

1.1 Solving Simple Equations

Learning Target: Write and solve one-step equations.

Success Criteria:

- I can apply properties of equality to produce equivalent equations.
- I can solve equations using addition, subtraction, multiplication, or division.
- I can use equations to model and solve real-life problems.

EXPLORATION 1

Using Properties of Equality

Work with a partner.

a. You have used the following properties in a previous course. Explain the meaning of each property.

- Addition Property of Equality
- Subtraction Property of Equality
- Multiplication Property of Equality
- Division Property of Equality

$$+ = +1$$

$$- = -1$$

$$+ = \text{variable}$$

$$- = -\text{variable}$$

b. Which property can you use to solve each of the equations modeled by the algebra tiles? Solve each equation and explain your method.

$$+ + + + = -$$

$$+ - - - - = - - - -$$

$$- = + + + + + + + +$$

c. Write an equation that can be solved using one property of equality. Exchange equations with another pair and find the solution.

Math Practice

Recognize Usefulness of Tools

Can you use algebra tiles to solve any equation? Explain your reasoning.

1.1 Lesson

Key Ideas

Remember

Addition and subtraction are inverse operations.



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 $a - c = b - c$.

EXAMPLE 1 Solving Equations Using Addition or Subtraction

a. Solve $x - 7 = -6$.

$$x - 7 = -6$$

Write the equation.

Undo the subtraction.

$$\xrightarrow{+7 \quad +7}$$

Addition Property of Equality

$$x = 1$$

Simplify.

The solution is $x = 1$.

Check

$$x - 7 = -6$$

$$1 - 7 \stackrel{?}{=} -6$$

$$-6 = -6 \quad \checkmark$$

b. Solve $1 = w + 6$.

$$1 = w + 6$$

Write the equation.

Undo the addition.

$$\xrightarrow{-6 \quad -6}$$

Subtraction Property of Equality

$$-5 = w$$

Simplify.

The solution is $w = -5$.

Check

$$1 = w + 6$$

$$1 \stackrel{?}{=} -5 + 6$$

$$1 = 1 \quad \checkmark$$

c. Solve $y + 3.4 = 0.5$.

$$y + 3.4 = 0.5$$

Write the equation.

Undo the addition.

$$\xrightarrow{-3.4 \quad -3.4}$$

Subtraction Property of Equality

$$y = -2.9$$

Simplify.

The solution is $y = -2.9$.

Try It Solve the equation. Check your solution.

1. $b + 2 = -5$

2. $-3 = k + 3$

3. $t - \frac{1}{4} = -\frac{3}{4}$

Key Ideas

Remember

Multiplication and division are inverse operations.



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 $a \div c = b \div c$, $c \neq 0$.

EXAMPLE 2 Solving Equations Using Multiplication or Division

Math Practice

Maintain Oversight

Describe the relationship between $-\frac{4}{3}$ and $-\frac{3}{4}$. Then explain why it makes sense to multiply each side of the equation by $-\frac{4}{3}$.

a. Solve $-\frac{3}{4}n = -2$.

$$-\frac{3}{4}n = -2$$

Write the equation.

$$-\frac{4}{3} \cdot \left(-\frac{3}{4}n\right) = -\frac{4}{3} \cdot (-2)$$

Multiplication Property of Equality

$$n = \frac{8}{3}$$

Simplify.

▶ The solution is $n = \frac{8}{3}$.

b. Solve $\pi x = 3\pi$.

$$\pi x = 3\pi$$

Write the equation.

Undo the multiplication.

$$\frac{\pi x}{\pi} = \frac{3\pi}{\pi}$$

Division Property of Equality

$$x = 3$$

Simplify.

▶ The solution is $x = 3$.

Check

$$\pi x = 3\pi$$

$$\pi(3) \stackrel{?}{=} 3\pi$$

$$3\pi = 3\pi \quad \checkmark$$

Try It Solve the equation. Check your solution.

4. $\frac{y}{4} = -7$

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

6. $0.09w = 1.8$

7. $6\pi = \pi x$

EXAMPLE 3**Identifying the Solution of an Equation**

What value of k makes the equation $k + 4 \div 0.2 = 5$ true?

A. -15

B. -5

C. -3

D. 1.5

$$k + 4 \div 0.2 = 5$$

Write the equation.

$$k + 20 = 5$$

Divide 4 by 0.2.

$$\underline{-20} \quad \underline{-20}$$

Subtraction Property of Equality

$$k = -15$$

Simplify.

▶ The correct answer is **A**.

Check

$$k + 4 \div 0.2 = 5$$

$$-15 + 4 \div 0.2 \stackrel{?}{=} 5$$

$$-15 + 20 \stackrel{?}{=} 5$$

$$5 = 5 \quad \checkmark$$

Try It Solve the equation. Check your solution.

8. $p - 8 \div \frac{1}{2} = -3$

9. $q + |-10| = 2$



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

WRITING Are the equations equivalent? Explain.

10. $x + 3 = 4$ and $x = 1$

11. $-\frac{y}{5} = 2$ and $y = 10$

12. **OPEN-ENDED** Write an equation that you can use the Division Property of Equality to solve.

SOLVING EQUATIONS Solve the equation. Check your solution.

13. $-5 = w - 3$

14. $-\frac{2}{3}n = 8$

15. $p - 9 \div \frac{1}{3} = 6$

16. $q + |3| = -5$

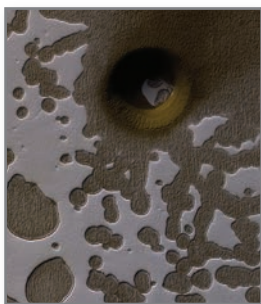
17. **WHICH ONE DOESN'T BELONG?** Which equation does *not* belong with the other three? Explain your reasoning.

$$x - 2 = 4$$

$$x - 3 = 9$$

$$x - 5 = 1$$

$$x - 6 = 0$$

EXAMPLE 4**Modeling Real Life**

The temperature in a crater on Mars is 0°C at 1 P.M. The temperature decreases 8°C every hour. When will the temperature be -50°C ?

To determine when the temperature will be -50°C , find how long it will take the temperature to decrease by 50°C . Write and solve an equation to find the time.

Verbal Model

Change in
temperature
($^{\circ}\text{C}$)

=

Hourly change
in temperature
($^{\circ}\text{C}$ per hour)

•

Time
(hours)

Variable Let t be the time for the temperature to decrease 50°C .

Equation -50

=

 -8

•

 t

The changes in temperature are negative because the temperatures are decreasing.

$$-50 = -8t$$

Write the equation.

$$\frac{-50}{-8} = \frac{-8t}{-8}$$

Division Property of Equality

$$6.25 = t$$

Simplify.

The temperature will be -50°C at 6.25 hours after 1 P.M., or 6 hours and 15 minutes after 1 P.M.



So, the temperature will be -50°C at 7:15 P.M.

**Self-Assessment for Problem Solving**

Solve each exercise. Then rate your understanding of the success criteria in your journal.



18. A shipwreck is 300 meters away from a diving station. An undersea explorer travels away from the station at a speed of 2 meters per second. The explorer is x meters away from the station and will reach the shipwreck in 100 seconds. What is the value of x ?
19. You conduct an inventory for a hardware store and count 40 rolls of duct tape. Your manager wants to keep 7 boxes of duct tape in stock. If each box holds 8 rolls of duct tape, how many boxes should you order? Justify your answer.
20. **DIG DEEPER!** Your fitness tracker overestimates the number of steps you take by 5%. The tracker indicates that you took 7350 steps today. Write and solve an equation to find the actual number of steps you took today.

Go to **BigIdeasMath.com** to get
HELP with solving the exercises.

SOLVING EQUATIONS USING MULTIPLICATION OR DIVISION Solve the equation.

Check your solution.

22. $7x = 35$

23. $4 = -0.8n$

24. $6 = -\frac{w}{8}$

25. $\frac{m}{\pi} = 7.3$

26. $-4.3g = 25.8$

27. $\frac{3}{2} = \frac{9}{10}k$

28. $-7.8x = -1.56$

29. $-2 = \frac{6}{7}p$

30. $3\pi d = 12\pi$

31. **MP YOU BE THE TEACHER** Your friend solves the equation. Is your friend correct? Explain your reasoning.

$$\begin{aligned} -1.5 + k &= 8.2 \\ k &= 8.2 + (-1.5) \\ k &= 6.7 \end{aligned}$$

32. **MP STRUCTURE** A gym teacher orders 42 tennis balls. The tennis balls come in packs of 3. Which of the following equations represents the number x of packs?

$x + 3 = 42$

$3x = 42$

$\frac{x}{3} = 42$

$x = \frac{3}{42}$

33. **MP MODELING REAL LIFE** You clean a community park for 6.5 hours. You earn \$42.25. How much do you earn per hour?

34. **MP MODELING REAL LIFE** A rocket is scheduled to launch from a command center in 3.75 hours. What time is it now?

35. **MP MODELING REAL LIFE** After earning interest, the balance of an account is \$420. The new balance is $\frac{7}{6}$ of the original balance. How much interest did it earn?

36. **MP MODELING REAL LIFE** After a cleanup, algae covers 2 miles of a coastline. The length of the coastline covered after the cleanup is $\frac{1}{3}$ of the previous length. How many miles of the coast did the algae previously cover?



Roller Coasters at Cedar Point	
Coaster	Height (feet)
Top Thrill Dragster	420
Millennium Force	310
Valravn	225
Rougarou	?

37. **MP PROBLEM SOLVING** Cedar Point, an amusement park in Ohio, has some of the tallest roller coasters in the United States. The Rougarou is 165 feet shorter than the Millennium Force. What is the height of the Rougarou?

SOLVING AN EQUATION Solve the equation. Check your solution.

38. $-3 = h + 8 \div 2$

39. $12 = w - |-7|$

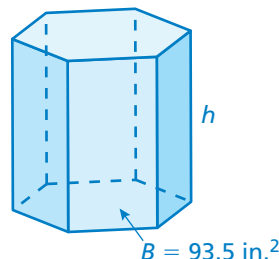
40. $q + |6.4| = 9.6$

41. $d - 2.8 \div 0.2 = -14$

42. $\frac{8}{9} = x + \frac{1}{3}(7)$

43. $p - \frac{1}{4} \cdot 3 = -\frac{5}{6}$

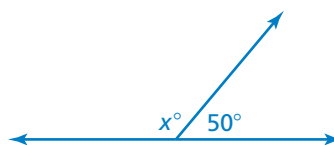
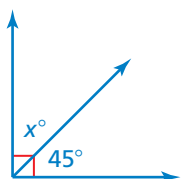
44. **GEOMETRY** The volume V of the prism is 1122 cubic inches. Use the formula $V = Bh$ to find the height h of the prism.



SOLVING AN EQUATION Write and solve an equation to find the value of x .

45. The angles are complementary.

46. The angles are supplementary.



47. **CRITICAL THINKING** Which of the operations $+$, $-$, $\times$, and $\div$ are inverses of each other? Explain.

48. **MP LOGIC** Without solving, determine whether the solution of $-2x = -15$ is *greater than* or *less than* -15 . Explain.

49. **OPEN-ENDED** Write a subtraction equation and a division equation so that each has a solution of -2 . Justify your answer.

50. **MP MODELING REAL LIFE** Ants of a particular species can carry 50 times their body weight. It takes 32 ants of that species to carry the cherry shown. About how much does each ant weigh?



51. **MP REASONING** One-fourth of the girls and one-eighth of the boys in a grade retake their school pictures. The photographer retakes pictures for 16 girls and 7 boys. How many students are in the grade?

52. **DIG DEEPER!** You use a crowdfunding website to raise money. The website keeps 5% of each donation. Five of your friends each donate the same amount. The total funding you receive is \$47.50. How much does each friend donate?

53. **CRITICAL THINKING** A neighbor pays you and two friends \$90 to paint her garage. You divide the money three ways in the ratio $2:3:5$.

- How much does each person receive?
- What is one possible reason the money is not divided evenly?