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Item #	Rationale	
1	Option C is correct	To determine the function (a relationship where each input has a single output) that relates y, the number of jars of tomato sauce in the pantry, and x, the number of boxes, the student could have multiplied the number of jars per box (8) by the number of boxes (x) and then subtracted the jars the cook used (2). The function representing the number remaining in the pantry is $y = 8x - 2$. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely subtracted the jars of tomato sauce the cook used (2) from the number of jars in one box (8) and then added the difference ($8 - 2 = 6$) to the number of jars in one box ($8x$) without regard for the partial box. The student needs to focus on understanding how to write linear equations given a description of a situation.
	Option B is incorrect	The student likely determined the total number of jars stored in the pantry instead of determining the number of jars remaining after the cook used 2 of the jars. The student needs to focus on understanding how to write linear equations given a description of a situation.
	Option D is incorrect	The student likely subtracted the jars the cook used (2) from the number of jars in one box ($8 - 2 = 6$), identifying 6 as the number of jars remaining in each box. The student needs to focus on understanding how to write linear equations given a description of a situation.

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Item #	Rationale	
2	Option G is correct	To determine the equivalent expression, the student could have determined $-7x$ is the common factor (a number or expression that divides another number or expression) of $-28x^2$ and $35x$. Because $-7(4) = -28$ and $x(x) = x^2$, $-28x^2$ can be expressed as $-7x(4x)$. Similarly, $35x$ can be expressed as $-7x(-5)$. The student should have recognized the common factor as $-7x$ and combined the other two terms to indicate that $-28x^2 + 35x$ is equal to $-7x$ times $(4x - 5)$, or $-7x(4x - 5)$. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely divided each term by $7x$ instead of $-7x$ but made a sign error when dividing $-28x^2$ by $7x$. The student needs to focus on understanding how to multiply and divide positive and negative numbers.
	Option H is incorrect	The student likely divided each term by $-7x$ but did not include the negative sign in the final expression. The student needs to focus on representing all factors in an expression with accuracy.
	Option J is incorrect	The student likely divided by $-7x$ but made a sign error when dividing $35x$ by $-7x$, resulting in 5 instead of -5. The student needs to focus on understanding how to multiply and divide positive and negative numbers.
3	Option D is correct	On a graph, a system of equations has a solution when the lines intersect (cross over). To determine which graph represents a system of equations with no solution, the student should have identified the graph with parallel lines. Regardless of how far these two lines extend, they will never intersect.
	Option A is incorrect	The student likely chose a graph that has a solution. The student needs to focus on understanding how to determine the solution of a system of equations from a graph.
	Option B is incorrect	The student likely chose a graph that did not show where the lines intersect and misinterpreted this graph as having no solution. The student needs to focus on understanding how to determine the solution of a system of equations from a graph.
	Option C is incorrect	The student likely misinterpreted a solution of $(0, 0)$ as "no solution." The student needs to focus on understanding how to determine the solution of a system of equations from a graph.

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Item #	Rationale	
4	Option G is correct	The student could have graphed the equation and determined where the curve crossed the y-axis, the y-intercept, $(0, 8)$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely interpreted the exponential factor, 0.25, to be an x-intercept, a value where a function crosses the x-axis. The student needs to focus on understanding how to identify and distinguish key features of exponential functions (a function in the form $y = ab^x$, where x is a variable, and a and b are constants).
	Option H is incorrect	The student likely interpreted $x =$ to mean the x-axis, which is $y = 0$. The student needs to focus on understanding how to identify and distinguish key features of exponential functions (a function in the form $y = ab^x$, where x is a variable, and a and b are constants).
	Option J is incorrect	The student likely identified the point $(1, 2)$ as part of the graph or the table of values, but switched the x-values and y-values. The student needs to focus on understanding which number in an ordered pair represents the x-value and which number represents the y-value.

Item #	Rationale	
5	Option C is correct	The student could have graphed the function to determine which y-values are represented on it. As the graph of this function opens downward, it is bound above by $y = 4$, so the range is all values of y less than or equal to 4, or $y \leq 4$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely identified the correct range values as less than or equal to 4, but associated range to the x variable instead of the y variable. The student needs to focus on understanding how to represent the range of a graph using the dependent variable, y.
	Option B is incorrect	The student likely associated range to the x variable instead of the y variable, interpreted "$\geq$" to mean "less than or equal to," and included the negative sign from the leading term ($-x^2$). The student needs to focus on understanding how to represent the range of a graph using the dependent variable, y, and on understanding the meaning of inequality symbols.
	Option D is incorrect	The student likely interpreted "$\geq$" to mean "less than or equal to" and included the negative sign from the leading term ($-x^2$). The student needs to focus on understanding how to represent the range of a graph using the dependent variable, y, and on understanding the meaning of inequality symbols.

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Item #	Rationale	
6	Option F is correct	To determine the equivalent expression, the student should have recognized the $\frac{1}{2}$ represents a square root (a value that, when multiplied by itself, is equal to the number under the $\sqrt{\ }$); therefore $144^{\frac{1}{2}} = \sqrt{144} = 12$. Raising each variable (symbol used to represent an unknown number) to the $\frac{1}{2}$ power means the student should multiply the exponents 2 and 14 by $\frac{1}{2}$, namely $(144k^2r^{14})^{\frac{1}{2}} = 144^{\frac{1}{2}}k^{2\cdot\frac{1}{2}}r^{14\cdot\frac{1}{2}} = 12kr^7$.
	Option G is incorrect	The student likely misinterpreted the power to mean multiplication by a coefficient (a number used to multiply a variable) and calculated $144 \cdot \frac{1}{2} = 72$, leaving the variables and their exponents as they are. The student needs to focus on understanding how to simplify expressions using the laws of exponents.
	Option H is incorrect	The student likely simplified the variables correctly but did not simplify $144^{\frac{1}{2}}$. The student needs to focus on understanding how to simplify numbers raised to powers.
	Option J is incorrect	The student likely simplified $144^{\frac{1}{2}}$ correctly but did not simplify the variables. The student needs to focus on understanding how to simplify variables with powers raised to powers.

Item #	Rationale	
7	Option C is correct	To determine which function is best represented by the graph of the situation, the student could have used a graphing calculator to analyze the key features of the graph of each function versus the graph given. The graph given has a vertex (highest or lowest point) at $(2, 64)$, zeroes (input value, x, that produces an output value, y, of zero) at $(0, 0)$ and $(4, 0)$, and opens downward. The function whose graph has matching key features is $h(t) = -16t^2 + 64t$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely identified this function as having a vertex at $y = 64$, disregarding that the solution (zero) of this function is at $(-4, 0)$ instead of $(4, 0)$ as shown in the graph. The student needs to focus on understanding how graphs of quadratics relate to their functions.
	Option B is incorrect	The student likely divided each term by -16 to get $t^2 - 8t + 16$ and then factored, resulting in $(x - 4)(x - 4)$, which has a solution (zero) of $x = 4$. The student needs to focus on identifying key features of quadratic functions.
	Option D is incorrect	The student likely divided each term by -16 to get $t^2 + 8t + 16$ and then factored, resulting in $(x + 4)(x + 4)$. The student then likely interpreted $(x + 4)$ as corresponding to the graph having a solution (zero) at 4. The student needs to focus on identifying key features of quadratic functions.

Item #	Rationale	
8	Option G is correct	To determine what value of n makes the given equation true, the student could have solved the equation for n. To solve the equation, the student could have first distributed (multiplied) the number immediately in front of the parenthesis by the values inside the parentheses. This step results in $4(0.5n) - 4(3) = n - 0.25(12) - 0.25(-8n)$, which is $2n - 12 = n - 3 + 2n$. Next, the student could have combined the n terms $(n + 2n)$ on the right side of the equation, resulting in $2n - 12 = 3n - 3$. The student could have then determined that to finish combining the n terms, $2n$ should be subtracted from both sides of the equation. This step results in $-12 = n - 3$. To solve for n, the student could have added 3 to both sides of the equation, resulting in $-9 = n$ or $n = -9$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely made a sign error when distributing the right side of the equation and solved $2n - 12 = n - 3 - 2n$. The student needs to focus on applying the distributive property correctly when solving equations.
	Option H is incorrect	The student likely did not distribute the coefficients (a number used to multiply a variable) to the second term inside each set of parentheses and made a sign error when distributing the right side of the equation, resulting in the equation $2n - 3 = n - 3 - 8n$. The student needs to focus on applying the distributive property correctly when solving equations.
	Option J is incorrect	The student likely distributed the equation correctly but subtracted 3 instead of adding 3 when solving for n, resulting in $n = -12 - 3 = -15$. The student needs to focus on understanding how to combine like terms when isolating the variable to solve the equation.

Item #	Rationale	
9	Option C is correct	To determine which equation can be used to find the n^{th} term in the sequence a_n, the student could have used the pattern or the sequence to determine the common difference, the distance between each number in the sequence, and the initial value, the number where the sequence begins, a_0. Examining the sequence 0, 6, 12, 18, 24, the student could see that the common difference is 6, namely $0 + 6 = 6$, $6 + 6 = 12$, ... The student could also note that a_3 is the third number after the initial value. The student would need to work backward three sets of 6 from the first given value 0, or $0 - 3(6) = -18$. The equation of the sequence is $a_n = 6n - 18$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely calculated the common difference to be -6 and the initial value, a_0, to be 18. The student needs to focus on understanding how to determine the proper sign of values in equations.
	Option B is incorrect	The student likely reversed the positions of the common difference and the initial value. The student needs to focus on understanding how to write the equation of an arithmetic sequence once the common difference and the initial value have been identified.
	Option D is incorrect	The student likely calculated the common difference to be -6 and the initial value, a_0, to be 18 and reversed the positions of the common difference and the initial value. The student needs to focus on understanding how to apply the general form of an arithmetic sequence.

Item #	Rationale	
10	Option J is correct	To determine the value of x when $y = 105$ the student could have determined that when two variables (symbols used to represent unknown numbers), x and y, vary directly with each other, their relation can be represented by the equation $y = kx$. This equation represents the value of y, which can be determined by multiplying the value of x by the value of k (known as the variation constant). The student could have calculated what number, when multiplied by 3, equals 21, resulting in $k = 7$. The student could have then substituted 7 for k and 105 for y, resulting in $105 = 7x$. To solve for x, the student should have divided both sides of the equation by 7 to arrive at $x = 15$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely interpreted direct variation (a relationship between two variables in which one is a constant multiple of the other) to mean inverse variation and used $y = \frac{k}{x}$ instead of $y = kx$ to solve for k and then x. The student needs to focus on understanding how to set up and solve direct variation problems.
	Option G is incorrect	The student likely interpreted direct variation (a relationship between two variables in which one is a constant multiple of the other) to mean the reciprocal of inverse variation and used $y = \frac{x}{k}$ instead of $y = kx$ to solve for k and then x. The student needs to focus on understanding how to set up and solve direct variation problems.
	Option H is incorrect	The student likely solved for k correctly and chose 7 without completing the final steps to solve for x. The student needs to focus on understanding how to solve direct variation (a relationship between two variables in which one is a constant multiple of the other) problems.

Item #	Rationale	
11	Option A is correct	To determine the equivalent expression, the student could have found the factors (numbers or expressions that can be multiplied to get another number or expression) of $x^2 - 17x - 60$. To find the factors, the student could have determined that x^2 is equal to $x \cdot x$ and written x as the first term in the factors. The student could have then determined that the second terms are -20 and 3 because their product (answer when multiplying) is -60 (last term in the expression given) and their sum is -17 (number in middle term in the expression given). The student could have then written the two factors as $(x - 20)(x + 3)$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option B is incorrect	The student likely calculated $-5 - 12 = -17$ correctly, but incorrectly multiplied -5 by -12 to get -60. The student needs to focus on understanding how to factor trinomials in the form $ax^2 + bx + c$.
	Option C is incorrect	The student likely subtracted -20 and -3 incorrectly to get -17 and multiplied -20 by -3 incorrectly to get -60. The student needs to focus on understanding how to factor trinomials in the form $ax^2 + bx + c$.
	Option D is incorrect	The student likely calculated $5 \cdot -12 = -60$ correctly, but incorrectly added 5 and -12 to get -17. The student needs to focus on understanding how to factor trinomials in the form $ax^2 + bx + c$.

Item #	Rationale	
12	Option G is correct	To determine the best prediction, the student could have used the graphing calculator to determine a line of best fit and evaluated it for 25 weeks. Therefore, the student could have determined that 6% is the best prediction. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely determined a percentage for 22 weeks since it was the last value represented on the *x*-axis (horizontal axis). The student needs to focus on understanding how to analyze data trends to make predictions.
	Option H is incorrect	The student likely estimated the percentage of body mass corresponding to 5 grid units right of 20, not taking into account that each grid line represents 2 weeks. The student needs to focus on understanding how to analyze data trends to make predictions.
	Option J is incorrect	The student likely identified the percentage of body mass close to the value at an age of 20 weeks. The student needs to focus on understanding how to analyze data trends to make predictions.

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Item #	Rationale	
13	Option D is correct	To determine the domain (all possible x values) and range (all possible y values), the student could have used a graphing calculator to generate the graph of $f(x) = -37$ or $y = -37$. Since the graph is a line that extends forever to the left and the right, the domain is all real numbers. No matter which x-value is chosen, its corresponding y-value is -37; therefore, the range is $\{-37\}$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely associated domain with the y-values and range with the x-values. The student likely also considered the horizontal line to be a minimum (smallest) value and determined that the domain is greater than or equal to -37. The student needs to focus on understanding how to identify the domain and range of a function (a relationship where each input has a single output).
	Option B is incorrect	The student likely associated domain with the y-values and range with the x-values. The student needs to focus on understanding how to identify the domain and range of a function (a relationship where each input has a single output).
	Option C is incorrect	The student likely considered the horizontal line to be a minimum (smallest) value and determined that the range is greater than or equal to -37. The student needs to focus on understanding how to determine the range of a function (a relationship where each input has a single output).
14	-6 and any equivalent values are correct	To determine the value of n, the student could have recognized that $k(x) = x^2$ is the quadratic parent function, which has the vertex (highest or lowest point on the graph of a quadratic function) at $(0, 0)$. The student could have then noted that the vertex of quadratic function p (the graph shown on the grid) is 6 units below $(0, 0)$, making the value of n equal to -6. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.

Item #	Rationale	
15	Option A is correct	To determine the cost of each large envelope, the student could have set up and solved a system of linear equations. Using the variables (symbols used to represent unknown numbers) p as "the cost of each postcard" and e as "the cost of each large envelope," the equation for the first customer is $14p + 5e = 12$, and the equation for the second customer is $10p + 15e = 24.80$. Using the elimination method, the student could have multiplied the first equation by -3 in order to add the two equations and eliminate the variable e; $\begin{pmatrix} -3(14p & +5e & = 12) \\ 10p & +15e & = 24.80 \end{pmatrix} \Rightarrow \begin{pmatrix} -42p & -15e & = -36 \\ 10p & +15e & = 24.80 \end{pmatrix} \Rightarrow -32p = -11.20 \Rightarrow$ $p = 0.35$. Then the student could have substituted the value of p to solve for the value of e ($10(0.35) + 15e = 24.80$, $e = 1.42$). The cost in dollars of each large envelope is \$1.42. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option B is incorrect	The student likely set up and solved the system of linear equations for the cost of a postcard instead of a large envelope, as directed. The student needs to focus on understanding how to solve a system of equations given verbal descriptions.
	Option C is incorrect	The student likely set up the system of equations correctly but then solved for the cost of a postcard, making distribution and sign errors during the elimination method process $\begin{pmatrix} -3(14p & +5e & = 12) \\ 10p & +15e & = 24.80 \end{pmatrix} \Rightarrow \begin{pmatrix} -42p & -15e & = 12 \\ 10p & +15e & = 24.80 \end{pmatrix} \Rightarrow 32p = 36.80 \Rightarrow p = \$1.15$. The student needs to focus on understanding how to solve a system of equations given verbal descriptions.
	Option D is incorrect	The student likely assumed the cost of each postcard and each envelope was the same and divided 12 (the total cost for the first customer) by 19 (the total number of postcards and envelopes purchased by the first customer), resulting in \$0.63. The student needs to focus on understanding how to set up and solve a system of equations given verbal descriptions.

Item #	Rationale	
16	Option H is correct	To identify the best description of the *y*-intercept (value where a line crosses the *y*-axis), the student should have determined that the line intersects (crosses) the *y*-axis (vertical axis) at (0, 16). Since the *x*-axis (horizontal axis) represents the number of days and the *y*-axis represents the water level in feet, the *y*-intercept means that the initial water level (at 0 days) was 16 feet.
	Option F is incorrect	The student likely interpreted *y*-intercept to mean slope (steepness of a straight line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$). The student needs to focus on understanding the key features of linear functions.
	Option G is incorrect	The student likely interpreted *y*-intercept to mean the maximum (greatest) *y*-value of the graph. The student needs to focus on understanding the key features of linear functions.
	Option J is incorrect	The student likely interpreted *y*-intercept to mean the maximum (greatest) *x*-value of the graph. The student needs to focus on understanding the key features of linear functions.

Item #	Rationale	
17	Option B is correct	To determine the correct function, the student should have recalled that when a value is decreased by a factor (half in this case), the situation is represented with an exponential equation or function, $f(x) = ab^x$, where a is the initial or starting value, b is 1 minus the factor that the value is decreased, and x is the iteration (in this case, x is the number of rounds). The student should have identified that $a = 1{,}024$ and $b = 1 - \frac{1}{2} = \frac{1}{2}$ or 0.50, resulting in the function $f(x) = 1{,}024(0.50)^x$.
	Option A is incorrect	The student likely added 0.5 and 1 instead of subtracting to find the value of b. This function represents an increase of 50% at the end of each round. The student needs to focus on understanding how to write exponential functions.
	Option C is incorrect	The student likely determined that $\frac{1}{2}$ is equal to 0.05 instead of 0.50 and then added instead of subtracting to find the value of b. This function represents an increase of 5% at the end of each round. The student needs to focus on converting fractions to decimals and on understanding how to write exponential functions.
	Option D is incorrect	The student likely determined that $\frac{1}{2}$ is equal to 0.05 instead of 0.50 and used it as the value of b. The student needs to focus on converting fractions to decimals and on understanding how to write exponential functions.

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Item #	Rationale	
18	Option H is correct	To determine which statement is true, the student could have recognized that because x^2 and 576 are perfect squares (a number made by squaring a whole number), $x^2 - 576$ is the difference (indicated by the subtraction symbol) of two squares ($x^2 = x \cdot x$ and $576 = 24 \cdot 24$). The student could have then written the factors (numbers or expressions that can be multiplied to get another number or expression) as $(x + 24)(x - 24)$ and solved for the values that make each factor (expression within the parentheses) equal to zero. The zeros are -24 and 24 because $-24 + 24 = 0$ and $24 - 24 = 0$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely divided 576 by 2 instead of finding the factors of -57 to determine the factored form. The student needs to focus on understanding the factored form of a difference of two squares.
	Option G is incorrect	The student likely divided 576 by 2 instead of finding the square root (a value that, when multiplied by itself, is equal to the number under the $\sqrt{\ }$) and made a sign error to determine the factored form. The student needs to focus on understanding the factored form of a difference of two squares.
	Option J is incorrect	The student likely made a sign error to determine the factored form. The student needs to focus on understanding the factored form of a difference of two squares.

Item #	Rationale	
19	Option A is correct	To determine which graph best represents the solution set of $-4x \leq 6y - 54$, the student could have first isolated the y on one side of the inequality. The first step to isolate y is to add 54 to both sides of the inequality, resulting in $-4x + 54 \leq 6y$. The next step is to divide both sides of the inequality by 6, resulting in $-\frac{4}{6}x + 9 \leq y$ or $y \geq -\frac{4}{6}x + 9$, which can be simplified to $y \geq -\frac{2}{3}x + 9$. The student could have then determined that the " $\geq$ " symbol means "greater than or equal to" and the correct solution will be shaded above a solid line (to indicate that points on and above the line are part of the solution). Also, the line will cross the y-axis (vertical axis) at 9 and will have a slope (steepness of a straight line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$) of $-\frac{2}{3}$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option B is incorrect	The student likely identified a solution set with the correct y-intercept (9) and the correct slope $\left(-\frac{2}{3}\right)$, but the shading below a dashed line indicates that the solution set is the points below the line (not including the points on the line.) This graph represents the solution set of $y < -\frac{2}{3}x + 9$. The student needs to focus on understanding how inequality symbols affect the graph of a solution set.
	Option C is incorrect	The student likely identified a solution set with the correct y-intercept (9) but with a dashed line and a slope of $-\frac{3}{2}$ instead of $-\frac{2}{3}$. The student needs to focus on understanding how inequality symbols affect the graph of a solution set and on how the rate of change affects the position of the points on the line.
	Option D is incorrect	The student likely identified a solution set with the correct y-intercept (9) and a solid line but with a slope of $-\frac{3}{2}$ instead of $-\frac{2}{3}$, and with shading below the line instead of above it. The student needs to focus on understanding how inequality symbols affect the graph of a solution set and on how the rate of change affects the position of the points on the line.

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Item #	Rationale	
20	48 and any equivalent values are correct	To determine the value of $f(16)$, the student should have substituted 16 for x in the function and simplified to calculate the result: $f(16) = \frac{1}{3}(4-16)^2$, $f(16) = \frac{1}{3}(-12)^2$, $f(16) = \frac{1}{3}(144)$, $f(16) = 48$.
21	Option C is correct	To determine the rate of change, the student could have analyzed the rate at which the line rises from left to right. The student could have found that 400 square feet can be painted with 1 gallon, 800 square feet can be painted with 2 gallons, 1,200 square feet can be painted with 3 gallons, and so on. The maximum (greatest) area that can be painted with respect to the number of gallons of paint is 400 square feet per 1 gallon of paint (400 ft^2/gal). The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely misinterpreted the point $(0.5, 200)$ as $(1, 200)$, resulting in a rate of change of 200 ft^2/gal. The student needs to focus on understanding how to calculate the rate of change of a graph.
	Option B is incorrect	The student likely misinterpreted the point $(0.5, 200)$ as $(1, 200)$ and expressed the answer as the number of gallons of paint needed with respect to the maximum area that can be painted instead of the maximum area that can be painted with respect to the number of gallons of paint as directed. The student needs to focus on understanding how to calculate the rate of change of a graph.
	Option D is incorrect	The student likely expressed the answer as the number of gallons of paint needed with respect to the maximum area that can be painted instead of the maximum area that can be painted with respect to the number of gallons of paint as directed. The student needs to focus on understanding how to calculate the rate of change of a graph.

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Item #	Rationale	
22	Option J is correct	To determine the solutions to the equation, the student could have solved the equation for x. The first step is to find the square root (a value that, when multiplied by itself, is equal to the number under the $\sqrt{\ }$) of both sides of the equation, resulting in $x + 7 = \pm 9$. Next, the student could have set up and solved $x + 7 = 9$ and $x + 7 = -9$. To solve each equation, the student could have subtracted 7 from both sides of each equation, resulting in $x = 2$ and $x = -16$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely did not find the square root of 81 and calculated $7 + 81 = 88$ and $7 - 81 = -74$. The student needs to focus on understanding how to solve equations involving square roots.
	Option G is incorrect	The student likely added 7 in the last step instead of subtracting 7, resulting in $9 + 7 = 16$ and $-9 + 7 = -2$. The student needs to focus on understanding how to solve equations involving addition and subtraction.
	Option H is incorrect	The student likely did not find the square root of 81 and instead calculated $-81 - 7 = -88$ and $81 - 7 = 74$. The student needs to focus on understanding how to solve equations by taking square roots.

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Item #	Rationale	
23	Option A is correct	To determine the domain (all possible x-values), the student could have identified all the values of x for which the graph has a y-value. The graph extends from -1 on the far left to 3 on the far right and includes all points between -1 and 3. The domain is therefore all values of x from -1 to 3, including -1 and 3 or $-1 \leq x \leq 3$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option B is incorrect	The student likely associated domain with the variable y. The student needs to focus on understanding how to determine and express domain from a graph.
	Option C is incorrect	The student likely approximated the least and greatest vertical values of the graph instead of the least and greatest horizontal values. The student needs to focus on understanding how to determine and express domain from a graph.
	Option D is incorrect	The student likely interpreted domain to mean range (all possible y-values). The student needs to focus on understanding how to determine and express domain from a graph.

Item #	Rationale	
24	Option G is correct	To determine the system of equations represented by lines q and v, the student could have used a graphing calculator to determine the equation of each line in slope-intercept form ($y = mx + b$). This results in the equation $y = 3x + 27$ for line q and $y = -\frac{1}{2}x + 8$ for line v. The student could have then determined that the answers must be written in standard form ($Ax + By = C$, where A, B, and C are integers, and A is usually positive). To write the equation for line q in standard form, the student could have subtracted $3x$ from both sides of the equation, resulting in $-3x + y = 27$. To make -3 positive, the student could have multiplied every term of the equation by -1. This results in $3x - y = -27$. To write the equation for line v in standard form, the student could have added $\frac{1}{2}x$ to both sides of the equation, resulting in $\frac{1}{2}x + y = 8$. To make $\frac{1}{2}$ an integer, the student could have multiplied every term in the equation by 2. This step results in the equation $x + 2y = 16$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely switched the x- and y-values of the first ordered pair in the table for line q, using -9 as the y-intercept (value where a line crosses the y-axis), and then calculated the slope (steepness of a straight line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$) by subtracting -3 from 18, resulting in the slope-intercept form $y = 21x - 9$, and then changed it to standard form, $21x - y = 9$. For line v, the student likely switched the x- and y-values of the middle ordered pair in the table and then used $(-4, 10)$ and $(8, 0)$ to calculate the slope ($m = \frac{0 - 10}{8 - (-4)} = -\frac{10}{12} = -\frac{5}{6}$) and y-intercept ($0 = -\frac{5}{6}(8) + b$, $b = \frac{40}{6} = \frac{20}{3}$), resulting in the slope-intercept form $y = -\frac{5}{6}x + \frac{20}{3}$, and then changed it to standard form, $5x + 6y = 40$. The student needs to focus on understanding how to use coordinates from a table to determine the equation of a line.

Item #	Rationale	
	Option H is incorrect	The student likely switched the x- and y-values of the first ordered pair in the table for line q, using -9 as the y-intercept (value where a line crosses the y-axis), and then calculated the slope (steepness of a straight line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$) by subtracting -3 from 18, resulting in the slope-intercept form $y = 21x - 9$, and then changed it to standard form, $21x - y = 9$. For line v, the student likely switched the x- and y-values of the middle ordered pair in the table, then used $(-4, 10)$ and $(8, 0)$ to calculate the slope ($m = \frac{0 - 10}{8 - (-4)} = -\frac{10}{12} = -\frac{5}{6}$) and y-intercept ($0 = -\frac{5}{6}(8) + b$, $b = \frac{40}{6} = \frac{20}{3}$), resulting in the slope-intercept form $y = -\frac{5}{6}x + \frac{20}{3}$, and then made a multiplication error when changing it to standard form to get $5x + 6y = 20$. The student needs to focus on understanding how to use coordinates from a table to determine the equation of a line.
	Option J is incorrect	The student likely switched the x- and y-values of the first ordered pair in the table for line q, used $(0, -9)$ and $(-3, 18)$ to calculate the slope (steepness of a straight line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$) as $m = \frac{-9 - 18}{0 - 3} = \frac{-27}{-3} = 9$, and did not calculate the corresponding y-intercept (value where a line crosses the y-axis), instead just choosing the answer with a matching slope. For line v, the student likely found the slope-intercept form of the equation and then made a multiplication error when changing to standard form, resulting in $x + 2y = 8$ instead of $x + 2y = 16$. The student needs to focus on understanding how to use coordinates from a table to determine the equation of a line.

Item #	Rationale	
25	Option D is correct	To determine that this situation does not show causation (an event that is the result of the occurrence of another event), the student should have recognized that although a balanced diet may contribute to an athlete's health, the consumption of protein does not necessarily cause the athlete to score more points.
	Option A is incorrect	The student likely did not realize that an increase in the number of students causes an increase in the number of teachers. The student needs to focus on understanding causation in real-world problems.
	Option B is incorrect	The student likely did not realize that a decrease in the amount of sugar causes a decrease in the number of calories. The student needs to focus on understanding causation in real-world problems.
	Option C is incorrect	The student likely did not realize that more workers on a project causes the project to be completed in less time. The student needs to focus on understanding causation in real-world problems.

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Item #	Rationale	
26	Option F is correct	To determine which function is equivalent to $f(x) = -4(x+7)^2 - 6$ the student could have used the order of operations, or PEMDAS, completing the operations in this order: 1. Operations contained in Parentheses or brackets, 2. Exponents (numbers raised to a power), 3. Multiplication/Division from left to right, and 4. Addition/Subtraction from left to right. Because the expression in the parentheses contains the variable x, $(x+7$ cannot be combined. Therefore, the first step is to eliminate the exponent (2) by multiplying $(x+7$ times itself, resulting in $x^2+14x+49$. The next step is to multiply -4 by each of the terms in $x^2+14x+49$, resulting in $-4x^2-56x-196$. Finally, the student could have combined -196 and -6 to conclude that $f(x) = -4(x+7)^2 - 6$ is equivalent to $f(x) = -4x^2 - 56x - 202$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option G is incorrect	The student likely multiplied$(x+7$ times itself correctly but only multiplied -4 by the first term, resulting in $-4x^2+14x+49$, before subtracting 6. The student needs to focus on understanding how to convert quadratic functions from vertex to standard form.
	Option H is incorrect	The student likely subtracted 6 from the constant term (49) and then multiplied by -4 , $-4(x^2+14x+43) \Rightarrow f(x) = -4x^2 - 56x - 172$. The student needs to focus on understanding how to convert quadratic functions from vertex to standard form.
	Option J is incorrect	The student likely did not multiply $(x+7$ times itself correctly and then made a sign error when multiplying by -4, $(x+7)^2 \Rightarrow x^2+49$, $-4(x^2+49) \Rightarrow -4x^2+196-6 \Rightarrow f(x) = -4x^2+190$. The student needs to focus on understanding how to convert quadratic functions from vertex to standard form.
27	40 and any equivalent values are correct	To determine the number of seconds it takes the paper airplane to reach the ground, the student could have first determined that when the airplane reaches the ground, the height, represented by y, is equal to 0. The student could have then substituted 0 for y and solved the resulting equation $(0 = -1.5x + 60)$ for x, the time in seconds. The first step in solving the equation is to subtract 60 from both sides of the equation. This results in $-60 = -1.5x$. To solve for x, the student could have divided both sides of the equation by -1.5, resulting in $x = 40$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.

Item #	Rationale	
28	Option H is correct	To determine the equivalent expression, the student should have applied the properties of exponents for power of a power ($(a^m)^n = a^{mn}$) and quotient of a power ($\frac{a^m}{a^n} = a^{(m-n)}$). Applying these properties results in $\frac{(q^4)^{-3}}{q^{-15}} = \frac{q^{-12}}{q^{-15}}, \frac{q^{-12}}{q^{-15}} = q^{-12-(-15)} = q^{-12+15} = q^3$.
	Option F is incorrect	The student likely applied the power of a power property correctly, resulting in $\frac{q^{-12}}{q^{-15}}$, and then likely applied the negative exponent property $\left(a^{-n} = \frac{1}{a^n}\right)$ to get $\frac{q^{15}}{q^{12}}$. The student then likely added the exponents instead of subtracting them. The student needs to focus on understanding how to apply the quotient of a power property by subtracting positive and/or negative numbers.
	Option G is incorrect	The student likely applied the power of a power property correctly, resulting in $\frac{q^{-12}}{q^{-15}}$, but then combined exponents as $-12-15=-27$ to get q^{-27}. The student then likely applied the negative exponent property $\left(a^{-n} = \frac{1}{a^n}\right)$ to get $\frac{1}{q^{27}}$. The student needs to focus on understanding how to apply the quotient of a power property by subtracting positive and/or negative numbers.
	Option J is incorrect	The student likely applied the power of a power property correctly, resulting in $\frac{q^{-12}}{q^{-15}}$, but then combined exponents as $12-15=-3$ to get q^{-3}. The student then likely applied the negative exponent property $\left(a^{-n} = \frac{1}{a^n}\right)$ to get $\frac{1}{q^3}$. The student needs to focus on understanding how to apply the quotient of a power property by subtracting positive and/or negative numbers.

Item #	Rationale	
28	Option H is correct	To determine the equivalent expression, the student should have applied the properties of exponents for power of a power ($(a^m)^n = a^{mn}$) and quotient of a power ($\frac{a^m}{a^n} = a^{(m-n)}$). Applying these properties results in $\frac{(q^4)^{-3}}{q^{-15}} = \frac{q^{-12}}{q^{-15}}$, $\frac{q^{-12}}{q^{-15}} = q^{-12-(-15)} = q^{-12+15} = q^3$.
	Option F is incorrect	The student likely applied the power of a power property correctly, resulting in $\frac{q^{-12}}{q^{-15}}$, and then likely applied the negative exponent property ($a^{-n} = \frac{1}{a^n}$) to get $\frac{q^{15}}{q^{12}}$. The student then likely added the exponents instead of subtracting them. The student needs to focus on understanding how to apply the quotient of a power property by subtracting positive and/or negative numbers.
	Option G is incorrect	The student likely applied the power of a power property correctly, resulting in $\frac{q^{-12}}{q^{-15}}$, but then combined exponents as $-12 - 15 = -27$ to get q^{-27}. The student then likely applied the negative exponent property ($a^n = \frac{1}{a^n}$) to get $\frac{1}{q^{27}}$. The student needs to focus on understanding how to apply the quotient of a power property by subtracting positive and/or negative numbers.
	Option J is incorrect	The student likely applied the power of a power property correctly, resulting in $\frac{q^{-12}}{q^{-15}}$, but then combined exponents as $12 - 15 = -3$ to get q^{-3}. The student then likely applied the negative exponent property ($a^n = \frac{1}{a^n}$) to get $\frac{1}{q^3}$. The student needs to focus on understanding how to apply the quotient of a power property by subtracting positive and/or negative numbers.

Item #	Rationale	
29	Option B is correct	To determine which graph best represents a quadratic function that has only one zero, the student should have identified the graph that has one point at which the y-value is zero. The y-value is zero when the graph touches or crosses the x-axis (horizontal axis). This graph touches the x-axis once at $x = 4$.
	Option A is incorrect	The student likely interpreted "zero" to mean where the x-value is 0, instead of where the y-value is 0, and focused on the y-intercept. The student needs to focus on understanding how to identify the zeroes of a function from a graph.
	Option C is incorrect	The student likely interpreted "zero" to mean the vertex (high or low point of the curve) of the graph is where the x-value is 0, instead of where the y-value is 0. The student needs to focus on understanding how to identify the zeroes of a function from a graph.
	Option D is incorrect	The student likely interpreted "zero" to mean "no solution" and chose the graph that does not touch or cross the x-axis. The student needs to focus on understanding how to identify the zeroes of a function from a graph.

Item #	Rationale	
30	Option H is correct	To determine the solution set for the inequality, the student could have solved for x. The first step could be to combine the x terms by adding $4x$ to both sides of the inequality, resulting in $10 \geq 9x + 55$. Next, the student could have combined the 10 and the 55 by subtracting 55 from both sides of the inequality, resulting in $-45 \geq 9x$. Finally, to isolate the x, the student could have divided both sides by 9, resulting in $-5 \geq x$, or $x \leq -5$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely made an error when combining the x-terms ($4x + 5$), solving $9x \geq 4$. The student needs to focus on understanding how to solve inequalities with variables (symbol used to represent an unknown number) on both sides.
	Option G is incorrect	The student likely made an error when combining the x-terms ($-4x + 5$), resulting in $x \geq 4$. The student needs to focus on understanding how to solve inequalities with variables (symbol used to represent an unknown number) on both sides.
	Option J is incorrect	The student likely made an error when combining the x-terms ($4x - 5$), solving $-x \geq 45 \rightarrow x \leq -45$ The student needs to focus on understanding how to solve inequalities with variables (symbol used to represent an unknown number) on both sides.

Item #	Rationale	
31	Option B is correct	To determine which expression is a factor (numbers or expressions that can be multiplied to get another number or expression) of $21x^2 + 13x - 20$, the student could have identified two factors in the form $(Ax + B)$ and $(Cx - D)$, for which $A \cdot C = 21$, $(A \cdot D) + (B \cdot C) = 13$, and $B \cdot D = -20$. The student could have identified the two factors as $(3x + 4)$ and $(7x - 5)$ because $3x \cdot 7x = 21x^2$, $(3x \cdot -5) + (4 \cdot 7x) = -15x + 28x = 13x$, and $4 \cdot -5 = -20$, and chosen $7x - 5$ from the options given. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely made a sign error. The student needs to focus on understanding how to find the factors of an expression in the form $ax^2 + bx + c$.
	Option C is incorrect	The student likely identified the factors $(7x + 4)$ and $(3x - 5)$, verified that $7x \cdot 3x = 21x^2$ and $4 \cdot -5 = -20$, but did not verify the middle term ($(7x \cdot -5) + (4 \cdot 3x) = -23x$, not $13x$). The student needs to focus on understanding how to find the factors of an expression in the form $ax^2 + bx + c$.
	Option D is incorrect	The student likely identified the factors $(3x + 5)$ and $(7x - 4)$, verified that $3x \cdot 7x = 21x^2$ and $5 \cdot -4 = -20$, but did not verify the middle term ($(3x \cdot -4) + (5 \cdot 7x) = 23x$, not $13x$). The student needs to focus on understanding how to find the factors of an expression in the form $ax^2 + bx + c$.

Item #	Rationale	
32	Option J is correct	To determine the equation and slope (steepness of a line when graphed on a coordinate grid; $m = \frac{y_2 - y_1}{x_2 - x_1}$), the student should have recognized that because the line is vertical, its equation is written as $x = c$, where c is the value through which the line intersects (crosses) the x-axis (horizontal axis), resulting in $x = 6$. To determine the slope, the student should have chosen two points on the line and substituted the corresponding values in the equation for the slope of a line. Using (6, 0) and (6, 2), $m = \frac{2-0}{6-6} = \frac{2}{0}$, which is "undefined" because division by zero is not possible.
	Option F is incorrect	The student likely used the variable (symbol used to represent an unknown number) y for the equation because the line is parallel to the y-axis. The student then likely determined that when a line is vertical, its slope is the opposite reciprocal (a pair of numbers that, when multiplied together, equal -1) of the x-intercept (if $x = 6$, then $m = -\frac{1}{6}$). The student needs to focus on understanding how to write the equation of a vertical line and on understanding that the slope of all vertical lines is undefined.
	Option G is incorrect	The student likely reversed the values of x and y when calculating the slope, resulting in $m = \frac{6-6}{2-0} = \frac{0}{2} = 0$. The student needs to focus on understanding how to use the slope formula and on understanding that the slope of all vertical lines is undefined.
	Option H is incorrect	The student likely used the variable (symbol used to represent an unknown number) y for the equation because the line is parallel to the y-axis and then used the x-value of 6 as the slope. The student needs to focus on understanding how to write the equation of a vertical line and on understanding that the slope of all vertical lines is undefined.

Item #	Rationale	
33	Option A is correct	To determine the correct function, the student should have recalled that when a value is increased by a constant factor (number or expression that can be multiplied to get another number or expression) over each iteration (3.25% in this case), the situation is represented with an exponential equation or function, $f(x) = ab^x$, where a is the initial or starting value, b is 1 plus the factor that the value is increased, and x is the variable (symbol used to represent an unknown number). In this case, the variable x represents the number of years since 1900. The student should have identified that $a = 495{,}000$ and that $b = 1 + 3.25\%$, $b = 1 + \frac{3.25}{100} = 1.0325$, resulting in the function $c(x) = 495{,}000(1.0325)^x$.
	Option B is incorrect	The student likely calculated the factor by subtracting from 1 instead of adding, resulting in $b = 1 - \frac{3.25}{100} = 0.9675$ instead of 1.0325. The student needs to focus on understanding how to calculate factors for exponential functions.
	Option C is incorrect	The student likely switched the position for b and x when writing the function. The student needs to focus on understanding how to write an exponential function that models a given situation.
	Option D is incorrect	The student likely calculated the factor by subtracting from 1 instead of adding, resulting in $b = 1 - \frac{3.25}{100} = 0.9675$ instead of 1.0325, and then switched the position for b and x when writing the function. The student needs to focus on understanding how to calculate factors for exponential functions and how to write an exponential function that models a given situation.
34	8.5 and any equivalent values are correct	To determine the solution, the student could have solved the equation for x. First, the student could have eliminated the parentheses by multiplying 3 by $(14x + 9)$, resulting in $34x + 95 = 42x + 27$. Next, the student could have combined the x terms by subtracting $42x$ from both sides of the equation. This step results in the equation $-8x + 95 = 27$. Next, the student could have combined the 95 and 27 by subtracting 95 from both sides of the equation, resulting in $-8x = -68$. Lastly, the student could have divided both sides of the equation by -8. This step results in the solution to the equation, which is $x = 8.5$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could have been used to solve the problem correctly.

Item #	Rationale	
35	Option B is correct	To determine which function is best represented by the graph of g, the student should have compared the slope (steepness of a straight line when graphed on a coordinate grid; $m = \frac{y_2 - y_1}{x_2 - x_1}$) and y-intercept (value where a line crosses the y-axis) of both lines on the grid. The graph of function f is increasing at a rate of 1 (each time the x-value increases by 1 unit, the y-value also increases by 1 unit) and has a y-intercept of 0. The graph of function g is increasing at a rate of $\frac{1}{3}$ (each time the x-value increases by 3 units, the y-value increases by 1 unit) and also has a y-intercept of 0. The difference between the two graphs is that the graph of function g is increasing $\frac{1}{3}$ as fast as the graph of function f. This relationship is best represented by $g(x) = \frac{1}{3}f(x)$.
	Option A is incorrect	The student likely compared $(6, 6)$ on the graph of function f and $(6, 2)$ on the graph of function g to conclude that the graph of function g is 4 units lower than the graph of function f. The student needs to focus on understanding how the slope and y-intercept affect the graph of a line.
	Option C is incorrect	The student likely compared (3, 3) on the graph of function f and (3, 1) on the graph of function g to conclude that the graph of function g is 2 units lower than the graph of function f. The student needs to focus on understanding how the slope and y-intercept affect the graph of a line.
	Option D is incorrect	The student likely noted that every time the x-value of the graph of function g increases by 3, its y-value increases by 1, and determined that the graph of function g increases 3 times as fast as the graph of function f. The student needs to focus on understanding how to compare the slopes of two graphs.

Item #	Rationale	
36	Option F is correct	To determine the equivalent expression, the student could have multiplied each term in $h^2 + 9h -$ by each term in $-4h + 3$ and then combined any like terms. The multiplication steps are $(h^2 \cdot -4h) + (h^2 \cdot 3) + (9h \cdot -4h) + (9h \cdot 3) + (-1 \cdot -4h) + (-1 \cdot 3)$, which results in $-4h^3 + 3h^2 - 36h^2 + 27h + 4h - 3$. Combining the like terms ($3h^2 - 36h^2$ and $27h + 4h$) results in $-4h^3 - 33h^2 + 31h - 3$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option G is incorrect	The student likely made multiple sign errors when multiplying the terms. The student needs to focus on understanding how to multiply and combine positive and negative numbers.
	Option H is incorrect	The student likely made multiple sign errors when multiplying the terms. The student needs to focus on understanding how to multiply and combine positive and negative numbers.
	Option J is incorrect	The student likely carried out the multiplication using $(4h - 3$ instead of $(-4h + 3)$. The student needs to focus on understanding how to multiply and combine positive and negative numbers.

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Item #	Rationale	
37	Option C is correct	To determine which system of equations can be used to represent the number of 7-inch and 12-inch plates in the cabinet, the student should have written one equation to represent the total number of plates and one equation to represent the total diameter of the plates. The number of 7-inch plates, x, plus the number of 12-inch plates, y, equals the 15 plates in the cabinet and is represented by $x + y = 15$. The total diameter of the plates (140) is equal to 7 inches times the number of 7-inch plates ($7x$) plus 12 inches times the number of 12-inch plates ($12y$) and is represented by $7x + 12y = 140$.
	Option A is incorrect	The student likely reversed the total number of plates and the total diameter in the equations. The student also likely assigned x to represent the number of 12-inch plates and y to represent the number of 7-inch plates. The student needs to focus on understanding how to write a system of equations from a verbal description.
	Option B is incorrect	The student likely used the diameter of each plate when writing both equations. The student needs to focus on understanding how to write a system of equations from a verbal description.
	Option D is incorrect	The student likely assigned x to represent the number of 12-inch plates and y to represent the number of 7-inch plates. The student needs to focus on understanding how to write a system of equations from a verbal description.
38	Option G is correct	To determine the domain (all possible x-values) of the function, the student should have identified all the x-values for which the graph has a y-value. The student should have determined that the graph continues to expand upward and outward indefinitely, making the domain all real numbers.
	Option F is incorrect	The student likely considered only the portion of the graph that is shown on the grid. The student needs to focus on understanding how to represent domain from a graph.
	Option H is incorrect	The student likely interpreted domain to mean possible y-values instead of possible x-values. The student needs to focus on understanding how to represent domain.
	Option J is incorrect	The student likely wrote the domain using a verbal description of the x-values to the left and right of the given graph. The student needs to focus on understanding how to represent domain from a graph.

Item #	Rationale	
39	Option D is correct	To determine the equation of a line perpendicular (a line meeting another line at a right angle, or 90°) to another line, the student could have recalled that if the slope (steepness of a straight line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$) of a line is $\frac{a}{t}$, then the slope of a line perpendicular to it is $-\frac{t}{a}$. The equation $y = \frac{2}{5}x + 2$ has a slope of $\frac{2}{5}$; therefore, the slope of a line perpendicular to it is $-\frac{5}{2}$. To determine the y-intercept (value where a line crosses the y-axis) of the perpendicular line, the student could have substituted $-\frac{5}{2}$ for the slope (m) and the point $(2, -2)$ for the x and y-values in the slope-intercept form ($y = mx + b$). This produces the equation $-2 = -\frac{5}{2}(2) + b$. Multiplying $-\frac{5}{2}$ by 2 results in $-2 = -5 + b$. To solve the equation for b, add 5 to both sides of the equation, resulting in $b = 3$. The slope-intercept form of the equation of the perpendicular line is $y = -\frac{5}{2}x + 3$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely determined that if the slope of a line is $\frac{a}{t}$, the slope of a line perpendicular to it is $\frac{t}{a}$ instead of $-\frac{t}{a}$. The student then likely used the slope they calculated to determine the y-intercept of the perpendicular line. The student needs to focus on understanding how to determine the slope of a line given the equation of a line perpendicular to it.

Item #	Rationale	
	Option B is incorrect	The student likely determined that if the slope of a line is $\frac{a}{t}$, the slope of a line perpendicular to it is $\frac{t}{a}$ instead of $-\frac{t}{a}$. The student then likely made an error when calculating the y-intercept, $-2 = \frac{5}{2}(2) + b$, calculating $b = 7$ instead of $b = -7$. The student needs to focus on understanding how to determine the equation of a line that passes through a given point and is perpendicular to another line.
	Option C is incorrect	The student likely made an error when calculating the y-intercept, calculating $b = -3$ instead of $b = 3$. The student needs to focus on understanding how to calculate the y-intercept of a line.
40	Option F is correct	To determine which graph best represents the function, the student could have calculated the value of $f(x)$, or y, for several values of x and determined which graph includes those values. Using the values of -1, 0, 1, and 2 for x yields the points $(-1, 0.4)$, $(0, 2)$, $(1, 10)$, and $(2, 50)$, which are all on this graph. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option G is incorrect	The student likely ignored the 2 in the given function and identified the graph of the function $f(x) = 5^x$. The student needs to focus on understanding how to identify the graphs of exponential functions.
	Option H is incorrect	The student likely multiplied 2 and 5 and determined that the graph crosses the y-axis (vertical axis) at 10. The student needs to focus on understanding how to identify the graphs of exponential functions.
	Option J is incorrect	The student likely reversed the 2 and the 5 when generating the points, identifying the graph of the function $f(x) = 5(2)^x$. The student needs to focus on understanding how to identify the graphs of exponential functions.

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Item #		Rationale
41	Option C is correct	To determine the width of the trampoline, the student could have solved the equation for w by factoring the expression $w^2 + 6w - 112$. To factor (replacing a number or expression with two or more numbers or expressions that when multiplied together will equal the original number or expression) the expression, the student could have determined that $w^2 = w \cdot w$ and written w as the first term in the factors: $(w \pm \_)(w \pm \_)$. Next, the student could have determined that the second terms are 14 and -8 because their product (answer when multiplying) is -112 (last term in the expression given) and their sum is 6 (number in middle term in the expression given). This gives factors of $(w + 14)$ and $(w - 8)$. The student could have then set each factor equal to zero and solved both. This step results in $w = -14$ and $w = 8$. Since the width of the trampoline must be a positive number, the width is 8 feet. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely identified 16 and -7 as the factors, only verifying that their product is -112. The student needs to focus on understanding how to determine the factors of a quadratic equation.
	Option B is incorrect	The student likely identified -16 and 7 as the factors, only verifying that their product is -112. The student needs to focus on understanding how to determine the factors of a quadratic equation.
	Option D is incorrect	The student likely calculated the length instead of the width. The student needs to focus on understanding how to select solutions based on a problem situation.
42	7.00 and any equivalent values are correct	To determine the rate of change of the balance of the savings account, the student could have chosen two sets of values from the table and calculated how much the balance changed each week. Using the first and last set of values, the balance increased \$91 in 13 weeks, which when divided ($\frac{91}{13} = 7$) is \$7 per week. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.

2018 STAAR Algebra I Rationales

Item #	Rationale	
43	Option A is correct	To determine which equation is best represented by the graph, the student could have found the slope (steepness of a line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$) and a point to substitute into the point-slope form of a line ($y - y_1 = m(x - x_1)$). The slope can be found by calculating the change in y-values over the change in x-values ($m = \frac{5-2}{0-1} = \frac{3}{-1} = -3$). The equation can be completed by substituting $(4, -7)$ for x_1 and y_1, respectively ($y - (-7) = -3(x - 4)$, $y + 7 = -3(x - 4)$). The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option B is incorrect	The student likely reversed the coordinates of $(1, 2)$ in the point-slope form of a line and made sign errors for x_1 and y_1 in the equation. The student needs to focus on understanding how to write a linear equation in point-slope form given a graph.
	Option C is incorrect	The student likely reversed the coordinates of $(4, -7)$ in the point-slope form of a line and made a sign error in the slope. The student needs to focus on understanding how to write a linear equation in point-slope form given a graph.
	Option D is incorrect	The student likely made a sign error when determining the slope. The student needs to focus on understanding how to write a linear equation in point-slope form given a graph.

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Item #	Rationale	
44	Option J is correct	To determine which expression is a factor (numbers or expressions that can be multiplied to get another number or expression) of $9r^2 - 4r + 1$, the student could have graphed the function and seen that it did not cross the *x*-axis. As this is the case, the student could have determined that $9r^2 - 4r + 1$ has no real factors. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely identified the factors as $(3r - 1)(3r - 1$ because $3 \cdot 3 = 9$ and $-1 \cdot -1 = 1$. However, $(3 \cdot -1) + (-1 \cdot 3) = -6$ instead of -4. The student needs to focus on understanding how to identify the factors of quadratic expressions.
	Option G is incorrect	The student likely identified the factors as $(9r - 1)(r - 1$ because $9 \cdot 1 = 9$ and $-1 \cdot -1 = 1$. However, $(9 \cdot -1) + (-1 \cdot 1) = -10$ instead of -4. The student needs to focus on understanding how to identify the factors of quadratic expressions.
	Option H is incorrect	The student likely identified the factors as $(9r - 1)(r - 1$ because $9 \cdot 1 = 9$ and $-1 \cdot -1 = 1$. However, $(9 \cdot -1) + (-1 \cdot 1) = -10$ instead of -4. The student needs to focus on understanding how to identify the factors of quadratic expressions.

Item #	Rationale	
45	Option B is correct	To determine which ordered pair is in the solution set of $2x - 5y \geq 10$, the student could have substituted the given x- and y-values of the ordered pair into the inequality to see if it generates a true statement. Using the ordered pair $(5, 0)$, 5 will be substituted into the inequality for the x-value and 0 will be substituted for the y-value. This gives $2(5) - 5(0) \geq 10$, which simplifies to $10 - 0 \geq 10$, which is a true statement. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely reversed the x- and y-coordinates when substituting the values into the inequality. The student needs to focus on understanding how to determine if an ordered pair is in the solution set of an inequality.
	Option C is incorrect	The student likely interpreted the "$\geq$" symbol in the inequality as meaning "less than or equal to." The student needs to focus on understanding how to determine whether an ordered pair is in the solution set of an inequality.
	Option D is incorrect	The student likely interpreted the "$\geq$" symbol in the inequality as meaning "less than or equal to." The student needs to focus on understanding how to determine whether an ordered pair is in the solution set of an inequality.

Item #	Rationale	
46	Option H is correct	To determine the best interpretation of one of the values in the function $f(x) = 245(1.12)^x$ the student should have recognized that in an exponential function written in the form $f(x) = ab^x$, a represents the initial or starting value, b is 1 plus the factor that the value is increased (when $b > 1$) or 1 minus the factor that the value is decreased (when $b < 1$), and x is the variable (symbol used to represent an unknown number). In this case, the variable x represents the number of days. In $f(x) = 245(1.12)^x$, 245 is the initial value and because $1.12 > 1$, the 0.12 represents an increase rate of 0.12, or 12%.
	Option F is incorrect	The student likely misinterpreted the growth rate to be the initial value. The student needs to focus on understanding and interpreting the meaning of the values of a and b in exponential functions in the form $f(x) = ab^x$.
	Option G is incorrect	The student likely misinterpreted growth to be decay and only considered the initial number of bacteria. The student needs to focus on understanding and interpreting the meaning of the values of a and b in exponential functions in the form $f(x) = ab^x$.
	Option J is incorrect	The student likely misinterpreted the initial value to be the final value. The student needs to focus on understanding and interpreting the meaning of the values of a and b in exponential functions in the form $f(x) = ab^x$.

Item #	Rationale	
47	Option B is correct	To determine the range (all possible y-values), the student could have calculated the cost of hiring the plumber to work 0 hours and the cost of hiring the plumber the maximum (greatest) number of hours (8) per day. If the plumber works 0 hours, the cost is the \$80 fixed cost. If the plumber works 8 hours, the cost is the \$80 fixed cost plus \$45 per hour, or $80 + 45(8)$, which equals 440. The range for this situation is all values from 80 to 440, including 80 and 440, which is represented by $80 \leq y \leq 440$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely interpreted "range" to mean "domain" and represented all possible x-values. The student needs to focus on understanding how to determine and represent range.
	Option C is incorrect	The student likely misinterpreted "range" to mean "domain" (all possible x-values) and divided 80 by 8 to determine the maximum domain value. The student needs to focus on understanding how to determine and represent range.
	Option D is incorrect	The student likely calculated the cost of 0 hours and 8 hours using \$45 as the fixed cost and \$80 as the hourly cost. The student needs to focus on how to calculate costs given a fixed amount and a rate.

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Item #	Rationale	
48	Option F is correct	To determine the best description of the transformation from $g(x) = x^2$ to $h(x) = -(\frac{x}{4})^2$, the student could have recognized that the negative sign outside the parentheses reflects (flips) the parabola (U-shaped graph) across the x-axis (horizontal axis) to open downward. The student could have then recognized that dividing x^2 by 4, $(\frac{x}{4})^2$, causes the parabola to stretch horizontally. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option G is incorrect	The student likely misinterpreted the direction of the reflection. The student needs to focus on understanding how a leading negative sign affects a graph.
	Option H is incorrect	The student likely misinterpreted the stretch to be vertical instead of horizontal. The student needs to focus on understanding how changing the squared term, $(x)^2$, affects a graph.
	Option J is incorrect	The student likely misinterpreted the direction of the reflection and the stretch to be vertical instead of horizontal. The student needs to focus on understanding how changes to a function affect the graph of the function.

Item #	Rationale	
49	Option B is correct	To determine the equivalent expression, the student could have first used the power of a power property ($(a^m)^n = a^{mn}$) to simplify $4(q^6)^2 = 4q^{12}$. Next, the student could have multiplied $10q^5w^7$ by $4q^{12}$, using the product of powers property ($a^m a^n = a^{(m+n)}$) to get $40q^{17}w^7$. The student could have then used the product of powers property to multiply $2w^3$ by w^{-5} and get $2w^{-2}$. Lastly, the student could have used the quotient of powers property ($\frac{a^m}{a^n} = a^{(m-n)}$) to simplify $\frac{40q^{17}w^7}{2w^{-2}} = 20q^{17}w^{(7-(-2))} = 20q^{17}w^9$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely subtracted the coefficients (a number used to multiply a variable) of the fractions $(10 - 2)$ and then multiplied the result by the coefficient 4 to get 32. The student likely then simplified the exponents (numbers raised to a power) of each variable (symbol used to represent an unknown number) as follows: $q^{6(2)-5} = q^7$ and $w^{7-(3+5)} = w^{-1} = \frac{1}{w}$. The student needs to focus on understanding how to apply the properties of exponents to simplify expressions with fractions.
	Option C is incorrect	The student likely subtracted the coefficients (a number used to multiply a variable) of the fractions $(10 - 2)$ and then multiplied the result by the coefficient 4 to get 32. The student likely then simplified the exponents (numbers raised to a power) of each variable (symbol used to represent an unknown number) as follows: $q^{5+2} = q^7$ and $w^{7-(3-5)} = w^{7+2} = w^9$. The student needs to focus on understanding how to apply the properties of exponents to simplify expressions with fractions.
	Option D is incorrect	The student likely simplified exponents (numbers raised to a power) of each variable (symbol used to represent an unknown number) as follows: $q^{6-5} = q$ and $w^{(3-7-(-5))} \rightarrow w^1 = w$. The student needs to focus on understanding how to apply the properties of exponents to simplify expressions with fractions.

Item #	Rationale	
50	Option J is correct	The vertex is the highest or lowest point of a quadratic function. To determine which coordinates best represent the vertex of the graph, the student should have identified the coordinates of the minimum (lowest point) of the graph, $(1, -2)$.
	Option F is incorrect	The student likely identified one of the points where the graph crosses the x-axis (horizontal axis). The student needs to focus on understanding how to identify key attributes of graphs of quadratic functions.
	Option G is incorrect	The student likely identified the y-intercept (value where a line crosses the y-axis) of the graph. The student needs to focus on understanding how to identify key attributes of graphs of quadratic functions.
	Option H is incorrect	The student likely identified one of the points where the graph crosses the x-axis (horizontal axis). The student needs to focus on understanding how to identify key attributes of graphs of quadratic functions.

Item #	Rationale	
51	Option A is correct	To determine the slope (steepness of a line when graphed on a coordinate grid, $m = \frac{y_2 - y_1}{x_2 - x_1}$) of the line, the student could have substituted the x- and y-coordinates of $(5, -11)$ and $(-9, 17)$ into the formula for the slope of a line: $\frac{17 - (-11)}{-9 - 5} = \frac{17 + 11}{-9 - 5} = \frac{28}{-14} = -2$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option B is incorrect	The student likely calculated the slope as $m = \frac{x_2 - x_1}{y_2 - y_1}$. The student needs to focus on understanding how to use the formula for the slope of a line when given two points.
	Option C is incorrect	The student likely calculated the slope as $m = \frac{-11 - 17}{5 - 9} = \frac{-28}{-4} = 7$. The student needs to focus on understanding how to use the formula for the slope of a line when given two points.
	Option D is incorrect	The student likely calculated the slope as $m = \frac{-11 - 17}{-9 - 5} = \frac{-28}{-14} = 2$. The student needs to focus on understanding how to use the formula for the slope of a line when given two points.

Item #	Rationale	
52	Option H is correct	To determine the x-value of the solution to the system of equations, the student could have used the substitution method to first find the value of y and then used the y-value to determine the x-value. Since the first equation indicates that x is equal to $2y - 4$, the student could have substituted $2y - 4$ for x in the second equation. This step results in $7(2y - 4) + 5y = -66$. To solve for y, first distribute the 7 to get $14y - 28 + 5y = -66$. Next, combine $14y$ and $5y$ to get $19y - 28 = -66$. Then add 28 to both sides of the equation to get $19y = -38$ and then divide both sides by 19 to isolate the y to get $y = -2$. To determine the value of x, the student could have substituted -2 for y in the first equation and solved for x ($x = 2(-2) - 4 = -4 - 4 = -8$). The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option F is incorrect	The student likely determined the y-value of the solution. The student needs to focus on understanding how to complete all the steps to calculate the solution to a system of equations.
	Option G is incorrect	The student likely left out the 5 term when determining the y-value of the solution after substituting and distributing. The student solved $7(2y - 4) = -66$ for y, so $y = -\frac{19}{7}$. Then, the student likely substituted the value obtained to find the value of x. The student needs to focus on understanding how to complete all the steps to calculate the solution to a system of equations.
	Option J is incorrect	The student likely did not distribute completely when solving for y. The student solved $7(2y - 4) + 5y = -66$, getting $14y - 4 + 5y = -66$, and then simplified and solved for y. The student needs to focus on understanding how to complete all the steps to calculate the solution to a system of equations.

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Item #	Rationale	
53	Option D is correct	To determine the equivalent expression, the student could have rewritten $\sqrt{96}$ as $\sqrt{16} \cdot \sqrt{6}$ and then calculated the square root (a value that, when multiplied by itself, is equal to the number under the $\sqrt{\ }$) of 16 to get $4 \cdot \sqrt{6}$, or $4\sqrt{6}$. The rationale for the correct answer is an efficient way to solve the problem. However, other methods could be used to solve the problem correctly.
	Option A is incorrect	The student likely simplified $\sqrt{96} = \sqrt{16} \cdot \sqrt{6}$ but then divided 16 and 6 by 2 instead of finding their square roots ($\sqrt{16} \cdot \sqrt{6} \rightarrow 8 \cdot 3 = 24$). The student needs to focus on understanding how to simplify square roots.
	Option B is incorrect	The student likely simplified $\sqrt{96} = \sqrt{16} \cdot \sqrt{6}$ but then divided 16 by 2 instead of finding its square root ($\sqrt{16} \cdot \sqrt{6} \rightarrow 8\sqrt{6}$). The student needs to focus on understanding how to simplify square roots.
	Option C is incorrect	The student likely divided 96 by 2 instead of finding its square root. The student needs to focus on understanding how to simplify square roots.
54	Option G is correct	To determine which line appears to have an x-intercept (value where a line crosses the x-axis) of -5 and a y-intercept (value where a line crosses the y-axis) of 3, the student should have identified the graph of the line that appears to cross the x-axis (horizontal axis) at -5 and appears to cross the y-axis (vertical axis) at 3.
	Option F is incorrect	The student likely reversed the x- and y-intercepts and determined that the graph of the line crosses the x- and y-axis at the values opposite the given x- and y-intercepts. The student needs to focus on understanding how to identify intercepts.
	Option H is incorrect	The student likely determined that the graph of the line crosses the x- and y-axis at the values opposite the given x- and y-intercepts. The student needs to focus on understanding how to identify intercepts.
	Option J is incorrect	The student likely reversed the x- and y-intercepts. The student needs to focus on understanding how to identify intercepts.