CHAPTER 21

Math: Questions—Algebra

Algebra questions in the Math section focus on the mastery of linear equations and inequalities, linear functions, and systems of linear equations. The ability to interpret, create, use, and solve problems using linear representations and to make connections between different representations of linear relationships is essential for success in college and careers.

Across the Math section, Algebra questions vary significantly in form and appearance. They may be straightforward fluency exercises or pose challenges of strategy or understanding, such as interpreting the relationship between graphical and algebraic representations or solving as a process of reasoning. You'll be required to demonstrate both procedural skill and a deep understanding of concepts.

The questions in the Algebra content domain include both multiple-choice questions and student-produced response (SPR) questions.

Let's explore the content, skills, and knowledge assessed by Algebra questions.

QUICK TAKE

Questions in the Math section require you to demonstrate deep understanding of several core algebra topics, namely linear equations and inequalities, linear functions, and systems of linear equations. These topics are fundamental to the learning and work often required in college and careers.

REMINDER

Multiple-choice questions have four answer choices and one (and only one) correct answer, or *key*. Questions in the SPR format require you to generate and enter your own answer.

Linear Equations, Linear Inequalities, and Linear Functions in Context

When you use algebra to analyze and solve a problem in real life, a key step is to represent the context of the problem algebraically. To do this, you may need to define one or more variables that represent quantities in the context. Then you may need to write one or more expressions, equations, inequalities, or functions that represent the relationships described in the context. For some algebra questions, you may need to rewrite an equation or interpret a given algebraic representation. For other questions, once you write an equation that represents the context, you then need to solve that equation. Then you may need to interpret the solution to the equation in terms of the context. Questions in the Math section may assess your ability to accomplish any or all of these steps.

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STRATEGY

Many Algebra questions such as this one will require you to perform the following steps:

1. Define one or more variables that represent quantities in the question.
2. Write one or more equations, expressions, inequalities, or functions that represent the relationships described in the question.
3. Solve the equation.
4. Interpret the solution in terms of what the question is asking.

Ample practice with each of these steps will help you develop the math skills and knowledge needed to successfully answer questions in the Algebra content domain.

Algebra Sample Question 1

In 2014, County X had 783 miles of paved roads. Starting in 2015, the county has been building 8 miles of new paved roads each year. At this rate, how many miles of paved road will County X have in 2030? (Assume that no paved roads go out of service.)

The first step in answering this question is to decide what variable or variables you need to define. Since the number of miles paved depends on the year, we can define a variable to represent the year. The number of years after 2014 can be represented using the variable n. Then, since the question says that County X had 783 miles of paved road in 2014 and has been building 8 miles of new paved roads each year, the expression $783 + 8n$ gives the number of miles of paved roads in County X in the year that is n years after 2014. The year 2030 is $2030 - 2014 = 16$ years after 2014; thus, the year 2030 corresponds to $n = 16$. Hence, to find the number of miles of paved roads in County X in 2030, substitute 16 for n in the expression $783 + 8n$, giving $783 + 8(16)$. This is equivalent to $783 + 128$, or 911. Therefore, at the given rate of building, County X will have 911 miles of paved roads in 2030.

Note that this example provides no answer choices. It's in the student-produced response format mentioned briefly above. To respond to this question, you would enter your answer in Bluebook. Directions for entering your answers to student-produced response questions are presented in chapter 29.

Note that the same context could have generated different sorts of questions, as in samples 2 and 3, below.

Algebra Sample Question 2

In 2014, County X had 783 miles of paved roads. Starting in 2015, the county has been building 8 miles of new paved roads each year. At this rate, which of the following functions f gives the number of miles of paved road there will be in County X n years after 2014? (Assume that no paved roads go out of service.)

A) $f(n) = 8 + 783n$
B) $f(n) = 2{,}014 + 783n$
C) $f(n) = 738 + 8n$
D) $f(n) = 2{,}014 + 8n$

This question already defines the variable and asks you to identify a function that describes the context. The discussion for sample 1 shows that the correct answer is choice C.

REMINDER

There are several different ways you may be tested on the same underlying algebra concepts. Practicing a variety of questions with different contexts is a good way to ensure you'll be ready for the questions you'll come across in the Math section.

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Algebra Sample Question 3

In 2014, County X had 783 miles of paved roads. Starting in 2015, the county has been building 8 miles of new paved roads each year. At this rate, in which year will County X first have at least 1,000 miles of paved roads? (Assume that no paved roads go out of service.)

In this question, you must create and solve an inequality. As in sample 1, let n be the number of years after 2014. Then the expression $783 + 8n$ gives the number of miles of paved roads in County X n years after 2014. The question is asking when there will first be at least 1,000 miles of paved roads in County X. This condition can be represented by the inequality $783 + 8n \geq 1{,}000$. To find the year in which there will first be at least 1,000 miles of paved roads, you solve this inequality for n. Subtracting 783 from each side of $783 + 8n \geq 1{,}000$ gives $8n \geq 217$. Then dividing each side of $8n \geq 217$ by 8 gives $n \geq 27.125$. Note that an important part of relating the inequality $783 + 8n \geq 1{,}000$ back to the context is to notice that n is counting calendar years, and so the value of n must be an integer. The least value of n that satisfies $783 + 8n \geq 1{,}000$ is 27.125, but the year $2014 + 27.125 = 2041.125$ does not make sense as an answer, and in 2041, there would be only $783 + 8(27) = 999$ miles of paved roads in the county. Therefore, the variable n needs to be rounded up to the next integer, and so the least possible value of n is 28. Therefore, the year that County X will first have at least 1,000 miles of paved roads is 28 years after 2014, which is 2042.

In sample 1, once the variable n was defined, you needed to find an expression that represents the number of miles of paved road in terms of n. In other questions, creating the correct expression, equation, or function may require a more insightful understanding of the context.

STRATEGY

Solving an equation or inequality is often only part of the problem-solving process. You'll also need to interpret the solution in the context of the question, so be sure to remind yourself of the question's context and the meaning of the variables you solved for before selecting your answer.

Algebra Sample Question 4

To edit a manuscript, Miguel charges \$50 for the first 2 hours and \$20 per hour after the first 2 hours. Which of the following expresses the amount, C, in dollars, Miguel charges if it takes him x hours to edit a manuscript, where $x > 2$?

A) $C = 20x$

B) $C = 20x + 10$

C) $C = 20x + 50$

D) $C = 20x + 90$

The question defines the variables C and x and asks you to express C in terms of x. To create the correct equation, you must note that since the \$50 that Miguel charges pays for his first 2 hours of editing, he charges \$20 per hour only *after* the first 2 hours. Thus, if it takes x hours for Miguel to edit a manuscript, he charges \$50 for the first 2 hours and \$20 per hour for the remaining time, which is $x - 2$ hours. Thus, his total charge, C, in dollars, can be written as $C = 50 + 20(x - 2)$, where $x > 2$.

STRATEGY

When the solution you arrive at doesn't match any of the answer choices provided in a given multiple-choice question, consider whether expanding, simplifying, or rearranging your solution will cause it to match an answer choice. Sometimes this extra step is needed to arrive at the correct answer.

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This doesn't match any of the provided answer choices. But when you apply the distributive property to the right-hand side of $C = 50 + 20(x - 2)$, you get $C = 50 + 20x - 40$, or $C = 20x + 10$, which is choice B.

As with samples 1 to 3, different questions could have been asked about this context. For example, you could be asked to find how long it took Miguel to edit a manuscript if he charged $370.

In some questions in the Math section, you'll be given a function that represents a context and be asked to find the value of the output of the function given an input or, as in sample 5, below, the value of the input that corresponds to a given output.

Algebra Sample Question 5

A builder uses the function g defined by $g(x) = 110x + 10{,}000$ to estimate the cost $g(x)$, in dollars, to build a one-story home of planned floor area of x square feet in Stillwater. If the builder estimates that the cost to build a certain one-story home in Stillwater is $142,000, what is the planned floor area, in square feet, of the home?

This question asks you to find the value of the input of a function when you're given the value of the output and the equation of the function. The estimated cost of the home, in dollars, is the output of the function g for a one-story home of planned floor area of x square feet. That is, the output of the function, $g(x)$, is 142,000, and you need to find the value of the input x that gives an output of 142,000. To do this, substitute 142,000 for $g(x)$ in the equation that defines g: $142{,}000 = 110x + 10{,}000$. Now solve for x: First, subtract 10,000 from each side of the equation $142{,}000 = 110x + 10{,}000$, which gives $132{,}000 = 110x$. Then, divide each side of $132{,}000 = 110x$ by 110, which gives $1{,}200 = x$. Therefore, a one-story home with an estimated cost of $142,000 to build in Stillwater has a planned floor area of 1,200 square feet.

Systems of Linear Equations and Inequalities in Context

You may need to define more than one variable and create more than one equation or inequality to represent a context and answer a question. Questions on the Math section may require you to create and solve a system of equations or create a system of inequalities.

Algebra Sample Question 6

Maizah bought pants and a briefcase at a department store. The sum of the prices of the pants and the briefcase before sales tax was $130.00. There was no sales tax on the pants and a 9% sales tax on the briefcase. The total Maizah paid, including the sales tax, was $136.75. What was the price, in dollars, of the pants?

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To answer the question, you first need to define the variables. The question discusses the prices of pants and a briefcase and asks you to find the price of the pants. So it's appropriate to let P be the price, in dollars, of the pants and to let B be the price, in dollars, of the briefcase. Since the sum of the prices before sales tax was \$130.00, the equation $P + B = 130$ represents the sum of the prices. A sales tax of 9% was added to the price of the briefcase. Since 9% is equal to 0.09, the price of the briefcase with tax was $B + 0.09B = 1.09B$. There was no sales tax on the pants, and the total Maizah paid, including tax, was \$136.75, so the equation $P + 1.09B = 136.75$ represents the total, in dollars, Maizah paid.

STRATEGY

You can use either of two approaches—combination or substitution—when solving a system of linear equations. One may get you to the answer more quickly than the other, depending on the equations you're working with and what you're solving for. Practice using both approaches to give you greater flexibility on test day.

Now you need to solve the system

$$P + B = 130$$
$$P + 1.09B = 136.75$$

Subtracting the left- and right-hand sides of the first equation from the corresponding sides of the second equation gives you $(P + 1.09B) - (P + B) = 136.75 - 130$, which can be rewritten as $0.09B = 6.75$. Now you can divide each side of the equation $0.09B = 6.75$ by 0.09. This gives you $B = \frac{6.75}{0.09}$, or $B = 75$. Thus, the price, in dollars, of the briefcase is 75. The question asks for the price, in dollars, of the pants, which is P. You can substitute 75 for B in the equation $P + B = 130$, which gives you $P + 75 = 130$, or $P = 130 - 75$, or $P = 55$, so the price of the pants is \$55.

STRATEGY

While this question may seem complex, as it involves numerous steps, solving it calls on the same underlying principles outlined earlier: defining variables, creating equations to represent relationships, solving equations, and interpreting the solution.

Algebra Sample Question 7

Each morning, John jogs at 6 miles per hour and rides a bike at 12 miles per hour. His goal is to jog and ride his bike a total of at least 9 miles in no more than 1 hour. If John jogs j miles and rides his bike b miles, which of the following systems of inequalities represents John's goal?

A) $\frac{j}{6} + \frac{b}{12} \leq 1$
$j + b \geq 9$

B) $\frac{j}{6} + \frac{b}{12} \geq 1$
$j + b \leq 9$

C) $6j + 12b \geq 9$
$j + b \leq 1$

D) $6j + 12b \leq 1$
$j + b \geq 9$

It's given that John jogs j miles and rides his bike b miles. It's also given that his goal is to jog and ride his bike a total of at least 9 miles. This goal is represented by the inequality $j + b \geq 9$. This eliminates choices B and C.

STRATEGY

In sample 7, the answer choices each contain two parts. Use this to your advantage by tackling one part at a time and eliminating answers that don't work.

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STRATEGY

You should be able to quickly rearrange equations such as rate × time = distance by solving for any of the variables. Sample 7 requires you to solve the equation for time.

Since rate × time = distance, it follows that time = $\frac{\text{distance}}{\text{rate}}$. John jogs j miles at 6 miles per hour, so the time he jogs is equal to $\frac{j \text{ miles}}{6 \text{ miles/hour}} = \frac{j}{6}$ hours. Similarly, since John rides his bike b miles at 12 miles per hour, the time he rides his bike is $\frac{b}{12}$ hours. Thus, John's goal to complete his jog and his bike ride in no more than 1 hour can be represented by the inequality $\frac{j}{6} + \frac{b}{12} \leq 1$. The system $j + b \geq 9$ and $\frac{j}{6} + \frac{b}{12} \leq 1$ is choice A.

Fluency in Solving Linear Equations, Linear Inequalities, and Systems of Linear Equations

Creating linear equations, linear inequalities, and systems of linear equations that represent a context are key skills for success in college and careers. It's also essential to be able to fluently solve these linear equations, linear inequalities, and systems of linear equations. Some of the Algebra questions in the Math section may also present equations, inequalities, or systems without a context and directly assess your fluency in solving them.

All such fluency questions in the Math section permit the use of a calculator, and some of them test your ability to solve equations, inequalities, and systems of equations. Even though a calculator is permitted for all Math section questions, you may be able to answer certain questions more quickly without using a calculator, such as in sample 9, below. Part of what the Math section assesses is your ability to decide whether using a calculator to answer a question offers efficiency or whether it's more efficient to solve by hand. Sample 8 is an example of a question that could be solved either by hand or by using a graphing calculator.

Algebra Sample Question 8

$$3\left(\frac{1}{2} - x\right) = \frac{3}{5} + 15x$$

What is the solution to the given equation?

Using the distributive property to rewrite the left-hand side of the equation gives $\frac{3}{2} - 3x = \frac{3}{5} + 15x$. Adding $3x$ to both sides of this equation and then subtracting $\frac{3}{5}$ from both sides of this equation gives $\frac{3}{2} - \frac{3}{5} = 18x$. The equation may be easier to solve if it's transformed

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into an equation without fractions; to do this, multiply each side of $\frac{3}{2} - \frac{3}{5} = 18x$ by 10, which is the least common multiple of the denominators 2 and 5. This gives $\frac{30}{2} - \frac{30}{5} = 180x$, which can be rewritten as $15 - 6 = 180x$, or $9 = 180x$. Dividing both sides of this equation by 180 gives $x = \frac{1}{20}$.

Alternatively, each side of the given equation can be set equal to y and entered in a graphing calculator. Then the problem can be solved by finding the intersection point of the two lines that each represent one side of the given equation. You would enter $y = 3\left(\frac{1}{2} - x\right)$ and $y = \frac{3}{5} + 15x$ in the graphing interface and draw the graphs. The intersection point is (0.05, 1.35), which means $x = 0.05$, which is equivalent to $x = \frac{1}{20}$. Note that .05 and 1/20 are examples of ways to enter a correct answer.

Algebra Sample Question 9

$$-2(3x + 2.4) = -3(3x + 2.4)$$

What is the solution to the given equation?

You could solve this in the same way as sample 8, by multiplying everything out and simplifying, or by graphing each side of the equation. But the structure of the equation reveals that −2 times a quantity, $3x + 2.4$, is equal to −3 times the same quantity. This is only possible if the quantity $3x + 2.4$ is equal to zero. Thus, $3x + 2.4 = 0$, or $3x = -2.4$. Therefore, the solution is $x = -0.8$.

STRATEGY

While a calculator is permitted on all questions in the Math section, it's important to not rely too much on the tool. Some questions, such as sample 9, can be solved more efficiently without using a calculator. Your ability to choose when to use and when not to use a calculator is one of the things the Math section assesses, so be sure to practice this.

Algebra Sample Question 10

$$-2x = 4y + 6$$

$$2(2y + 3) = 3x - 5$$

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

A) (1, 2)

B) (1, −2)

C) (−1, −1)

D) (−1, 1)

This is an example of a system you can solve more efficiently by substitution than by using the elimination method demonstrated in sample 6. Since $-2x = 4y + 6$, it follows that $-x = 2y + 3$. Now you can substitute $-x$ for $2y + 3$ in the second equation. This gives you $2(-x) = 3x - 5$, which is equivalent to $5x = 5$, or $x = 1$. Substituting 1 for x in the first equation gives you $-2 = 4y + 6$, which is equivalent to $4y = -8$, or $y = -2$. Therefore, the solution to the system is (1, −2).

STRATEGY

In sample 6, the elimination method yields an efficient solution to the question. In sample 10, the substitution method turns out to be an efficient approach. These examples illustrate the benefits of knowing both approaches and thinking critically about which approach may be more efficient for a given question.

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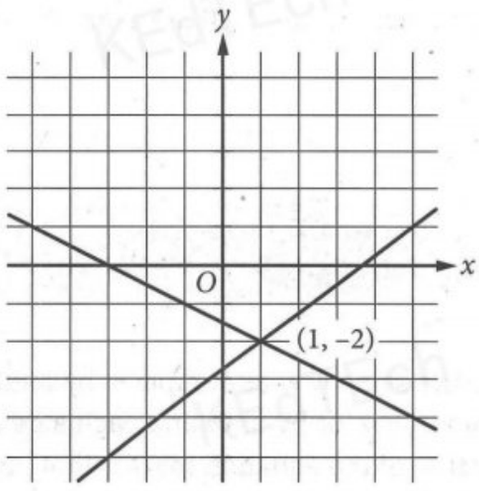
In the preceding examples, you found a unique solution to linear equations and to systems of two linear equations in two variables. But not all such equations and systems have solutions, and some have infinitely many solutions. Some questions in the Math section assess your ability to determine whether an equation or a system of linear equations has one solution, no solutions, or infinitely many solutions.

The Relationships Among Linear Equations, Lines in the Coordinate Plane, and the Contexts They Describe

STRATEGY

Graphing systems of two linear equations is another effective approach to solving them. Practice arranging linear equations into $y = mx + b$ form and graphing them in the coordinate plane.

A system of two linear equations in two variables can be solved by graphing the lines in the coordinate plane. For example, you can graph the equations of the system in the xy-plane in sample 10, above.



The point of intersection gives the solution to the system.

If the equations in a system of two linear equations in two variables are graphed, each graph will be a line. There are three possibilities:

1. The lines intersect at one point. In this case, the system has a unique solution.
2. The lines are parallel. In this case, the system has no solution.
3. The lines are identical. In this case, every point on the line is a solution, and so the system has infinitely many solutions.

One way that the second and third cases can be identified is by rewriting the equations of the system in slope-intercept form, $y = mx + b$, where m is the slope of the line and b is the y-coordinate of the y-intercept of the line when the system is graphed in the xy-plane. If the lines have the same slope and different y-coordinates of the y-intercepts, the lines are parallel; if both the slope and the y-coordinate of the y-intercept are the same, the lines are identical.

How are the second and third cases represented algebraically? Samples 11 and 12 answer this question.

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Algebra Sample Question 11

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

How many solutions (x, y) does the given system of equations have?

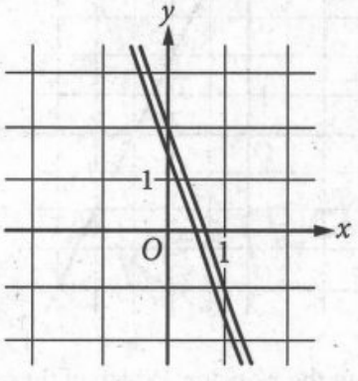
A) Zero
B) Exactly one
C) Exactly two
D) Infinitely many

To rewrite the second equation in slope-intercept form, subtract $3x$ from both sides of the equation, which gives $y = -3x + 2$. To rewrite the first equation in slope-intercept form, subtract $6x$ from both sides of the equation, which gives $2y = -6x + 3$. Next, divide both sides of this equation by 2, which gives $y = -3x + \frac{3}{2}$. Now that the two equations are written in slope-intercept form, you can identify that the slope of each line is -3 and that the y-coordinates of the y-intercepts are $\frac{3}{2}$ and 2.

Since the slopes are the same and the y-coordinates of the y-intercepts are different, the graphs of the lines will show distinct parallel lines. Because parallel lines never intersect, the system of equations has zero solutions.

Alternatively, if you multiply each side of $y + 3x = 2$ by 2, you get $2y + 6x = 4$. Then subtracting each side of $2y + 6x = 3$ from the corresponding side of $2y + 6x = 4$ gives $0 = 1$. This is a false statement. Therefore, the system has zero solutions (x, y).

You could also use graphing technology to graph the two equations. The graphs are parallel lines, so there are no points of intersection, and the system of equations has zero solutions.



STRATEGY

When the graphs of a system of two linear equations are distinct parallel lines, as in sample 11, the system has zero solutions. If the question states that a system of two linear equations has an infinite number of solutions, as in sample 12, the equations must be equivalent.

STRATEGY

The equations in the system in sample 11 are in a form that allows you to quickly find both the x-intercept and the y-intercept of the graph of the equation. For example, the graph of $y + 3x = 2$ has an x-intercept of $\left(\frac{2}{3}, 0\right)$ because if $y = 0$, then $3x = 2$ and $x = \frac{2}{3}$. Similarly, the graph has a y-intercept of $(0, 2)$ because if $x = 0$, then $y = 2$.

Algebra Sample Question 12

$$3s - 2t = a$$
$$-15s + bt = -7$$

In the given system of equations, a and b are constants. If the system has infinitely many solutions, what is the value of a?

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If a system of two linear equations in two variables has infinitely many solutions, the two equations in the system must be equivalent. Since the two equations are presented in the same form, the second equation must be equal to the first equation multiplied by a constant. Since the coefficient of s in the second equation is -5 times the coefficient of s in the first equation, multiply each side of the first equation by -5. This gives you the system

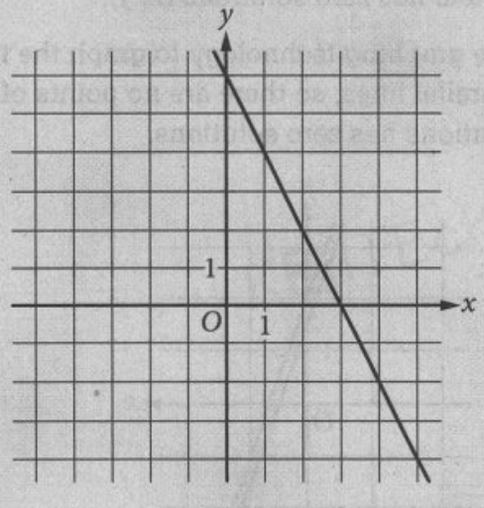
$$-15s + 10t = -5a$$
$$-15s + bt = -7$$

Since these two equations are equivalent and have the same coefficient of s, the coefficients of t and the constants on the right-hand side must also be the same. Thus, $b = 10$ and $-5a = -7$. Therefore, the value of a is $\frac{7}{5}$.

There may also be questions in the Math section that assess your knowledge of the relationship between the algebraic and the geometric representations of a line—that is, between an equation of a line and its graph. The key concepts are

- If the slopes of line ℓ and line k are each defined (that is, if neither line is a vertical line), then
  - Line ℓ and line k are parallel if and only if they have the same slope.
  - Line ℓ and line k are perpendicular if and only if the product of their slopes is -1.

Algebra Sample Question 13



The graph of line k is shown in the xy-plane. Which of the following is an equation of a line that is perpendicular to line k?

A) $y = -2x + 1$

B) $y = -\frac{1}{2}x + 2$

C) $y = \frac{1}{2}x + 3$

D) $y = 2x + 4$

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Note that the graph of line k passes through the points (0, 6) and (3, 0). Thus, the slope of line k is $\frac{0-6}{3-0} = -2$. Since the product of the slopes of perpendicular lines is −1, a line that is perpendicular to line k will have slope $\frac{1}{2}$. All the choices are in slope-intercept form, and so the coefficient of x is the slope of the line represented by the equation. Therefore, choice C, $y = \frac{1}{2}x + 3$, is an equation of a line with slope $\frac{1}{2}$, and thus this line is perpendicular to line k.

As we've noted, some contexts can be described with a linear equation. The graph of a linear equation is a line. A nonvertical line has geometric properties such as its slope and its y-intercept. These geometric properties can often be interpreted in terms of the context. The Math section may have questions that assess your ability to make these interpretations. For example, reconsider the contexts in samples 1 to 3. You created a linear function, $f(n) = 783 + 8n$, that describes the number of miles of paved road County X will have n years after 2014. This equation can be graphed in the coordinate plane, with n on the horizontal axis and $f(n)$ on the vertical axis. The points of this graph lie on a line with slope 8 and y-intercept of (0, 783). The slope, 8, gives the number of miles of new paved roads added each year, and the y-intercept gives the number of miles of paved roads in 2014, the year that corresponds to $n = 0$.

Algebra Sample Question 14

A voter registration drive was held in Town Y. The number of voters, V, registered T days after the drive began can be estimated by the equation $V = 3{,}450 + 65T$. What is the best interpretation of the number 65 in this context?

A) The estimated number of registered voters at the beginning of the registration drive

B) The estimated number of registered voters at the end of the registration drive

C) The total estimated number of voters registered during the drive

D) The estimated number of voters registered each day during the drive

The correct answer is choice D. For each day that passes, it's the next day of the registration drive, and so T increases by 1. In the given equation, when T, the number of days after the drive began, increases by 1, V, the estimated number of voters registered, becomes $V = 3{,}450 + 65(T + 1)$, or $V = 3{,}450 + 65T + 65$. That is, the estimated number of voters registered increases by 65 for each day of the drive. Therefore, 65 is the estimated number of voters registered each day during the drive.

You should note that choice A describes the number 3,450, and the numbers described by choices B and C can be found only if you know how many days the registration drive lasted; this information isn't given in the question.

REMINDER

The Math section will further assess your understanding of linear equations by, for instance, asking you to select a linear equation that describes a given graph, select a graph that describes a given linear equation, or determine how a graph may be affected by a change in its equation.

STRATEGY

Sample 13 requires a strong understanding of slope as well as the ability to calculate slope: slope is equal to rise over run, or the change in the y-value divided by the change in the x-value. Parallel lines have slopes that are equal. Perpendicular lines have slopes whose product is −1.

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Summary: Algebra Questions

Main purpose: To assess your understanding of linear relationships

Proportion of the test section: About 35 percent (thirteen to fifteen questions)

Question types

- Linear equations in one variable
- Linear equations in two variables
- Linear functions
- Systems of two linear equations in two variables
- Linear inequalities in one or two variables

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CHAPTER 22

Math: Questions—Algebra Drills

1

$$3a + 4b = 25$$

A shipping company charged a customer $25 to ship some small boxes and some large boxes. The given equation represents the relationship between a, the number of small boxes, and b, the number of large boxes, the customer had shipped. If the customer had 3 small boxes shipped, how many large boxes were shipped?

A) 3

B) 4

C) 5

D) 6

2

$$ax = 5$$

In the given equation, a is a constant. For which of the following values of a will the equation have no solution?

A) 0

B) 1

C) 5

D) 10

3

Tom scored 85, 78, and 98 on his first three exams in history class. Solving which inequality gives all the possible scores, G, that Tom could get on his fourth exam that will result in a mean score on all four exams of at least 90?

A) $90 - (85 + 78 + 98) \leq 4G$

B) $4G + 85 + 78 + 98 \geq 360$

C) $\frac{(G + 85 + 78 + 98)}{4} \geq 90$

D) $\frac{(85 + 78 + 98)}{4} \geq 90 - 4G$

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4

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

A) $-\frac{23}{7}$

B) $-\frac{15}{7}$

C) $-\frac{13}{7}$

D) $\frac{7}{11}$

5

On Monday, Jao walked a total of 11,400 steps. On Tuesday, Jao has a goal to walk at least 1,500 more steps than he did on Monday. What is the least number of steps Jao could walk on Tuesday to meet his goal?

6

$$x - 3y = 7$$

$$3y = 9$$

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

A) -2

B) 10

C) 16

D) 34

7

$$P = 1.20x + 5.00$$

The given equation gives the total monthly price P, in dollars, for using an online gaming service. The total monthly price for the online service consists of a flat monthly fee and a charge for each game played during a month. Of the following, which is the best interpretation of the value of x in this context?

A) The number of games played during a month

B) The charge, in dollars, for playing x games

C) The flat monthly fee, in dollars, for the gaming service

D) The number of months the gaming service was used

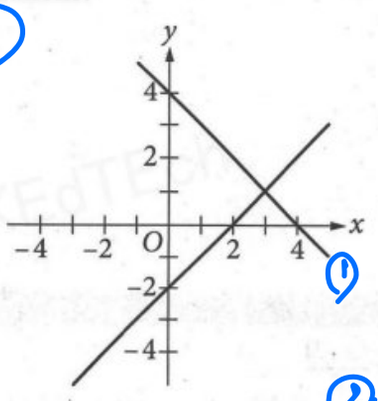
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8

$$x + y = 4$$
$$x - y = 2$$

Which of the following is the graph in the *xy*-plane of the given system of equations?

A)

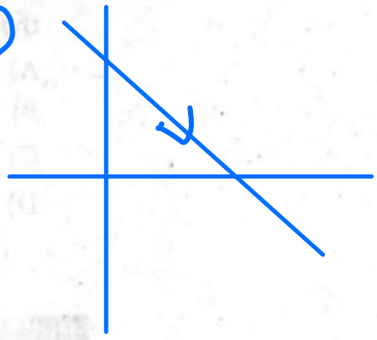


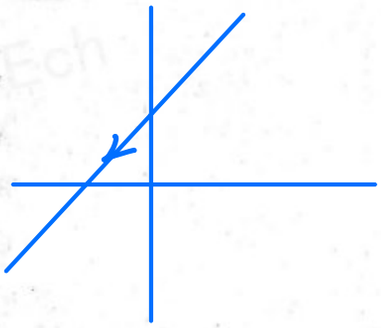
$y = -x + 4$ ①

$y = x - 2$

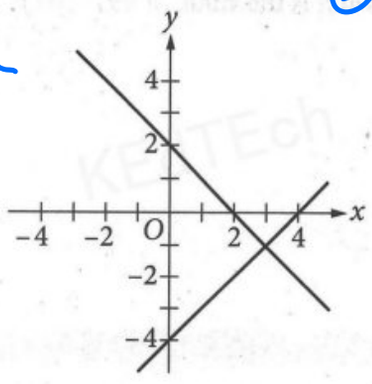
① $x = 0$ $y = 4$

② $x = 0$ $y = -2$

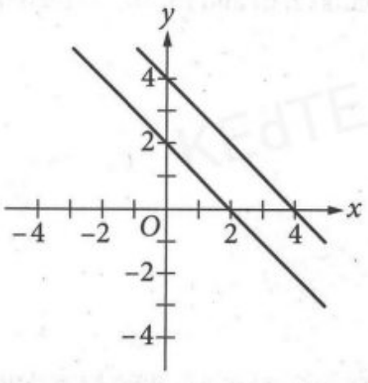




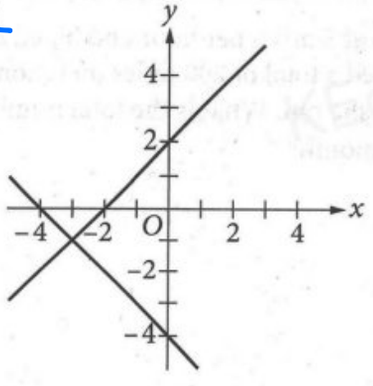
B)



C)



D)



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9

Nayya burns 5 kilocalories per minute running on a treadmill and 10 kilocalories per minute pedaling on a stationary bike. Which of the following equations represents the total number of kilocalories, T, Nayya has burned after running on the treadmill for 50 minutes and pedaling on the stationary bike for m minutes?

A) $T = 15m + 50$

B) $T = 50m + 50$

C) $T = 5m + 500$

D) $T = 10m + 250$

10

$$f(x) = \frac{(x+7)}{4}$$

For the function f defined as shown, what is the value of $f(9) - f(1)$?

A) 1

B) 2

C) $\frac{1}{4}$

D) $\frac{9}{4}$

11

In the xy-plane, line l contains the points (2, 6) and (8, 10). Which of the following is an equation of line l?

A) $y = \frac{2}{3}x + \frac{14}{3}$

B) $y = \frac{3}{2}x - 2$

C) $y = 2x + 6$

D) $y = 8x + 10$

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{10-6}{8-2} = \frac{4}{6} = \frac{2}{3}$$

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

$$y - 6 = \frac{2}{3}x - \frac{4}{3}$$

$$y = \frac{2}{3}x - \frac{4}{3} + 6 = \frac{2}{3}x + \frac{18-4}{3} = \frac{2}{3}x + \frac{14}{3}$$

12

During a month, Morgan ran r miles at 5 miles per hour and biked b miles at 10 miles per hour. She ran and biked a total of 200 miles that month, and she biked for twice as many hours as she ran. What is the total number of miles that Morgan biked during the month?

A) 80

B) 100

C) 120

D) 160

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13

The equation $c = \frac{5}{4}x + 406$ gives the total cost c, in dollars, to produce a quantity of x units. If the quantity of units produced increases by 39 units, what is the corresponding increase in the total cost, in dollars?

48.75

14

$$kx - 3y = 4$$
$$4x - 5y = 7$$

In the given system of equations, 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) $-\frac{12}{5}$

15

x	y
−10	66
−5	45
5	3
10	−18

$(-5)\cdot A + 5\cdot 45 = C$ ①

$5\cdot A + 3\cdot 5 = C$ ②

① $-5A + 225 = C$

② $5A + 15 = C$

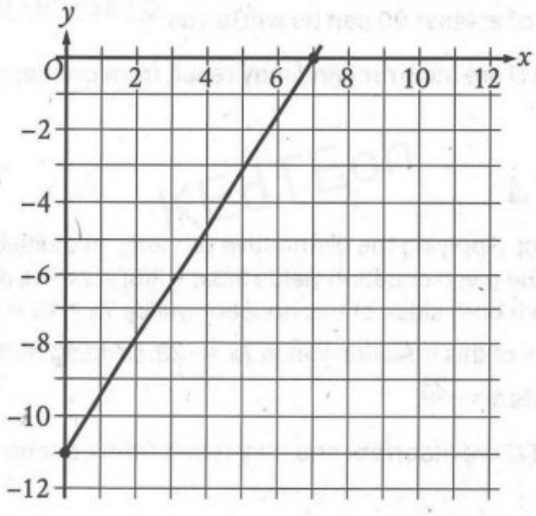
The table shows four values of x and their corresponding values of y. There is a linear relationship between x and y. If an equation representing this relationship is written in the form $Ax + 5y = C$, where A and C are constants, what is the value of C?

$-5A + 225 = 5A + 15$

$5 \times 21 + 15 = 105 + 15 = 120 = C$

$210 = 10A$ $\quad A = 21$

16



-6.28

The point $(3, d)$ lies on the line shown. What is the value of d?

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Answer Explanations

QUESTION 1

Choice B is correct. It's given that a represents the number of small boxes and b represents the number of large boxes the customer had shipped. If the customer had 3 small boxes shipped, then $a = 3$. Substituting 3 for a in the equation $3a + 4b = 25$ yields $3(3) + 4b = 25$, or $9 + 4b = 25$. Subtracting 9 from both sides of this equation yields $4b = 16$. Dividing both sides of this equation by 4 yields $b = 4$. Therefore, the customer had 4 large boxes shipped.

Choice A is incorrect. If the customer had 3 small boxes and 3 large boxes shipped, then the company would have charged the customer $21, not $25. *Choice C* is incorrect. If the customer had 3 small boxes and 5 large boxes shipped, then the company would have charged the customer $29, not $25. *Choice D* is incorrect. If the customer had 3 small boxes and 6 large boxes shipped, then the company would have charged the customer $33, not $25.

QUESTION 2

Choice A is correct. An equation has no solution when there is no value of x that produces a true statement. To solve the given equation for x, both sides of the equation can be divided by a, yielding $x = \frac{5}{a}$. Since 5 can be divided by any number except 0, it follows that the value of a can't be 0. Therefore, if the value of a is 0, the given equation will have no solution.

Alternate approach: Substituting 0 for a in the given equation yields $0x = 5$, or $0 = 5$, which isn't a true statement. Therefore, when $a = 0$, there is no solution to the given equation.

Choice B is incorrect. If $a=1$, then $x=\frac{5}{1}$, or $x= 5$, which yields exactly one solution rather than no solution. *Choice C* is incorrect. If $a=5$, then $x=\frac{5}{5}$, or $x= 1$, which yields exactly one solution rather than no solution. *Choice D* is incorrect. If $a=10$, then $x=\frac{5}{10}$, or $x=\frac{1}{2}$, which yields exactly one solution rather than no solution.

QUESTION 3

Choice C is correct. The mean of the four scores (G, 85, 78, and 98) can be expressed as $\frac{G + 85 + 78 + 98}{4}$. Thus, an inequality that represents a mean score on all four exams of at least 90 can be written as $\frac{G + 85 + 78 + 98}{4} \geq 90$.

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

QUESTION 4

Choice A is correct. Applying the distributive property of multiplication on the left-hand side of the given equation yields $3(3x) + 3(5) = 2x - 8$, or $9x + 15 = 2x - 8$. Subtracting $2x$ from both sides of this equation yields $7x + 15 = -8$. Subtracting 15 from both sides of this equation yields $7x = -23$. Dividing both sides of this equation by 7 yields $x = -\frac{23}{7}$.

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

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QUESTION 5

The correct answer is 12,900. It's given that Jao walked a total of 11,400 steps on Monday. It's also given that Jao has a goal to walk at least 1,500 more steps on Tuesday than he did on Monday. Let x represent the possible number of steps Jao could walk on Tuesday to meet his goal. This situation can be represented by the inequality $x \geq 11{,}400 + 1{,}500$, or $x \geq 12{,}900$. Thus, the least number of steps Jao could walk on Tuesday to meet his goal is 12,900.

QUESTION 6

Choice C is correct. From the given system of equations, adding the second equation, $3y = 9$, to the first equation, $x - 3y = 7$, yields $x - 3y + 3y = 7 + 9$, or $x = 16$.

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

QUESTION 7

Choice A is correct. It's given that the total monthly price P, in dollars, is the sum of a flat monthly fee and a charge for each game played during a month. A charge for each game played implies the multiplication of the rate, in dollars per game, and the number of games played. Therefore, $1.20 must be the charge per game, and x must be the number of games played during a month.

Choice B is incorrect. The charge, in dollars, for playing x games is $1.20x$. *Choice C* is incorrect. The flat monthly fee, in dollars, for the gaming service is $5.00. *Choice D* is incorrect. No information has been provided about the number of months the gaming service was used.

QUESTION 8

Choice A is correct. Each of the equations in the given system can be rewritten in the form $y = mx + b$, where m represents the slope and $(0, b)$ represents the y-intercept of the line. The first equation in the given system can be rewritten as $y = -x + 4$. It follows that this line has a slope of -1 and a y-intercept at $(0, 4)$. The second equation in the given system can be rewritten as $y = x - 2$. It follows that this line has a slope of 1 and a y-intercept at $(0, -2)$. Of the given choices, only the graph in choice A represents these lines.

Choices B and *D* are incorrect. These systems of equations represent lines with y-intercepts at $(0, 2)$ and $(0, -4)$ rather than $(0, 4)$ and $(0, -2)$. *Choice C* is incorrect. This system of equations represents lines with y-intercepts at $(0, 2)$ and $(0, 4)$ rather than $(0, 4)$ and $(0, -2)$.

QUESTION 9

Choice D is correct. It's given that Nayya burns 5 kilocalories per minute running on a treadmill. It follows that Nayya will burn 5(50), or 250, kilocalories running on the treadmill for 50 minutes. It's also given that Nayya burns 10 kilocalories per minute pedaling on a stationary bike. It follows that she will burn $10m$ kilocalories pedaling on the stationary bike for m minutes. The sum of the kilocalories burned after running on the treadmill for 50 minutes, 250, and the kilocalories burned after pedaling on the stationary bike for m minutes, $10m$, gives the total number of kilocalories, T, Nayya burned. Therefore, $T = 250 + 10m$, or $T = 10m + 250$.

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Choice A is incorrect. This equation represents the total number of kilocalories Nayya has burned if she burns 15, not 10, kilocalories per minute pedaling on a stationary bike and ran on the treadmill for 10, not 50, minutes. *Choice B* is incorrect. This equation represents the total number of kilocalories Nayya has burned if she burns 50, not 10, kilocalories per minute pedaling on a stationary bike and ran on the treadmill for 10, not 50, minutes. *Choice C* is incorrect. This equation represents the total number of kilocalories Nayya has burned if she burns 5, not 10, kilocalories per minute pedaling on a stationary bike and ran on the treadmill for 100, not 50, minutes.

QUESTION 10

Choice B is correct. The value of $f(9)$ represents the value of $f(x)$ when $x = 9$. Substituting 9 for x in the given function yields $f(9) = \frac{(9 + 7)}{4}$, which can be rewritten as $f(9) = \frac{16}{4}$, or $f(9) = 4$. Similarly, the value of $f(1)$ represents the value of $f(x)$ when $x = 1$. Substituting 1 for x in the given function yields $f(1) = \frac{(1 + 7)}{4}$, which can be rewritten as $f(1) = \frac{8}{4}$, or $f(1) = 2$. Therefore, $f(9) - f(1) = 4 - 2$, which is equivalent to 2.

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

QUESTION 11

Choice A is correct. The equation of a line in the xy-plane can be written as $y = mx + b$, where m represents the slope and b represents the y-coordinate of the y-intercept of the line. Given two points on a line, (x_1, y_1) and (x_2, y_2), the slope of the line can be calculated as $m = \frac{y_2 - y_1}{x_2 - x_1}$. Substituting (2, 6) for (x_1, y_1) and (8, 10) for (x_2, y_2) in the equation $m = \frac{y_2 - y_1}{x_2 - x_1}$ yields $m = \frac{10 - 6}{8 - 2}$, which is equivalent to $m = \frac{4}{6}$, or $m = \frac{2}{3}$. Substituting $\frac{2}{3}$ for m in the equation $y = mx + b$ yields $y = \frac{2}{3}x + b$. Since it's given that line l contains the point (2, 6), substituting 2 for x and 6 for y in $y = \frac{2}{3}x + b$ yields $6 = \frac{2}{3}(2) + b$, or $6 = \frac{4}{3} + b$. Subtracting $\frac{4}{3}$ from both sides of this equation yields $b = \frac{14}{3}$. Substituting $\frac{14}{3}$ for b in the equation $y = \frac{2}{3}x + b$ gives $y = \frac{2}{3}x + \frac{14}{3}$.

Choice B is incorrect. The line for this equation contains the point (2, 1), not (2, 6). *Choice C* is incorrect. The line for this equation contains the point (2, 10), not (2, 6). *Choice D* is incorrect. The line for this equation contains the point (2, 26), not (2, 6).

QUESTION 12

Choice D is correct. The number of hours Morgan spent running or biking can be calculated by dividing the distance, in miles, she traveled during that activity by her speed, in miles per hour, for that activity. It's given that Morgan ran r miles at 5 miles per hour and biked b miles at 10 miles per hour. It follows that the number of hours she ran can be represented by the expression $\frac{r}{5}$ and the number of hours she biked can be represented by the expression $\frac{b}{10}$. It's given that she biked for twice as many hours as she ran, so this can be represented by the equation $\frac{b}{10} = 2\left(\frac{r}{5}\right)$, which can be rewritten as $5b = 20r$, or $b = 4r$. It's also given that she ran and biked a total of 200 miles. This can be represented by the equation $r + b = 200$. Substituting $4r$ for b in this equation yields $r + 4r = 200$, or $5r = 200$.

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Dividing both sides of this equation by 5 yields $r = 40$. Determining the number of miles she biked, b, can be found by substituting 40 for r in the equation $r + b = 200$, which yields $40 + b = 200$. Subtracting 40 from both sides of this equation yields $b = 160$. Therefore, Morgan biked a total of 160 miles during the month.

Choice A is incorrect. If Morgan had biked a total of 80 miles during the month, it follows that Morgan would have run 120 miles, which doesn't satisfy the condition that Morgan biked for twice as many hours as she ran. *Choice B* is incorrect. If Morgan had biked a total of 100 miles during the month, it follows that Morgan would have run 100 miles, which doesn't satisfy the condition that Morgan biked for twice as many hours as she ran. *Choice C* is incorrect. If Morgan had biked a total of 120 miles during the month, it follows that Morgan would have run 80 miles, which doesn't satisfy the condition that Morgan biked for twice as many hours as she ran.

QUESTION 13

The correct answer is 48.75. It's given that the equation $c = \frac{5}{4}x + 406$ gives the total cost c, in dollars, to produce a quantity of x units. Since $c = \frac{5}{4}x + 406$ is a linear equation with a positive rate of change, $\frac{5}{4}$, it follows that the value of c increases by $\frac{5}{4}$ for every increase in x by 1. Therefore, if the value of x increases by 39, the value of c increases by $\frac{5}{4}(39)$, or $\frac{195}{4}$, which is equivalent to 48.75. Thus, if the quantity of units produced increases by 39, the corresponding increase in the total cost, in dollars, is 48.75. Note that 48.75 and 195/4 are examples of ways to enter a correct answer.

QUESTION 14

Choice A is correct. If a system of two linear equations has no solution, then the lines represented by the equations in the coordinate plane are parallel and distinct. The equation $kx - 3y = 4$ can be rewritten as $y = \frac{k}{3}x - \frac{4}{3}$, where $\frac{k}{3}$ is the slope and $\left(0, -\frac{4}{3}\right)$ is the y-intercept of the line. The equation $4x - 5y = 7$ can be rewritten as $y = \frac{4}{5}x - \frac{7}{5}$, where $\frac{4}{5}$ is the slope and $\left(0, -\frac{7}{5}\right)$ is the y-intercept of the line. If the two lines are parallel, then the lines have the same slope and different y-intercepts. Therefore, $\frac{k}{3} = \frac{4}{5}$, or $k = \frac{12}{5}$.

Choice B is incorrect. Substituting $\frac{16}{7}$ for k in the equation $kx - 3y = 4$ yields a line with a slope of $\frac{16}{21}$, not $\frac{4}{5}$. Therefore, for the given system of equations, if $k = \frac{16}{7}$, then the system has exactly one solution. *Choice C* is incorrect. Substituting $-\frac{16}{7}$ for k in the equation $kx - 3y = 4$ yields a line with a slope of $-\frac{16}{21}$, not $\frac{4}{5}$. Therefore, for the given system of equations, if $k = -\frac{16}{7}$, then the system has exactly one solution. *Choice D* is incorrect. Substituting $-\frac{12}{5}$ for k in the equation $kx - 3y = 4$ yields a line with a slope of $-\frac{4}{5}$, not $\frac{4}{5}$. Therefore, for the given system of equations, if $k = -\frac{12}{5}$, then the system has exactly one solution.

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QUESTION 15

The correct answer is 120. It's given that there is a linear relationship between x and y and that the table shows four values of x and their corresponding values of y. Based on the given table, when $x = -5$, the corresponding value of y is 45 and when $x = 5$, the corresponding value of y is 3. Substituting -5 for x and 45 for y in the equation $Ax + 5y = C$ yields $A(-5) + 5(45) = C$, or $-5A + 225 = C$. Substituting 5 for x and 3 for y in the equation $Ax + 5y = C$ yields $A(5) + 5(3) = C$, or $5A + 15 = C$. Since $-5A + 225 = C$ and $5A + 15 = C$, it follows that $-5A + 225 = 5A + 15$. Subtracting $5A$ and 225 from both sides of this equation yields $-10A = -210$. Dividing both sides of this equation by -10 yields $A = 21$. Substituting 21 for A in the equation $-5A + 225 = C$ yields $-5(21) + 225 = C$, which is equivalent to $-105 + 225 = C$, or $C = 120$. Therefore, if an equation representing this relationship is written in the form $Ax + 5y = C$, where A and C are constants, the value of C is 120.

QUESTION 16

The correct answer is $-\frac{44}{7}$. It's given from the graph that the points (7, 0) and (0, −11) lie on the line shown in the xy-plane. For two points on a line, (x_1, y_1) and (x_2, y_2), the slope, m, of the line can be calculated using the slope formula $m = \frac{y_2 - y_1}{x_2 - x_1}$. Substituting (7, 0) for (x_1, y_1) and (0, −11) for (x_2, y_2) in this formula, the slope of the line can be calculated as $m = \frac{-11 - 0}{0 - 7}$, or $m = \frac{11}{7}$. It's also given that the point $(3, d)$ lies on the line. Substituting (7, 0) for (x_1, y_1), $(3, d)$ for (x_2, y_2), and $\frac{11}{7}$ for m in the slope formula yields $\frac{11}{7} = \frac{d - 0}{3 - 7}$, or $\frac{11}{7} = \frac{d}{-4}$. Multiplying both sides of this equation by -4 yields $(-4)\left(\frac{11}{7}\right) = d$, or $d = -\frac{44}{7}$. Thus, the value of d is $-\frac{44}{7}$. Note that −44/7, −6.285, and −6.286 are examples of ways to enter a correct answer. $\frac{12}{5}$

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