Name ________________________________________________ Date ____________________

1. Solve the following equations for $x$. Write your answer in set notation.

   a. $3x - 5 = 16$

   b. $3(x + 3) - 5 = 16$

   c. $3(2x - 3) - 5 = 16$

   d. $6(x + 3) - 10 = 32$

   e. Which two equations above have the same solution set? Write a sentence explaining how the properties of equality can be used to determine the pair without having to find the solution set for each.



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2. Let $c$ and $d$ be real numbers.

   a. If $c = 42 + d$ is true, then which is greater: $c$ or $d$, or are you not able to tell? Explain how you know your choice is correct.

   b. If $c = 42 - d$ is true, then which is greater: $c$ or $d$, or are you not able to tell? Explain how you know your choice is correct.

3. If $a < 0$ and $c > b$, circle the expression that is greater:

$$a(b - c) \quad \text{or} \quad a(c - b)$$

Use the properties of inequalities to explain your choice.



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4. Solve for $x$ in each of the equations or inequalities below, and name the property and/or properties used:

a. $\frac{3}{4}x = 9$

b. $10 + 3x = 5x$

c. $a + x = b$

d. $cx = d$

e. $\frac{1}{2}x - g < m$

f. $q + 5x = 7x - r$


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g. $\frac{3}{4}(x+2) = 6(x+12)$

h. $3(5-5x) > 5x$

5. The equation $3x + 4 = 5x - 4$ has the solution set $\{4\}$.

 a. Explain why the equation $(3x + 4) + 4 = (5x - 4) + 4$ also has the solution set $\{4\}$.



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b. In part (a), the expression $(3x + 4) + 4$ is equivalent to the expression $3x + 8$. What is the definition of equivalent expressions? Why does changing an expression on one side of an equation to an equivalent expression leave the solution set unchanged?

c. When we square both sides of the original equation, we get the following new equation:

$$(3x + 4)^2 = (5x - 4)^2.$$

Show that $4$ is still a solution to the new equation. Show that $0$ is also a solution to the new equation but is not a solution to the original equation. Write a sentence that describes how the solution set to an equation may change when both sides of the equation are squared.


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d. When we replace $x$ by $x^2$ in the original equation, we get the following new equation:

$$3x^2 + 4 = 5x^2 - 4.$$

Use the fact that the solution set to the original equation is $\{4\}$ to find the solution set to this new equation.

6. The Zonda Information and Telephone Company (ZI&T) calculates a customer's total monthly cell phone charge using the formula,

$$C = (b + rm)(1 + t),$$

where $C$ is the total cell phone charge, $b$ is a basic monthly fee, $r$ is the rate per minute, $m$ is the number of minutes used that month, and $t$ is the tax rate.

Solve for $m$, the number of minutes the customer used that month.


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7. Students and adults purchased tickets for a recent basketball playoff game. All tickets were sold at the ticket booth—season passes, discounts, etc., were not allowed.

   Student tickets cost $\$5$ each, and adult tickets cost $\$10$ each. A total of $\$4{,}500$ was collected. $700$ tickets were sold.

   a. Write a system of equations that can be used to find the number of student tickets, $s$, and the number of adult tickets, $a$, that were sold at the playoff game.

   b. Assuming that the number of students and adults attending would not change, how much more money could have been collected at the playoff game if the ticket booth charged students and adults the same price of $\$10$ per ticket?

   c. Assuming that the number of students and adults attending would not change, how much more money could have been collected at the playoff game if the student price was kept at $\$5$ per ticket and adults were charged $\$15$ per ticket instead of $\$10$?


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8. Alexus is modeling the growth of bacteria for an experiment in science. She assumes that there are $B$ bacteria in a Petri dish at 12:00 noon. In reality, each bacterium in the Petri dish subdivides into two new bacteria approximately every $20$ minutes. However, for the purposes of the model, Alexus assumes that each bacterium subdivides into two new bacteria exactly every $20$ minutes.

   a. Create a table that shows the total number of bacteria in the Petri dish at $\frac{1}{3}$ hour intervals for $2$ hours starting with time $0$ to represent 12:00 noon.

   b. Write an equation that describes the relationship between total number of bacteria $T$ and time $h$ in hours, assuming there are $B$ bacteria in the Petri dish at $h = 0$.

   c. If Alexus starts with $100$ bacteria in the Petri dish, draw a graph that displays the total number of bacteria with respect to time from 12:00 noon ($h = 0$) to 4:00 p.m. ($h = 4$). Label points on your graph at time $h = 0, 1, 2, 3, 4$.



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d. For her experiment, Alexus plans to add an anti-bacterial chemical to the Petri dish at 4:00 p.m. that is supposed to kill $99.9\%$ of the bacteria instantaneously. If she started with $100$ bacteria at 12:00 noon, how many live bacteria might Alexus expect to find in the Petri dish right after she adds the anti-bacterial chemical?

9. Jack is $27$ years older than Susan. In $5$ years, he will be $4$ times as old as she is.

a. Find the present ages of Jack and Susan.

b. What calculations would you do to check if your answer is correct?


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10.

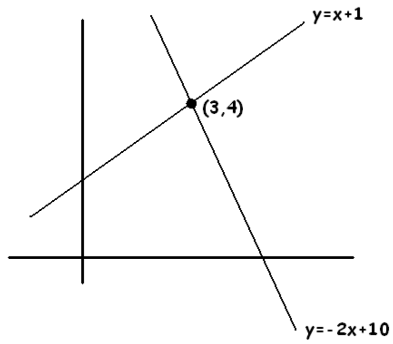
a. Find the product: $(x^2 - x + 1)(2x^2 + 3x + 2)$.

b. Use the results of part (a) to factor $21{,}112$ as a product of a two-digit number and a three-digit number.

11. Consider the following system of equations with the solution $x = 3$, $y = 4$.

Equation A1: $y = x + 1$

Equation A2: $y = -2x + 10$




a. Write a unique system of two linear equations with the same solution set. This time make both linear equations have positive slope.

Equation B1: ________________

Equation B2: ________________



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b. The following system of equations was obtained from the original system by adding a multiple of equation A2 to equation A1.

Equation C1: $y = x + 1$

Equation C2: $3y = -3x + 21$

What multiple of A2 was added to A1?

c. What is the solution to the system given in part (b)?

d. For any real number $m$, the line $y = m(x - 3) + 4$ passes through the point $(3,4)$.

Is it certain, then, that the system of equations

Equation D1: $y = x + 1$

Equation D2: $y = m(x - 3) + 4$

has only the solution $x = 3$, $y = 4$? Explain.


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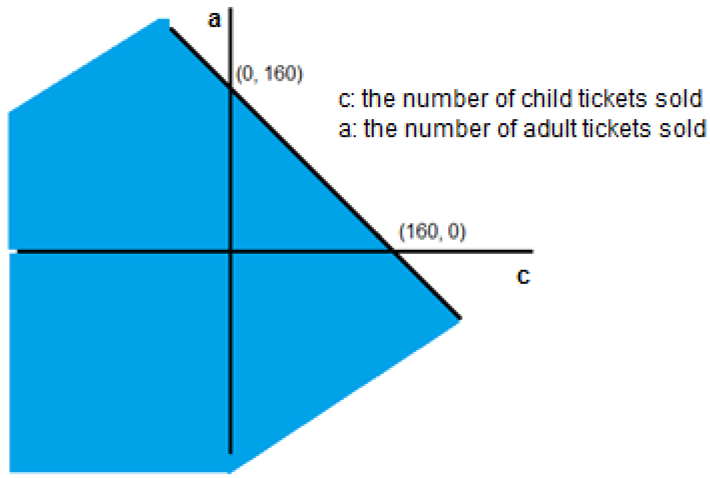
12. The local theater in Jamie's home town has a maximum capacity of 160 people. Jamie shared with Venus the following graph and said that the shaded region represented all the possible combinations of adult and child tickets that could be sold for one show.




a. Venus objected and said there was more than one reason that Jamie's thinking was flawed. What reasons could Venus be thinking of?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b. Use equations, inequalities, graphs, and/or words to describe for Jamie the set of all possible combinations of adult and child tickets that could be sold for one show.

c. The theater charges $\$9$ for each adult ticket and $\$6$ for each child ticket. The theater sold $144$ tickets for the first showing of the new release. The total money collected from ticket sales for that show was $\$1,164$. Write a system of equations that could be used to find the number of child tickets and the number of adult tickets sold, and solve the system algebraically. Summarize your findings using the context of the problem.



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| A Progression Toward Mastery | | | | | |
|---|---|---|---|---|---|
| **Assessment Task Item** | | **STEP 1** Missing or incorrect answer and little evidence of reasoning or application of mathematics to solve the problem. | **STEP 2** Missing or incorrect answer but evidence of some reasoning or application of mathematics to solve the problem. | **STEP 3** A correct answer with some evidence of reasoning or application of mathematics to solve the problem, <u>or</u> an incorrect answer with substantial evidence of solid reasoning or application of mathematics to solve the problem. | **STEP 4** A correct answer supported by substantial evidence of solid reasoning or application of mathematics to solve the problem. |
| **1** | **a–d** A-REI.A.1 | Student gives a short incorrect answer or leaves the question blank. | Student shows at least one correct step, but the solution is incorrect. | Student solves the equation correctly (every step that is shown is correct) but does not express the answer as a solution set. | Student solves the equation correctly (every step that is shown is correct) and expresses the answer as a solution set. |
| | **e** A-SSE.A.1b A-REI.B.3 | Student does not answer or answers incorrectly with something other than (b) and (d). | Student answers (b) and (d) but does not demonstrate solid reasoning in the explanation. | Student answers (b) and (d) but makes minor misstatements in the explanation. | Student answers (b) and (d) and articulates solid reasoning in the explanation. |
| **2** | **a** A-CED.A.3 | Student responds incorrectly or leaves the question blank. | Student responds correctly that (c) must be greater but does not use solid reasoning to explain the answer. | Student responds correctly that (c) must be greater but gives an incomplete or slightly incorrect explanation of why. | Student responds correctly that (c) must be greater and supports the statement with solid, well-expressed reasoning. |
| | **b** A-CED.A.3 | Student responds incorrectly or leaves the question blank. | Student responds correctly that there is no way to tell but does not use solid reasoning to explain the answer. | Student responds correctly that there is no way to tell but gives an incomplete or slightly incorrect explanation of why. | Student responds correctly that there is no way to tell and supports the statement with solid, well-expressed reasoning. |


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| **3** | **A-SSE.A.1b** | Student responds incorrectly or leaves the question blank. | Student responds correctly by circling the expression on the left but does not use solid reasoning to explain the answer. | Student responds correctly by circling the expression on the left but gives limited explanation or does not use the properties of inequality in the explanation. | Student responds correctly by circling the expression on the left and gives a complete explanation that uses the properties of inequality. |
| **4** | **a–h**<br><br>**A-REI.A.1**<br>**A-REI.B.3** | Student answers incorrectly with no correct steps shown. | Student answers incorrectly but has one or more correct steps. | Student answers correctly but does not correctly identify the property or properties used. | Student answers correctly and correctly identifies the property or properties used. |
| **5** | **a**<br><br>**A-REI.A.1** | Student does not answer or demonstrates incorrect reasoning throughout. | Student demonstrates only limited reasoning. | Student demonstrates solid reasoning but falls short of a complete answer or makes a minor misstatement in the answer. | Student answer is complete and demonstrates solid reasoning throughout. |
| | **b**<br><br>**A-REI.A.1** | Student does not answer or does not demonstrate understanding of what the question is asking. | Student makes more than one misstatement in the definition. | Student provides a mostly correct definition with a minor misstatement. | Student answers completely and uses a correct definition without error or mis-statement. |
| | **c**<br><br>**A-REI.A.1** | Student makes mistakes in both verifications and demonstrates incorrect reasoning or leaves the question blank. | Student conducts both verifications but falls short of articulating reasoning to answer the question. | Student conducts both verifications and articulates valid reasoning to answer the question but makes a minor error in the verification or a minor misstatement in the explanation. | Student conducts both verifications without error and articulates valid reasoning to answer the question. |
| | **d**<br><br>**A-REI.A.1** | Student answers incorrectly or does not answer. | Student identifies one or both solutions but is unable to convey how the solutions could be found using the fact that $4$ is a solution to the original equation. | Student identifies only one solution correctly but articulates the reasoning of using the solution to the original equation to find the solution to the new equation. | Student identifies both solutions correctly and articulates the reasoning of using the solution to the original equation to find the solution to the new equation. |


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| 6 | A-CED.A.4 | Student does not answer or shows no evidence of reasoning. | Student makes more than one error in the solution process but shows some evidence of reasoning. | Student answer shows valid steps but with one minor error. | Student answers correctly. |
| 7 | a–c<br>A-CED.A.3 | Student is unable to answer any portion correctly. | Student answers one part correctly or shows some evidence of reasoning in more than one part. | Student shows solid evidence of reasoning in every part but may make minor errors. | Student answers every part correctly and demonstrates and expresses valid reasoning throughout. |
| 8 | a<br>A-CED.A.2 | Student provides no table or a table with multiple incorrect entries. | Student provides a data table that is incomplete or has more than one minor error. | Student provides a data table that is complete but may have one error or slightly inaccurate headings. | Student provides a data table that is complete and correct with correct headings. |
| | b<br>A-CED.A.2 | Student provides no equation or an equation that does not represent exponential growth. | Student provides an incorrect equation but one that models exponential growth. | Student provides a correct answer in the form of $T = B(2)^{3h}$. | Student provides a correct answer in the form of $T = B8^h$ or in more than one form, such as $T = B(2)^{3h}$ and $T = B8^h$. |
| | c<br>A-CED.A.2 | Student provides no graph or a grossly inaccurate graph. | Student provides a graph with an inaccurate shape but provides some evidence of reasoning in labeling the axes and/or data points. | Student creates a graph with correct general shape but may leave off or make an error on one or two axes or data points. | Student creates a complete graph with correctly labeled axes and correctly labeled data points (or a data table) showing the values for $h = 0, 1, 2, 3, 4$. |
| | d<br>A-CED.A.2 | Student provides no answer or an incorrect answer with no evidence of reasoning in arriving at the answer. | Student provides limited evidence of reasoning and an incorrect answer. | Student answers that $409.6$ bacteria are alive. | Student answers that $410$, or about $410$, bacteria are alive. |



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| **9** | **a**<br><br>**A-CED.A.1** | Student writes incorrect equations or does not provide equations. | Student answers are incorrect, but at least one of the equations is correct. Student makes a gross error in the solution, makes more than one minor error in the solution process, or has one of the two equations incorrect. | Both equations are correct, but student makes a minor mistake in finding the solution. | Both equations are correct and student solves them correctly to arrive at the answer that Jack is $31$ and Susan is $4$. |
| | **b**<br><br>**A-REI.B.3** | Student does not answer or gives a completely incorrect answer. | Student articulates only one of the calculations correctly. | Student articulates the two calculations but with a minor mis-statement in one of the descriptions. | Student articulates both calculations correctly. |
| **10** | **a–b**<br><br>**A-APR.A.1** | Student work is blank or demonstrates no understanding of multiplication of polynomials, nor how to apply part (a) to arrive at an answer for part (b). | Student makes more than one error in the multiplication but demonstrates some understanding of multiplication of polynomials. Student may not be able to garner or apply information from part (a) to use in answering part (b) correctly. | Student demonstrates the ability to multiply the polynomials (expressing the product as a sum of monomials with like terms combined) and to apply the structure from part (a) to solve part (b). There may be minor errors. | Student demonstrates the ability to multiply the polynomials (expressing the product as a sum of monomials with like terms combined) and to apply the structure from part (a) to solve part (b) as $91(232)$. |
| **11** | **a**<br><br>**A-REI.C.6** | Student is unable to demonstrate the understanding that two equations with $(3, 4)$ as a solution are needed. | Student provides two equations that have $(3, 4)$ as a solution (or attempts to provide such equations) but makes one or more errors. Student may provide an equation with a negative slope. | Student shows one minor error in the answer but attempts to provide two equations both containing $(3, 4)$ as a solution and both with positive slope. | Student provides two equations both containing $(3, 4)$ as a solution and both with positive slope. |
| | **b**<br><br>**A-REI.C.6** | Student is unable to identify the multiple correctly. | Student identifies the multiple as $3$. | N/A | Student correctly identifies the multiple as $2$. |


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| | **c**<br><br>**A-REI.C.6** | Student is unable to demonstrate even a partial understanding of how to find the solution to the system. | Student shows some reasoning required to find the solution but makes multiple errors. | Student makes a minor error in finding the solution point. | Student successfully identifies the solution point as $(3, 4)$. |
| | **d**<br><br>**A-REI.C.5**<br>**A-REI.C.6**<br>**A-REI.D.10** | Student is unable to answer or to support the answer with any solid reasoning. | Student concludes yes or no but is only able to express limited reasoning in support of the answer. | Student correctly explains that all the systems have the solution point $(3, 4)$ but incorrectly assumes this is true for all cases of $m$. | Student correctly explains that while in most cases this is true, if $m = 1$, the two lines are coinciding lines, resulting in a solution set consisting of all the points on the line. |
| **12** | **a**<br><br>**MP.2**<br>**A-REI.D.12** | Student is unable to articulate any sound reasons. | Student is only able to articulate one sound reason. | Student provides two sound reasons but makes minor errors in the expression of reasoning. | Student is able to articulate at least two valid reasons. Valid reasons include the following: the graph assumes $x$ could be less than zero, the graph assumes $y$ could be less than zero, the graph assumes $a$ and $b$ could be non-whole numbers, the graph assumes $160$ children could attend with no adults. |
| | **b**<br><br>**A-CED.A.2**<br>**A-REI.D.10**<br>**A-REI.D.12** | Student is unable to communicate a relevant requirement of the solution set. | Student provides a verbal description that lacks precision and accuracy but demonstrates some reasoning about the solution within the context of the problem. | Student makes minor errors in communicating the idea that both (a) and (b) must be whole numbers whose sum is less than or equal to $160$. | Student communicates effectively that both (a) and (b) must be whole numbers whose sum is less than or equal to $160$. |


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| | **c**<br><br>**A-CED.A.2**<br>**A-REI.C.6** | Student is unable to demonstrate any substantive understanding in how to create the equations and solve the system of equations. | Student makes multiple errors in the equations and/or solving process but demonstrates some understanding of how to create equations to represent a context and/or solve the system of equations. | Student makes minor errors in the equations but solves the system accurately, or the student creates the correct equations but makes a minor error in solving the system of equations. | Student correctly writes the equations to represent the system. Student solves the system accurately and summarizes by defining or describing the values of the variable in the context of the problem (i.e., that there are $100$ adult tickets and $44$ child tickets sold.) |


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Name ______________________________ Date ______________

1. Solve the following equations for $x$. Write your answer in set notation.

   a. $3x - 5 = 16$

   $3x = 21$ Solution set: $\{7\}$
   $x = 7$

   b. $3(x + 3) - 5 = 16$

   $3x + 9 - 5 = 16$ Solution set: $\{4\}$
   $3x = 12$
   $x = 4$

   c. $3(2x - 3) - 5 = 16$

   $6x - 9 - 5 = 16$ Solution set: $\{5\}$
   $6x - 14 = 16$
   $6x = 30$
   $x = 5$

   d. $6(x + 3) - 10 = 32$

   $6x + 18 - 10 = 32$ Solution set: $\{4\}$
   $6x = 24$
   $x = 4$

   e. Which two equations above have the same solution set? Write a sentence explaining how the properties of equality can be used to determine the pair without having to find the solution set for each.

   *Problems (b) and (d) have the same solution set. The expressions on each side of the equal sign for (d) are twice those for (b). So, if (left side) = (right side) is true for only some x-values, then 2(left side) = 2(right side) will be true for exactly the same x-values. Or simply, applying the multiplicative property of equality does not change the solution set.*



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2. Let $c$ and $d$ be real numbers.

   a. If $c = 42 + d$ is true, then which is greater: $c$ or $d$ or are you not able to tell? Explain how you know your choice is correct.

   *c must be greater because c is always 42 more than d.*

   b. If $c = 42 - d$ is true, then which is greater: $c$ or $d$ or are you not able to tell? Explain how you know your choice is correct.

   *There is no way to tell. We only know that the sum of c and d is 42. If d were 10, c would be 32 and, therefore, greater than d. But if d were 40, c would be 2 and, therefore, less than d.*

3. If $a < 0$ and $c > b$, circle the expression that is greater:

$$\boxed{a(b-c)} \quad \text{or} \quad a(c-b)$$

Use the properties of inequalities to explain your choice.

*Since $c > b$,*
*it follows that $0 > b - c$,*
*and since $a < 0$, a is negative,*
*and the product of two negatives will be a positive.*

*Since $c > b$,*
*it follows that $c - b > 0$.*
*so $(c - b)$ is positive. And since a is negative, the product of*
*$a \cdot (c - b) < a \cdot (b - c)$.*



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4. Solve for $x$ in each of the equations or inequalities below and name the property and/or properties used:

a. $\frac{3}{4}x = 9$

$x = 9 \cdot \left(\frac{4}{3}\right)$ Multiplication property of equality

$x = 12$

b. $10 + 3x = 5x$

$10 = 2x$ Addition property of equality

$5 = x$ Multiplication property of equality

c. $a + x = b$

$x = b - a$ Addition property of equality

d. $cx = d$

$x = \frac{d}{c},\ c \neq 0$ Multiplication property of equality

e. $\frac{1}{2}x - g < m$

$\frac{1}{2}x < m + g$ Addition property of equality

$x < 2 \cdot (m + g)$ Multiplication property of equality

f. $q + 5x = 7x - r$

$q + r = 2x$ Addition property of equality

$\frac{(q+r)}{2} = x$ Multiplication property of equality



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g. $\frac{3}{4}(x+2) = 6(x+12)$

$3 \cdot (x+2) = 24 \cdot (x+12)$ Multiplication property of equality

$3x + 6 = 24x + 288$ Distributive property

$-\frac{282}{21} = x$ Addition property of equality and multiplication

$-\frac{94}{7} = x$ Property of equality

$-\frac{94}{7} = x$

h. $3(5 - 5x) > 5x$

$15 - 15x > 5x$ Distributive property

$15 > 20x$ Addition property of inequality

$\frac{3}{4} > x$ Multiplication property of equality

5. The equation, $3x + 4 = 5x - 4$, has the solution set $\{4\}$.

a. Explain why the equation, $(3x + 4) + 4 = (5x - 4) + 4$, also has the solution set $\{4\}$.

Since the new equation can be created by applying the addition property of equality, the solution set does not change.

OR

Each side of this equation is 4 more than the sides of the original equation. Whatever value(s) make $3x + 4 = 5x - 4$ true would also make 4 more than $3x + 4$ equal to 4 more than $5x - 4$.



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b. In part (a), the expression $(3x + 4) + 4$ is equivalent to the expression $3x + 8$. What is the definition of equivalent algebraic expressions? Describe why changing an expression on one side of an equation to an equivalent expression leaves the solution set unchanged?

*Algebraic expressions are equivalent if (possibly repeated) use of the distributive, associative, and commutative properties and/or the properties of rational exponents can be applied to one expression to convert it to the other expression.*

*When two expressions are equivalent, assigning the same value to x in both expressions will give an equivalent numerical expression, which then evaluates to the same number. Therefore, changing the expression to something equivalent will not change the truth value of the equation once values are assigned to x.*

c. When we square both sides of the original equation, we get the following new equation:

$$(3x + 4)^2 = (5x - 4)^2.$$

Show that $4$ is still a solution to the new equation. Show that $0$ is also a solution to the new equation but is not a solution to the original equation. Write a sentence that describes how the solution set to an equation may change when both sides of the equation are squared.

*$(3 \cdot 4 + 4)^2 = (5 \cdot 4 - 4)^2$ gives $16^2 = 16^6$, which is true.*

*$(3 \cdot 0 + 4)^2 = (5 \cdot 0 - 4)^2$ gives $4^2 = (-4)^2$, which is true.*

*But, $(3 \cdot 0 + 4) = (5 \cdot 0 - 4)$ gives $4 = -4$, which is false.*

*When both sides are squared, you might introduce new numbers to the solution set because statements like $4 = -4$ are false, but statements like $4^2 = (-4)^2$ are true.*



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d. When we replace $x$ by $x^2$ in the original equation, we get the following new equation:

$$3x^2 + 4 = 5x^2 - 4.$$

Use the fact that the solution set to the original equation is {4} to find the solution set to this new equation.

*Since the original equation $3x + 4 = 5x - 4$ was true when $x = 4$, the new equation $3x^2 + 4 = 5x^2 - 4$ should be true when $x^2 = 4$. And, $x^2 = 4$ when $x = 2$, so the solution set to the new equation is $\{-2, 2\}$.*

6. The Zonda Information and Telephone Company calculates a customer's total monthly cell phone charge using the formula,

$$C = (b + rm)(1 + t),$$

where $C$ is the total cell phone charge, $b$ is a basic monthly fee, $r$ is the rate per minute, $m$ is the number of minutes used that month, and $t$ is the tax rate.

Solve for $m$, the number of minutes the customer used that month.

$$C = b + bt + rm + rmt$$
$$C - b - bt = m \cdot (r + rt)$$
$$\frac{C - b - bt}{r + rt} = m \qquad t \neq -1$$
$$r \neq 0$$


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7. Students and adults purchased tickets for a recent basketball playoff game. All tickets were sold at the ticket booth—season passes, discounts, etc., were not allowed.

Student tickets cost $\$5$ each, and adult tickets cost $\$10$ each. A total of $\$4,500$ was collected. $700$ tickets were sold.

a. Write a system of equations that can be used to find the number of student tickets, $s$, and the number of adult tickets, $a$, that were sold at the playoff game.

$5s + 10a = 4500$
$s + a = 700$

b. Assuming that the number of students and adults attending would not change, how much more money could have been collected at the playoff game if the ticket booth charged students and adults the same price of $\$10$ per ticket?

$700 \times \$10 = \$7000$
$\$7000 - \$4500 = \$2500$ more

c. Assuming that the number of students and adults attending would not change, how much more money could have been collected at the playoff game if the student price was kept at $\$5$ per ticket and adults were charged $\$15$ per ticket instead of $\$10$?

First solve for a and s

$5s + 10a = 4500$
$-5s - 5a = -3500$
$5a = 1000$
$a = 200$
$s = 500$

$\$5 \cdot (500) + \$15 \cdot (200) = \$5500$
$\$1,000$ more
OR
$\$5$ more per adult ticket $(200 \cdot \$5 = \$1000$ more$)$


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8. Alexus is modeling the growth of bacteria for an experiment in science. She assumes that there are $B$ bacteria in a Petri dish at 12:00 noon. In reality, each bacterium in the Petri dish subdivides into two new bacteria approximately every $20$ minutes. However, for the purposes of the model, Alexus assumes that each bacterium subdivides into two new bacteria exactly every $20$ minutes.

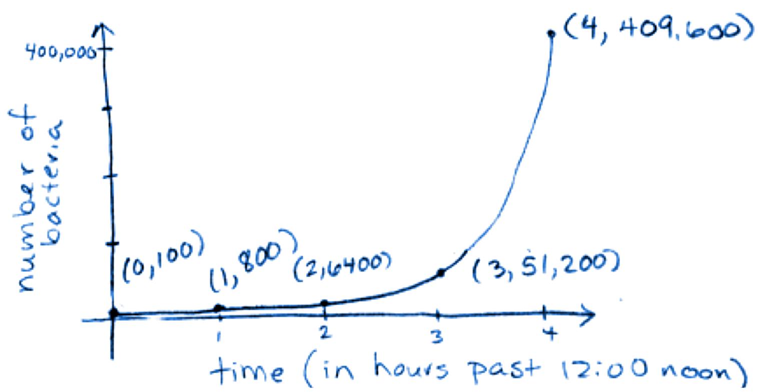
   a. Create a table that shows the total number of bacteria in the Petri dish at $\frac{1}{3}$ hour intervals for $2$ hours starting with time $0$ to represent 12:00 noon.

| Time | Number of Bacteria |
|---|---|
| 0 | B |
| 1/3 hour | 2B |
| 2/3 hour | 4B |
| 1 hour | 8B |
| 1 1/3 hour | 16B |
| 1 2/3 hour | 32B |
| 2 hour | 64B |

   b. Write an equation that describes the relationship between total number of bacteria $T$ and time $h$ in hours, assuming there are $B$ bacteria in the Petri dish at $h = 0$.

$$T = B \cdot (2)^{3h} \text{ or } T = B \cdot 8^h$$

   c. If Alexus starts with $100$ bacteria in the Petri dish, draw a graph that displays the total number of bacteria with respect to time from 12:00 noon ($h = 0$) to 4:00 p.m. ($h = 4$). Label points on your graph at time $h = 0, 1, 2, 3, 4$.



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d. For her experiment, Alexus plans to add an anti-bacterial chemical to the Petri dish at 4:00 p.m. that is supposed to kill $99.9\%$ of the bacteria instantaneously. If she started with $100$ bacteria at 12:00 noon, how many live bacteria might Alexus expect to find in the Petri dish right after she adds the anti-bacterial chemical?

$$(1 - 0.999) \cdot 409\,600 = 409.6$$

*about 410 live bacteria*

9. Jack is $27$ years older than Susan. In $5$ years time, he will be $4$ times as old as she is.

a. Find the present ages of Jack and Susan.

$$J = S + 27$$
$$J + 5 = 4 \cdot (S + 5)$$

$$S + 27 + 5 = 4S + 20$$
$$S + 32 = 4S + 20$$
$$12 = 3S$$
$$S = 4$$

$$J = 4 + 27$$
$$J = 31$$

*Jack is 31 and Susan is 4.*

b. What calculations would you do to check if your answer is correct?

*Is Jack's age – Susan's age = 27?*
*Add 5 years to Jack's and Susan's ages, and see if that makes Jack 4 times as old as Susan.*



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10.

a. Find the product: $(x^2 - x + 1)(2x^2 + 3x + 2)$

$$2x^4 + 3x^3 + 2x^2 - 2x^3 - 3x^2 - 2x + 2x^2 + 3x + 2$$
$$2x^4 + x^3 + x^2 + x + 2$$

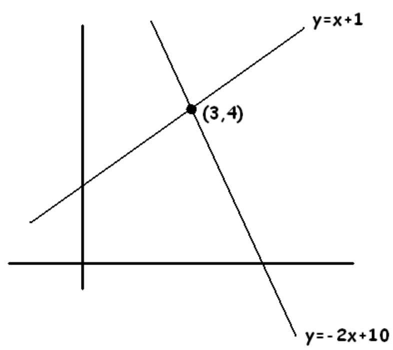
b. Use the results of part (a) to factor 21,112 as a product of a two-digit number and a three-digit number.

$$(100 - 10 + 1) \cdot (200 + 30 + 2)$$
$$(91) \cdot (232)$$

11. Consider the following system of equations with the solution $x = 3, y = 4$.

Equation A1: $y = x + 1$

Equation A2: $y = -2x + 10$




a. Write a unique system of two linear equations with the same solution set. This time make both linear equations have positive slope.

Equation B1: $y = \frac{4}{3}x$

Equation B2: $y = x + 1$



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b. The following system of equations was obtained from the original system by adding a multiple of equation A2 to equation A1.

Equation C1: $y = x + 1$

Equation C2: $3y = -3x + 21$

What multiple of A2 was added to A1?

*2 times A2 was added to A1.*

c. What is the solution to the system given in part (b)?

*(3,4)*

d. For any real number $m$, the line $y = m(x - 3) + 4$ passes through the point $(3,4)$.

Is it certain then that the system of equations:

Equation D1: $y = x + 1$

Equation D2: $y = m(x - 3) + 4$

has only the solution $x = 3$, $y = 4$? Explain.

*No. If m = 1, then the two lines have the same slope. Both lines pass through the point (3,4), and the lines are parallel; therefore, they coincide. There are infinite solutions. The solution set is all the points on the line. Any other nonzero value of m would create a system with the only solution of (3,4).*



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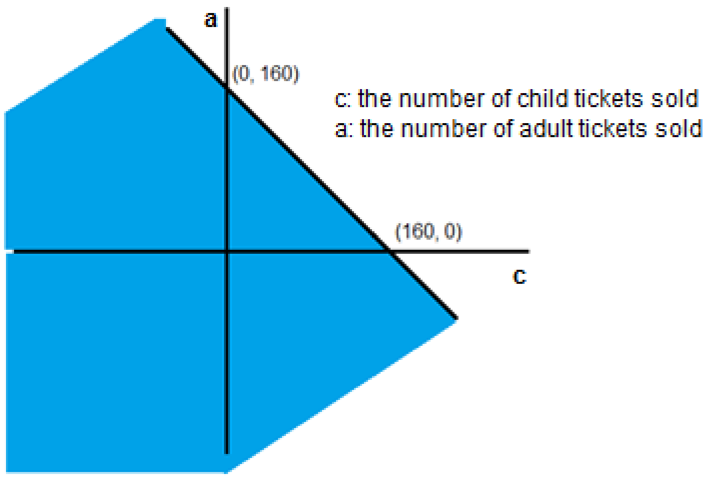
12. The local theater in Jamie's home town has a maximum capacity of 160 people. Jamie shared with Venus the following graph and said that the shaded region represented all the possible combinations of adult and child tickets that could be sold for one show.




a. Venus objected and said there was more than one reason that Jamie's thinking was flawed. What reasons could Venus be thinking of?

1. *The graph implies that the number of tickets sold could be a fractional amount, but really it only makes sense to sell whole number tickets. x and y must be whole numbers.*

2. *The graph also shows that negative ticket amounts could be sold, which does not make sense.*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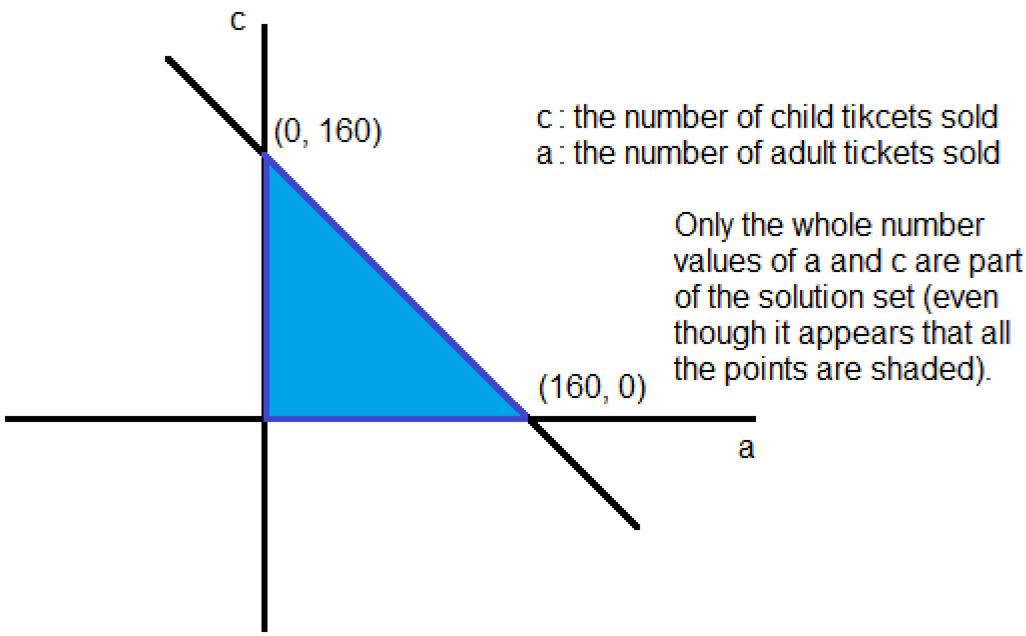
b. Use equations, inequalities, graphs, and/or words to describe for Jamie the set of all possible combinations of adult and child tickets that could be sold for one show.

The system would be $\begin{cases} a + c \le 160 \\ a \ge 0 \\ c \ge 0 \end{cases}$ where $a$ and $c$ are whole numbers.




c. The theater charges $9 for each adult ticket and $6 for each child ticket. The theater sold 144 tickets for the first showing of the new release. The total money collected from ticket sales for that show was $1,164. Write a system of equations that could be used to find the number of child tickets and the number of adult tickets sold, and solve the system algebraically. Summarize your findings using the context of the problem.

$a$: the number of adult tickets sold (must be a whole number)

$c$: the number of child tickets sold (must be a whole number)

$$\begin{cases} 9a + 6c = 1164 \\ a + c = 144 \end{cases}$$

$$9a + 6c = 1164$$
$$-6a - 6c = -864$$
$$3a = 300$$
$$a = 100, \quad c = 44$$

In all, 100 adult tickets and 44 child tickets were sold.



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