

3.4 Lesson

Key Vocabulary
equivalent equations,
p. 193

Two equations are **equivalent equations** when they have the same solutions. You can use properties of equality to produce equivalent equations.

Key Ideas

Addition Property of Equality

Words Adding the same number to each side of an equation produces an equivalent equation.

Algebra If $a = b$, then $a + c = b + c$.

Subtraction Property of Equality

Words Subtracting the same number from each side of an equation produces an equivalent equation.

Algebra If $a = b$, then $a - c = b - c$.

Remember

Addition and subtraction are inverse operations.

Example 1 Solving Equations Using Addition or Subtraction

a. Solve $x - 5 = -1$.

$$x - 5 = -1$$

Write the equation.

Undo the subtraction.

$$\xrightarrow{+5 \quad +5}$$

Addition Property of Equality

$$x = 4$$

Simplify.

▶ The solution is $x = 4$.

Check

$$x - 5 = -1$$

$$4 - 5 \stackrel{?}{=} -1$$

$$-1 = -1 \quad \checkmark$$

b. Solve $z + \frac{3}{2} = \frac{1}{2}$.

$$z + \frac{3}{2} = \frac{1}{2}$$

Write the equation.

Undo the addition.

$$\xrightarrow{-\frac{3}{2} \quad -\frac{3}{2}}$$

Subtraction Property of Equality

$$z = -1$$

Simplify.

▶ The solution is $z = -1$.

Check

$$z + \frac{3}{2} = \frac{1}{2}$$

$$-1 + \frac{3}{2} \stackrel{?}{=} \frac{1}{2}$$

$$\frac{1}{2} = \frac{1}{2} \quad \checkmark$$



Handwritten work for problem b:

$$z + \frac{3}{2} = \frac{1}{2}$$

$$\frac{z}{1} + \frac{3}{2} = \frac{1}{2}$$

$$\frac{z}{1} = \frac{1}{2} - \frac{3}{2}$$

$$\frac{z}{1} = \frac{1-3}{2}$$

$$\frac{z}{1} = \frac{-2}{2}$$

$$z = -1$$

Try It

Solve the equation. Check your solution.

1. $p - 5 = -2$

$$\begin{array}{r} +5 \\ p - 5 = -2 \\ \hline p = 3 \end{array}$$

2. $w + 13.2 = 10.4$

$$\begin{array}{r} -13.2 \\ w + 13.2 = 10.4 \\ \hline w = -2.8 \end{array}$$

3. $x - \frac{5}{6} = -\frac{1}{6}$

$$\begin{array}{r} +\frac{5}{6} \\ x - \frac{5}{6} = -\frac{1}{6} \\ \hline x = \frac{2}{3} \end{array}$$

$$\begin{array}{r} 4.58 + y = 3.5 \\ -4.58 \\ \hline y = -1.08 \end{array}$$

Key Ideas**Multiplication Property of Equality****Words** Multiplying each side of an equation by the same number produces an equivalent equation.**Algebra** If $a = b$, then $a \cdot c = b \cdot c$.**Division Property of Equality****Words** Dividing each side of an equation by the same number produces an equivalent equation.**Algebra** If $a = b$, then $a \div c = b \div c$, $c \neq 0$.**Remember**

Multiplication and division are inverse operations.

Example 2 Solving Equations Using Multiplication or Division

a. Solve $\frac{x}{3} = -6$.

$\frac{x}{3} = -6$

Write the equation.

Undo the division.

$3 \cdot \frac{x}{3} = 3 \cdot (-6)$

Multiplication Property of Equality

$x = -18$

Simplify.

▶ The solution is $x = -18$.**Check**

$\frac{x}{3} = -6$

$\frac{-18}{3} = -6$

$-6 = -6$ ✓

b. Solve $18 = -4y$.

$18 = -4y$

Write the equation.

Undo the multiplication.

$\frac{18}{-4} = \frac{-4y}{-4}$

Division Property of Equality

$-4.5 = y$

Simplify.

▶ The solution is $y = -4.5$.**Check**

$18 = -4y$

$18 = -4(-4.5)$

$18 = 18$ ✓



Try It

Solve the equation. Check your solution.

4. $\frac{x}{5} = -2$

$x = -10$

5. $-a = -24$

$a = 24$

6. $3 = -1.5n$

$-2 = n$

Example 3 Solving Equations Using Reciprocals

a. Solve $-\frac{4}{5}x = -8$.

Multiply each side by $-\frac{5}{4}$,
the reciprocal of $-\frac{4}{5}$.

$$-\frac{4}{5}x = -8$$

$$\begin{array}{l} \xrightarrow{\cdot -\frac{5}{4}} \\ -\frac{5}{4} \cdot \left(-\frac{4}{5}x\right) = -\frac{5}{4} \cdot (-8) \\ x = 10 \end{array}$$

▶ The solution is $x = 10$.

b. Solve $-6 = \frac{3}{2}z$.

Multiply each side by $\frac{2}{3}$,
the reciprocal of $\frac{3}{2}$.

$$-6 = \frac{3}{2}z$$

$$\begin{array}{l} \xrightarrow{\cdot \frac{2}{3}} \\ \frac{2}{3} \cdot (-6) = \frac{2}{3} \cdot \frac{3}{2}z \\ -4 = z \end{array}$$

▶ The solution is $z = -4$.

$$\begin{array}{l} -\frac{4}{5}x = -8 \\ \div -\frac{4}{5} \quad \div -\frac{4}{5} \\ x = 10 \end{array}$$

Write the equation.

Multiplication Property of Equality

Simplify.

Write the equation.

Multiplication Property of Equality

Simplify.

Try It

Solve the equation. Check your solution.

7. $-\frac{8}{5}b = 5$

$$\begin{array}{l} \div -\frac{8}{5} \\ b = -3\frac{1}{8} \end{array}$$

8. $\frac{3}{8}h = -9$

$$\begin{array}{l} \div \frac{3}{8} \\ h = -24 \end{array}$$

9. $-14 = \frac{2}{3}x$

$$\begin{array}{l} \div \frac{2}{3} \\ -21 = x \end{array}$$



In-Class Practice

1 I don't understand yet.

2 I can do it with help.

3 I can do it on my own.

4 I can teach someone else.

SOLVING AN EQUATION Solve the equation. Check your solution.

10. $c - 12 = -4$

$$\begin{array}{r} c - 12 = -4 \\ +12 \\ \hline c = 8 \end{array}$$

11. $k + 8.4 = -6.3$

$$\begin{array}{r} k + 8.4 = -6.3 \\ -8.4 \\ \hline k = -14.7 \end{array}$$

12. $-\frac{2}{3}w = -\frac{7}{3}$

$$\begin{array}{r} -\frac{2}{3}w = -\frac{7}{3} \\ +\frac{7}{3} \\ \hline \frac{1}{3}w = -\frac{7}{3} \end{array}$$

13. $6d = 24$

14. $\frac{t}{3} = -4$

15. $-\frac{2}{5}p = -6$

16. **WRITING** Explain why you can use multiplication to solve equations involving division.

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17. **STRUCTURE** Are the equations $\frac{2}{3}m = -4$ and $-4m = 24$ equivalent? Explain.

REASONING Describe the inverse operation that will undo the given operation.

18. subtracting 12

19. multiplying by $-\frac{1}{8}$

20. adding -6