Today, we will write and solve multi-step equations.

Gather your clicker, notebook and pencil.

Get ready for the warm-up questions.

Solve: -7 + 2q = 3. What is the value of q?

Copy down the equation in your notebook, use the inverse of the order of operations to solve it.

16 = -2v + 34

Copy the equation, undo it, and
text in your answer.

$$\frac{m}{2} + 7 = 21$$

Copy the equation, undo it, and text in your response.

Algebra

2-3 Solving Multi-Step Equations

What You'll Learn

To write and solve multi-step equations

CONTENT STANDARDS

8.EE.7, 8.EE.7.b

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.

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.

1 EXAMPLE Solve $2c + 2 + 3c = 12$.

$2c + 2 + 3c = 12$

$2c + 3c + 2 = 12$ ⟵ Commutative Property

$5c + 2 = 12$ ⟵ Combine like terms.

$5c + 2 - 2 = 12 - 2$ ⟵ Subtract 2 from each side.

$5c = 10$ ⟵ Simplify.

$\frac{5c}{5} = \frac{10}{5}$ ⟵ Divide each side by 5.

$c = 2$ ⟵ Simplify.

Check $2c + 2 + 3c = 12$

$2(2) + 2 + 3(2) \stackrel{?}{=} 12$ ⟵ Substitute 2 for c.

$12 = 12$ ✓ ⟵ The solution checks.

Solve: -15 = 5b + 12 - 2b + 6

A -11

B -1

C 11

D 1

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 per student

Equation Let r = the number of additional bottles.

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

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

$$816 + 24r = 1{,}200 \quad \leftarrow \text{Distributive Property}$$

$$816 - 816 + 24r = 1{,}200 - 816 \quad \leftarrow \text{Subtract 816 from each side.}$$

$$24r = 384 \quad \leftarrow \text{Simplify.}$$

$$\frac{24r}{24} = \frac{384}{24} \quad \leftarrow \text{Divide each side by 24.}$$

$$r = 16 \quad \leftarrow \text{Simplify.}$$

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 · 40, or 800 bottles. They need to collect 400 more, or 20 bottles per student. 16 is close to 20. The answer is reasonable.

Test Prep Tip

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

2 EXAMPLE Eight cheerleaders set a goal of selling 424 boxes of cards to raise money. After two weeks, each cheerleader has sold 28 boxes. How many more boxes must each cheerleader sell?

Words 8 cheerleaders • (28 boxes + additional boxes) = 424 boxes

Let x = the number of additional boxes.

Equation $8 \cdot (28 + x) = 424$

$8(28 + x) = 424$

$224 + 8x = 424$ ← Distributive Property

$224 - 224 + 8x = 424 - 224$ ← Subtract 224 from each side.

$8x = 200$ ← Simplify.

$\frac{8x}{8} = \frac{200}{8}$ ← Divide each side by 8.

$x = 25$ ← Simplify.

Each cheerleader must sell 25 more boxes.

Check for Reasonableness Round 8 to 10 and 28 to 20. The cheerleaders sold about 10 • 20, or 200 boxes. This means each cheerleader must sell about 22 more boxes. 25 is close to 22. The answer is reasonable.

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 $x + 1 = 6$.

$2(x + 1) = 12$ $\quad \dfrac{2(x + 1)}{2} = \dfrac{12}{2}$ $\quad x + 1 = 6$

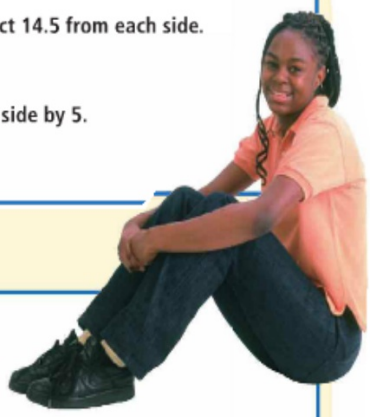
More Than One Way

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.

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

Solve: 2(z-20) + 3z = 10

Write it down, work it out,
text it in

Extra practice

Solve each equation. Check the solution.

6. $5h + 2 - h = 22$

7. $-8 = z + 3z$

8. $3b + b - 8 = 4$

9. $3a + 12 - 6a = -9$

10. $21 = 6 - x - 4x$

11. $2m + 8 - 4m = 28$

12. $-3y + 4 + 5y = -6$

13. $78 = 3c + 12 - c + 4$

14. $4(m + 3) = -32$

15. $14 = 2(s + 5)$

16. $40 = 5(d - 2)$

17. $2(z - 1) = 16$

18. $-2(x - 9) = -24$

19. $7(4 - t) = -84$

You can power down your clickers.

You have an assignment worksheet, due tomorrow.

You can put your clickers away now.

Name _____ Class _____ Date _____

Practice 2-3

Solving Multi-Step Equations

Solve each equation. Check the solution.

1. $2x - 3 + 4x = 39$

2. $0.7w + 16 + 4w = 27.28$

3. $-6(m + 1) = 24$

4. $\frac{2}{3}(k - 8) = 52$

5. $4(1.5c + 6) - 2c = -9$

6. $0.5n + 17 + n = 20$

7. $20 = -4(f + 6) + 14$

8. $9a - 4 + 3(a - 11) = 23$

9. You want to join the tennis team. You go to the sporting goods store with \$100. If the tennis racket you want costs \$80 and the tennis balls cost \$4 per can, how many cans of tennis balls can you buy?

10. Johnny wants to ship a package to his friend. A shipping company charges \$2.49 for the first pound and \$1.24 for each additional pound. If it cost Johnny \$11.17 to ship the package, how much did his package weigh?