2-2 Solving Equations by Using Addition and Subtraction

Main Ideas

- Solve equations by using addition.
- Solve equations by using subtraction.

New Vocabulary

equivalent equations

solve an equation

Study Tip

Look Back

To review **writing algebraic expressions**, see Lesson 1-1.

GET READY for the Lesson

The graph shows some of the fastest-growing occupations from 1992 to 2005.

Source: Bureau of Labor Statistics

The percent of growth for travel agents is 5 less than the percent of growth for medical assistants. An equation can be used to find the percent of growth expected for medical assistants. If m is the percent of growth for medical assistants, then $66 = m - 5$. You can use a property of equality to find the value of m.

Solve Using Addition Suppose the boys' soccer team has 15 members and the girls' soccer team has 15 members. If each team adds 3 new players, the number of members on the boys' and girls' teams would still be equal.

$15 = 15$ Each team has 15 members before adding the new players.

$15 + 3 = 15 + 3$ Each team adds 3 new members.

$18 = 18$ Each team has 18 members after adding the new members.

This example illustrates the **Addition Property of Equality**.

KEY CONCEPT *Addition Property of Equality*

Words If an equation is true and the same number is added to each side, the resulting equation is true.

Symbols For any numbers a, b, and c, if $a = b$, then $a + c = b + c$.

Examples

$7 = 7$
$7 + 3 = 7 + 3$
$10 = 10$

$14 = 14$
$14 + (-6) = 14 + (-6)$
$8 = 8$

If the same number is added to each side of an equation, then the result is an equivalent equation. **Equivalent equations** have the same solution.

$t + 3 = 5$ The solution of this equation is 2.

$t + 3 + 4 = 5 + 4$ Using the Addition Property of Equality, add 4 to each side.

$t + 7 = 9$ The solution of this equation is also 2.

Study Tip

Coefficients

Remember that x means $1 \cdot x$. The coefficient of x is 1.

To **solve an equation** means to find all values of the variable that make the equation a true statement. One way to do this is to isolate the variable having a coefficient of 1 on one side of the equation. You can sometimes do this by using the Addition Property of Equality.

EXAMPLE Solve by Adding

1 **Solve each equation. Check your solution.**

a. $m - 48 = 29$

$m - 48 = 29$ Original equation

$m - 48 + 48 = 29 + 48$ Add 48 to each side.

$m = 77$ $-48 + 48 = 0$ and $29 + 48 = 77$

To check that 77 is the solution, substitute 77 for m in the original equation.

CHECK $m - 48 = 29$ Original equation

$77 - 48 \stackrel{?}{=} 29$ Substitute 77 for m.

$29 = 29$ ✓ Subtract.

The solution 77 is correct.

b. $21 + q = -18$

$21 + q = -18$ Original equation

$21 + q + (-21) = -18 + (-21)$ Add -21 to each side.

$q = -39$ $21 + (-21) = 0$ and $-18 + (-21) = -39$

The solution is -39. To check, substitute -39 for q in the original equation.

CHECK Your Progress

1A. $32 = r - 8$ **40** **1B.** $7 = 42 + t$ **−35**

Solve Using Subtraction Similar to the Addition Property of Equality, the **Subtraction Property of Equality** can also be used to solve equations.

KEY CONCEPT *Subtraction Property of Equality*

Words If an equation is true and the same number is subtracted from each side, the resulting equation is true.

Symbols For any numbers a, b, and c, if $a = b$, then $a - c = b - c$.

Examples

$17 = 17$
$17 - 9 = 17 - 9$
$8 = 8$

$3 = 3$
$3 - 8 = 3 - 8$
$-5 = -5$

EXAMPLE 2 Solve by Subtracting

Solve $142 + d = 97$. Check your solution.

$$142 + d = 97 \quad \text{Original equation}$$
$$142 + d - 142 = 97 - 142 \quad \text{Subtract 142 from each side.}$$
$$d = -45 \quad 142 - 142 = 0 \text{ and } 97 - 142 = -45$$

The solution is -45. To check, substitute -45 for d in the original equation.

CHECK Your Progress **Solve each equation. Check your solution.**

2A. $27 + k = 30$ **3** **2B.** $-12 = p + 16$ **-28**

Remember that subtracting a number is the same as adding its inverse.

EXAMPLE 1 Solve by Adding or Subtracting

Solve $g + \frac{3}{4} = -\frac{1}{8}$ in two ways.

Method 1 Use the Subtraction Property of Equality.

$$g + \frac{3}{4} = -\frac{1}{8} \quad \text{Original equation}$$
$$g + \frac{3}{4} - \frac{3}{4} = -\frac{1}{8} - \frac{3}{4} \quad \text{Subtract } \tfrac{3}{4} \text{ from each side.}$$
$$g = -\frac{7}{8} \quad \tfrac{3}{4} - \tfrac{3}{4} = 0 \text{ and } -\tfrac{1}{8} - \tfrac{3}{4} = -\tfrac{1}{8} - \tfrac{6}{8} \text{ or } -\tfrac{7}{8}$$

Method 2 Use the Addition Property of Equality.

$$g + \frac{3}{4} = -\frac{1}{8} \quad \text{Original equation}$$
$$g + \frac{3}{4} + \left(-\frac{3}{4}\right) = -\frac{1}{8} + \left(-\frac{3}{4}\right) \quad \text{Add } -\tfrac{3}{4} \text{ to each side.}$$
$$g = -\frac{7}{8} \quad \tfrac{3}{4} + \left(-\tfrac{3}{4}\right) = 0 \text{ and } -\tfrac{1}{8} + \left(-\tfrac{3}{4}\right) = -\tfrac{1}{8} + \left(-\tfrac{6}{8}\right) \text{ or } -\tfrac{7}{8}$$

CHECK Your Progress

3. Solve $t + 10 = 55$ in two ways. **45**

EXAMPLE 4 Write and Solve an Equation

Write an equation for the problem. Then solve the equation.

A number increased by 5 is equal to 42. Find the number.

A number	increased by	5	is equal to	42.
n	+	5	=	42

$$n + 5 = 42 \quad \text{Original equation}$$
$$n + 5 - 5 = 42 - 5 \quad \text{Subtract 5 from each side.}$$
$$n = 37$$

The solution is 37.

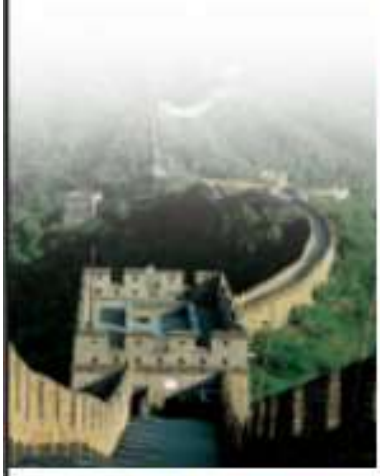
CHECK Your Progress

4. Twenty-five is 3 less than a number. Find the number. **$25 = n - 3$; 28**

Study Tip

Checking Solutions

You should always check your solution in the context of the original problem. For instance, in Example 4, is 37 increased by 5 equal to 42? The solution checks.



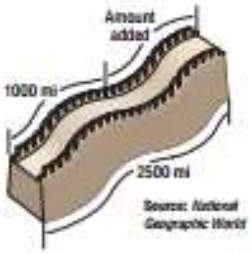
Real-World Link

The first emperor of China, Qui Shi Huangdi, ordered the building of the Great Wall of China to protect his people from nomadic tribes that attacked and looted villages. By 204 B.C., this wall guarded 1000 miles of China's border.

Source: *National Geographic World*

Real-World EXAMPLE

5 **HISTORY** In the fourteenth century, part of the Great Wall of China was repaired and the wall was extended. When the wall was completed, it was 2500 miles long. How much of the wall was added during the 1300s?



Words The original length plus the additional length is 2500.

Variable Let a = the additional length.

Equation

The original length	plus	the additional length	is	2500.
1000	+	a	=	2500

$$1000 + a = 2500 \quad \text{Original equation}$$

$$1000 + a - 1000 = 2500 - 1000 \quad \text{Subtract 1000 from each side.}$$

$$a = 1500 \quad 1000 - 1000 = 0 \text{ and } 2500 - 1000 = 1500$$

The Great Wall of China was extended 1500 miles in the 1300s.

CHECK Your Progress

5. DEER In a recent year, 1286 female deer were born in Lewis County. That was 93 fewer than the number of male deer born. How many male deer were born that year? **1379**

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