the sine of  $x^\circ$  is 0.6. What is the cosine of  $y^\circ$  ?



SAT - ACT - EST

**QUESTION 570**

If  $\sin x^\circ = a$ , which of the following must be true for all values of  $x$  ?

- A)  $\cos x^\circ = a$
- B)  $\sin (90^\circ - x^\circ) = a$
- C)  $\cos (90^\circ - x^\circ) = a$
- D)  $\sin (x^2)^\circ = a^2$

4.5

## PART IV: ADDITIONAL TOPICS

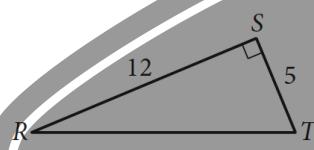
## TRIGONOMETRY

QUESTION 571



In triangle  $ABC$ , the measure of  $\angle B$  is  $90^\circ$ ,  $BC = 16$ , and  $AC = 20$ . Triangle  $DEF$  is similar to triangle  $ABC$ , where vertices  $D$ ,  $E$ , and  $F$  correspond to vertices  $A$ ,  $B$ , and  $C$ , respectively, and each side of triangle  $DEF$  is  $\frac{1}{3}$  the length of the corresponding side of triangle  $ABC$ . What is the value of  $\sin F$ ?

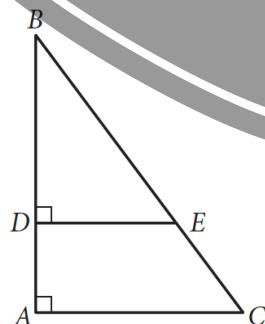
QUESTION 572



In triangle  $RST$  above, point  $W$  (not shown) lies on  $\overline{RT}$ . What is the value of  $\cos(\angle RSW) - \sin(\angle WST)$ ?

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QUESTION 573



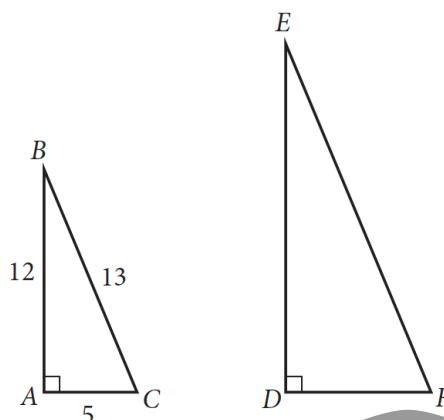
In the figure above,  $\tan B = \frac{3}{4}$ . If  $BC = 15$  and  $DA = 4$ , what is the length of  $\overline{DE}$ ?

4.5

## PART IV: ADDITIONAL TOPICS

## TRIGONOMETRY

QUESTION 574



In the figure above, triangle  $ABC$  is similar to triangle  $DEF$ . What is the value of  $\cos(E)$ ?

- A)  $\frac{12}{5}$
- B)  $\frac{12}{13}$
- C)  $\frac{5}{12}$
- D)  $\frac{5}{13}$

QUESTION 575



Triangle  $PQR$  has right angle  $Q$ . If  $\sin R = \frac{4}{5}$ , what is the value of  $\tan P$ ?



## 4.6

## PART IV: ADDITIONAL TOPICS

## COMPLEX NUMBERS

QUESTION 576



For  $i = \sqrt{-1}$ , what is the sum  $(7 + 3i) + (-8 + 9i)$ ?

- A)  $-1 + 12i$
- B)  $-1 - 6i$
- C)  $15 + 12i$
- D)  $15 - 6i$

QUESTION 577



Which of the following complex numbers is

equivalent to  $\frac{3 - 5i}{8 + 2i}$ ? (Note:  $i = \sqrt{-1}$ )

- A)  $\frac{3}{8} - \frac{5i}{2}$
- B)  $\frac{3}{8} + \frac{5i}{2}$
- C)  $\frac{7}{34} - \frac{23i}{34}$
- D)  $\frac{7}{34} + \frac{23i}{34}$

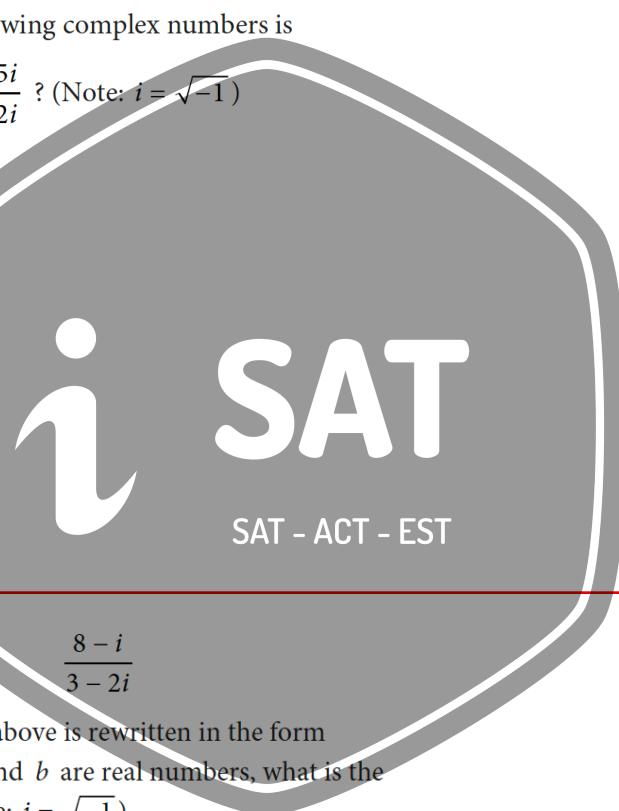
QUESTION 578



$$\frac{8 - i}{3 - 2i}$$

If the expression above is rewritten in the form  $a + bi$ , where  $a$  and  $b$  are real numbers, what is the value of  $a$ ? (Note:  $i = \sqrt{-1}$ )

- A) 2
- B)  $\frac{8}{3}$
- C) 3
- D)  $\frac{11}{3}$



## 4.6

## PART IV: ADDITIONAL TOPICS

## COMPLEX NUMBERS

QUESTION 579



What is the sum of the complex numbers  $2 + 3i$  and  $4 + 8i$ , where  $i = \sqrt{-1}$  ?

- A) 17
- B)  $17i$
- C)  $6 + 11i$
- D)  $8 + 24i$

QUESTION 580



Which of the following complex numbers is equal to  $(5 + 12i) - (9i^2 - 6i)$ , for  $i = \sqrt{-1}$  ?

- A)  $-14 - 18i$
- B)  $-4 - 6i$
- C)  $4 + 6i$
- D)  $14 + 18i$