

## **7.1 Equations with the Variable on Both Sides**

8.EE.7

Solve linear equations in one variable

8.EE.7b

Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms

**EXPLORE ACTIVITY****Modeling an Equation with a Variable on Both Sides**

Algebra tiles can model equations with a variable on both sides.

**KEY**

$$\begin{array}{l} \text{+} = 1 \\ \text{-} = -1 \\ \text{+} + \text{-} = 0 \end{array} \quad \begin{array}{l} \text{+} = x \end{array}$$

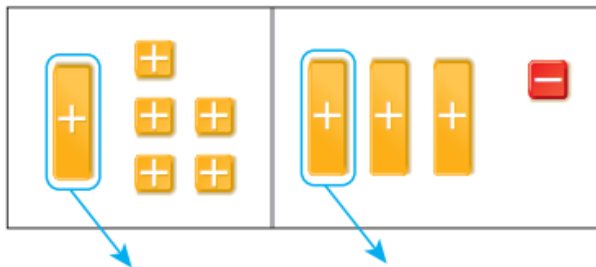
Use algebra tiles to model and solve  $x + 5 = 3x - 1$ .



Model  $x + 5$  on the left side of the mat and  $3x - 1$  on the right side.

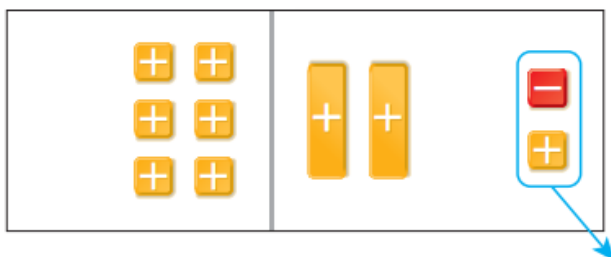
Remember that  $3x - 1$  is the same as

$$3x + \underline{-1}.$$

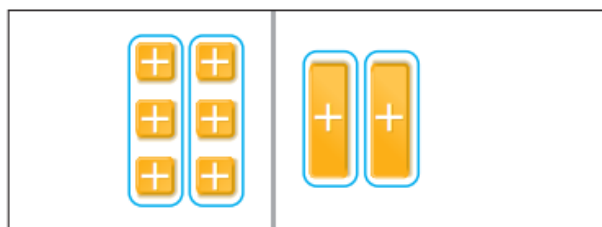


Remove one  $x$ -tile from both sides. This

represents subtracting  $\underline{x}$  from both sides of the equation.



Place one +1-tile on both sides. This represents adding 1 to both sides of the equation. Remove zero pairs.



Separate each side into 2 equal groups.

One x-tile is equivalent to 3 +1-tiles.

The solution is x = 3.

$$\begin{array}{r}
 \cancel{x} + 5 = 3x + 1 \\
 \underline{+x} \quad \quad \underline{-x} \\
 5 = 2x + \cancel{1} \\
 \underline{+1} \quad \quad \underline{-1} \\
 6 = 2x
 \end{array}$$

$$\begin{array}{r}
 6 = 2x \\
 \underline{2} \quad \quad \underline{2} \\
 3 = x
 \end{array}$$

# Solving an Equation with the Variable on Both Sides

To solve these equations, use inverse operations to get the variable on one side and the numbers on the other side

+ opposite -

x opposite ÷

**EXAMPLE 1**

Andy's Rental Car charges an initial fee of \$20 plus an additional \$30 per day to rent a car. Buddy's Rental Car charges an initial fee of \$36 plus an additional \$28 per day. For what number of days is the total cost charged by the companies the same?

$$y = mx + b$$

↑                    ↑  
Slope                y-int

**STEP 1**

Write equations for the scenario

$$\text{ARC: } y = 30x + 20$$

$$\text{BRC: } y = 28x + 36$$

**STEP 2**

Write equation by setting equations equal to one another

$$30x + 20 = 28x + 36$$

**STEP 3**

Solve equation for the variable

$$30x + 20 = 28x + 36$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$30x = 28x + 16$$

$$-28x \quad -28x$$

$$2x = 16$$

$$\frac{2x}{2} = \frac{16}{2}$$

$$x = 8$$

8 days

## ADDITIONAL EXAMPLE 1

Peppy Pets charges a flat fee of \$15 plus \$3 per hour to keep a dog during the day. Happy Hounds charges a flat fee of \$21 plus \$1 per hour. For how many hours is the total fee charged by the companies the same?

$$\underline{\text{P.P.}} \quad y = 3x + 15$$

$$\underline{\text{H.H.}} \quad y = x + 21$$

$$\begin{array}{r} 3x + 15 = x + 21 \\ \underline{-x} \quad \underline{-x} \\ 2x + 15 = 21 \\ \underline{-15} \quad \underline{-15} \end{array}$$

$$\begin{array}{r} 2x = 6 \\ \underline{\div 2} \quad \underline{\div 2} \\ x = 3 \end{array}$$

**YOUR TURN**

2. A water tank holds 256 gallons but is leaking at a rate of 3 gallons per week. A second water tank holds 384 gallons but is leaking at a rate of 5 gallons per week. After how many weeks will the amount of water in the two tanks be the same?

$$\underline{\text{WT a}} \quad y = -3x + 256$$

$$\underline{\text{WT b}} \quad y = -5x + 384$$

$$\begin{array}{r} -3x + 256 = -5x + 384 \\ \underline{-384} \qquad \qquad \underline{-384} \end{array}$$

$$\begin{array}{r} -3x + 128 = -5x \\ \underline{+3x} \qquad \qquad \underline{+3x} \end{array}$$

$$\begin{array}{r} -128 = -2x \\ \underline{-2} \qquad \underline{-2} \end{array}$$

$$64 = x$$

64 weeks

**EXAMPLE 2**

Write a real-world situation that could be modeled by the equation

$$150 + 25x = 55x.$$

unit rate  
unit rate  
unit rate

C.A.  
\$25/hr plus \$150 labor fee

C.B.  
\$55/hr



**YOUR TURN**

3. Write a real-world situation that could be modeled by the equation  $30x = 48 + 22x$ .

$$y = 30x$$

$$y = 22x + 48$$

## Guided Practice

Use algebra tiles to model and solve each equation. (Explore Activity)

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

$$\begin{array}{r}
 x + 4 = -x - 4 \\
 \hline
 +x \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \\
 2x + 4 = -4 \\
 \hline
 -4 \quad \quad -4 \\
 \hline
 2x = -8 \\
 \hline
 x = -4
 \end{array}$$

2.  $2 - 3x = -x - 8$   $x = 5$

$$\begin{array}{r}
 2 - 3x = -x - 8 \\
 \hline
 +3x \quad \quad +3x \\
 \hline
 2 = 2x - 8 \\
 \hline
 +8 \quad \quad +8 \\
 \hline
 10 = 2x \\
 \hline
 5 = x
 \end{array}$$

3. At Silver Gym, membership is \$25 per month, and personal training sessions are \$30 each. At Fit Factor, membership is \$65 per month, and personal training sessions are \$20 each. In one month, how many personal training sessions would Sarah have to buy to make the total cost at the two gyms equal? (Example 1)

$$\underline{\text{S.G.}} \quad y = 30x + 25$$

$$\underline{\text{F.F.}} \quad y = 20x + 65$$

4 training sessions

$$\begin{array}{r} 30x + 25 = 20x + 65 \\ -20x \quad \quad -20x \\ \hline \end{array}$$

$$\begin{array}{r} 10x + 25 = 65 \\ -25 \quad \quad -25 \\ \hline \end{array}$$

$$\begin{array}{r} 10x = 40 \\ \hline 10 \quad \quad 10 \\ \hline x = 4 \end{array}$$

$$\textcircled{1} \quad 3x + 2 = 5x$$

$$\textcircled{4} \quad 4d - 11 = 2d + 7$$

$$\textcircled{2} \quad n - 12 = 3n$$

$$\textcircled{5} \quad 2f + 3 = 11f - 24$$

$$\textcircled{3} \quad 2 - 3b = 7b + 12$$

$$\textcircled{6} \quad 8y + 11 = 2y + 29$$