2-3 Solving Multi-Step Equations

Check Skills You'll Need

1. **Vocabulary Review** Identify the *like terms* in $3x + 2x + 8 - x$.

Simplify.

2. $5 - 3m + 7 - 23m$
3. $4(7 - 3r)$
4. $(q + 1)5 + 3q$

GO for Help Lesson 2-2

What You'll Learn

To write and solve multi-step equations

Why Learn This?

You can model many situations with one- and two-step equations. More complicated situations, such as finding the cost of multiple items, involve multiple steps.

You often need to simplify at least one side of an equation before solving it. To simplify, you combine like terms.

CONTENT STANDARDS 8.EE.7, 8.EE.7b

EXAMPLE 1 Simplifying Before Solving an Equation

Solve $3n + 9 + 4n = 2$.

$3n + 9 + 4n = 2$

$3n + 4n + 9 = 2$ ← Commutative Property

$7n + 9 = 2$ ← Combine like terms.

$7n + 9 - 9 = 2 - 9$ ← Subtract 9 from each side.

$7n = -7$ ← Simplify.

$\frac{7n}{7} = \frac{-7}{7}$ ← Divide each side by 7.

$n = -1$ ← Simplify.

Check $3n + 9 + 4n = 2$

$3(-1) + 9 + 4(-1) \stackrel{?}{=} 2$ ← Substitute –1 for n.

$2 = 2$ ✔ ← The solution checks.

GO for Help

For help combining like terms, see Lesson 2-2, Example 1.

Quick Check

1. Solve $-15 = 5b + 12 - 2b + 6$. Check the solution.

You can use the Distributive Property to simplify an equation.

EXAMPLE 2 Using the Distributive Property

Multiple Choice Your class hopes to collect 1,200 returnable bottles to raise money for a class trip. During the first week, the 24 students in your class collect an average of 34 bottles each. How many more bottles per student should the class collect?

(A) 11 bottles (B) 16 bottles (C) 49 bottles (D) 384 bottles

Words 24 students · (34 bottles per student + additional bottles per student) = 1,200 bottles

Equation Let r = the number of additional bottles.

$$24 \cdot (34 + r) = 1{,}200$$

$$24(34 + r) = 1{,}200$$
$$816 + 24r = 1{,}200 \quad \leftarrow \text{Distributive Property}$$
$$816 - 816 + 24r = 1{,}200 - 816 \quad \leftarrow \text{Subtract 816 from each side.}$$
$$24r = 384 \quad \leftarrow \text{Simplify.}$$
$$\frac{24r}{24} = \frac{384}{24} \quad \leftarrow \text{Divide each side by 24.}$$
$$r = 16 \quad \leftarrow \text{Simplify.}$$

Test Prep Tip

Be sure to answer the question asked. You need to find the number of additional bottles each student should collect, not the total number each should collect.

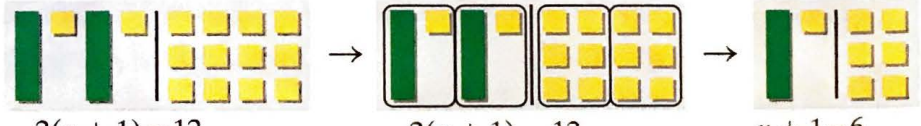
Each student should collect 16 more bottles. The correct answer is choice B.

Check for Reasonableness Round 24 to 20 and 34 to 40. The class collected about $20 \cdot 40$, or 800 bottles. They need to collect 400 more, or 20 bottles per student. 16 is close to 20. The answer is reasonable.

Quick Check

2. **Class Trips** Your class goes to an amusement park. Admission is \$10 for each student and \$15 for each chaperone. The total cost is \$380. There are 12 girls in your class and 6 chaperones on the trip. How many boys are in your class?

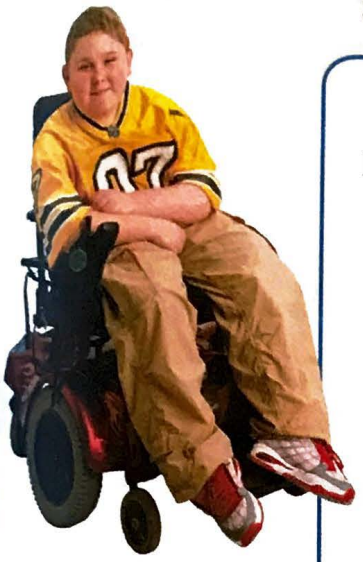
You can also use division to simplify equations. The algebra tiles below model one way to simplify the equation $2(x + 1) = 12$. First, divide each side by 2, grouping the tiles into two equal groups. Then, remove one group from each side. The simplified equation is $x + 1 = 6$.



$2(x + 1) = 12$ $\qquad$ $\frac{2(x + 1)}{2} = \frac{12}{2}$ $\qquad$ $x + 1 = 6$

More Than One Way

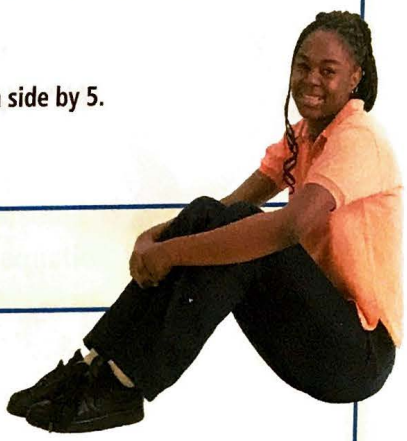
Solve the equation $5(2.9 + k) = 8.3$.



Eric's Method

I'll use the Distributive Property to eliminate the parentheses.

$$5(2.9 + k) = 8.3$$
$$5(2.9) + 5k = 8.3 \quad \leftarrow \text{Distributive Property}$$
$$14.5 + 5k = 8.3 \quad \leftarrow \text{Simplify.}$$
$$14.5 - 14.5 + 5k = 8.3 - 14.5 \quad \leftarrow \text{Subtract 14.5 from each side.}$$
$$5k = -6.2 \quad \leftarrow \text{Simplify.}$$
$$\frac{5k}{5} = \frac{-6.2}{5} \quad \leftarrow \text{Divide each side by 5.}$$
$$k = -1.24 \quad \leftarrow \text{Simplify.}$$



Jasmine's Method

I'll use division to eliminate the parentheses.

$$5(2.9 + k) = 8.3$$
$$\frac{5(2.9 + k)}{5} = \frac{8.3}{5} \quad \leftarrow \text{Divide each side by 5.}$$
$$2.9 + k = 1.66 \quad \leftarrow \text{Simplify.}$$
$$2.9 - 2.9 + k = 1.66 - 2.9 \quad \leftarrow \text{Subtract 2.9 from each side.}$$
$$k = -1.24 \quad \leftarrow \text{Simplify.}$$

Choose a Method

Solve $3(m - 6.5) = 27$. Explain why you chose the method you used.

Check Your Understanding

1. **Vocabulary** When you simplify an expression, you combine ? terms.

2. Describe the first step in simplifying the expression $2h - 4(h - 5)$.

Match each equation to the correct solution.

3. $-7 + x = 4$
4. $16 = -2x$
5. $-9 = x - 12$

A. -8
B. 3
C. 11

Homework Exercises

For more exercises, see Extra Skills and Word Problems.

GO for Help

For Exercises	See Examples
6–13	1
14–20	2

Solve each equation. Check the solution. Write your answer in simplest form.

6. $5h + 2 - h = 22$
7. $-8 = \frac{1}{10}z + \frac{3}{10}z$
8. $3b + b - 8 = 4$
9. $3a + 12 - 6a = -9$
10. $21 = 6 - 2.3x - 2.7x$
11. $2m + 8 - 4m = 28$
12. $-3y + 4 + 5y = -6$
13. $8 = \frac{3}{4}c + 12 - c + 4$
14. $4(m + 3) = -32$
15. $14 = 2(s + 5)$
16. $40 = 1.6(d - 2)$
17. $\frac{8}{9}(z - 1) = 16$
18. $-2(x - 9) = -24$
19. $7(4 - t) = -84$

20. **Food** You want to buy 4 lb of Cortland apples and some Gala apples. Each variety of apple costs \$1.20/lb. You can spend \$7.20. How many pounds of Gala apples can you buy?

GPS

21. **Guided Problem Solving** You mailed 3 identical letters weighing more than 1 oz each. Mailing each letter cost \$.37 for the first ounce, plus \$.23 for each additional ounce. Each letter required \$1.29 postage. How much did each letter weigh, to the nearest ounce?
    - **Make a Plan** Write and solve an equation to solve for x, the number of additional ounces.
    - **Check the Answer** Be sure you answer the question asked.
22. **Jobs** An employee earns \$7.00 an hour for the first 35 hours worked in a week and \$10.50 for any hours over 35. One week's paycheck (before deductions) was for \$308.00. How many hours did the employee work?

GO Online
Homework Video Tutor
PearsonSuccessNet.com

Use this information to write an equation for Exercises 23–25.
When you count by ones from any integer, you are counting consecutive integers. Using variables, three consecutive integers are n, $n + 1$, and $n + 2$.

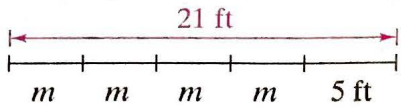
23. The sum of two consecutive integers is -45. What are they?
24. The sum of three consecutive integers is 48. What are they?
25. The sum of three consecutive integers is -255. What are they?
26. **Writing in Math** To solve $5y - 2 - 3y = 8$, can you start by adding 2 to each side? Justify your reasoning.

Solve each equation. Write your answer in simplest form.

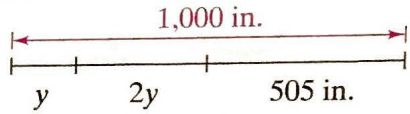
27. $15 = -3(c - 1) + 9$
28. $2(1.5n + 4) - 6n = -7$
29. $2(z - 20) + 3z = 10$
30. $\frac{2}{5}s - 2 + 3(s - 11) = 50$

Write an equation for each diagram. Then find the unknown lengths.

31.



32.



33. **Choose a Method** To make peanut butter and jelly sandwiches for her class, a teacher bought bread for \$2.79 per loaf, peanut butter for \$3.19 per jar, and jars of jelly. The total cost was \$14.56. If the teacher bought two of each item, what was the cost of one jar of jelly? Explain why you chose the method you used.

34. **Challenge** Solve $1.5 - 0.25(a + 4) = 3 + 3(0.05 - 0.5a)$.

Test Prep and Mixed Review

Practice

Multiple Choice

35. Two classes went to the zoo for \$5 per person. The total cost was \$200. One class has 19 people. Solve the equation $5(n + 19) = 200$ to find n, the number of people in the other class.

Ⓐ 105 Ⓒ 21

Ⓑ 36 Ⓓ 10

36. You draw a triangle that has side lengths of 6 cm, 9 cm, and 12 cm. Which of the following may be used to show that the triangle is NOT a right triangle?

Ⓕ $2(6) + 2(9) \neq 2(12)$

Ⓖ $6^2 + 9^2 \neq 12^2$

Ⓗ $6 + 2(9) = 2(12)$

Ⓙ $6^2 + 2(6)(9) = 12^2$

37. When Juan is painting his house, he can reach 5 ft above the top of his 12-ft ladder. He places the bottom of the ladder 4 ft from the house. To the nearest foot, how high up the side of the house can Juan reach?

Ⓐ 11 ft Ⓒ 16 ft

Ⓑ 13 ft Ⓓ 18 ft

38. In one evening, customers at a restaurant ordered 72 dinners. Fifty-six customers ordered salad with their dinners. The rest ordered soup. What fraction of the dinners was ordered with soup?

Ⓕ $\frac{7}{9}$ Ⓗ $\frac{1}{4}$

Ⓖ $\frac{2}{8}$ Ⓙ $\frac{2}{9}$

GO for Help

For Exercises	See Lesson
39–41	2-1

Algebra **Solve each equation.**

39. $\frac{n}{4} - 1 = 10$ **40.** $\frac{x}{-5} - 7 = 8$ **41.** $\frac{a}{8} + 12 = -4$