Investigation 3: Solving Equations

- 7.EE.B.4: Use variables to represent quantities in the real world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

<table>
<thead>
<tr>
<th>Date</th>
<th>Learning Target/s</th>
<th>Classwork</th>
<th>Homework</th>
<th>Self-Assess Your Understanding of the Learning Target/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon, Feb. 1</td>
<td>Find the rate of change and write equations for linear relationships.</td>
<td>☐ Check Up 1</td>
<td>☐ Zaption: MSA 3.2 – Coins and Pouches</td>
<td></td>
</tr>
<tr>
<td>Tues, Feb. 2</td>
<td>Solve visual equations with one variable.</td>
<td>☐ Pg. 2-3: MSA 3.2 – Exploring Equality</td>
<td>☐ Complete/Correct Classwork</td>
<td></td>
</tr>
<tr>
<td>Weds, Feb. 3</td>
<td>Write and solve symbolic equations with one variable.</td>
<td>☐ Pg. 5-7: MSA 3.3 – Writing Equations</td>
<td>☐ Complete/Correct Classwork</td>
<td>☐ Complete/Correct Classwork Pg. 8: Puzzles</td>
</tr>
<tr>
<td>Thurs, Feb. 4</td>
<td>Write and solve symbolic equations with one variable.</td>
<td>☐ Layered Book ☐ Exit Ticket 2</td>
<td>☐ Complete/Correct Classwork</td>
<td>☐ Complete/Correct Classwork Pg. 9: Puzzles</td>
</tr>
<tr>
<td>Fri, Feb. 5</td>
<td>Solve symbolic equations with one variable.</td>
<td>☐ Pg. 10-12: MSA 3.4 – Solving Equations</td>
<td>☐ Complete/Correct Classwork</td>
<td>☐ Complete/Correct Classwork Pg. 13: Zaption: MSA 3.4 Practice</td>
</tr>
<tr>
<td>Mon, Feb. 8</td>
<td>Solve symbolic equations with one variable.</td>
<td>☐ Pg. 14-15: Puzzles ☐ Challenge: Pg. 16 (Optional)</td>
<td>☐ Complete Packet (All Pages)</td>
<td>☐ Packet Signature</td>
</tr>
</tbody>
</table>

Check Up 1
- Determine if a table represents a linear function.
- Find the rate of change in a graph.
- Determine the rate of change from an equation.
- Make a table, graph, and equation for a linear relationship and solve for a missing value.

Exit Ticket 2
Write and solve equations with one variable.

Parent/Guardian Signature: ________________________________  Due: ______________________________
In the Kingdom of Montarek, money takes the form of $1 gold coins called rubas. Messengers carry money between the king’s castles in sealed pouches that always hold equal numbers of coins.

One day a messenger arrived at one of the castles with a box containing two sealed pouches and five loose $1 coins. The ruler thanks the messenger for the money, which equaled $11.

- Does the following visual equation help in finding the number of coins in each pouch?

### Visual Equation

**Remember:**

- Each pouch contains the same number of $1 gold coins.
- The total number of coins on each side of the equation is the same.

Find the number of gold coins in each pouch. Write down your steps so that someone else could follow your steps to find the number of coins in a pouch.

Describe how you can check your answer. That is, how do you know you have found the correct number of gold coins in each pouch?

<table>
<thead>
<tr>
<th>1.</th>
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</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
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</table>

<table>
<thead>
<tr>
<th>2.</th>
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<tbody>
<tr>
<td><img src="image4.png" alt="Image" /></td>
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<thead>
<tr>
<th>3.</th>
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<tbody>
<tr>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
</tbody>
</table>
Challenge:

In Visual Equation 2, Nichole thought of the left-hand side of the situation as having two groups. Each group contained one pouch and two coins. She visualized the following steps to help her find the number of coins in a pouch.

Is Nichole correct? Explain.

Noah looked at Nichole’s strategy and claimed that she was applying the Distributive Property. Is Noah’s claim correct? Explain.

Are there other situations in which Nichole’s method might work? Explain.
## Visual Equation

Remember:
- Each pouch contains the same number of $1 gold coins.
- The total number of coins on each side of the equation is the same.

**Find the number of gold coins in each pouch.** Write down your steps so that someone else could follow your steps to find the number of coins in a pouch.

**Describe how you can check your answer. That is, how do you know you have found the correct number of gold coins in each pouch?**

<table>
<thead>
<tr>
<th></th>
<th>Find the number of gold coins in each pouch. Write down your steps so that someone else could follow your steps to find the number of coins in a pouch.</th>
<th>Describe how you can check your answer. That is, how do you know you have found the correct number of gold coins in each pouch?</th>
</tr>
</thead>
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<td>1.</td>
<td><img src="image1.png" alt="Image" /></td>
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<td>2.</td>
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<tr>
<td>3.</td>
<td><img src="image3.png" alt="Image" /></td>
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</tr>
<tr>
<td>4.</td>
<td><img src="image4.png" alt="Image" /></td>
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</tbody>
</table>
**MSA 3.3: Writing Equations**

The picture shows a situation from Problem 3.2.

Because the number of gold coins in each pouch is unknown, you can let \( x \) represent the number of coins in one pouch. You can let 1 represent the value of one gold coin.

You can write the following equation to represent the situation: \( 2x + 4 = 12 \)

Or, you can use Nichole’s method from Problem 3.2 to write this equation: \( 2(x+2) = 12 \)

The expressions \( 2x + 4 \) and \( 2(x+2) \) are equivalent expressions. Two or more expressions are equivalent if they have the same value, regardless of what number is substituted for the variable. These two expressions are an example of the **Distributive Property** for numbers.

\[
2(x+2) = 2x + 4
\]

In this problem, you will revisit situations with pouches and coins, but you will use **symbolic equations** to represent your solution process.

<table>
<thead>
<tr>
<th>Visual Equation</th>
<th>Description of Steps for Finding the Coins in Each Pouch</th>
<th>Symbolic Equation</th>
</tr>
</thead>
</table>
|                 | • Use \( x \) to represent the number of gold coins in each pouch  
| 1.              | • Use the number 1 to represent each coin  
|                 | • Remember the Balance Check |                  |
|                 |                                                           |                  |
| 2.              |                                                           |                  |
### Visual Equation
- Each x represents a pouch
- Each 1 represents a coin

### Description of Steps for Finding the Coins in Each Pouch
- Remember the Balance Check

### Symbolic Equation
- \(3x = 12\)
- \(2x + 5 = 19\)
Challenge: Find the Mystery Number

a. If you add 15 to 3 times the mystery number, you get 78. What is the mystery number?

b. If you subtract 27 from 5 times the mystery number, you get 83. What is the mystery number?

c. Make up clues for a riddle whose mystery number is 9.
Daffynition Decoder

Information:

Buccaneer:

TO DECODE THESE TWO DAFFYNITIONS:
Solve each equation below and find your solution in the code. Each time the solution appears, write the letter of that exercise above it. Enjoy the de-fun-lions!

E  x + 5 = 11  V  x + 20 = 45  R  y - 4 = 9  L  n + 36 = 12

W  u + 7 = 2  I  x + 30 = 1  S  b + 8 = -4  O  5 + m = -16

G  y - 10 = -3  A  t + 1 = -20  Y  6 + n = 17  H  15 + x = 4

F  -18 + a = -8  C  -2 + x = -33  N  y + 14 = -14  P  -7 + d = 25

Why Didn’t the Elephant Like to Play Cards in the Jungle?

Solve each equation and find your solution in the code. Each time the solution appears, write the letter of the exercise in the box containing the solution.
Did You Hear About...

Answers: A - K:

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
</tr>
<tr>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
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<td>P</td>
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<tr>
<td>Q</td>
<td>R</td>
<td>S</td>
<td>T</td>
<td>U</td>
<td>?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Solve each equation and find your solution in the appropriate answer column. Notice the word next to the solution. Write this word in the box containing the letter of the exercise.

Answers: L - U:

68 WERE
13 FOUND
-3 DOGS
-24 BEARS
21 ALREADY
-39 FULL
-35 THEY
34 SHE
6 TEDDY
-26 THAT
0 STUFFED
38 WHEN
-22 OUT
28 HEARD
72 UNTIL

What Do You Call A Slow Skier?

Solve each equation and find the solution in the rectangle below. Cross out the boxes containing the solution. When you finish, write the letters from the remaining boxes in the spaces at the bottom of the page.

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) 1/2 y = 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) 3/5 x = 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9) 2 = 13/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(12) 3 = 7/4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(15) 1/2 = -1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(18) 12 = 12</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(21) 12 = 7/3</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(19) x = 8</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

16 3 = 15/4
17 6 = 12
18 1/2
19 3 = 15
20 1/2 x = 8

1 2/3
2 1/2
3 1/2
4 1/2
5 1/2
6 1/2
7 1/2
8 1/2
9 1/2
10 1/2
11 1/2
12 1/2
13 1/2
14 1/2
15 1/2
16 1/2
17 1/2
18 1/2
19 1/2
20 1/2
MSA 3.4: Solving Equations

To maintain the equality of two expressions, you can add, subtract, multiply or divide each side of the equality by the same number. These are called the properties of equality. In the last problem, you applied properties of equality and numbers to find a solution to an equation.

So far in the Investigation, all of the situations have involved positive whole numbers.

What strategies do you have for solving an equation like \(-2x + 10 = 15\)?

1. For each problem, record each step you take to find your solution and then check your answer.

<table>
<thead>
<tr>
<th>5x + 10 = 20</th>
<th>5x - 10 = 20</th>
<th>5x + 10 = -20</th>
<th>5x - 10 = -20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance Check</td>
<td>Balance Check</td>
<td>Balance Check</td>
<td>Balance Check</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10 - 5x = 20</th>
<th>10 - 5x = -20</th>
<th>How do you solve a symbolic equation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance Check</td>
<td>Balance Check</td>
<td>How do you check to make sure your equation is balanced?</td>
</tr>
</tbody>
</table>
2. For each problem, record each step you take to find your solution and then check your answer.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Problem</th>
<th>Problem</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{4} x + 6 = 12 )</td>
<td>( 1 \frac{1}{2} + 2x = 6 \frac{1}{2} )</td>
<td>( \frac{3}{5} = -x + 15 )</td>
<td>( 3.5x = 130 + 10x )</td>
</tr>
<tr>
<td>15 - 4x = 10x + 45</td>
<td>3(x + 1) = 21</td>
<td>2 + 3(x + 1) = 6x</td>
<td>-2(2x - 3) = -2</td>
</tr>
<tr>
<td>Balance Check</td>
<td>Balance Check</td>
<td>Balance Check</td>
<td>Balance Check</td>
</tr>
<tr>
<td>Balance Check</td>
<td>Balance Check</td>
<td>Balance Check</td>
<td>Balance Check</td>
</tr>
</tbody>
</table>
3. Below are examples of students’ solutions to the equations from question 3. Is each solution correct? If not, explain what the error is.

**Corry’s Solution**

3(x + 1) = 21

3 times something in the parentheses must be 21.
So 3(  ) = 21.
The something is 7.
So x + 1 = 7, and
x = 6.

**Hadden's Solution**

2 + 3(x + 1) = 6x

2 + 3(x + 1) is equivalent to 5(x + 1).
So I can rewrite the original equation as 5(x + 1) = 6x.
Using the Distributive Property, this is the same as
5x + 5 = 6x.
Subtracting 5x from each side, I get 5 = 1x.
So x = 5.

**Jackie's Solution**

-2(2x - 3) = -2

By using the Distributive Property on the left-hand side of the equality, I get -4x - 6 = -2.
By adding 6 to each side, I get -4x = 4.
By dividing both sides by -4, I get x = -1.

**Challenge:** Solve each equation for x. Show all steps and check your answer.

3(2x + 5) = 39

2(6k - 1) = -38

8(7 - y) = -24

-4(8 + 5n) = 8
1. Solve each equation. Check your answers.

<table>
<thead>
<tr>
<th>Equation 1</th>
<th>Equation 2</th>
<th>Equation 3</th>
<th>Equation 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2x + 6 = 6x + 2$</td>
<td>$2x - 6 = -6x + 2$</td>
<td>$2x + 6 = 6x - 2$</td>
<td>$-2x - 6 = -6x - 2$</td>
</tr>
<tr>
<td>Balance Check:</td>
<td>Balance Check:</td>
<td>Balance Check:</td>
<td>Balance Check:</td>
</tr>
</tbody>
</table>

2. Solve each equation. Check your answers. (Remember to use the Distributive Property)

<table>
<thead>
<tr>
<th>Equation 1</th>
<th>Equation 2</th>
<th>Equation 3</th>
<th>Equation 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3(x+2) = 12$</td>
<td>$3(x+2) = x - 18$</td>
<td>$3(x+2) = 2x$</td>
<td>Challenge: $5 - 2(x-1) = 12$</td>
</tr>
<tr>
<td>Balance Check:</td>
<td>Balance Check:</td>
<td>Balance Check:</td>
<td>Balance Check:</td>
</tr>
</tbody>
</table>
Vive la France!

1. Why did Pierre Jacques Marseille feel at home in a bakery?

2. What do they call the famous French general who kept dynamite in his kitchen?

---

You've probably heard about the guy who fell off a bridge in Paris. He went in Seine. To find out about two other French citizens:

Solve each equation below and find your solution in the code. Each time the solution appears, write the letter of the exercise above it.

- **S** $3n - 5 = 19$
- **O** $4x + 2 = 14$
- **C** $9y + 10 = -8$
- **E** $2a - 15 = -1$
- **T** $-5x + 7 = 27$
- **I** $-8w + 4 = -36$
- **A** $11 + 6k = 65$
- **M** $7 + 3m = -29$
- **D** $1 - 10x = 81$
- **H** $2 - 7d = -75$
- **U** $-4y - 9 = 15$
- **W** $-8 + 12e = -20$
- **F** $44 = 5x - 6$
- **P** $-7 = 2n + 19$
- **L** $31 = 4 - 9y$
- **R** $-52 - 3u = 8$
- **N** $-11r - 2 = -24$
- **B** $6 - x = 15$
BOOKS NEVER WRITTEN

The Break-in by
10  -13  -7  -7  -25  8  72  6  5  -4

Origin of Man by
-1  -11  -2  72  17  -6  25  17  12

Making Soap by
-9  25  -13  72  -8  25  -2  12  -6

ABOVE ARE THE TITLES OF THREE "BOOKS NEVER WRITTEN."
TO DECODE THE NAMES OF THEIR AUTHORS:

Solve each equation below and find your solution in the code. Each time the
solution appears, write the letter of that exercise above it.

O  4y - 9 = 15
A  6x + 7 = -5
S  -9t + 2 = 56
P  -69 = 7v - 6
Y  35 = -2x - 15
I  4 - 3n = 43
N  12 - 5u = -48
C  -27 + 20w = 73
E  13 = 5 - 8m

K  11r + 60 = 16
U  y - 24 = -7
J  23 - x = 13
V  -67 = 6x - 1
M  -4e - 9 = 19
D  -8 = 32 - 5q
H  6 + 10k = 256
T  -100 = 12t - 4
L  36 - x = -36
What Did Bonzo Say When He Saw the Ivy-covered Walls of the Ivy League College?

TO FIND THE WORDS OF BONZO: Solve each equation below and find your solution in the rectangle above. Shade in the area containing that solution.

1. $3x + 9 = 5$
2. $8z - 1 = 11$
3. $\frac{1}{2}t + 6 = -7$
4. $12 - \frac{1}{3}u = 2$
5. $\frac{2}{5}n + 6 = 10$
6. $-7 - 6y = 13$
7. $4 = 7 + x + 6x$
8. $-\frac{3}{4}m + 3 = 8$
9. $-18 = \frac{5}{2}r + 12$
10. $10 + v - 17v = 4$
11. $40 = 5y - 8$
12. $-\frac{3}{8}x + 2 = 0$
13. $\frac{w}{3} - 6 = -8$
14. $2t - 12 - 3t = 60$
15. $6 + \frac{9}{7}n = 24$
16. $-30 = q - 10 + 11q$
17. $3 - \frac{x}{8} = -2$
18. $-20y + 20 = -20$