

3.2

Solving Equations with Variables on Both Sides

Warm Up

Lesson Presentation

Lesson Quiz

3.2**Solving Equations with
Variables on Both Sides****Warm up**

1. Sara paid \$15.95 to become a member at a gym. She then paid a monthly membership fee. Her total cost for 12 months was \$735.95. How much was the monthly fee?

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2. Josie bought 4 cases of sports drinks for an upcoming meet. After talking to her coach, she bought 3 more cases and spent an additional \$6.95 on other items. Her receipts totaled \$74.15. Write and solve an equation to find how much each case of sports drinks cost.

$$4c + 3c + 6.95 = 74.15; \$9.60$$

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Solving Equations with Variables on Both Sides

Example 1: Solving Equations with Variables on Both Sides

Solve $7n - 2 = 5n + 6$.

$$7n - 2 = 5n + 6$$

$$\underline{-5n} \quad \underline{-5n}$$

$$2n - 2 = 6$$

$$\underline{+2} \quad \underline{+2}$$

$$2n = 8$$

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

$$n = 4$$

To collect the variable terms on one side, subtract $5n$ from both sides.

Since n is multiplied by 2, divide both sides by 2 to undo the multiplication.

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Example 2: Simplifying Each Side Before Solving Equations

Solve $4 - 6a + 4a = -1 - 5(7 - 2a)$.

$$4 - 6a + 4a = -1 - 5(7 - 2a) \quad \text{Distribute } -5 \text{ to the expression in parentheses.}$$

$$4 - 6a + 4a = -1 - 5(7) - 5(-2a)$$

$$4 - 6a + 4a = -1 - 35 + 10a$$

$$4 - 2a = -36 + 10a$$

$$\begin{array}{r} +36 \\ \hline \end{array} \quad \begin{array}{r} +36 \\ \hline \end{array}$$

$$40 - 2a = 10a$$

$$\begin{array}{r} + 2a \\ \hline \end{array}$$

$$40 = 12a$$

Combine like terms.

Since -36 is added to $10a$, add 36 to both sides.

To collect the variable terms on one side, add $2a$ to both sides.

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Example 2 Continued

Solve $4 - 6a + 4a = -1 - 5(7 - 2a)$.

$$40 = 12a$$

$$\frac{40}{12} = \frac{12a}{12}$$

$$\frac{10}{3} = a$$

*Since a is multiplied by 12,
divide both sides by 12.*

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An **identity** is an equation that is true for all values of the variable. An equation that is an identity has infinitely many solutions.

Some equations are always false. These equations have no solutions.

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Example 3: Infinitely Many Solutions or No Solutions

Solve $12x - 3 + x = 5x - 4 + 8x$.

$$12x - 3 + x = 5x - 4 + 8x$$

$$12x - 3 + x = 5x - 4 + 8x \quad \text{Identify like terms.}$$

$$13x - 3 = 13x - 4 \quad \text{Combine like terms on the left and the right.}$$

$$\begin{array}{r} -13x \\ \hline \end{array} \quad \begin{array}{r} -13x \\ \hline \end{array} \quad \text{Subtract } 13x \text{ from both sides.}$$

$$-3 = -4 \quad \text{False statement.}$$

The equation $12x - 3 + x = 5x - 4 + 8x$ is a false equation. There is no value of x that will make the equation true. There are no solutions.

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Example 4

Solve $2c + 7 + c = -14 + 3c + 21$.

$$2c + 7 + c = -14 + 3c + 21$$

$$2c + 7 + c = -14 + 3c + 21 \text{ Identify like terms.}$$

$$3c + 7 = 3c + 7 \quad \text{Combine like terms on the left and the right.}$$

$$\begin{array}{r} -3c \\ \hline \end{array} \quad \begin{array}{r} -3c \\ \hline \end{array} \quad \text{Subtract } 3c \text{ both sides.}$$

$$7 = 7 \quad \checkmark \text{ True statement.}$$

The equation $2c + 7 + c = -14 + 3c + 21$ is an identity. All values of c will make the equation true. All real numbers are solutions.

3.2**Solving Equations with Variables on Both Sides****Example 5: Application**

Jon and Sara are planting tulip bulbs. Jon has planted 60 bulbs and is planting at a rate of 44 bulbs per hour. Sara has planted 96 bulbs and is planting at a rate of 32 bulbs per hour. In how many hours will Jon and Sara have planted the same number of bulbs? How many bulbs will that be?

Person	Bulbs
Jon	60 bulbs plus 44 bulbs per hour
Sara	96 bulbs plus 32 bulbs per hour

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Example 5: Application Continued

Let b represent bulbs, and write expressions for the number of bulbs planted.

When is 60
bulbs plus 44
bulbs
each
hour the
same
as 96
bulbs plus 32
bulbs
each
hour ?

$$60 + 44b = 96 + 32b$$

$$60 + 44b = 96 + 32b$$

$$\quad \quad \quad \underline{- 32b} \quad \quad \quad \underline{- 32b}$$

To collect the variable terms on one side, subtract $32b$ from both sides.

$$60 + 12b = 96$$

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Example 5: Application Continued

$$\begin{aligned}60 + 12b &= 96 \\ \underline{-60} \quad \quad \quad \underline{-60} & \\ 12b &= 36 \\ \frac{12b}{12} &= \frac{36}{12} \\ b &= 3\end{aligned}$$

Since 60 is added to $12b$, subtract 60 from both sides.

Since b is multiplied by 12, divide both sides by 12 to undo the multiplication.

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Example 5: Application Continued

After 3 hours, Jon and Sara will have planted the same number of bulbs. To find how many bulbs they will have planted in 3 hours, evaluate either expression for $b = 3$:

$$60 + 44b = 60 + 44(3) = 60 + 132 = 192$$

$$96 + 32b = 96 + 32(3) = 96 + 96 = 192$$

After 3 hours, Jon and Sara will each have planted 192 bulbs.

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Example 6

Four times Greg's age, decreased by 3 is equal to 3 times Greg's age increased by 7. How old is Greg?

Let g represent Greg's age, and write expressions for his age.

four
times
Greg's
age

decreased
by

3

is
equal
to

three
times
Greg's
age

increased
by

7

$4g$

-

3

=

$3g$

+

7

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Example 6 Continued

$$4g - 3 = 3g + 7$$

$$\begin{array}{r} -3g \\ \hline \end{array} \quad \begin{array}{r} -3g \\ \hline \end{array}$$

$$g - 3 = 7$$

$$\begin{array}{r} + 3 \\ \hline \end{array} \quad \begin{array}{r} + 3 \\ \hline \end{array}$$

$$g = 10$$

To collect the variable terms on one side, subtract $3g$ from both sides.

Since 3 is subtracted from g , add 3 to both sides.

Greg is 10 years old.

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Lesson Quiz

Solve each equation.

1. $7x + 2 = 5x + 8$ **3**

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

3. $6 - 7(a + 1) = -3(2 - a)$ **$\frac{1}{2}$**

4. $4(3x + 1) - 7x = 6 + 5x - 2$ **all real numbers**

5. $\frac{2}{3}(3x + 9) = 8x$ **1**

6. $\frac{2}{3}r + \frac{3}{4} = \frac{7}{12}$

7. A painting company charges \$250 base plus \$16 per hour. Another painting company charges \$210 base plus \$18 per hour. How long is a job for which the two companies costs are the same? **20 hours**