Item Position	Rationales	
1	Option C is correct	To determine the rate of change (constant rate of increase or decrease) of the total number of books signed with respect to time, the student could have chosen two points from the table and calculated the rate of change. The student could have used the first two sets of values in the table and applied the slope formula, $m = \frac{y_2 - y_1}{x_2 - x_1}$, resulting in $m = \frac{50-35}{20-14} = \frac{15}{6} = \frac{5}{2} = 2.5$. Therefore, the rate of change is 2.5 books signed per minute. 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 divided the second *y*-value in the table by the first *y*-value in the table, resulting in $\frac{50}{35}$ or approximately 1.4 books signed per minute. The student needs to focus on understanding that the rate of change of a linear relationship is equal to the change in the values of the dependent variable divided by the corresponding change in the values of the independent variable.
	Option B is incorrect	The student likely found the change in *x* over the change in *y*, resulting in $\frac{2}{5}$ or 0.4 book signed per minute. The student needs to focus on understanding that the rate of change of a linear relationship is equal to the change in the values of the dependent variable divided by the corresponding change in the values of the independent variable.
	Option D is incorrect	The student likely divided the first *y*-value in the table by the second *y*-value in the table, resulting in $\frac{35}{50} = 0.7$ book signed per minute. The student needs to focus on understanding that the rate of change of a linear relationship is equal to the change in the values of the dependent variable divided by the corresponding change in the values of the independent variable.

Item Position	Rationales	
2	Option A is correct	To determine which graph best represents the quadratic function $f(x) = x^2 - 4x + 3$, the student could have identified the vertex (highest or lowest point of the curve) of the parabola. The student could have first found the x-coordinate of the vertex of the parabola using the formula $x = -\frac{b}{2a}$, resulting in $x = -\left(\frac{-4}{2(1)}\right) = \frac{4}{2} = 2$. The student then could have found the y-value of the vertex by evaluating $f(2)$, resulting in $f(2) = (2)^2 - 4(2) + 3 = 4 - 8 + 3 = -1$. The student then could have chosen the graph of a parabola with a vertex at (2, −1). This 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 evaluated $f(2)$ as 1, rather than −1, and then reversed the x- and y-values of the vertex and chose a graph of a parabola with a vertex at (1, 2). The student needs to focus on identifying the correct graph of a quadratic function in the form $f(x) = ax^2 + bx + c$.
	Option C is incorrect	The student likely identified the vertex (2, −1) as (−2, −1) and chose a graph of a parabola with this vertex. The student needs to focus on identifying the correct graph of a quadratic function in the form $f(x) = ax^2 + bx + c$.
	Option D is incorrect	The student likely reversed the x- and y-values of the vertex and chose a graph of a parabola with a vertex at (−1, 2). The student needs to focus on identifying the correct graph of a quadratic function in the form $f(x) = ax^2 + bx + c$.

<table>
<tr><th>Item Position</th><th colspan="2">Rationales</th></tr>
<tr><td rowspan="4">3</td><td>Option C is correct</td><td>To determine how many adults’ shirts were sold, the student could have set up and solved a system of equations (two or more equations containing the same set of variables [symbols used to represent unknown numbers]). If x represents the number of children’s shirts sold and y represents the number of adults’ shirts sold, the student could have set up two equations: $x + y = 14$ (the store sold a total of 14 shirts) and $15x + 19y = 250$ (the store sold children’s shirts for $15 each and adults’ shirts for $19 each and earned a total of $250).

Next, the student could have solved the system of equations using the elimination method. Multiplying the first equation by −15 results in $-15x - 15y = -210$. The student then could have added this to the second equation in the system, resulting in $(-15x - 15y) + (15x + 19y) = -210 + 250$, which simplifies to $4y = 40$. The student then could have divided both sides of the equation by 4 to determine that y, the number of adults’ shirts sold, is equal to 10. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.</td></tr>
<tr><td>Option A is incorrect</td><td>The student likely determined that the same number of children’s and adults’ shirts were sold and divided the total number of shirts sold, 14, by 2, resulting in $\frac{14}{2} = 7$. The student needs to focus on understanding how to write and solve a system of equations from a verbal description.</td></tr>
<tr><td>Option B is incorrect</td><td>The student likely transposed the coefficients of x and y and solved the system of equations $x + y = 14$ and $19x + 15y = 250$. The student likely multiplied the first equation by −19, resulting in $-19x - 19y = -266$, and then added the two equations together, resulting in $(-19x - 19y) + (19x + 15y) = -266 + 250$, which simplifies to $-4y = -16$. The student then likely divided both sides of the equation by −4 and determined that y, the number of adults’ shirts sold, is equal to 4. The student needs to focus on understanding how to write a system of equations from a verbal description.</td></tr>
<tr><td>Option D is incorrect</td><td>The student likely chose the total number of shirts given in the problem situation. The student needs to focus on understanding how to write and solve a system of equations from a verbal description.</td></tr>
</table>

Item Position	Rationales	
4	Option D is correct	To determine which expression is a factor of $2x^2 - 16x + 32$, the student could have found the factors (numbers or expressions that can be multiplied to get another number or expression) of the expression. The student could have first factored out the greatest common factor (largest factor that divides evenly into all the terms) from each term, resulting in $2(x^2 - 8x + 16)$. Next, the student could have factored the trinomial by identifying two numbers that have a sum of -8 and a product of 16, which are -4 and -4. Then the student could have rewritten the expression as $2(x - 4)(x - 4)$. Finally, the student could have recognized that $(x - 4)$ is a factor of the given expression. 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 factored out the greatest common factor from each term, resulting in $2(x^2 - 8x + 16)$. The student then likely determined that two factors of x^2 are x and x and that two factors of 16 are 4 and 4 but disregarded the value of the linear term of the quadratic expression, resulting in $2(x + 4)(x + 4)$. The student then likely determined that $(x + 4)$ is a factor of the given quadratic expression. The student needs to focus on understanding how to factor an expression of the form $ax^2 + bx + c$.
	Option B is incorrect	The student likely determined that two factors of $2x^2$ are $2x$ and x and that two factors of 32 are -1 and -32 but disregarded the value of the linear term of the quadratic expression, resulting in $(2x - 1)(x - 32)$. The student then likely determined that $(2x - 1)$ is a factor of the given quadratic expression. The student needs to focus on understanding how to factor an expression of the form $ax^2 + bx + c$.
	Option C is incorrect	The student likely factored out the greatest common factor from each term, resulting in $2(x^2 - 8x + 16)$. The student then likely determined that two factors of x^2 are x and x and that two factors of 16 are 2 and 8 but disregarded the value of the linear term of the quadratic expression, resulting in $2(x + 2)(x + 8)$. The student then likely determined that $(x + 2)$ is a factor of the quadratic expression. The student needs to focus on understanding how to factor an expression of the form $ax^2 + bx + c$.

Item Position	Rationales	
5	Option B is correct	To determine which statement about the relationship between sweater sales and swimsuit sales is best supported by the information given, the student should have recalled the definitions of causation (in which an event is the result of the occurrence of another event) and association (relationship). Since the sales of swimsuits increase when the sales of sweaters decrease, the relationship shows association. Since the decrease in the sales of sweaters does not result in the increase in the sales of swimsuits, the relationship does not show causation. The student could then have determined that there is an association but not a causation.
	Option A is incorrect	The student likely considered the decrease in sweater sales to have caused the increase in swimsuit sales. The student needs to focus on understanding association and causation in real-world problems.
	Option C is incorrect	The student likely confused the definitions of causation and association. The student needs to focus on understanding association and causation in real-world problems.
	Option D is incorrect	The student likely did not recognize the relationship between sweater sales and swimsuit sales as an association. The student needs to focus on understanding association and causation in real-world problems.

Item Position	Rationales	
6	Second option is correct	To determine which statements about the graph of $y = 30(0.8)^x$ are true, the student could have realized that $y = 30(0.8)^x$ represents an exponential function in the form $y = a(b)^x$, where *a* is the *y*-intercept (the value where the graph crosses the *y*-axis), *b* is the growth factor, and *x* is the variable (symbol used to represent an unknown number). Therefore, the *y*-intercept of the graph of $y = 30(0.8)^x$ is (0, 30). This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.
	Third option is correct	To determine which statements about the graph of $y = 30(0.8)^x$ are true, the student could have recognized that if the *b*-value, the growth factor, is greater than 1, then the graph of the function will increase for all values of *x*, and if the *b*-value is between 0 and 1, then the graph of the function will decrease for all values of *x*. The student then could have determined that since the *b* value, 0.8, is between 0 and 1, the graph of $y = 30(0.8)^x$ is decreasing for all values of *x*. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.
	First option is incorrect	The student likely confused the *x*-intercept with the *y*-intercept. The student needs to focus on understanding how to identify the key features of an exponential function when given the equation of the function.
	Fourth option is incorrect	The student likely considered the *b*-value, the growth factor, to be the *x*-intercept of the graph of the function. The student needs to focus on understanding how to identify the key features of an exponential function when given the equation of the function.
	Fifth option is incorrect	The student likely confused the *a*-value of the function, the *y*-intercept, with the *b*-value, the growth factor. The student needs to focus on understanding how to identify the key features of an exponential function when given the equation of the function.
	Sixth option is incorrect	The student likely used the *a*-value to determine whether the function was increasing or decreasing for all values of *x* and determined that, since the *a*-value, 30, is greater than 1, the graph of the function is increasing for all values of *x*. The student needs to focus on understanding how to identify the key features of an exponential function when given the equation of the function.

<table>
<tr><th>Item Position</th><th colspan="2">Rationales</th></tr>
<tr><td rowspan="4">7</td><td>Option D is correct</td><td>To determine which system of equations (two or more equations containing the same set of variables [symbols used to represent unknown numbers]) represents the lines, the student could use the given tables of ordered pairs to write each equation in slope-intercept form, y = mx + b, where m represents the slope of each line and b represents the y-intercept of each line.

To find the equation for Line 1, the student could have used the first two pairs of values from the table, (−7, −5) and (−3, −1), and applied the slope formula, $m = \frac{y_2 - y_1}{x_2 - x_1}$, resulting in $m = \frac{-1-(-5)}{-3-(-7)} = \frac{4}{4} = 1$. Next, the student could have recognized that the point (0, 2) in the table of values represents the y-intercept, b. Since m = 1 and b = 2, the student could have written the equation for Line 1 as y = x + 2.

To find the equation for Line 2, the student could have used the first two pairs of values from the table, (−4, 7) and (−1, 1), and applied the slope formula, $m = \frac{y_2 - y_1}{x_2 - x_1}$, resulting in $m = \frac{1-7}{-1-(-4)} = \frac{-6}{3} = -2$. Next, the student could have recognized that the point (0, −1) in the table of values represents the y-intercept, b. Since m = −2 and b = −1, the student could have written the equation for Line 2 as y = −2x − 1.

This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.</td></tr>
<tr><td>Option A is incorrect</td><td>The student likely reversed the order of the y-values in the numerator (top number) of the slope formula for Line 2 and found $m = \frac{7-1}{-1-(-4)} = \frac{6}{3} = 2$, resulting in the equation y = 2x − 1. The student needs to focus on understanding how to write a system of equations from a table of values.</td></tr>
<tr><td>Option B is incorrect</td><td>The student likely reversed the order of the y-values in the numerator of the slope formula for Line 1 and found $m = \frac{-5-(-1)}{-3-(-7)} = \frac{-4}{4} = -1$, resulting in the equation y = −x + 2. The student likely reversed the order of the y-values in the numerator of the slope formula for Line 2 and found $m = \frac{7-1}{-1-(-4)} = \frac{6}{3} = 2$, resulting in the equation y = 2x − 1. The student needs to focus on understanding how to write a system of equations from a table of values.</td></tr>
<tr><td>Option C is incorrect</td><td>The student likely reversed the order of the y-values in the numerator of the slope formula for Line 1 and found $m = \frac{-5-(-1)}{-3-(-7)} = \frac{-4}{4} = -1$, resulting in the equation</td></tr>
</table>

		$y = -x + 2$. The student needs to focus on understanding how to write a system of equations from a table of values.

Item Position	Rationales	
8	Option C is correct	To determine which function could represent *g*, the student could have recognized that since $g\left(\frac{2}{3}\right) = 0$ and $g\left(-\frac{3}{4}\right) = 0$, the zeros of the function are $\frac{2}{3}$ and $-\frac{3}{4}$. The student then could have determined the factors that yield the given zeros by setting each of the zeros equal to x and rearranging the equation. To find the factor that corresponds to $x = \frac{2}{3}$, the student could have multiplied both sides of the equation by 3, resulting in $3x = 2$, and then subtracted 2 from both sides of the equation, resulting in $3x - 2 = 0$ and the factor $(3x - 2)$. To find the factor that corresponds to $x = -\frac{3}{4}$, the student could have multiplied both sides of the equation by 4, resulting in $4x = -3$, and then added 3 to both sides of the equation, resulting in $4x + 3 = 0$ and the factor $(4x + 3)$. The student then could have concluded that the function $g(x) = (3x - 2)(4x + 3)$ could represent function *g*. 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 reversed the numerators and the denominators of $\frac{2}{3}$ and $-\frac{3}{4}$ when setting up the equations, resulting in $\frac{3}{2} = x$, $3 = 2x$, or $0 = 2x - 3$, and $-\frac{4}{3} = x$, $-4 = 3x$, or $0 = 3x + 4$. The student then likely determined that the function could be $g(x) = (2x - 3)(3x + 4)$. The student needs to focus on understanding the relationship between the factors and the zeros of a quadratic function.
	Option B is incorrect	The student reversed the numerators and the denominators of $\frac{2}{3}$ and $-\frac{3}{4}$ when setting up the equations and did not use inverse operations when adding or subtracting in the final step of rearranging each equation, resulting in $\frac{3}{2} = x$, $3 = 2x$, or $0 = 2x + 3$, and $-\frac{4}{3} = x$, $-4 = 3x$, or $0 = 3x - 4$. The student then likely concluded that the function could be $g(x) = (2x + 3)(3x - 4)$. The student needs to focus on understanding the relationship between the factors and the zeros of a quadratic function.
	Option D is incorrect	The student likely did not use inverse operations when adding or subtracting in the final step of rearranging the equations, resulting in $-\frac{3}{4} = x$, $-3 = 4x$, or $0 = 4x - 3$, and $\frac{2}{3} = x$, $2 = 3x$, or $0 = 3x + 2$. The student then likely concluded that the function could be $g(x) = (3x + 2)(4x - 3)$. The student needs to focus on understanding the relationship between the factors and the zeros of a quadratic function.

Item Position	Rationales	
9	Line going through (0, 2) and (3, 0)	To determine the graph of the line represented by the equation $y = -\frac{2}{3}x + 2$, the student could have first recognized that the equation is in slope-intercept form (*y* = *mx* + *b*, where *m* represents the slope [steepness of a line] and *b* represents the value of the *y*-intercept [value where a graph crosses the *y*-axis]). The student could have identified the slope, *m*, as $-\frac{2}{3}$ and the *y*-intercept, *b*, as 2. Since the *y*-intercept is 2, the student could have graphed a point at (0, 2). Next, the student could have used the slope of $-\frac{2}{3}$ to find that the point (3, 0) also lies on the line since the point (3, 0) is 2 units down from and 3 units to the right of the point (0, 2). This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
10	Option C is correct	To determine which inequality represents all possible combinations of the number of cookies, x, and the number of muffins, y, that can be purchased, the student should have identified that each cookie costs \$2, and so the cost of the cookies purchased can be represented by $2x$. The student should have also identified that each muffin costs \$3, and so the cost of the muffins purchased can be represented by $3y$. The student then should have represented the total cost of the cookies and muffins with the expression $2x + 3y$. Finally, the student should have interpreted the phrase “has at most \$20 to spend” as “less than or equal to 20,” resulting in the inequality $2x + 3y \leq 20$.
	Option A is incorrect	The student likely switched the prices of the cookies and the muffins, resulting in $3x + 2y \leq 20$. The student needs to focus on understanding how to write a linear inequality from a verbal description.
	Option B is incorrect	The student likely interpreted the phrase “has at most \$20 to spend” as “greater than or equal to 20” instead of “less than or equal to 20,” resulting in $2x + 3y \geq 20$. The student needs to focus on understanding how to write a linear inequality from a verbal description.
	Option C is incorrect	The student likely switched the prices of the cookies and the muffins and interpreted the phrase “has at most \$20 to spend” as “greater than or equal to 20” instead of “less than or equal to 20,” resulting in $3x + 2y \geq 20$. The student needs to focus on understanding how to write a linear inequality from a verbal description.

Item Position	Rationales	
11	−4.65, 0.65	To determine the values closest to the solutions of $2x^2 + 8x - 6 = 0$, the student could have used the quadratic formula ($x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$, where a, b, and c are the coefficients of the quadratic equation $ax^2 + bx + c = 0$) to solve for x. The student could have recognized that $a = 2$, $b = 8$, and $c = -6$ and substituted these values into the quadratic formula and simplified, resulting in $x = \frac{-8 \pm \sqrt{8^2-4(2)(-6)}}{2(2)} = \frac{-8 \pm \sqrt{64-(-48)}}{4} = \frac{-8 \pm \sqrt{112}}{4} = \frac{-8 \pm 4\sqrt{7}}{4} = -2 \pm \sqrt{7}$. The student then could have evaluated this result to determine that the approximate values of x are $-2 - \sqrt{7} \approx -4.65$ and $-2 + \sqrt{7} \approx 0.65$. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
12	Option A is correct	To determine the quotient (answer when divided) of (4*x* − 8) ÷ (*x* − 2) for all values of *x* where the function is defined, the student could have first factored out the greatest common factor (largest factor that can be divided evenly into all the terms) from the dividend (a quantity or total to be divided). The student could have recognized that the greatest common factor of 4*x* and −8 is 4 and that the expression 4x − 8 can be rewritten as 4(*x* − 2). Next, the student could have recognized that the factor *x* − 2 is present in the divisor (the expression by which the dividend is to be divided) and the dividend, and therefore the quotient could be written as $\frac{4(x-2)}{x-2} = 4\left(\frac{x-2}{x-2}\right) = 4(1) = 4$. This 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 divided the first term of the dividend, 4*x*, by the first term of the divisor, *x*, and obtained 4. The student then likely found the difference of the constant terms, −8 − (−2) = −6, and used it as the remainder, resulting in the expression $4 - \frac{6}{x-2}$. The student needs to focus on understanding how to determine the quotient of a polynomial of degree one divided by a polynomial of degree one.
	Option C is incorrect	The student likely considered the difference between the constant terms, −2 − (−8) = 6, to be the quotient. The student needs to focus on understanding how to determine the quotient of a polynomial of degree one divided by a polynomial of degree one.
	Option D is incorrect	The student likely used the difference between the constant terms, −2 − (−8) = 6, as the quotient, and the quotient of the linear terms, 4*x* ÷ *x* = 4, as the remainder, resulting in $6 + \frac{4}{x-2}$. The student needs to focus on understanding how to determine the quotient of a polynomial of degree one divided by a polynomial of degree one.

Item Position	Rationales	
13	has the same steepness as, less than	To complete the statements to best describe how the graphs of functions *f* and *g* are related, the student could have first identified $f(x) = x$ as the linear parent function. The student could have recognized that in the function rule $g(x) = f(x) - 3$, subtracting 3 from $f(x)$ represents a vertical translation of 3 units down. The student then could have concluded that the graph of *g* has the same steepness as the graph of *f*, and the *y*-intercept of the graph of *g* is less than the *y*-intercept of the graph of *f*. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
14	Option D is correct	To determine the equation of a line that is parallel (lines that do not intersect [cross] and are always the same distance from each other) to the *x*-axis (horizontal number line) and contains the point (3.6, 8.7), the student could have first determined that since the *x*-axis is the horizontal axis, a line parallel to it would also be a horizontal line. The student then could have recognized that the equation of a horizontal line can be written as $y = a$, where a is the *y*-coordinate of a point on the line. The student then could have concluded that the equation of the line that is parallel to the *x*-axis and contains the point (3.6, 8.7) is $y = 8.7$. 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 used the wrong variable in the equation and wrote the equation of a vertical line, $x = 8.7$, instead of a horizontal line. The student needs to focus on understanding how to write the equation of a horizontal line.
	Option B is incorrect	The student likely chose an equation for a line that is parallel to the *x*-axis but used the value of the *x*-coordinate instead of the value of the *y*-coordinate in the equation, resulting in $y = 3.6$. The student needs to focus on understanding how to write the equation of a horizontal line.
	Option C is incorrect	The student likely confused parallel and perpendicular lines and chose an equation, $x = 3.6$, of a line that is perpendicular to the *x*-axis and contains the point (3.6, 8.7). The student needs to focus on understanding how to write the equation of a horizontal line.

Item Position	Rationales	
15	Option A is correct	To determine which function is represented by the graph of an exponential function that passes through the points (−1, 10) and (0, 4), the student could have recognized that an exponential function is in the form $g(x) = ab^x$, where *a* is the *y*-intercept (value where the graph crosses the *y*-axis), *b* is the common factor (rate by which successive values increase or decrease), and *x* is the variable (symbol used to represent an unknown number). From the graph, the student could have interpreted that the point (0, 4) is the *y*-intercept, which means that the value of *a* is 4. From the information given, the student could have determined the common factor, *b*, by dividing each value of *f(x)* by the previous value of *f(x)*, resulting in $b = \frac{4}{10} = \frac{2}{5}$. Substituting *a* = 4 and $b = \frac{2}{5}$ into the exponential equation $g(x) = ab^x$, the student could have obtained $g(x) = 4\left(\frac{2}{5}\right)^x$. This 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 considered the graph of the function to pass through the point (1, 2) and solved the equation $2 = (4)(b)^1$, resulting in $2 = 4b$, or $\frac{1}{2} = b$ and the function $g(x) = 4\left(\frac{1}{2}\right)^x$. The student needs to focus on understanding how to write the equation of an exponential function when given a graph of the function.
	Option C is incorrect	The student likely transposed the *a*-value and *b*-value in the function $g(x) = ab^x$, resulting in $g(x) = \frac{2}{5}(4)^x$. The student needs to focus on understanding how to write the equation of an exponential function when given a graph of the function.
	Option D is incorrect	The student likely considered the graph of the function to pass through the point (1, 2) and solved the equation $2 = (4)(b)^1$, resulting in $2 = 4b$, or $\frac{1}{2} = b$. The student then likely transposed the *a*-value and *b*-value in the function $g(x) = ab^x$, resulting in $g(x) = \frac{1}{2}(4)^x$. The student needs to focus on understanding how to write the equation of an exponential function when given a graph of the function.

Item Position	Rationales	
16	Option B is correct	To determine which graph best represents the solution set of $3x < 4y - 12$, the student could have recognized that the "<" symbol means "less than," which can be represented by a dashed boundary line (a solid or dashed line representing the edge of the solution set of a linear inequality) to indicate that the points on the line are not part of the solution set. The student could have graphed the boundary line by rewriting the inequality in slope-intercept form ($y = mx + b$, where m represents the slope [steepness of a line] and b represents the value of the y-intercept [value where a graph crosses the y-axis]). The student could have solved the given inequality for y by first adding 12 to both sides, resulting in $3x + 12 < 4y - 12 + 12$, or $3x + 12 < 4y$, and then dividing both sides of the inequality by 4, resulting in $\frac{3}{4}x + 3 < y$, or $y > \frac{3}{4}x + 3$. The student could have graphed this line by plotting a point at the y-intercept, (0, 3), and then using the slope, $\frac{3}{4}$, to plot a point 3 units up and 4 units to the right of the y-intercept, which is the point (4, 6). Thus, the student could have determined that the graph should have a dashed line passing through the points (0, 3) and (4, 6). The student could have determined the region to be shaded by substituting an ordered pair, such as (0, 0), into the inequality $3x < 4y - 12$ to test for a true statement. Since $3(0) < 4(0) - 12$ is equivalent to $0 < -12$, which is a false statement, the point (0, 0) should not be included in the shaded part of the graph. Therefore, the student should have shaded the part of the graph that does not contain the point (0, 0). 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 solved the inequality for x rather than y when rewriting it in slope-intercept form, resulting in $x < \frac{4}{3}y - 4$, and graphed a dashed line with a y-intercept of −4 and a slope of $\frac{4}{3}$. The student then likely determined that the point (0, 0) should not be included in the shaded part of the graph. The student needs to focus on understanding how to graph the solution set of an inequality.
	Option C is incorrect	The student likely did not divide the coefficient of x, 3, by 4 when rewriting the inequality in slope-intercept form, resulting in the inequality $y > 3x + 3$, and graphed a dashed line with a y-intercept of 3 and a slope of 3. The student then likely confused greater

		than, >, with less than, <, when testing the point (0, 0) and concluded that the point (0, 0) should be included in the shaded solution set. The student needs to focus on understanding how to graph the solution set of an inequality.
	Option D is incorrect	The student likely solved the inequality for *x* rather than *y* when rewriting it in slope-intercept form and did not divide the coefficient of *y*, 4, by 3, resulting in the inequality $x < 4y - 4$, and graphed a dashed line with a *y*-intercept of −4 and a slope of 4. The student then likely confused greater than, >, with less than, <, when testing the point (0, 0) and concluded that the point (0, 0) should be included in the shaded solution set. The student needs to focus on understanding how to graph the solution set of an inequality.

Item Position	Rationales	
17	10, 24	To determine the lengths of $\overline{PR}$ and $\overline{RQ}$ in centimeters, the student could have recognized that the perimeter, $5x$, is equal to the sum of all the side lengths. The student then could have found the value of x by setting up and solving the equation $x + 16 + 3(x - 2) = 5x$, resulting in $x + 16 + 3x - 6 = 5x$, $4x + 10 = 5x$, or $10 = x$. The student then could have substituted $x = 10$ for the variable that represents PR, x, resulting in $PR = 10$ cm. The student then could have substituted $x = 10$ into the expression for RQ, $3(x - 2)$, resulting in $RQ = 3(10 - 2) = 3(8) = 24$ cm. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
18	Option A is correct	To determine which statement is true for the part of the function shown, the student should have found the domain (all possible *x*-values) of the part of the function graphed on the grid. The student should have identified all values of *x* for which the graph has a *y*-value. The student should have recognized that the graph of the parabola (U-shaped graph) contains the closed point (−8, 2) on the left and the closed point (2, −3) on the right. Thus, the student should have concluded that the domain is all real numbers greater than or equal to the least *x*-value, −8, and less than or equal to the greatest *x*-value, 2.
	Option B is incorrect	The student likely used the least *y*-value, −3, and the greatest *y*-value, 6, to determine the domain. The student then likely concluded that the domain of the part of the function shown is the set of real numbers greater than or equal to −3 and less than or equal to 6. The student needs to focus on understanding how to represent the domain and range of a quadratic function when given a part of the graph.
	Option C is incorrect	The student likely ignored the part of the graph to the left of the *y*-axis and considered the greatest *y*-value to be the *y*-intercept, 2. The student then likely concluded that the range (all possible *y*-values) of the part of the function shown is the set of real numbers greater than or equal to −3 and less than or equal to 2. The student needs to focus on understanding how to represent the domain and range of a quadratic function when given a part of the graph.
	Option D is incorrect	The student likely considered the least *y*-value to be the least labeled value on the *y*-axis, −4, and concluded that the range is the set of real numbers greater than or equal to −4 and less than or equal to 6. The student needs to focus on understanding how to represent the domain and range of a quadratic function when given a part of the graph.

Item Position	Rationales	
19	$\geq$, $-\frac{3}{4}$	To determine the solution set to the inequality $-5m + 4 \leq 3(m + 3) + 1$, the student could have solved the inequality by following the order of operations. The student should have first distributed the 3 on the right side of the inequality, resulting in $-5m + 4 \leq 3m + 9 + 1$. Next, the student should have combined like terms, resulting in $-5m + 4 \leq 3m + 10$. Next, the student could have moved the variable terms to the left side of the inequality and the constant terms to the right side of the inequality by subtracting 3m from both sides and subtracting 4 from both sides, resulting in $-5m - 3m + 4 - 4 \leq 3m - 3m + 10 - 4$, or $-8m \leq 6$. Finally, the student should have divided both sides of the inequality by −8, resulting in $m \geq -\frac{6}{8}$ or $m \geq -\frac{3}{4}$. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
20	Option B is correct	To determine which expression is equivalent to $\frac{m^7}{m^{-3}}$ for all values of *m* where the expression is defined, the student could have applied the quotient of powers property $\left(\frac{a^m}{a^n} = a^{m-n}\right)$, resulting in $m^{7-(-3)} = m^{10}$. 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 added the exponents instead of subtracting, resulting in $m^{7+-3} = m^4$. The student needs to focus on understanding how to use the properties of exponents to simplify expressions.
	Option C is incorrect	The student likely added the exponents instead of subtracting, m^{7+-3}, and made a sign error in the result, resulting in $m^{-4} = \frac{1}{m^4}$. The student needs to focus on understanding how to use the properties of exponents to simplify expressions.
	Option D is incorrect	The student likely subtracted the exponents, $m^{7-(-3)}$, and made a sign error in the result, resulting in $m^{-10} = \frac{1}{m^{10}}$ The student needs to focus on understanding how to use the properties of exponents to simplify expressions.

Item Position	Rationales	
21	−3, −2	To determine the vertex of the graph of g, the student could have first recognized that the vertex of the quadratic parent function, $f(x) = x^2$, is (0, 0). The student then could have interpreted the transformed function, $g(x) = 5f(x + 3) - 2$, as the result of translating the graph of f to the left 3 units and down 2 units. The student then could have concluded that the vertex of g is located 3 units to the left of and 2 units down from the vertex of f, at (−3, −2). This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
22	Option C is correct	To determine which relation (relationship between the *x*- and *y*-values of ordered pairs) best represents *y* as a function of *x*, the student should have recalled that a function is a relation where each input value, *x*, corresponds to a single output value, *y*. The student could have analyzed the table and determined that each *x*-value in the table corresponds to a single *y*-value.
	Option A is incorrect	The student likely confused the input values and output values and chose a table in which each output value corresponds to a single input value. The student needs to focus on understanding whether a relation represented in a table defines a function.
	Option B is incorrect	The student likely considered a relation that represents a negative linear association to be a function and did not recognize that the *x*-value –3 corresponds to two *y*-values. The student needs to focus on understanding whether a relation represented in a graph defines a function.
	Option D is incorrect	The student likely considered a relation that contains no negative *x*-values to be a function and did not recognize that several of the *x*-values correspond to two *y*-values. The student needs to focus on understanding whether a relation represented in a graph defines a function.

Item Position	Rationales	
23	Option B is correct	To determine the domain (all possible *x*-values) of the function for the situation, the student should have recognized that the situation represents a linear function with discrete values since the number of payments, *x*, is represented by the set of whole numbers from 0 to 4. The student then should have determined that the domain of the function for this situation is {0, 1, 2, 3, 4}.
	Option A is incorrect	The student likely identified the values of the range (all possible *y*-values), resulting in {0, 25, 50, 75, 100}. The student needs to focus on understanding how to identify the domain of a linear function with discrete values.
	Option C is incorrect	The student likely did not consider that the values of the function should be discrete, and the student likely did not include the values 0 and 4 in the domain. The student thus likely identified the domain of a linear function that is continuous with non-inclusive endpoints: all real numbers greater than 0 and less than 4. The student needs to focus on understanding how to identify the domain of a linear function with discrete values.
	Option D is incorrect	The student likely confused the domain with the range and did not consider that the values of the function should be discrete. The student likely did not include the values 0 and 100 in the set, thus identifying the values of the range of a linear function that is continuous with non-inclusive endpoints: all real numbers greater than 0 and less than 100. The student needs to focus on understanding how to identify the domain of a linear function with discrete values.

Item Position	Rationales	
24	Option C is correct	To determine the slope of the line represented by $5x + 2y = 8$, the student could have rewritten the equation in slope-intercept form ($y = mx + b$, where m represents the slope [steepness of a line] and b represents the value of the y-intercept [value where a graph crosses the y-axis]) and identified the value of m in the equation. The student could have subtracted $5x$ from both sides of the equation, resulting in $5x - 5x + 2y = 8 - 5x$, or $2y = -5x + 8$. The student then could have divided each side by 2, resulting in $y = -\frac{5}{2}x + 4$. Last, the student could have identified the value of m to be $-\frac{5}{2}$. 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 found the reciprocal of the slope by reversing the order of division when dividing both sides of the equation by 2 and made a sign error in the quotient, resulting in $\frac{2}{5}$ rather than $-\frac{5}{2}$. The student needs to focus on understanding how to find the slope given the equation of the line.
	Option B is incorrect	The student likely found the reciprocal of the slope by reversing the order of division when dividing both sides of the equation by 2, resulting in $-\frac{2}{5}$ rather than $-\frac{5}{2}$. The student needs to focus on understanding how to find the slope given the equation of the line.
	Option D is incorrect	The student likely made a sign error when dividing -5 by 2, resulting in $\frac{5}{2}$ rather than $-\frac{5}{2}$. The student needs to focus on understanding how to find the slope given the equation of the line.

Item Position	Rationales	
25	Option D is correct	To determine the first four terms of the sequence generated by the equation $a_n = a_{(n-1)} + 2.8$, where $a_1 = 9$ and n is a whole number greater than 1, the student should have first recognized that the sequence is arithmetic (a sequence of numbers where the difference between every two consecutive terms is the same) since 2.8 is added to each previous term, $a_{(n-1)}$, to determine a_n. Since $a_1 = 9$, the student should have added 2.8 to 9 to find a_2, resulting in $a_2 = 9 + 2.8 = 11.8$. Next, the student should have added 2.8 to 11.8 to find a_3, resulting in $a_3 = 11.8 + 2.8 = 14.6$. Last, the student should have added 2.8 to 14.6 to find a_4, resulting in $a_4 = 14.6 + 2.8 = 17.4$. The student then could have concluded that the first four terms of the sequence are {9, 11.8, 14.6, 17.4}.
	Option A is incorrect	The student likely added 2.8 to the sum of all the previous terms and considered the notation $a_{(n-1)}$ to indicate subtracting 1 from each term, resulting in $a_2 = 9 + 2.8 - 1 = 10.8$, $a_3 = 9 + 10.8 + 2.8 - 1 = 21.6$, and $a_4 = 9 + 10.8 + 21.6 + 2.8 - 1 = 43.2$. The student likely concluded that the first four terms of the sequence are {9, 10.8, 21.6, 43.2}. The student needs to focus on understanding how to identify terms of an arithmetic sequence.
	Option B is incorrect	The student likely added 2.8 to the sum of all the previous terms, resulting in $a_2 = 9 + 2.8 = 11.8$, $a_3 = 9 + 11.8 + 2.8 = 23.6$, and $a_4 = 9 + 11.8 + 23.6 + 2.8 = 47.2$. The student likely concluded that the first four terms of the sequence are {9, 11.8, 23.6, 47.2}. The student needs to focus on understanding how to identify terms of an arithmetic sequence.
	Option C is incorrect	The student likely added 2.8 to the previous term in the sequence but then subtracted 1 from the sum, resulting in $a_2 = 9 + 2.8 - 1 = 10.8$, $a_3 = 10.8 + 2.8 - 1 = 12.6$, and $a_4 = 12.6 + 2.8 - 1 = 14.4$. The student likely then concluded that the first four terms of the sequence are {9, 10.8, 12.6, 14.4}. The student needs to focus on understanding how to identify terms of an arithmetic sequence.

Item Position	Rationales	
26	Option A is correct	To determine the rate of change (constant rate of increase or decrease) of *y* with respect to *x* for the function, the student could have used the two labeled points from the graph, (−4, −6) and (3, −4), and applied the slope formula, $m = \frac{y_2 - y_1}{x_2 - x_1}$, to calculate the ratio of the change in *y*-values to the change in *x*-values, resulting in $m = \frac{-4-(-6)}{3-(-4)} = \frac{2}{7}$. This 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 determined that the *y*-intercept must be an integer value and calculated the rate of change using the given point (3, −4) and the estimated point (0, −5), resulting in $m = \frac{-5-(-4)}{0-3} = \frac{-1}{-3} = \frac{1}{3}$. The student needs to focus on understanding that the rate of change of a linear relationship is equal to the change in the values of the dependent variable divided by the corresponding change in the values of the independent variable.
	Option C is incorrect	The student likely estimated (−10, −8) and (10, −2) as two points on the line and used these points to calculate the rate of change, resulting in $m = \frac{-2-(-8)}{10-(-10)} = \frac{6}{20} = \frac{3}{10}$. The student needs to focus on understanding that the rate of change of a linear relationship is equal to the change in the values of the dependent variable divided by the corresponding change in the values of the independent variable.
	Option D is incorrect	The student likely determined that the *y*-intercept must be an integer value and calculated the rate of change using the given point (−4, −6) and the estimated point (0, −5), resulting in $m = \frac{-5-(-6)}{0-(-4)} = \frac{1}{4}$. The student needs to focus on understanding that the rate of change of a linear relationship is equal to the change in the values of the dependent variable divided by the corresponding change in the values of the independent variable.

Item Position	Rationales	
27	Option C is correct	To determine the value that is the best estimate of the number of members the group will have after it has been meeting for 15 years, the student could have used a graphing calculator to generate the function using exponential regression (a method of determining an exponential function, $y = ab^x$, where a and b are real numbers). The exponential function that best models the data is approximately $y \approx 5.08436(1.99425)^x$. Then the student could have substituted $x = 15$ into the exponential function, resulting in $y = 5.08436(1.99425)^{15} \approx 159{,}560$. 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 determined the change in the total number of members over a 3-year interval by subtracting 310 from 2,555, resulting in 2,245. The student likely considered 2,245 to represent a constant change in the number of members over each 3-year period. The student likely then treated the relationship as linear and, since 15 years represents two 3-year intervals past 9 years, multiplied 2,245 by 2, resulting in 4,490 new members in 6 years. The student then likely added 4,490 to 2,555, the number of members in year 9, resulting in 4,490 + 2,555 = 7,045. The student needs to focus on understanding how to make predictions using an exponential function that was generated using exponential regression.
	Option B is incorrect	The student likely generated a function using linear regression rather than exponential regression, resulting in $y \approx 263.93333x - 549.7$. Then the student likely substituted $x = 15$ into the linear function, resulting in $y \approx 263.93333(15) - 549.7 \approx 3{,}499$. The student needs to focus on understanding how to make predictions using an exponential function that was generated using exponential regression.
	Option D is incorrect	The student likely correctly determined the exponential function that best models the data as $y \approx 5.08436(1.99425)^x$ but substituted $x = 14$ rather than $x = 15$ into the function, resulting in $y = 5.08436(1.99425)^{14} \approx 80{,}0110$. The student needs to focus on understanding how to make predictions using an exponential function that was generated using exponential regression.

Item Position	Rationales	
28	Option B is correct	To determine the equation of the axis of symmetry (an imaginary vertical line that goes through the vertex of a parabola [U-shaped graph]) of the graph, the student could have determined that the vertex (highest or lowest point of the curve) of the graph is located at (30, 50). Next, the student could have recognized that the axis of symmetry is represented by the equation $x = h$, where h represents the x-coordinate of the vertex. Therefore, the student could have concluded that the equation of the axis of symmetry of the graph is $x = 30$. 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 represented the axis of symmetry by the equation $y = k$, where k represents the y-coordinate of the vertex, resulting in $y = 50$. The student needs to focus on understanding how to identify the key features of a quadratic function when given a graph of the function.
	Option C is incorrect	The student likely represented the axis of symmetry as a vertical line through a zero of the function located at (60, 0), resulting in $x = 60$. The student needs to focus on understanding how to identify the key features of a quadratic function when given a graph of the function.
	Option D is incorrect	The student likely represented the axis of symmetry as a horizontal line located halfway between the y-intercept and the vertex rather than a vertical line halfway between the two zeros, resulting in $y = 25$. The student needs to focus on understanding how to identify the key features of a quadratic function when given a graph of the function.

Item Position	Rationales	
29	Option D is correct	To determine the function that represents *f*, the student could have used the slope-intercept form of a linear equation (*y* = *mx* + *b*, where *m* represents the slope [steepness of a line] and *b* represents the value of the *y*-intercept [value where a graph crosses the *y*-axis]). The student could have first calculated the slope by substituting any two ordered pairs from the table into the slope formula, $m = \frac{y_2 - y_1}{x_2 - x_1}$. Substituting the ordered pairs (−4, 20) and (−2, 14) into the slope formula, the student could have obtained $m = \frac{14-20}{-2-(-4)} = \frac{-6}{2} = -3$. Next, the student could have substituted the *x*- and *y*-coordinates of the point (−4, 20) and *m* = −3 into *f*(*x*) = *m*x + *b* and solved for *b*, resulting in 20 = −3(−4) + *b*, or *b* = 20 − 12 = 8. Since *m* = −3 and *b* = 8, the student could have concluded that the equation of the function in slope-intercept form is *f*(*x*) = −3*x* + 8. 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 calculated the correct slope but added 12 instead of subtracting 12 when solving for *b* using the point (−4, 20), resulting in *b* = 20 + 12 = 32. The student then likely substituted *m* = −3 and *b* = 32 into *f*(*x*) = *mx* + *b*, resulting in *f*(*x*) = −3*x* + 32. The student needs to focus on understanding how to write a linear function in slope-intercept form when given a table.
	Option B is incorrect	The student likely used the change in *x* divided by the change in *y* to calculate the slope of the line, resulting in $m = -\frac{1}{3}$, and used the point (3, −1) to solve for *b*, resulting in $-1 = -\frac{1}{3}(3) + b$, or *b* = −1 + 1 = 0. The student then likely substituted $m = -\frac{1}{3}$ and *b* = 0 into *f*(*x*) = *mx* + *b*, resulting in $f(x) = -\frac{1}{3}x$. The student needs to focus on understanding how to write a linear function in slope-intercept form when given a table.
	Option C is incorrect	The student likely used the change in *x* divided by the change in *y* to calculate the slope of the line, resulting in $m = -\frac{1}{3}$, and used the first listed *y*-value in the table as the *y*-intercept, resulting in *b* = 20. The student then likely substituted $m = -\frac{1}{3}$ and *b* = 20 into *f*(*x*) = *mx* + *b*, resulting in $f(x) = -\frac{1}{3}x + 20$. The student needs to focus on understanding how to write a linear function in slope-intercept form when given a table.

Item Position	Rationales	
30	x^4, y^3	To determine the expression that is equivalent to $(x^{12}y^{-9})^{\frac{1}{3}}$ for all values of x and y where the expression is defined, the student could have applied the power of a power property $[(a^m)^n = a^{mn}]$, resulting in $x^{(12)(\frac{1}{3})}y^{(-9)(\frac{1}{3})} = x^4y^{-3}$. Next, the student could have applied the negative exponent property $(a^{-n} = \frac{1}{a^n})$, resulting in $x^4y^{-3} = \frac{x^4}{y^3}$. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
31	Option C is correct	To determine the statement that describes the relationship between the two graphs, the student could have interpreted $g(x) = f(x + 5)$ as representing a translation of the graph of $f(x) = x^2$ to the left 5 units. The student could have concluded that the graph of f was shifted 5 units to the left to create the graph of g. 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 interpreted $g(x) = f(x + 5)$ as the result of shifting the graph of f up 5 units. The student needs to focus on understanding how changes to a function affect the graph of the function.
	Option B is incorrect	The student likely interpreted $g(x) = f(x + 5)$ as the result of shifting the graph of f down 5 units. The student needs to focus on understanding how changes to a function affect the graph of the function.
	Option D is incorrect	The student likely interpreted $g(x) = f(x + 5)$ as the result of shifting the graph of f to the right 5 units. The student needs to focus on understanding how changes to a function affect the graph of the function.

Item Position	Rationales	
32	Option B is correct	To determine the statement that is best supported by the graph of the function, the student should have recognized that the graph represents an exponential function and extends infinitely to the left and the right without ever crossing the *x*-axis (horizontal axis). Therefore, the graph of the function has no *x*-intercepts (points where the curve touches the *x*-axis) and has an asymptote at $y = 0$.
	Option A is incorrect	The student likely interpreted the *y*-intercept (the value where the graph crosses the *y*-axis [vertical number line]), (0, 15) as an intersection (crossing) of the graph with the *x*-axis at (15, 0). The student needs to focus on understanding how to identify the key features of an exponential function when given the graph of the function.
	Option C is incorrect	The student likely interpreted the arrow on the left side of the graph, which points up, as indicating that the graph is increasing. The student needs to focus on understanding how to identify the key features of an exponential function when given the graph of the function.
	Option D is incorrect	The student likely disregarded the scale of the *y*-axis and therefore interpreted the *y*-intercept as an intersection of the graph with the *y*-axis at (0, 3) instead of at (0, 15). The student needs to focus on understanding how to identify the key features of an exponential function when given the graph of the function.

Item Position	Rationales	
33	Option A is correct	To determine the function that could represent *f*, the student could have used the solutions to construct and simplify the equation of a quadratic function using $f(x) = (x - u)(x - v)$, where *u* and *v* represent solutions to the equation $f(x) = 0$. The student could have used the values of the given solutions, $x = 11$ and $x = -11$, letting $u = 11$ and $v = -11$, and substituted those values into $f(x) = (x - u)(x - v)$ to obtain $f(x) = (x - 11)[x - (-11)]$. Then the student could have found the product of $(x - 11)[x - (-11)]$ to equal $(x - 11)(x + 11) = x^2 - 121$, so $f(x) = x^2 - 121$. This 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 substituted the correct solutions into $f(x) = (x - u)(x - v)$ to obtain $f(x) = (x - 11)[x - (-11)] = (x - 11)(x + 11)$ but then made a sign error when multiplying 11 and −11, obtaining 121 instead of −121. The student needs to focus on understanding how to multiply binomial expressions.
	Option C is incorrect	The student likely substituted the correct solutions into $f(x) = (x - u)(x - v)$ to obtain $f(x) = (x - 11)[x - (-11)] = (x - 11)(x + 11)$ but then made an error when multiplying the binomial expressions. The student likely multiplied the first terms in each binomial together and the last terms in each binomial together but did not multiply the linear terms by the constant terms (last term, or the term with a degree of 0) from each of the binomials and made a sign error, resulting in $f(x) = x^2 - x - x - 121 = x^2 - 2x + 121$.
	Option D is incorrect	The student likely made a sign error when substituting $u = 11$ and $v = -11$ into the equation $f(x) = (x - u)(x - v)$, resulting in $f(x) = [x - (-11)][x - (-11)] = (x + 11)(x + 11)$. The student then likely multiplied the first terms in each binomial together and the last terms in each binomial together but did not multiply the linear terms by the constant terms for each of the binomial factors, resulting in $f(x) = x^2 + x + x + 121 = x^2 + 2x + 121$.

Item Position	Rationales	
34	Option B is correct	To determine the function that represents the relation shown in the table, the student could have recognized that an exponential function is of the form $f(x) = ab^x$, where a is the initial value (starting value), b is the common factor (rate by which successive values increase or decrease), and x is the variable (symbol used to represent an unknown number). From the information given in the table, the student could have determined the common factor, b, by dividing each value of $f(x)$ by the previous value of $f(x)$, resulting in $b = \frac{16}{64} = \frac{1}{4}$. Then the student could have determined the initial value, a, by identifying the value of $f(x)$ when $x = 0$ in the table, resulting in $a = 4$. The student then could have substituted $a = 4$ and $b = \frac{1}{4}$ into the exponential equation $f(x) = ab^x$ to obtain $f(x) = 4\left(\frac{1}{4}\right)^x$. 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 reversed the values of a and b in the exponential function, resulting in $f(x) = \frac{1}{4}(4)^x$. The student needs to focus on understanding how to determine the common factor and the initial value of an exponential function from the given information.
	Option C is incorrect	The student likely calculated b correctly but determined a to be the value of $f(x)$ when $x = 1$, resulting in $a = 1$. The student then likely substituted $a = 1$ and $b = \frac{1}{4}$ into the exponential equation $f(x) = ab^x$ to obtain $f(x) = 1\left(\frac{1}{4}\right)^x = \left(\frac{1}{4}\right)^x$. The student needs to focus on understanding how to determine the common factor and the initial value of an exponential function from the given information.
	Option D is incorrect	The student likely determined the common factor, b, by dividing each value of $f(x)$ by the subsequent value of $f(x)$, resulting in $b = 4$. The student then likely determined a to be the value of $f(x)$ when $x = 1$, resulting in $a = 1$. The student then likely substituted $a = 1$ and $b = 4$ into the exponential equation $f(x) = ab^x$ to obtain $f(x) = 1(4)^x = 4^x$. The student needs to focus on understanding how to determine the common factor and the initial value of an exponential function from the given information.

Item Position	Rationales	
35	Option A is correct	To determine the value of $f(-8)$, the student should have substituted -8 for x in the function (relationship where each input value has a single output value) and then simplified the function, resulting in $f(-8) = -4(-8) + 20 = 32 + 20 = 52$.
	Option B is incorrect	The student likely subtracted 20 from $-4(-8)$ rather than adding 20, resulting in $-4(-8) - 20 = 32 - 20 = 12$. The student needs to focus on understanding how to apply the order of operations when simplifying a numeric expression.
	Option C is incorrect	The student likely added -4 and 20 and used the sum as the coefficient of x, resulting in $f(x) = 16x$. Then the student likely substituted $x = -8$ into the function, resulting in $f(-8) = 16(-8) = -128$. The student needs to focus on understanding how to apply the order of operations when simplifying a numeric expression.
	Option D is incorrect	The student likely substituted 8, rather than -8, into the function, resulting in $f(8) = -4(8) + 20 = -32 + 20 = -12$. The student needs to focus on understanding how to apply the order of operations when simplifying a numeric expression.

Item Position	Rationales	
36	Option D is correct	To determine the value of v that makes the equation $3(v + 2) = 2(v - 9)$ true, the student could have distributed (multiplied) the numbers in front of the parentheses to each term inside the parentheses, resulting in $3v + 6 = 2v - 18$. Then the student could have subtracted $2v$ and 6 from both sides of the equation, resulting in $v = -24$. 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 distributed only to the first term in each set of parentheses, resulting in $3v + 2 = 2v - 9$. Then the student likely subtracted $2v$ and 2 from both sides of the equation, resulting in $v = -11$. The student needs to focus on understanding the arithmetic of solving equations.
	Option B is incorrect	The student likely did not apply inverse operations when moving terms across the equal sign, resulting in $3v + 2v = -18 + 6$. Then the student likely combined like terms, resulting in $5v = -12$. Finally, the student likely divided both sides of the equation by 5, resulting in $v = -\frac{12}{5}$. The student needs to focus on understanding the arithmetic of solving equations.
	Option C is incorrect	The student likely distributed only to the first term in each set of parentheses, resulting in $3v + 2 = 2v - 9$. Then the student likely did not apply inverse operations when moving terms across the equal sign, resulting in $3v + 2v = -9 + 2$. Next the student likely combined like terms, resulting in $5v = -7$. Finally, the student likely divided both sides of the equation by 5, resulting in $v = -\frac{7}{5}$. The student needs to focus on understanding the arithmetic of solving equations.

Item Position	Rationales	
37	Option A is correct	To determine the expression that is equivalent to $3x^2 + 11x - 42$, the student could have identified the factors (numbers or expressions that can be multiplied to get another number or expression) of the expression. The student could have first multiplied $3x^2$ by -42, resulting in $-126x^2$. The student then could have identified the two terms that have a product of $-126x^2$ and a sum of $11x$, which are $18x$ and $-7x$. Next, the student could have rewritten the function in expanded form using these two terms, resulting in $3x^2 + 18x - 7x - 42$. The student could have grouped the first two terms and last two terms and factored out the greatest (largest) common factor from each group of terms, resulting in $3x(x + 6) - 7(x + 6)$. Last, the student could have factored out the binomial $(x + 6)$, resulting in $(3x - 7)(x + 6)$. This 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 expanded the expression to $3x^2 + 18x - 7x - 42$ correctly but made sign errors when factoring out the greatest common factor from each group of terms, resulting in $3x(x - 6) - 7(x - 6) = (3x - 7)(x - 6)$. The student needs to focus on understanding how to factor a quadratic expression of the form $ax^2 + bx + c$.
	Option C is incorrect	The student likely determined that two factors of $3x^2$ are $3x$ and x and that two factors of 42 are 7 and 6 but disregarded the value of the linear term (middle term, or the term with degree of 1) of the quadratic function and the sign of the constant (last term, or the term with a degree of 0), resulting in $(3x + 7)(x + 6)$. The student needs to focus on understanding how to factor a quadratic expression of the form $ax^2 + bx + c$.
	Option D is incorrect	The student likely determined that the expression was not factorable since the coefficient of the quadratic term (first term, or the term with degree of 2) is a prime number, 3. Therefore, the student likely determined that none of the expressions was equivalent to the given expression. The student needs to focus on understanding how to factor a quadratic expression of the form $ax^2 + bx + c$.

Item Position	Rationales	
38	Option B is correct	To determine the value of x in the solution to the system of equations (two or more equations containing the same set of variables [symbols used to represent unknown numbers]), the student could have used the substitution method to solve the system. The student could have substituted $y = x - 1$ into the equation $6x + 3y = 0$ and solved for x, resulting in $6x + 3(x - 1) = 0$, or $6x + 3x - 3 = 0$. Next, the student could have combined like terms (terms that contain the same variables raised to the same powers or constant terms) on the left side of the equation, resulting in $9x - 3 = 0$. The student then could have added 3 to both sides of the equation, resulting in $9x = 3$. Last, the student could have divided both sides of the equation by 9, resulting in $x = \frac{3}{9} = \frac{1}{3}$. 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 3 from the right side of the equation when solving $9x - 3 = 0$, resulting in $9x = -3$ and $x = -\frac{1}{3}$. The student needs to focus on understanding how to complete all the steps to calculate the solution to a system of equations.
	Option C is incorrect	The student likely determined the y-value of the solution rather than the x-value by substituting $x = \frac{1}{3}$ into the second equation, resulting in $y = \frac{1}{3} - 1 = -\frac{2}{3}$. The student needs to focus on understanding how to complete all the steps to calculate the solution to a system of equations.
	Option D is incorrect	The student likely determined the y-value of the solution rather than the x-value by substituting $x = \frac{1}{3}$ into the second equation, and reversed the order of subtraction when evaluating the equation, resulting in $y = 1 - \frac{1}{3} = \frac{2}{3}$. The student needs to focus on understanding how to complete all the steps to calculate the solution to a system of equations.

Item Position	Rationales	
39	Solid line going through the points (0, 2) and (3, 4), dashed line through the points (−3, 0) and (0, −3), with shading in the area that includes the point (0, 0)	To determine the graph of the solution set of the system of linear inequalities in the coordinate plane, the student could have graphed each boundary line and then determined the region containing the solution set. To graph the boundary line for the inequality $y \leq \frac{2}{3}x + 2$, the student could have recognized that the line $y = \frac{2}{3}x + 2$ has a slope (steepness of a line) of $\frac{2}{3}$ and a *y*-intercept (value where a graph crosses the *y*-axis [vertical number line]) of 2. The student should have also recognized that the boundary line is solid since the inequality is inclusive. So the student should have graphed a solid boundary line through the points (0, 2) and (3, 4). To graph the boundary line for the inequality $y > -x - 3$, the student could have recognized that the line $y = -x - 3$ has a slope of −1 and a *y*-intercept of −3. The student should have also recognized that the boundary line is dashed since the inequality is non-inclusive. So the student should have graphed a dashed boundary line through the points (−3, 0) and (0, −3). To determine the region containing the solution set of the system, the student could have selected a test point at (0, 0). Substituting the test point (0, 0) into each inequality, the student could have obtained $0 \leq 0 + 2$ and $0 > 0 - 3$. Since $0 \leq 2$ and $0 > -3$ are true statements, the student could have concluded that the region containing the point (0, 0) should be shaded. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
40	Option D is correct	To determine the linear equation that represents the total cost in dollars, y, for renting a truck and driving it x miles, the student could have used the slope-intercept form of a linear equation ($y = mx + b$, where m represents the slope of the line and b represents the y-intercept). To determine the slope, the student could have calculated the rate of change (constant rate of increase or decrease) of the total cost with respect to the miles driven. Since one customer drove the truck 20 miles for a total cost of \$33, and another customer drove the truck 100 miles for a total cost of \$85, the student could have calculated the ratio of the difference in the total costs (85 – 33 = 52) to the difference in the numbers of miles (100 – 20 = 80). So the rate of change is \$52 divided by 80 miles, or \$0.65 per mile. Next, the student could have calculated the flat fee to rent the truck by substituting $m = 0.65$ and the ordered pair $(x, y) = (20, 33)$, representing the miles driven and total cost for the first customer, into $y = mx + b$ and solving for b, resulting in $33 = 0.65(20) + b$, or $b = 20$. Last, the student could have substituted $m = 0.65$ and $b = 20$ into the slope-intercept equation, resulting in $y = 0.65x + 20$. 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 interpreted the relationship as proportional and determined the slope to be the quotient (result of a division problem) of the cost and distance given for one of the customers, resulting in $m = \frac{85}{100} = 0.85$ and $y = 0.85x$. The student needs to focus on understanding how to write a linear function when given a description of a situation.
	Option B is incorrect	The student likely interpreted the relationship as proportional and did not calculate the flat fee to rent the truck, resulting in $y = 0.65x$. The student needs to focus on understanding how to write a linear function when given a description of a situation.
	Option C is incorrect	The student likely determined the slope to be the quotient of the cost and distance given for one of the customers, resulting in $m = \frac{85}{100} = 0.85$, and determined the y-intercept to be the total cost for the other customer, $b = 33$, resulting in $y = 0.85x + 33$. The student needs to focus on understanding how to write a linear function when given a description of a situation.

Item Position	Rationales	
41	Option B is correct	To determine the solutions of the equation $(x + 5)^2 = 36$, the student could have used the square root method to solve the equation for the values of x. The student could have first taken the square root of both sides of the equation, resulting in $x + 5 = \pm 6$. Then the student could have subtracted 5 from both sides of the equation, resulting in $x = 6 - 5 = 1$ and $x = -6 - 5 = -11$. 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 determined one solution by solving the equation $x + 5 = 0$, resulting in $x = -5$, and determined the other solution by solving the equation $x^2 = 36$ and using only the positive solution, resulting in $x = \sqrt{36} = 6$. The student needs to focus on understanding how to find solutions of quadratic equations using the square root method.
	Option C is incorrect	The student likely took the square root of both sides of the equation correctly, resulting in $x + 5 = \pm 6$, but likely added 5 to both sides, resulting in $6 + 5 = 11$ and $-6 + 5 = -1$. The student needs to focus on understanding how to find solutions of quadratic equations using the square root method.
	Option D is incorrect	The student likely determined one solution by solving the equation $x + 5 = 0$ and made a sign error, resulting in $x = 0 + 5 = 5$, and determined the other solution by solving the equation $x^2 = 36$ and using only the negative solution, resulting in $x = -\sqrt{36} = -6$. The student needs to focus on understanding how to find solutions of quadratic equations using the square root method.

Item Position	Rationales	
42	In the Solution Set, In the Solution Set, In the Solution Set, Not in the Solution Set	To determine whether each ordered pair in the table is in the solution set of $y \leq -\frac{1}{2}x + 3$, the student should have recognized that the "≤" symbol indicates that the solution set of the inequality includes the points on the boundary line. Next, the student could have tested the first given ordered pair, (−2, −1), to determine which halfplane is included in the solution set. Substituting (−2, −1) into $y \leq -\frac{1}{2}x + 3$, the student could have obtained $-1 \leq -\frac{1}{2}(-2) + 3$, which simplifies to −1 ≤ 4. Since that is a true statement, the student could have concluded that (−2, −1) is in the solution set and that the halfplane containing (−2, −1) is the solution set of the inequality. The student then could have determined that, since (2, 2) and (3, 0) are in the same halfplane as (−2, −1), those ordered pairs are also in the solution set of the inequality. Finally, the student could have concluded that, since (6, 1) is not in the same halfplane as (−2, −1), that ordered pair is not in the solution set of the inequality. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
43	Option B is correct	To determine the expression equivalent to $(-5k + 1)(k^2 - k + 4)$, the student could have multiplied each term in the factor $(-5k + 1)$ by each term in the factor $(k^2 - k + 4)$, resulting in $-5k(k^2 - k + 4) + 1(k^2 - k + 4) = -5k^3 + 5k^2 - 20k + k^2 - k + 4$. The student then could have combined like terms, resulting in $-5k^3 + 6k^2 - 21k + 4$. 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 multiplied by $5k$ instead of $-5k$ when multiplying by the first factor and omitted the middle term of the second factor, resulting in $5k(k^2 + 4) + 1(k^2 + 4) = 5k^3 + 20k + k^2 + 4 = 5k^3 + k^2 + 20k + 4$. The student needs to focus on understanding how to find the product of a binomial and a trinomial.
	Option C is incorrect	The student likely multiplied by $5k$ instead of $-5k$ when multiplying by the first factor, resulting in $5k(k^2 - k + 4) + 1(k^2 - k + 4) = 5k^3 - 5k^2 + 20k + k^2 - k + 4 = 5k^3 - 4k^2 + 19k + 4$. The student needs to focus on understanding how to find the product of a binomial and a trinomial.
	Option D is incorrect	The student likely omitted the middle term of the second factor, resulting in $-5k(k^2 + 4) + 1(k^2 + 4) = -5k^3 - 20k + k^2 + 4 = -5k^3 + k^2 - 20k + 4$. The student needs to focus on understanding how to find the product of a binomial and a trinomial.

Item Position	Rationales	
44	Option A is correct	To determine the inequality that best represents the range (all possible *y*-values) of the function for the situation, the student should have identified all the *y*-values shown on the graph. The graph contains a closed point at (0, 400), indicating that there were 400 pages remaining to be read when the time began, and extends downward and to the right, ending at another closed point at (16, 0), indicating that there were 0 pages remaining to be read after 16 hours. Therefore, the range of the function for the situation is all *y*-values greater than or equal to 0 and less than or equal to 400, represented by the inequality $0 \le y \le 400$.
	Option B is incorrect	The student likely used the variable (symbol used to represent an unknown number) *x*, which represents the domain rather than the range. The student needs to focus on understanding how to represent the range of a linear function when given a situation and a graph.
	Option C is incorrect	The student likely identified the domain (all possible *x*-values) instead of the range. The student needs to focus on understanding how to represent the range of a linear function when given a situation and a graph.
	Option D is incorrect	The student likely used the variable *y*, which represents the range, but identified the *x*-values contained in the domain. The student needs to focus on understanding how to represent the range of a linear function when given a situation and a graph.

Item Position	Rationales	
45	0, 3.2	To determine the domain (all possible *x*-values) of the function for the situation, the student could have first identified the time in seconds as the independent variable (the variable in a function that does not depend on another), *x*, and the height in feet of the launched object as the dependent variable (the variable in a function that depends on another), *y*, for the function representing the situation. The student then could have identified all the *x*-values for which the function has a *y*-value. Since the object was launched at 0 seconds and hit the ground after 3.2 seconds, the domain is the set of all real numbers greater than or equal to 0 and less than or equal to 3.2. This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item Position	Rationales	
46	Option C is correct	To determine the equation in point-slope form [$y - y_1 = m(x - x_1)$, where m represents the slope of the line and (x_1, y_1) represents a point on the line] that best describes the line that is parallel to (does not intersect [cross] and is always the same distance from) $y = -\frac{8}{9}x + 4$ and passes through the point (−3, −6), the student could have first determined the slope (steepness) of the given line. Since the equation is in slope-intercept form ($y = mx + b$, where m represents the slope and b represents the value of the y-intercept [value where a graph crosses the y-axis]), the student could have determined the slope to be $m = -\frac{8}{9}$. Since parallel lines have the same slope, the student should have then determined that the parallel line also has a slope of $m = -\frac{8}{9}$. Next, the student could have substituted the x- and y-coordinates of the given point, (−3, −6), and $m = -\frac{8}{9}$ into $y - y_1 = m(x - x_1)$, resulting in $y + 6 = -\frac{8}{9}(x + 3)$. 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 used the reciprocal of the slope of the given line, $m = -\frac{9}{8}$, resulting in $y + 6 = -\frac{9}{8}x(x + 3)$. The student needs to focus on understanding how to determine the slope of a line that is parallel to a given line.
	Option B is incorrect	The student likely used the slope of a line perpendicular to the given line, $m = \frac{9}{8}$, resulting in $y + 6 = \frac{9}{8}(x + 3)$. The student needs to focus on understanding how to determine the slope of a line that is parallel to a given line.
	Option D is incorrect	The student likely used the opposite of the slope of the given line, $m = \frac{8}{9}$, resulting in $y + 6 = \frac{8}{9}(x + 3)$. The student needs to focus on understanding how to determine the slope of a line that is parallel to a given line.

Item Position	Rationales	
47	Option B is correct	To determine what the correlation coefficient (a value, represented by r, that measures the strength of a linear association) for the data indicates about the strength of the linear association between the age and the weight of the kitten, the student should have determined the correlation coefficient using the linear regression feature on a graphing calculator. The correlation coefficient that best models this set of data is $r \approx 0.985$. Since the correlation coefficient is positive and close to 1, the student should have concluded that there is a strong positive correlation.
	Option A is incorrect	The student likely identified the correlation coefficient but interpreted a correlation coefficient less than 1 as representing a weak positive correlation. The student needs to focus on understanding how to determine the correlation coefficient between two quantitative variables and how to interpret this quantity as a measure of the strength of the linear association.
	Option C is incorrect	The student likely identified the y-intercept of the line of best fit ($b \approx -0.478$) as the correlation coefficient and interpreted this value as representing a weak negative correlation. The student needs to focus on understanding how to determine the correlation coefficient between two quantitative variables and how to interpret this quantity as a measure of the strength of the linear association.
	Option D is incorrect	The student correctly identified the correlation coefficient as strong since the value is close to 1 but likely determined that the linear association is negative because the y-intercept value is negative. The student needs to focus on understanding how to determine the correlation coefficient between two quantitative variables and how to interpret this quantity as a measure of the strength of the linear association.

Item Position	Rationales	
48	Option D is correct	To determine which inequality best represents the range (all possible *y*-values) of the part of the function shown, the student should have identified all the *y*-values shown on the graph. The graph contains a closed point at (−2, 16) and extends downward and to the right, ending at another closed point at (1, 2). Therefore, the range of the part shown is all *y*-values greater than or equal to 2 and less than or equal to 16, represented by the inequality $2 \le y \le 16$.
	Option A is incorrect	The student likely identified the domain (all possible *x*-values) instead of the range. The student needs to focus on understanding how to represent the range of an exponential function when given a part of the graph.
	Option B is incorrect	The student likely used the variable (symbol used to represent an unknown number) *y*, which represents the range, correctly but identified the *x*-values contained in the domain. The student needs to focus on understanding how to represent the range of an exponential function when given a part of the graph.
	Option C is incorrect	The student likely used the variable *x*, which represents the domain rather than the range. The student needs to focus on understanding how to represent the range of an exponential function when given a part of the graph.

Item Position	Rationales	
49	Option C is correct	To determine the value that best represents the *y*-intercept (point where the line crosses the *y*-axis [vertical number line]) of the function, the student should have recognized that the graph of the function passes through the *y*-axis at the point (0, 1) and therefore has a *y*-intercept value of 1.
	Option A is incorrect	The student likely used the wrong sign when representing the *y*-intercept, resulting in the point (0, −1) and the value −1. The student needs to focus on understanding how to identify key features of a linear function when given a graph of the function.
	Option B is incorrect	The student likely interpreted the *y*-intercept as the point where the line crosses the *x*-axis (horizontal number line) instead of the *y*-axis and used the wrong sign when representing the point, resulting in the point (−3, 0) and the value −3. The student needs to focus on understanding how to identify key features of a linear function when given a graph of the function.
	Option D is incorrect	The student likely interpreted the *y*-intercept as the point where the line crosses the *x*-axis instead of the *y*-axis, resulting in the point (3, 0) and the value 3. The student needs to focus on understanding how to identify key features of a linear function when given a graph of the function.

Item Position	Rationales	
50	Option B is correct	To determine the system of equations (two or more equations containing the same set of variables [symbols used to represent unknown numbers]) that can be used to determine the cost of a pack of white paper, x, and the cost of a pack of blue paper, y, in dollars, the student should have written one equation that represents the first customer’s purchase and one equation that represents the second customer’s purchase. The student should have represented the first customer’s purchase with the equation $8x + y = 75.01$, since the customer bought 8 packs of white paper for x dollars each and 1 pack of blue paper for y dollars and spent a total of \$75.01. The student should have represented the second customer’s purchase with the equation $6x + 2y = 70.12$ since the customer bought 6 packs of white paper for x dollars each and 2 packs of blue paper for y dollars each and spent a total of \$70.12.
	Option A is incorrect	The student likely switched the numbers of packs of blue paper and white paper in the equation representing the second customer’s purchase, resulting in $2x + 6y = 70.12$. The student needs to focus on understanding how to write a system of equations from a verbal description.
	Option C is incorrect	The student likely switched the numbers of packs of blue paper and white paper in the equation representing the first customer’s purchase, resulting in $x + 8y = 75.01$. 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 switched the numbers of packs of blue paper and white paper in both equations representing the customers’ purchases, resulting in $x + 8y = 75.01$ and $2x + 6y = 70.12$. The student needs to focus on understanding how to write a system of equations from a verbal description.