

Chapter 1 Pre-Algebra	Equations
MAFS.8.EE.3.7	Solve linear equations in one variable.
Essential Question	How can I solve a linear equation with one variable? In this lesson I am <i>using opposite operations</i> , so I can <i>find the value of the variable</i> .
1.1 Solving Simple Equations	<p><b>Key Ideas</b></p> <p><b>Addition Property of Equality</b>  <b>Words</b> Adding the same number to each side of an equation produces an equivalent equation.  <b>Algebra</b> If <math>a = b</math>, then <math>a + c = b + c</math>.</p> <p><b>Subtraction Property of Equality</b>  <b>Words</b> Subtracting the same number from each side of an equation produces an equivalent equation.  <b>Algebra</b> If <math>a = b</math>, then <math>a - c = b - c</math>.</p>
Example 1  Solving Equations using Addition or Subtraction  $2\pi$ is a constant	<p>a. Solve <math>x - 7 = -6</math>.  <math display="block">\begin{array}{r l} x - 7 &amp; = -6 \\ +7 &amp; +7 \\ \hline x &amp; = 1 \end{array}</math></p> <p>b. Solve <math>y + 3.4 = 0.5</math>.  <math display="block">\begin{array}{r l} y + 3.4 &amp; = 0.5 \\ -3.4 &amp; -3.4 \\ \hline y &amp; = -2.9 \end{array}</math></p> <p>c. Solve <math>h + 2\pi = 3\pi</math>.  <math display="block">\begin{array}{r l} h + 2\pi &amp; = 3\pi \\ -2\pi &amp; -2\pi \\ \hline h &amp; = \pi \end{array}</math> <p><i>circle infinity, not repeated</i></p> </p>
On Your Own	<p>Solve the equation. Check your solution.</p> <p>1. <math>b + 2 = -5</math>  <math display="block">\begin{array}{r l} b + 2 &amp; = -5 \\ -2 &amp; -2 \\ \hline b &amp; = -3 \end{array}</math></p> <p>2. <math>g - 1.7 = -0.9</math>  <math display="block">\begin{array}{r l} g - 1.7 &amp; = -0.9 \\ +1.7 &amp; +1.7 \\ \hline g &amp; = .8 \end{array}</math></p> <p>3. <math>-3 = k + 3</math>  <math display="block">\begin{array}{r l} -3 &amp; = k + 3 \\ -3 &amp; -3 \\ \hline -6 &amp; = k \end{array}</math></p> <p>4. <math>r - \pi = \pi</math>  <math display="block">\begin{array}{r l} r - \pi &amp; = \pi \\ +\pi &amp; +\pi \\ \hline r &amp; = 2\pi \end{array}</math></p> <p>5. <math>t - \frac{1}{4} = -\frac{3}{4}</math>  <math display="block">\begin{array}{r l} t - \frac{1}{4} &amp; = -\frac{3}{4} \\ +\frac{1}{4} &amp; +\frac{1}{4} \\ \hline t &amp; = -\frac{1}{2} \end{array}</math></p> <p>6. <math>5.6 + z = -8</math>  <math display="block">\begin{array}{r l} 5.6 + z &amp; = -8 \\ -5.6 &amp; -5.6 \\ \hline z &amp; = -13.6 \end{array}</math></p>

# Key Ideas

## Multiplication Property of Equality

**Words** Multiplying each side of an equation by the same number produces an equivalent equation.

**Algebra** If  $a = b$ , then  $a \cdot c = b \cdot c$ .

## Division Property of Equality

**Words** Dividing each side of an equation by the same number produces an equivalent equation.

**Algebra** If  $a = b$ , then  $a \div c = b \div c$ ,  $c \neq 0$ .

$\pi =$  is not a variable

anything you have to make predictions, is algebra

### Example 2

Solving Equations using Multiplication or Division

$$\left(\frac{-4}{3}\right) \cdot \frac{3}{4}n = 2 \left(\frac{-4}{3}\right)$$

$$n = \frac{8}{3} = 2\frac{2}{3}$$

a. Solve  $-\frac{3}{4}n = -2$

$$\begin{array}{r|l} -\frac{3}{4} & n \\ \hline & \frac{8}{3} = 2\frac{2}{3} \end{array}$$

b. Solve  $\pi x = 3\pi$

$$\begin{array}{r|l} \pi & x \\ \hline & 3 \end{array}$$

### On Your Own

Solve the equation. Check your solution.

7.  $7y = -7(4)$

$$\begin{array}{r|l} 7 & y \\ \hline & -28 \end{array}$$

8.  $\frac{6\pi}{\pi} = \frac{\pi x}{\pi}$

$$\begin{array}{r|l} 6 & x \\ \hline & x \end{array}$$

9.  $0.09w = 1.8$

$$\begin{array}{r|l} 0.09 & w \\ \hline & 20 \end{array}$$

$9 \overline{) 180} = 20$

### Example 3

Identifying the Solution of an Equation

PEMDAS

What value of  $k$  makes the equation  $k + 4 \div 0.2 = 5$  true?

- A -15       B -5       C -3       D 1.5

$$k + (4 \div 0.2) = 5$$

$$\begin{array}{r|l} k + 20 & = 5 \\ -20 & -20 \\ \hline k & = -15 \end{array}$$

**Example 4**

**Real Life Application**

The *melting point* of a solid is the temperature at which the solid becomes a liquid. The melting point of bromine is  $\frac{1}{30}$  of the melting point of nitrogen. Write and solve an equation to find the melting point of nitrogen.

Se Selenium 34 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29

$$\frac{1}{30}n = \frac{-7}{30}$$


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$$n = -210$$

The melting point of bromine is  $-7^\circ\text{C}$ .

**On Your Own**

10. Solve  $p - \left(8 \div \frac{1}{2}\right) = -3$ .

$$p - 16 = -3$$


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$$p = 13$$

11. Solve  $q + |-10| = 2$ .

$$q + 10 = 2$$


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$$q = -8$$

12. The melting point of mercury is about  $\frac{1}{4}$  of the melting point of krypton. The melting point of mercury is  $-39^\circ\text{C}$ . Write and solve an equation to find the melting point of krypton.

$$\frac{1}{4}k = -39$$


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$$k = -156$$

$$\begin{array}{r} 39 \\ \times 4 \\ \hline 156 \end{array}$$

MAFS.8.EE.3.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

**Essential Question** How do you solve multi-step linear equations?  
 In this lesson I am using what I know about solving simple equations, so I can use it to solve multi-step equations.

**1.2 Solving Multi-Step Equations**

**Key Idea**

**Solving Multi-Step Equations**  
 To solve multi-step equations, use inverse operations to isolate the variable.

\*\*\*Always combine like terms or distribute first when you can!\*\*\*

**Example 1**  
**Solving a Two-Step Equation**

The height (in feet) of a tree after  $x$  years is  $1.5x + 15$ . After how many years is the tree 24 feet tall?

$$\begin{array}{r} 24 = 1.5x + 15 \\ -15 \quad -15 \\ \hline 9 = 1.5x \\ \frac{9}{1.5} \quad \frac{1.5}{1.5} \\ \hline 6 = x \end{array}$$

**Example 2**  
**Combining Like Terms to Solve an Equation**

Solve  $8x + 6x - 25 = -35$ .

$$\begin{array}{r} 2x - 25 = -35 \\ +25 \quad +25 \\ \hline 2x = -10 \\ \frac{2x}{2} = \frac{-10}{2} \\ \hline x = -5 \end{array}$$

**On Your Own**

only one target

Solve the equation. Check your solution.

- $$\begin{array}{r} -3z + 1 = 7 \\ -1 \quad -1 \\ \hline -3z = 6 \\ \frac{-3z}{-3} = \frac{6}{-3} \\ \hline z = -2 \end{array}$$
- $$\begin{array}{r} \frac{1}{2}x - 9 = -25 \\ +9 \quad +9 \\ \hline \frac{1}{2}x = -16 \\ \frac{1}{2} \quad \frac{1}{2} \\ \hline x = -32 \end{array}$$
- Combine like terms

$$\begin{array}{r} -4n - 8n + 17 = 23 \\ -12n + 17 = 23 \\ -17 \quad -17 \\ \hline -12n = 6 \\ \frac{-12n}{-12} = \frac{6}{-12} \\ \hline n = -\frac{1}{2} \end{array}$$

**Example 3**  
Using the  
Distributive  
Property to  
Solve an  
Equation

Combine  
Distribute

Solve  $2(1 - 5x) + 4 = -8$ .

$$2 - 10x + 4 = -8$$

$$\begin{array}{r|l} -10x + 6 & = -8 \\ -6 & -6 \\ \hline -10x & = -14 \\ -10 & -10 \\ \hline x & = 1.4 \end{array}$$



**Example 4**  
Real Life  
Application

College  $\star$

Use the table to find the number of miles  $x$  you need to run on Friday so that the mean number of miles run per day is 1.5.

Day	Miles
Monday	2
Tuesday	0
Wednesday	1.5
Thursday	0
Friday	$x$

$$\frac{2 + 0 + 1.5 + 0 + x}{5} = 1.5$$

$$\frac{3.5 + x}{5} = 1.5$$

$$\begin{array}{r|l} 3.5 + x & = 7.5 \\ -3.5 & -3.5 \\ \hline x & = 4 \end{array}$$

**On Your Own**

Solve the equation. Check your solution.

4.  $-3(x + 2) + 5x = -9$

$$-3x - 6 + 5x = -9$$

$$\begin{array}{r|l} 2x - 6 & = -9 \\ +6 & +6 \\ \hline 2x & = -3 \\ \frac{2x}{2} & = \frac{-3}{2} \\ x & = -1.5, \text{ or } -\frac{1}{2} \end{array}$$

5.  $5 + 1.5(2d - 1) = 0.5$

$$5 + 3d - 1.5 = 0.5$$

$$\begin{array}{r|l} 3.5 + 3d & = 0.5 \\ -3.5 & -3.5 \\ \hline 3d & = -3 \\ \frac{3d}{3} & = \frac{-3}{3} \\ d & = -1 \end{array}$$


6. You scored 88/92, and 87 on three tests. Write and solve an equation to find the score you need on the fourth test so that your mean test score is 90.

$$\frac{88 + 92 + 87}{4} = 90$$

$$\frac{267}{4} = 90(4)$$

$$267 + x = 360$$

$$\begin{array}{r|l} 267 + x & = 360 \\ -267 & -267 \\ \hline x & = 93 \end{array}$$

MAFS.8.EE.3.7a	Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions.
<b>Essential Question</b>	<b>How do you solve an equation with variables on both sides?</b> In this lesson I am using opposite operations, so I can combine the variables on one side and combine the numbers on the other side of the equal sign.
<b>1.3 Solving Equations with Variables on Both Sides</b>	<div style="text-align: center;">  <b>Key Idea</b> </div> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <b>Solving Equations with Variables on Both Sides</b>          To solve equations with variables on both sides, collect the variable terms on one side and the constant terms on the other side.       </div>
<b>Example 1</b>  <b>Solving Equations with Variables on Both Sides</b>	<b>Solve <math>15 - 2x = -7x</math>. Check your solution.</b> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  15 - 2x &amp; = -7x \\  +2x &amp; +2x \\  \hline  15 &amp; -5x \\  -5 &amp; -5 \\  \hline  -3 &amp; = x  \end{array}  </math> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  15 - 2x &amp; = -7x \\  +7x &amp; +7x \\  \hline  15 + 5x &amp; = 0 \\  -15 &amp; -15 \\  \hline  5x &amp; = -15 \\  \div 5 &amp; \div 5 \\  \hline  x &amp; = -3  \end{array}  </math> </div> </div>
<b>Example 2</b>  <b>Using the Distributive Property to Solve an Equation</b>	<b>Solve <math>-2(x - 5) = 6(2 - \frac{1}{2}x)</math>.</b> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  -2x + 10 &amp; = 12 - 3x \\  +3x &amp; +3x \\  \hline  x + 10 &amp; = 12 \\  -10 &amp; -10 \\  \hline  x &amp; = 2  \end{array}  </math> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  6(1 + \frac{1}{2}x) &amp; = 2(x + 1) \\  6 + 3x &amp; = 2x + 2 \\  -2x &amp; -2x \\  \hline  6 + x &amp; = 2 \\  -6 &amp; -6 \\  \hline  x &amp; = -4  \end{array}  </math> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  r &amp; = -5r + 18 \\  +5r &amp; +5r \\  \hline  6r &amp; = 18 \\  \div 6 &amp; \div 6 \\  \hline  r &amp; = 3  \end{array}  </math> </div> </div>
<b>On Your Own</b>  lesser of the y's decimals = yes	<b>Solve the equation. Check your solution.</b> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  -3x &amp; = 2x + 19 \\  -2x &amp; -2x \\  \hline  -5x &amp; = 19 \\  \div 5 &amp; \div 5 \\  \hline  x &amp; = -3\frac{4}{5}  \end{array}  </math> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  2.5y + 6 &amp; = 4.5y - 1 \\  -2.5y &amp; -2.5y \\  \hline  6 &amp; = 2y - 1 \\  +1 &amp; +1 \\  \hline  7 &amp; = 2y \\  \div 2 &amp; \div 2 \\  \hline  3.5 &amp; = y  \end{array}  </math> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{r l}  6(4 - z) &amp; = 2z \\  24 - 6z &amp; = 2z \\  +6z &amp; +6z \\  \hline  24 &amp; = 8z \\  \div 8 &amp; \div 8 \\  \hline  3 &amp; = z  \end{array}  </math> </div> </div>

**Example 3**

Solving Equations with No Solution

$$X - x = 3$$

$$\longleftrightarrow -3 = -7$$

$$\longleftrightarrow -3 = 3$$

Solve  $3 - 4x = -7 - 4x$ .

$$\begin{array}{r|l} +4x & +4x \\ \hline 3 & = -7 \end{array}$$

No solution

**Example 4**  
Solving Equations with Infinitely Many Solutions

Solve  $6x + 4 = 4\left(\frac{3}{2}x + 1\right)$ .

$$6x + 4 = 6x + 4$$

infinity

$$\begin{array}{r|l} 3x - 5 & = 7 + 3x \\ -3x & -3x \\ \hline -5 & \neq 7 \\ & \text{No solution} \end{array}$$

**On Your Own**

Solve the equation.

4.  $2x + 1 = 2x - 1$

5.  $\frac{1}{2}(6t - 4) = 3t - 2$

6.  $\frac{1}{3}(2b + 9) = \frac{2}{3}\left(b + \frac{9}{2}\right)$

7.  $6(5 - 2v) = -4(3v + 1)$