

# 2-4

## Solving Equations With Variables on Both Sides



### Vocabulary

#### Review

Write the *like terms* in each expression or equation.

1.  $5x + 2x + 6$



2.  $1.5y - 1.2 + 1.2z + y$



3.  $\frac{1}{2}x + \frac{1}{2} = 3x$



#### Vocabulary Builder

**identity** (noun) eye DEN tuh tee

**Main Idea:** Any equation that is always true is an **identity**.

**Examples:** The equation  $39 = 39$  is an **identity** because it is always true.

The equation  $y + 3 = y + 3$  is an **identity** because it is true for all values of  $y$ .

**Nonexample:** The equation  $x + 5 = 8$  is *not* an **identity** because it is *not* always true. It is true only when  $x = 3$ .

$m = m$   
is an **identity**.

$m = 15$   
is NOT  
an **identity**.

#### Use Your Vocabulary

Write a number or expression to make each equation an *identity*.

4.  $25 + \square = 25$

5.  $27 \cdot \square = 27$

6.  $-5x + 3 = \square + 3$

7. **Multiple Choice** Which equation is NOT an *identity*?

(A)  $0 + 7 = 7$

(B)  $1 \cdot 9 = 9$

(C)  $x + 3 = 3 + x$

(D)  $x + 1 = x$

8. Draw a line from each equation in Column A to its description in Column B.

**Column A**

$x = x - 1$

$x + x = 2x$

$5x = 15$

**Column B**

always true

sometimes true

never true



## Problem 1 Solving an Equation With Variables on Both Sides

**Got It?** What is the solution of  $7k + 2 = 4k - 10$ ?

9. There is a variable on each side of the equation. Are they like terms?
10. Use one of the reasons from the box to justify each step. You may use a reason more than once.

Yes / No

Division Property of Equality  
Simplify.  
Subtraction Property of Equality  
Subtract.

$$7k + 2 = 4k - 10$$

Write the original equation.

$$7k + 2 - 4k = 4k - 10 - 4k$$

$$3k + 2 = -10$$

$$3k + 2 - 2 = -10 - 2$$

$$3k = -12$$

$$\frac{3k}{3} = -\frac{12}{3}$$

$$k = -4$$



## Problem 2 Using an Equation With Variables on Both Sides

**Got It?** An office manager spent \$650 on a new energy-saving copier that will reduce the monthly electric bill for the office from \$112 to \$88. In how many months will the copier pay for itself?

11. Complete the model below.

Relate cost of the copier plus new monthly cost times number of months is old monthly cost times number of months

Define Let  $m = ?$ . Circle the correct answer.

Cost of the copier Number of months Amount of savings

Write \$650 + \$88 ·  = \$  ·

12. Now write and solve the equation.

13. The copier will pay for itself in about  months.



### Problem 3 Solving an Equation With Grouping Symbols

**Got It?** What is the solution of  $4(2y + 1) = 2(y - 13)$ ?

14. Use the justifications at the right to solve the equation.

$$\begin{aligned}
 &4(2y + 1) = 2(y - 13) \\
 &4 \cdot (2y) + \boxed{\phantom{00}} \cdot (1) = \boxed{\phantom{00}} \cdot (y) - \boxed{\phantom{00}} \cdot (13) \\
 &\boxed{\phantom{00}} \cdot (y) + \boxed{\phantom{00}} = \boxed{\phantom{00}} \cdot (y) - \boxed{\phantom{00}} \\
 &\boxed{\phantom{00}} \cdot (y) + \boxed{\phantom{00}} - 4 = \boxed{\phantom{00}} \cdot (y) - \boxed{\phantom{00}} - 4 \\
 &\boxed{\phantom{00}} \cdot (y) = \boxed{\phantom{00}} \cdot (y) - \boxed{\phantom{00}} \\
 &\boxed{\phantom{00}} \cdot (y) - \boxed{\phantom{00}} \cdot (y) = \boxed{\phantom{00}} \cdot (y) - \boxed{\phantom{00}} - \boxed{\phantom{00}} \cdot (y) \\
 &\boxed{\phantom{00}} \cdot (y) = \boxed{\phantom{00}} \\
 &\boxed{\phantom{00}} = \boxed{\phantom{00}} \\
 &y = \boxed{\phantom{00}}
 \end{aligned}$$

Write the original equation.

Distributive Property

Multiply.

Subtraction Property of Equality

Subtract.

Subtraction Property of Equality

Subtract.

Division Property of Equality

Simplify.

15. Check your answer by substituting it for  $y$  in the original equation.



### Problem 4 Identities and Equations With No Solution

**Got It?** What is the solution of  $3(4b - 2) = -6 + 12b$ ?

16. Circle the first step you would take to isolate the variable. Underline the second step you would take.

Multiply each side by 3.

Distribute the 3.

Subtract  $12b$  from each side.

17. Solve the equation.

18. Because  $-6 = -6$  is always true, the original equation has  
no solution / infinitely many solutions.

## Concept Summary Solving Equations

Remember to follow these steps when solving equations.

- STEP 1** Use the Distributive Property to remove any grouping symbols.  
Use properties of equality to clear decimals and fractions.
- STEP 2** Combine like terms on each side of the equation.
- STEP 3** Use the properties of equality to get the variable terms on one side of the equation and the constants on the other.
- STEP 4** Use the properties of equality to solve for the variable.
- STEP 5** Check your solution in the original equation.



## Lesson Check • Do you UNDERSTAND?

**Vocabulary** Tell whether each equation has *infinitely many solutions*, *one solution*, or *no solution*.

$$3y - 5 = y + 2y - 9$$

$$2y + 4 = 2(y + 2)$$

$$2y - 4 = 3y - 5$$

Write the steps to isolate the variable in each equation.

19.  $3y - 5 = y + 2y - 9$

20.  $2y + 4 = 2(y + 2)$

21.  $2y - 4 = 3y - 5$

22. Tell whether each equation has *infinitely many solutions*, *one solution*, or *no solution*.

$$3y - 5 = y + 2y - 9$$

$$2y + 4 = 2(y + 2)$$

$$2y - 4 = 3y - 5$$



## Math Success

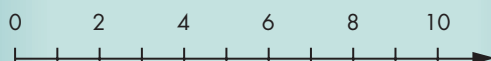
Check off the vocabulary words that you understand.

☐ like terms

☐ identity

Rate how well you can *solve equations with variables on both sides*.

Need to review



Now I get it!