

**Math: Question 1**

Lucia's heart rate is measured to be 1.25 beats per second. At this rate, which expression gives the number of beats in  $x$  seconds?

- A.  $x - 1.25$
- B.  $1.25 + x$
- C.  $\frac{1.25}{x}$
- D.  $1.25x$

Choice D is correct. It's given that Lucia's heart rate is measured to be 1.25 beats per second. This can be represented by  $\frac{1.25 \text{ beats}}{1 \text{ second}}$ . Multiplying this fraction by  $\frac{x}{x}$  yields  $\frac{1.25x \text{ beats}}{x \text{ seconds}}$ , or 1.25x beats per x seconds.

Choices A, B, and C are incorrect and may result from conceptual errors.

**Question Difficulty: Easy**

**Math: Question 2**

$$200n + 500(12) = 10,000$$

A physics class uses a set of weights with a total mass of 10,000 grams (g). The set consists of 200 g weights and 500 g weights, as represented by the equation shown. Which of the following is the best interpretation of the variable  $n$  in this context?

- A. The number of 200 g weights in the set
- B. The number of 500 g weights in the set
- C. The total weight, in grams, of the 200 g weights in the set
- D. The total weight, in grams, of the 500 g weights in the set

Choice A is correct. It's given that the set consists of 200 g weights and 500 g weights and that the total mass of the set is 10,000 g. Therefore, in the given equation,  $200n$  represents the total mass of the 200 g weights and  $500(12)$  represents the total mass of the 500 g weights. Since 200 represents the mass of each 200 g weight,  $n$  represents the number of 200 g weights in the set.

Choice B is incorrect. The number of 500 g weights in the set is represented by 12, not  $n$ , in the given equation. Choice C is incorrect. The total weight of the 200 g weights in the set is represented by  $200n$ , not  $n$ , in the given equation. Choice D is incorrect. The total weight of the 500 g weights in the set is represented by  $500(12)$ , not  $n$ , in the given equation.

**Question Difficulty: Easy**

**Math: Question 3**

State	Population in 2010
Alaska	710,000
Hawaii	1,360,000
Oregon	3,830,000
Washington	6,720,000

Paul calculated the mean population in 2010 of the 4 states shown in the table. Paul then calculated the mean population in 2010 of these 4 states along with California, which had a population of 37,250,000 in 2010. Which statement correctly compares the two means?

- A. The mean population of the 4 states in the table is greater.
- B. The mean population of the 4 states in the table along with California is greater.
- C. The two mean populations are equal.
- D. There is not enough information given to compare the two mean populations.

Choice B is correct. Because the population of California is greater than any of the populations shown in the table, the mean population of the 4 states along with California is greater than the mean population of the 4 states.

Alternate approach: The mean population of the 4 states in the table is the sum of the populations of the 4 states divided by the number of states, which is

$\frac{710,000 + 1,360,000 + 3,830,000 + 6,720,000}{4}$ , or 3,155,000. Similarly, the mean population of the 4

states along with California is the sum of the populations of the 5 states divided by the number of states, which is  $\frac{710,000 + 1,360,000 + 3,830,000 + 6,720,000 + 37,250,000}{5}$ , or 9,974,000. Since

9,974,000 is greater than 3,155,000, the mean population of the 4 states along with California is greater than the mean population of the 4 states.

Choices A, C, and D are incorrect and may result from conceptual errors.

**Question Difficulty: Easy**

**Math: Question 4**

Which expression represents  $p\%$  of 80 ?

- A.  $0.08p$
- B.  $0.8p$
- C.  $8p$
- D.  $80p$

Choice B is correct. The value of  $p\%$  of 80 can be represented by the expression  $\frac{p}{100} \times 80$ . This expression can be rewritten as  $\frac{80p}{100}$ , or  $0.8p$ .

Choice A is incorrect. This represents  $p\%$  of 8. Choice C is incorrect. This represents  $p\%$  of 800. Choice D is incorrect. This represents  $p\%$  of 8,000.

**Question Difficulty: Easy**

**Math: Question 5**

	Black	Blue	Total
Jacket	12	18	30
Shirt	36	24	60
Total	48	42	90

A display has jackets and shirts, each of which are available in either black or blue. The table shows the distribution by color for these items. If a jacket is selected at random from the display, what is the probability that it is black?

- A.  $\frac{12}{90}$
- B.  $\frac{12}{48}$
- C.  $\frac{12}{30}$
- D.  $\frac{12}{18}$

Choice C is correct. The probability of selecting at random a jacket with a certain color is equal to the number of jackets of that color divided by the total number of jackets in the display, which is 30. Of the 30 jackets, 12 are black. Therefore, if a jacket is selected at random from the display, the probability it is black is equal to  $\frac{12}{30}$ .

Choice A is incorrect. This is the probability of selecting at random a piece of clothing from the display that is a black jacket. Choice B is incorrect. If a piece of black clothing from the display is selected at random, this is the probability that it is a jacket. Choice D is incorrect. This is the number of black jackets in the display divided by the number of blue jackets in the display.

**Question Difficulty: Medium**

**Math: Question 6**

If  $5x - 3 = 3x + 5$ , what is the value of  $2x - 8$  ?

- A.  $-\frac{1}{4}$
- B. 0
- C. 4
- D. 17

Choice B is correct. Subtracting  $3x$  from each side of the equation  $5x - 3 = 3x + 5$  yields  $2x - 3 = 5$ . Subtracting 5 from each side of this equation yields  $2x - 8 = 0$ . Therefore, the value of  $2x - 8$  is 0.

Choice A is incorrect and may result from rewriting the equation  $5x - 3 = 3x + 5$  as  $8x = -2$ , rather than as  $2x - 3 = 5$ , and solving for  $x$ , rather than for  $2x - 8$ . Choice C is incorrect and may result from solving for  $x$ , rather than for  $2x - 8$ . Choice D is incorrect and may result from a conceptual or calculation error.

**Question Difficulty: Easy**

**Math: Question 7**

Day Number of paramecia

4	46
5	92
6	184
7	368
8	736

The table shows the number of paramecia in a petri dish for 5 days of a 10-day time period. For these 5 days, what type of function best models the number of paramecia in the petri dish?

- A. Increasing linear
- B. Decreasing linear
- C. Increasing exponential
- D. Decreasing exponential

Choice C is correct. In the first column of the table, each row after the first row represents a time increase of 1 day compared to the previous row. The corresponding number of paramecia in the petri dish, in the second column, is increasing. Since  $\frac{92}{46} = 2$ ,  $\frac{184}{92} = 2$ ,  $\frac{368}{184} = 2$ , and  $\frac{736}{368} = 2$ ,

there is a constant ratio of 2 between the number of paramecia at a given time and the number of paramecia 1 day before. The number of paramecia in the petri dish double, or increase by 100% of the number of paramecia in the petri dish the previous day. Therefore, the function that best models the number of paramecia in the petri dish is an increasing exponential function.

Choice A is incorrect. For an increasing linear function, each time increase of 1 day would correspond to a constant difference between the number of paramecia, not a common ratio between the number of paramecia. Choices B and D are incorrect. The number of paramecia in the petri dish is increasing, not decreasing.

**Question Difficulty: Easy**

**Math: Question 8**

A certain chemical reaction has an actual yield of 1.0 mole of water and a theoretical yield of 2.0 moles of water. What percentage of the theoretical yield is the actual yield?

- A. 25%
- B. 50%
- C. 100%
- D. 200%

Choice B is correct. The percentage that the actual yield is of the theoretical yield is

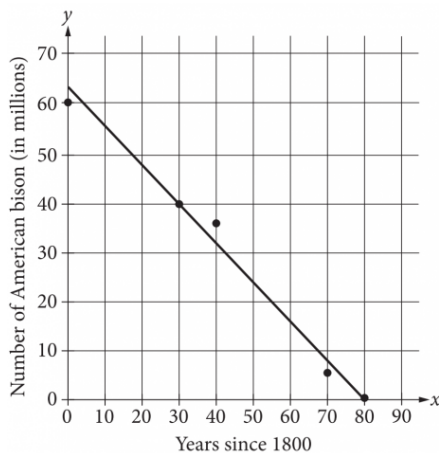
$\left(\frac{1.0}{2.0} \times 100\right)\%$ , or 50%.

Choice A is incorrect and may result from a conceptual error. Choice C is incorrect. This is the percentage difference between the actual yield and the theoretical yield. Choice D is incorrect. This is the percentage that the theoretical yield is of the actual yield.

**Question Difficulty: Medium**



## Math: Question 9



The scatterplot shows the relationship between the population  $y$ , in millions, of the American bison and the number of years,  $x$ , since 1800. A line of best fit for the data is also shown. Which equation is the most appropriate linear model for the data shown?

- A.  $y = 62.3 - 0.8x$
- B.  $y = 62.3 - 1.5x$
- C.  $y = 62.3 - 3.3x$
- D.  $y = 62.3 - 5.1x$

Choice A is correct. An equation of the line of best fit shown can be represented by  $y = a + bx$ , where  $a$  represents the  $y$ -coordinate of the  $y$ -intercept and  $b$  represents the slope of the line. It's given that  $y$  represents the population, in millions, of the American bison and  $x$  represents the number of years since 1800. In the choices given, all the equations have the same value of  $a$ , 62.3. Substituting 62.3 for  $a$  in the equation for the model yields  $y = 62.3 + bx$ . At approximately 30 years since 1800, the line of best fit predicts that the number of American bison was approximately 40 million. Substituting 30 for  $x$  and 40 for  $y$  in the equation  $y = 62.3 + bx$  yields  $40 = 62.3 + b(30)$ . Subtracting 62.3 from both sides of this equation and then dividing both sides by 30 yields  $b = -0.74$ . Substituting  $-0.74$  for  $b$  in the equation  $y = 62.3 + bx$  yields  $y = 62.3 - 0.74x$ . Of the choices given,  $-0.8x$  is the closest to  $-0.74x$ . Therefore, the most appropriate linear model for the data shown is  $y = 62.3 - 0.8x$ .

Choices B, C, and D are incorrect and may result from conceptual errors.

**Question Difficulty: Medium**

**Math: Question 10**

On a certain day in 2014, a bank converted 857.00 dollars to 634.18 euros. At this rate, which of the following is closest to the value, in euros, that was equivalent to 1.00 dollar?

- A. 0.23
- B. 0.26
- C. 0.74
- D. 1.35

Choice C is correct. It's given that the bank converted 857.00 dollars to 634.18 euros. The equation  $\frac{857.00 \text{ dollars}}{634.18 \text{ euros}} = \frac{1.00 \text{ dollar}}{x \text{ euros}}$  or  $\frac{857.00}{634.18} = \frac{1.00}{x}$ , can be set up to solve for the value  $x$ , in euros, that was equivalent to 1.00 dollar. Multiplying each side of this equation by  $x$  and by 634.18 yields  $(857.00)(x) = (1.00)(634.18)$ , or  $857.00x = 634.18$ . Dividing each side of this equation by 857.00 yields  $x = \frac{634.18}{857.00}$ , or 0.74.

Choice A is incorrect and may result from a calculation or conceptual error. Choice B is incorrect. This is the percentage decrease from 857.00 to 634.18 represented as a decimal. Choice D is incorrect and may result from calculating  $\frac{857.00}{634.18}$ .

**Question Difficulty: Medium**

**Math: Question 11**

A person was born with 270 individual bones. Over time, some of those bones fused. As an adult, this person has 206 individual bones. Which of the following is closest to the percent decrease, from birth to adulthood, in this person's number of individual bones?

- A. 24%
- B. 31%
- C. 69%
- D. 76%

Choice A is correct. From birth to adulthood, there is a decrease of  $270 - 206$ , or 64, bones. This is a percent decrease from 270 bones of  $\left(\frac{64}{270} \times 100\right)\%$ , or approximately 23.7%. Of the choices, 24% is closest to the percent decrease in the number of bones from birth to adulthood.

Choice B is incorrect. This is closest to the percent increase from 206 to 270 rather than the percent decrease from 270 to 206. Choice C is incorrect. This is closest to the percent increase from 206 to 270 subtracted from 100%. Choice D is incorrect. This is closest to the percent 206 is of 270.

**Question Difficulty:** Medium

**Math: Question 12**

The ratio  $c$  to  $d$  is equivalent to the ratio 2 to 1. What is the value of  $d$  in terms of  $c$  ?

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

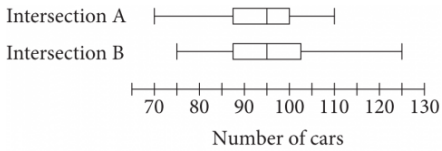
Choice D is correct. It's given that the ratio  $c$  to  $d$  is equivalent to the ratio 2 to 1. Therefore,  $\frac{c}{d} = \frac{2}{1}$ , or  $\frac{c}{d} = 2$ . Multiplying each side of this equation by  $d$  yields  $c = 2d$ . Dividing each side of this equation by 2 yields  $\frac{c}{2} = d$ .

Choice A is incorrect and may result from setting  $\frac{c}{d}$  equal to  $\frac{1}{1}$ , rather than  $\frac{2}{1}$ . Choice B is incorrect and may result from setting  $\frac{c}{d}$  equal to  $\frac{1}{2}$  rather than  $\frac{2}{1}$ . Choice C is incorrect and may result from setting  $c \cdot d$  rather than  $\frac{c}{d}$ , equal to 2.

**Question Difficulty: Medium**

## Math: Question 13

A civil engineer studying traffic patterns recorded the number of cars that passed through two intersections on weekdays between 7 a.m. and 9 a.m. over a three-month period. The box plots summarize the distributions of the data.



Which of the following statements best compares the medians of the two data sets?

- A. The median number of cars passing through intersection A is less than the median number of cars passing through intersection B.
- B. The median number of cars passing through intersection A is equal to the median number of cars passing through intersection B.
- C. The median number of cars passing through intersection A is greater than the median number of cars passing through intersection B.
- D. The median of a data set cannot be determined from a box plot.

Choice B is correct. The median of a data set summarized by a box plot is represented by the vertical line segment within the box. For each of these data sets, the median number of cars passing through the intersection is 95. Therefore, the medians of the two data sets are equal.

Choices A, C, and D are incorrect and may result from conceptual errors.

**Question Difficulty: Easy**

**Math: Question 14**

$$y = -3x + 9$$

$$y = 5x + 9$$

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

- A. 0
- B. 2
- C. 8
- D. 9

Choice A is correct. Subtracting the second equation,  $y = 5x + 9$ , from the first equation,  $y = -3x + 9$ , yields  $y - y = -3x - 5x + 9 - 9$ . Combining like terms yields  $0 = -8x$ . Dividing each side of this equation by  $-8$  yields  $0 = x$ . Therefore, in the solution  $(x, y)$  to the given system of equations, the value of  $x$  is 0.

Choices B and C are incorrect and may result from conceptual or calculation errors. Choice D is incorrect and may result from calculating the value of  $y$ , rather than the value of  $x$ , in the solution  $(x, y)$  to the given system of equations.

**Question Difficulty: Easy**

**Math: Question 15**

Which of the following is true about how the graph of the line  $y = \frac{3}{4}x + b$  and the graph of the line  $y = -\frac{4}{3}x + b$  are related, where  $b$  is a constant?

- A. The lines are parallel.
- B. The lines are perpendicular.
- C. The lines intersect at infinitely many points.
- D. The lines intersect at one point but are not perpendicular.

Choice B is correct. The given equations are each in slope-intercept form  $y = mx + b$ , where  $m$  is the slope of the line and  $(0, b)$  is the  $y$ -intercept of the line. Therefore, the slope of the line with equation  $y = \frac{3}{4}x + b$  is  $\frac{3}{4}$  and the slope of the line with equation  $y = -\frac{4}{3}x + b$  is  $-\frac{4}{3}$ . Since  $\frac{3}{4}$  and  $-\frac{4}{3}$  are negative reciprocals of each other, the lines are perpendicular.

Choice A is incorrect. Parallel lines have slopes that are equal to each other, not negative reciprocals of each other, and have different  $y$ -intercepts, not the same  $y$ -intercept. Choice C is incorrect. Lines that intersect at infinitely many points have slopes that are equal to each other and have the same  $y$ -intercept. Choice D is incorrect. Lines that intersect at one point but are not perpendicular don't have slopes that are negative reciprocals of each other.

**Question Difficulty: Easy**

**Math: Question 16**

$$f(x) = x^2 + c$$

For the function  $f$  shown,  $c$  is a constant. If  $f(4) = -7$ , what is the value of  $c$  ?

- A.  $-23$
- B.  $-9$
- C.  $9$
- D.  $23$

Choice A is correct. It's given that  $f(4) = -7$ . Substituting 4 for  $x$  and  $-7$  for  $f(x)$  in the given equation yields  $-7 = (4)^2 + c$ , or  $-7 = 16 + c$ . Subtracting 16 from each side of this equation yields  $-23 = c$ . Therefore, the value of  $c$  is  $-23$ .

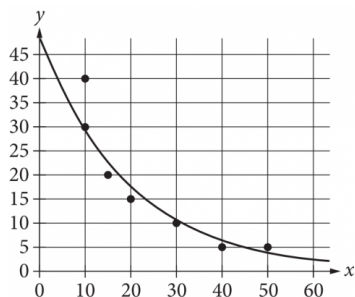
Choice B is incorrect and may result from substituting 7, rather than  $-7$ , for  $f(x)$  in the given equation. Choice C is incorrect and may result from adding 16 to, rather than subtracting 16 from, the left-hand side of the equation  $-7 = 16 + c$ . Choice D is incorrect and may result from substituting 7, rather than  $-7$ , for  $f(x)$  in the given equation and adding 16 to, rather than subtracting 16 from, the left-hand side of the resulting equation  $7 = 16 + c$ .

**Question Difficulty: Medium**



## Math: Question 17

The scatterplot shows the relationship between two variables,  $x$  and  $y$ . An exponential model is also shown.



What is an equation of the exponential model shown?

- A.  $y = -49 + (0.95)^x$
- B.  $y = 49 - (0.95)^x$
- C.  $y = 49(0.95)^x$
- D.  $y = 0.95(49)^x$

Choice C is correct. It's given that the model shown is an exponential model. The model shown is decreasing. The equation of a decreasing exponential model can be written in the form  $y = a(b)^x$ , where  $a$  is the  $y$ -coordinate of the  $y$ -intercept of the graph and  $0 < b < 1$ . The  $y$ -coordinate of the  $y$ -intercept of the model shown is slightly greater than 45. Of the choices, only the equation in choice C is in the form  $y = a(b)^x$ , where  $a$  is slightly greater than 45 and  $b$  is a value between 0 and 1.

Choice A is incorrect. This equation can't represent the model because the  $y$ -coordinate of the  $y$ -intercept of this model is  $-48$ . Choice B is incorrect. This equation can't represent the model because it's an increasing function. Also, the value of  $y$  in this equation approaches 49 as  $x$  increases, whereas in the graph, the value of  $y$  approaches 0 as  $x$  increases. Choice D is incorrect. This equation can't represent the model because the  $y$ -coordinate of the  $y$ -intercept of this model is 0.95, and  $b > 1$  instead of  $0 < b < 1$ .

**Question Difficulty: Medium**

**Math: Question 18**

$$x^3 + x^2 + 6x + 6$$

Which of the following is a factor of the polynomial above?

- A.  $x - 3$
- B.  $x - 1$
- C.  $x + 1$
- D.  $x + 2$

Choice C is correct. Factoring out the greatest common factor of  $x^2$  from the expression  $x^3 + x^2$  yields  $x^2(x + 1)$ . Factoring out the greatest common factor of 6 from the expression  $6x + 6$  yields  $6(x + 1)$ . Therefore, the given polynomial  $x^3 + x^2 + 6x + 6$  can be rewritten as  $x^2(x + 1) + 6(x + 1)$ . Factoring out the greatest common factor of  $x + 1$  from the expression  $x^2(x + 1) + 6(x + 1)$  yields  $(x + 1)(x^2 + 6)$ , which can't be factored any further. It follows that  $x + 1$  and  $x^2 + 6$  are the only factors of the expression  $x^3 + x^2 + 6x + 6$ . Of the choices, only  $x + 1$  is a factor of the given polynomial.

Choices A, B, and D are incorrect and may result from calculation errors.

**Question Difficulty:** Medium

**Math: Question 19**

Which of the following is equivalent to  $\sqrt{x+4}$  for  $x > 0$  ?

- A.  $x+2$
- B.  $x^{\frac{1}{2}}+2$
- C.  $x^{\frac{1}{2}}+4$
- D.  $(x+4)^{\frac{1}{2}}$

Choice D is correct. By the properties of radicals, for a positive number  $n$ ,  $\sqrt{n}$  is equivalent to  $n^{\frac{1}{2}}$ . Since it's given that  $x > 0$ , the expression  $x+4$  represents a positive number. Therefore, the expression  $\sqrt{x+4}$  is equivalent to the expression  $(x+4)^{\frac{1}{2}}$ .

Choices A, B, and C are incorrect and may result from rewriting the given expression as  $(x+4)^{\frac{1}{2}}$  and distributing  $\frac{1}{2}$  to each term in various ways. However, exponents aren't distributive across addition.

**Question Difficulty: Medium**

**Math: Question 20**

The Jefferson County School Board surveyed a random sample of 500 households in the Jefferson County School District. The table summarizes the number of students from each household enrolled in the Jefferson County School District.

Number of students	Number of households
0	270
1	65
2	128
3	27
4 or more	10

Of the households surveyed, what is the ratio of the number of households with 0 students enrolled in the Jefferson County School District to the number of households with at least 1 student enrolled in the Jefferson County School District?

- A. 27 to 50
- B. 27 to 23
- C. 27 to 1
- D. 65 to 128

Choice B is correct. The table shows that there are 270 households with 0 students enrolled in the Jefferson County School District. The table also shows that there are  $65 + 128 + 27 + 10$ , or 230, households with at least 1 student enrolled in the Jefferson County School District. Therefore, the ratio of the number of households with 0 students enrolled to the number of households with at least 1 student enrolled is 270 to 230, which can be rewritten as 27 to 23.

Choice A is incorrect. This is the ratio of the number of households with 0 students enrolled to the total number of households. Choice C is incorrect. This is the ratio of the number of households with 0 students enrolled to the number of households with 4 or more students enrolled. Choice D is incorrect. This is the ratio of the number of households with 1 student enrolled to the number of households with 2 students enrolled.

**Question Difficulty: Medium**

**Math: Question 21**

The Jefferson County School Board surveyed a random sample of 500 households in the Jefferson County School District. The table summarizes the number of students from each household enrolled in the Jefferson County School District.

Number of students	Number of households
0	270
1	65
2	128
3	27
4 or more	10

Of the 500 households surveyed, what is the median number of students from each household that are enrolled in the Jefferson County School District?

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

Choice D is correct. The median value of a data set is a value such that half the values in the data set are less than or equal to the median and half the values are greater than or equal to the median. It's given that 500 households were surveyed. It follows that the median number of students from each household that are enrolled in the Jefferson County School District is the number of students for which there are 250 households with that number of students or fewer enrolled and 250 households with that number of students or greater enrolled. Since there are 270 households with 0 students enrolled and 230 households with more than 0 students enrolled, then it's also true that there are 250 households with 0 students enrolled and 250 households with greater than or equal to 0 students enrolled. Therefore, the median number of students from each household that are enrolled in this district is 0.

Choice A is incorrect. There are 463 households in the table that have fewer than 3 students enrolled, which is more than half the households surveyed. Choice B is incorrect. There are 335 households in the table that have fewer than 2 students enrolled, which is more than half the households surveyed. Choice C is incorrect. There are 270 households in the table that have fewer than 1 student enrolled, which is more than half the households surveyed.

**Question Difficulty: Hard**

**Math: Question 22**

The lengths of two sides of a triangle are 8 and 14. Which of the following could be the length of the third side of the triangle?

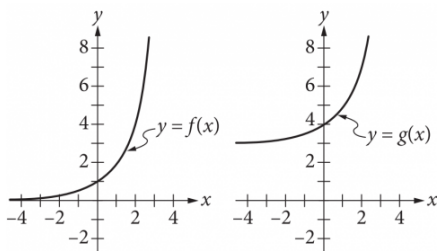
- A. 24
- B. 22
- C. 11
- D. 6

Choice C is correct. By the triangle inequality theorem, the sum of the lengths of any two sides of a triangle must be greater than the length of the third side. Let  $x$  represent the length of the third side of the triangle, such that the triangle has side lengths of 8, 14, and  $x$ . By the triangle inequality theorem,  $8 + x > 14$ ,  $14 + x > 8$ , and  $8 + 14 > x$ . Solving each of these inequalities for  $x$  yields  $x > 6$ ,  $x > -6$ , and  $x < 22$ . It follows that the length of the third side of the triangle must be greater than 6 and less than 22. Therefore, of the choices, only 11 can be the length of the third side of the triangle.

Choices A, B, and D are incorrect, because if any of these values were the length of the third side of the triangle described, the triangle would not meet the requirement of the triangle inequality theorem. For example, the sum of 8 and 14 is less than 24, not greater than 24; the sum of 8 and 14 is equal to 22, not greater than 22; and the sum of 6 and 8 is equal to 14, not greater than 14.

**Question Difficulty: Medium**

## Math: Question 23



The graphs of the functions  $f$  and  $g$  are shown. If  $f(x) = 2^x$ , which of the following could define the function  $g$  ?

- A.  $g(x) = 2^x + 3$
- B.  $g(x) = 2^x - 3$
- C.  $g(x) = 2^x + 4$
- D.  $g(x) = 2^x - 4$

Choice A is correct. The graph of  $y = g(x)$  has the same shape as the graph of  $y = f(x)$ . However, for each point  $(x, y)$  on the graph of  $y = f(x)$ , the point  $(x, y + 3)$  lies on the graph of  $y = g(x)$ . For example, the graph of  $y = f(x)$  contains the points  $(0, 1)$ ,  $(1, 2)$ , and  $(2, 4)$ , and the graph of  $y = g(x)$  contains the points  $(0, 4)$ ,  $(1, 5)$ , and  $(2, 7)$ . Therefore, the function  $g$  could be defined by  $g(x) = f(x) + 3$ , or  $g(x) = 2^x + 3$ .

Choices B, C, and D are incorrect. The graphs of each of these equations contain points that aren't on the graph of  $y = g(x)$  shown. For example,  $(0, -2)$  lies on the graph of the equation in choice B,  $(0, 5)$  lies on the graph of the equation in choice C, and  $(0, -3)$  lies on the graph of the equation in choice D. However, the graph of  $y = g(x)$  shown contains the point  $(0, 4)$ .

**Question Difficulty:** Medium

**Math: Question 24**

$$x^2 - 2x - 24 = 0$$

If  $s$  and  $t$  are the solutions to the given equation, what is the value of  $s + t$  ?

- A.  $-10$
- B.  $-2$
- C.  $2$
- D.  $10$

Choice C is correct. The left-hand side of the given equation can be factored and rewritten as  $(x - 6)(x + 4) = 0$ . Using the zero product property,  $x - 6 = 0$  or  $x + 4 = 0$ . Adding 6 to each side of the equation  $x - 6 = 0$  yields  $x = 6$ . Subtracting 4 from both sides of the equation  $x + 4 = 0$  yields  $x = -4$ . Therefore, the solutions  $s$  and  $t$  to the given equation are 6 and  $-4$ . The value of  $s + t$  is  $6 + (-4)$ , or 2.

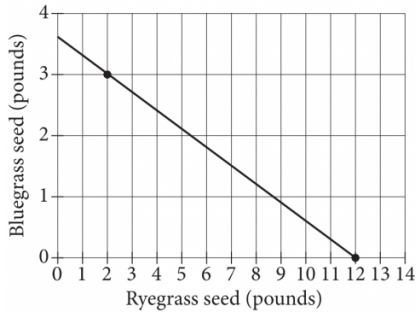
Alternate approach: For a quadratic equation in the form  $ax^2 + bx + c = 0$  with real solutions, the sum of the solutions is equal to  $-\frac{b}{a}$ . Therefore, if  $s$  and  $t$  are the solutions to the given equation, then  $s + t = -\frac{(-2)}{1}$ , or 2.

Choice A is incorrect and may result from finding the solutions to the given equation as  $-6$  and  $-4$ , rather than 6 and  $-4$ . Choice B is incorrect and may result from finding the solutions to the given equation as  $-6$  and 4, rather than 6 and  $-4$ . Choice D is incorrect and may result from finding the solutions to the given equation as 6 and 4, rather than 6 and  $-4$ .

**Question Difficulty: Medium**



## Math: Question 25



A landscaper will use two types of grass seed to plant a field. The graph shows the relationship between the number of pounds of bluegrass seed,  $y$ , and ryegrass seed,  $x$ , that the landscaper could use to plant a field. Which of the following represents this relationship?

- A.  $3x + 10y = 36$
- B.  $10x + 3y = 36$
- C.  $-3x + 10y = 36$
- D.  $-10x + 3y = 36$

Choice A is correct. An equation of the line that represents the relationship between the number of pounds of bluegrass seed,  $y$ , and ryegrass seed,  $x$ , can be written in point-slope form  $y - y_1 = m(x - x_1)$ , where  $m$  represents the slope of the line and  $(x_1, y_1)$  represents a point on the line. Based on the graph, the landscaper can plant a field using 2 pounds of ryegrass seed and 3 pounds of bluegrass seed, or the landscaper can plant 12 pounds of ryegrass seed and 0 pounds of bluegrass seed, which can be represented by the coordinates  $(2, 3)$  and  $(12, 0)$ , respectively. The slope of the line that passes through these two points is  $\frac{0-3}{12-2}$ , or  $-\frac{3}{10}$ . Substituting  $-\frac{3}{10}$  for  $m$  and  $(2, 3)$  for  $(x_1, y_1)$  in the equation  $y - y_1 = m(x - x_1)$  yields  $y - 3 = -\frac{3}{10}(x - 2)$ , which is equivalent to  $3x + 10y = 36$ . Therefore, an equation that represents the relationship between the number of pounds of bluegrass seed,  $y$ , and ryegrass seed,  $x$ , that the landscaper could use to plant the field is  $3x + 10y = 36$ .

Choice B is incorrect and may result from using  $x$ , rather than  $y$ , as the number of pounds of bluegrass seed, and  $y$ , rather than  $x$ , as the number of pounds of ryegrass seed. Choice C is incorrect and may result from calculating the slope of the line as  $\frac{3}{10}$ , rather than  $-\frac{3}{10}$ . Choice D is incorrect and may result from calculating the slope of the line as  $\frac{3}{10}$ , rather than  $-\frac{3}{10}$ , and using  $x$ , rather than  $y$ , as the number of pounds of bluegrass seed and  $y$ , rather than  $x$ , as the number of pounds of ryegrass seed.

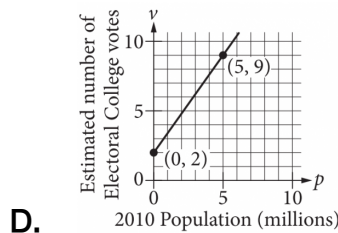
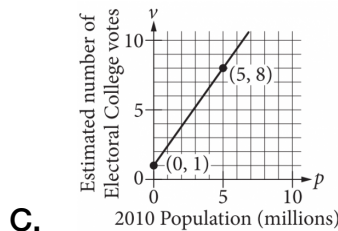
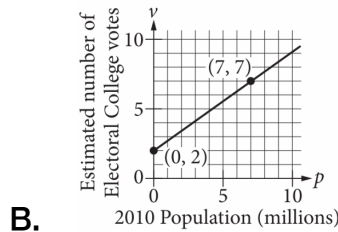
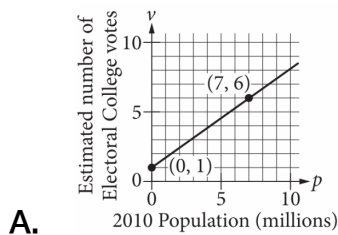
**Question Difficulty:** Medium

## Math: Question 26

$$v = \frac{7}{5}p + 2$$

The Electoral College was established by the United States Congress in 1788 and is the process used to elect the president of the United States. The number of Electoral College votes varies from state to state. The equation gives the estimated number of Electoral College votes,  $v$ , for a state, where  $p$  is the state's estimated population, in millions, for the year 2010.

Which of the following graphs best represents the relationship between  $p$  and  $v$  ?



Choice D is correct. The relationship between  $p$  and  $v$  is defined by the linear equation  $v = \frac{7}{5}p + 2$

. The graph of this equation in the  $pv$ -plane is a line. This equation is in slope-intercept form,  $v = mp + b$ , where  $m$  is the slope of the line and  $(0, b)$  is the  $v$ -intercept of the line. The values of  $m$  and  $b$  are  $\frac{7}{5}$  and 2, respectively. Therefore, the slope of the line is  $\frac{7}{5}$  and the  $v$ -intercept of the

line is  $(0,2)$ . A slope of  $\frac{7}{5}$  means that each 5-unit increase in the value of  $p$  results in a 7-unit increase in the value of  $v$ . Only the graph in choice D has a slope of  $\frac{7}{5}$  and a  $v$ -intercept of  $(0,2)$ .

Choice A is incorrect and may result from using a  $v$ -intercept of  $(0,1)$ , rather than  $(0,2)$ , and using a slope of  $\frac{5}{7}$ , rather than  $\frac{7}{5}$ . Choice B is incorrect and may result from using a slope of  $\frac{5}{7}$ , rather than  $\frac{7}{5}$ . Choice C is incorrect and may result from using a  $v$ -intercept of  $(0,1)$ , rather than  $(0,2)$ .

**Question Difficulty: Medium**

**Math: Question 27**

$$v = \frac{7}{5}p + 2$$

The Electoral College was established by the United States Congress in 1788 and is the process used to elect the president of the United States. The number of Electoral College votes varies from state to state. The equation gives the estimated number of Electoral College votes,  $v$ , for a state, where  $p$  is the state's estimated population, in millions, for the year 2010.

The number of each state's Electoral College votes is 2 more than its number of representatives, in the United States House of Representatives. Which of the following gives the estimated number of representatives,  $r$ , in terms of  $p$  ?

- A.  $r = \frac{7}{5}p + 4$
- B.  $r = \frac{7}{5}p$
- C.  $r = \frac{17}{5}p + 2$
- D.  $r = -\frac{3}{5}p + 2$

Choice B is correct. It's given that the number of each state's Electoral College votes is 2 more than its number of representatives in the US House of Representatives. It's also given that the relationship between the estimated number of Electoral College votes,  $v$ , for a state in 2010, and the state's estimated population  $p$ , in millions, is  $v = \frac{7}{5}p + 2$ . Therefore, if  $r$  represents the

estimated number of representatives for the state, then  $v = r + 2$ . Substituting  $\frac{7}{5}p + 2$  for  $v$  in the

equation  $v = r + 2$  yields  $\frac{7}{5}p + 2 = r + 2$ . Subtracting 2 from both sides of this equation yields

$r = \frac{7}{5}p$ . Therefore, the equation  $r = \frac{7}{5}p$  gives the estimated number of representatives,  $r$ , in terms of  $p$ .

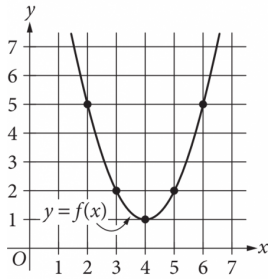
Choice A is incorrect and may result from adding 2 to, rather than subtracting 2 from, the left-hand side of  $\frac{7}{5}p + 2 = r + 2$ . Choice C is incorrect and may result from adding 2 to the coefficient

of  $p$  in, rather than subtracting 2 from, the left-hand side of  $\frac{7}{5}p + 2 = r + 2$ . Choice D is incorrect

and may result from subtracting 2 from the coefficient of  $p$  in, rather than subtracting 2 from, the left-hand side of  $\frac{7}{5}p + 2 = r + 2$ .

**Question Difficulty: Medium**

## Math: Question 28



The graph of the quadratic function  $f$  is shown in the  $xy$ -plane above. Another function  $g$  (not shown) is defined by  $g(x) = f(x) - 2$ . If  $g(a) = 0$ , what is one possible value of  $a$  ?

The correct answer is either 3 or 5. It's given that  $g(a) = 0$ , or that the value of  $g(x)$  is 0 when  $x = a$ . Substituting  $a$  for  $x$  and 0 for  $g(x)$  in the equation  $g(x) = f(x) - 2$  yields  $0 = f(a) - 2$ . Adding 2 to each side of this equation yields  $2 = f(a)$ . Therefore, the possible values of  $a$  are given by the values of  $x$  for which the value of  $f(x)$  is 2. On the graph of  $y = f(x)$ , the value of  $y$  is 2 when the value of  $x$  is 3 or 5. Either 3 or 5 may be entered as the correct answer.

**Question Difficulty:** Medium

**Math: Question 29**

$$ax + 5y = 8$$

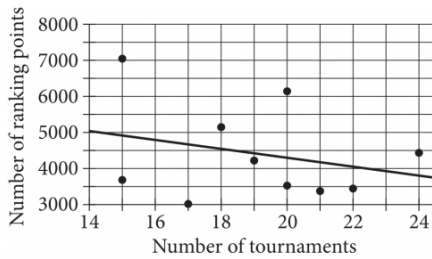
$$12x + 15y = 10$$

In the given system of equations,  $a$  is a constant. If the system has no solutions, what is the value of  $a$  ?

The correct answer is 4. Multiplying the first equation in the system,  $ax + 5y = 8$ , by 3 yields  $3ax + 15y = 24$ . Subtracting this from the second equation in the given system of equations,  $12x + 15y = 10$ , yields  $12x - 3ax + 15y - 15y = 10 - 24$ . Combining like terms in this equation yields  $(12 - 3a)x = -14$ . Dividing each side of this equation by  $12 - 3a$  yields  $x = \frac{-14}{12 - 3a}$ . Since the value of  $x$  is undefined if  $12 - 3a = 0$ , the given system of equations will have no solutions if  $12 - 3a = 0$ ; that is, if the value of  $a$  is 4.

**Question Difficulty: Hard**

## Math: Question 30



The scatterplot shows the number of tournaments played and the total number of ranking points that 10 professional women's tennis players were awarded for a certain year. A line of best fit is also shown.

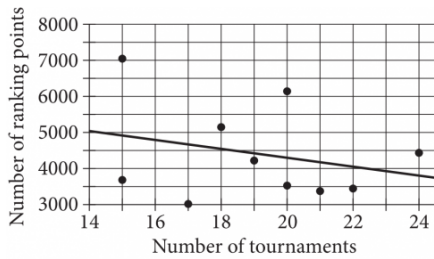
How many of the 10 players represented in the scatterplot were awarded more total ranking points for the tournaments played than what is predicted by the line of best fit?

The correct answer is 4. The line of best fit in the scatterplot predicts the total number of ranking points that a player was awarded given the number of tournaments played. For a player to have been awarded more total ranking points than predicted by the line of best fit, the player must have a greater total number of ranking points compared to the predicted total number of ranking points for the same number of tournaments. This can be seen as a data point that is located above the line of best fit. The total number of data points that are located above the line of best fit is 4. Therefore, 4 players represented in the scatterplot were awarded more total ranking points for the tournaments played than what is predicted by the line of best fit.

**Question Difficulty: Easy**



## Math: Question 31



The scatterplot shows the number of tournaments played and the total number of ranking points that 10 professional women's tennis players were awarded for a certain year. A line of best fit is also shown.

One of the players represented in the scatterplot who played at least 17 tournaments will be selected at random. What is the probability of selecting a player who was awarded more than 5000 ranking points? (Express your answer as a decimal or fraction, not as a percent.)

The correct answer is  $\frac{1}{4}$ . Of the players represented in the scatterplot, 8 played in at least 17 tournaments. Of those, 2 were awarded more than 5000 ranking points. Therefore, the probability of selecting a player who was awarded more than 5000 ranking points from the players who played in at least 17 tournaments is equal to  $\frac{2}{8}$ , or  $\frac{1}{4}$ . The answer may be entered as  $\frac{1}{4}$  or .25.

**Question Difficulty: Hard**