3.3 Solving Equations Using Addition or Subtraction

Essential Question How can you use algebra tiles to solve addition or subtraction equations?

1 ACTIVITY: Solving Equations

Work with a partner. Use algebra tiles to model and solve the equation.

a. $x - 3 = -4$

Model the equation $x - 3 = -4$.

To get the variable tile by itself, remove the ⬚ tiles on the left side by adding ⬚ ⬚ tiles to each side.

How many *zero pairs* can you remove from each side? ⬚
Circle them.

The remaining tile shows the value of *x*.

⋮⋮ So, $x = $ ⬚ .

b. $z - 6 = 2$ **c.** $p - 7 = -3$ **d.** $-15 = t - 5$

2 ACTIVITY: Solving Equations

Work with a partner. Use algebra tiles to model and solve the equation.

a. $-5 = n + 2$

Model the equation $-5 = n + 2$.

Remove the ⬚ tiles on the right side by adding ⬚ ⬚ tiles to each side.

How many *zero pairs* can you remove from the right side? ⬚
Circle them.

The remaining tiles show the value of *n*.

⋮⋮ So, $n = $ ⬚ .

b. $y + 10 = -5$ **c.** $7 + b = -1$ **d.** $8 = 12 + z$

Solving Equations
In this lesson, you will
- write simple equations.
- solve equations using addition or subtraction.
- solve real-life problems.

Math Practice

Interpret Results

How can you add tiles to make zero pairs? Explain how this helps you solve the equation.

3 **ACTIVITY: Writing and Solving Equations**

Work with a partner. Write an equation shown by the algebra tiles. Then solve.

a. [−][−] [−][−] = [+] [+]

b. [+] [−][−] [−] = [+][+] [+]

c. [+] [−][−][−] [−][−] = [−][−] [−][−]

d. [+][+][+] [+][+] = [+] [−] [−]

4 **ACTIVITY: Using a Different Method to Find a Solution**

Work with a partner. The *melting point* of a solid is the temperature at which the solid melts to become a liquid. The melting point of the element bromine is about 19°F. This is about 57°F more than the melting point of mercury.

a. Which of the following equations can you use to find the melting point of mercury? What is the melting point of mercury?

$$x + 57 = 19 \qquad x - 57 = 19 \qquad x + 19 = 57 \qquad x + 19 = -57$$

b. **CHOOSE TOOLS** How can you solve this problem without using an equation? Explain. How are these two methods related?

What Is Your Answer?

5. **IN YOUR OWN WORDS** How can you use algebra tiles to solve addition or subtraction equations? Give an example of each.

6. **STRUCTURE** Explain how you could use inverse operations to solve addition or subtraction equations without using algebra tiles.

7. What makes the cartoon funny?

8. The word *variable* comes from the word *vary*. For example, the temperature in Maine varies a lot from winter to summer.

Write two other English sentences that use the word *vary*.

"To vary or not to vary." That is the question.

"Dear Sir: Yesterday you said *x* = 2. Today you are saying *x* = 3. Please make up your mind."

Practice → Use what you learned about solving addition or subtraction equations to complete Exercises 5–8 on page 100.

Key Vocabulary
equivalent equations, p. 98

Two equations are **equivalent equations** if they have the same solutions. The Addition and Subtraction Properties of Equality can be used to write 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 $a + c = b + c$.

Remember

Addition and subtraction are inverse operations.

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

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

$$x - 5 = -1 \qquad \text{Write the equation.}$$

Undo the subtraction. ⟶ $\underline{+\ 5 \quad +\ 5} \qquad \text{Addition Property of Equality}$

$$x = 4 \qquad \text{Simplify.}$$

∴ The solution is $x = 4$.

Check

$$x - 5 = -1$$
$$4 - 5 \overset{?}{=} -1$$
$$-1 = -1 \ ✓$$

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

$$z + \frac{3}{2} = \frac{1}{2} \qquad \text{Write the equation.}$$

Undo the addition. ⟶ $\underline{-\dfrac{3}{2} \quad -\dfrac{3}{2}} \qquad \text{Subtraction Property of Equality}$

$$z = -1 \qquad \text{Simplify.}$$

∴ The solution is $z = -1$.

Check

$$z + \frac{3}{2} = \frac{1}{2}$$
$$-1 + \frac{3}{2} \overset{?}{=} \frac{1}{2}$$
$$\frac{1}{2} = \frac{1}{2} \ ✓$$

🔴 On Your Own

Now You're Ready
Exercises 5–20

Solve the equation. Check your solution.

1. $p - 5 = -2$ **2.** $w + 13.2 = 10.4$ **3.** $x - \dfrac{5}{6} = -\dfrac{1}{6}$

🔊 Multi-Language Glossary at BigIdeasMath.com

EXAMPLE **2**

Writing an Equation

A company has a profit of $750 this week. This profit is $900 more than the profit *P* last week. Which equation can be used to find *P*?

Ⓐ $750 = 900 - P$

Ⓑ $750 = P + 900$

Ⓒ $900 = P - 750$

Ⓓ $900 = P + 750$

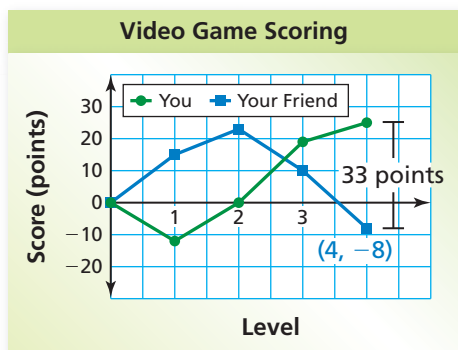| **Words**	The profit this week	is	$900	more than	the profit last week.
Equation	750	=	P	+	900

The equation is $750 = P + 900$. The correct answer is Ⓑ.

On Your Own

Now You're Ready
Exercises 22–25

4. A company has a profit of $120.50 today. This profit is $145.25 less than the profit *P* yesterday. Write an equation that can be used to find *P*.

EXAMPLE **3**

Real-Life Application

The line graph shows the scoring while you and your friend played a video game. Write and solve an equation to find your score after Level 4.

Video Game Scoring

33 points

(4, −8)

You can determine the following from the graph.

Words	Your friend's score	is	33 points	less than	your score.
Variable	Let *s* be your score after Level 4.				
Equation	−8	=	s	−	33

$$-8 = s - 33 \qquad \text{Write equation.}$$

$$\underline{+33} \quad \underline{+33} \qquad \text{Addition Property of Equality}$$

$$25 = s \qquad \text{Simplify.}$$

Your score after Level 4 is 25 points.

Reasonable? From the graph, your score after Level 4 is between 20 points and 30 points. So, 25 points is a reasonable answer.

On Your Own

5. WHAT IF? You have −12 points after Level 1. Your score is 27 points less than your friend's score. What is your friend's score?

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Vocabulary and Concept Check

1. **VOCABULARY** What property would you use to solve $m + 6 = -4$?

2. **VOCABULARY** Name two inverse operations.

3. **WRITING** Are the equations $m + 3 = -5$ and $m = -2$ equivalent? Explain.

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

$$x + 3 = -1 \qquad x + 1 = -5 \qquad x - 2 = -6 \qquad x - 9 = -13$$

Practice and Problem Solving

Solve the equation. Check your solution.

1   **5.** $a - 6 = 13$ **6.** $-3 = z - 8$ **7.** $-14 = k + 6$ **8.** $x + 4 = -14$

9. $c - 7.6 = -4$ **10.** $-10.1 = w + 5.3$ **11.** $\frac{1}{2} = q + \frac{2}{3}$ **12.** $p - 3\frac{1}{6} = -2\frac{1}{2}$

13. $g - 9 = -19$ **14.** $-9.3 = d - 3.4$ **15.** $4.58 + y = 2.5$ **16.** $x - 5.2 = -18.73$

17. $q + \frac{5}{9} = \frac{1}{6}$ **18.** $-2\frac{1}{4} = r - \frac{4}{5}$ **19.** $w + 3\frac{3}{8} = 1\frac{5}{6}$ **20.** $4\frac{2}{5} + k = -3\frac{2}{11}$

21. **ERROR ANALYSIS** Describe and correct the error in finding the solution.

✗
$$
\begin{array}{rcl}
x + 8 & = & 10 \\
+ 8 & & + 8 \\
\hline
x & = & 18
\end{array}
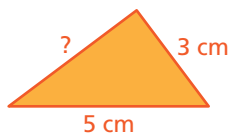$$

Write the word sentence as an equation. Then solve.

2   **22.** 4 less than a number n is -15.   **23.** 10 more than a number c is 3.

24. The sum of a number y and -3 is -8.

25. The difference between a number p and 6 is -14.

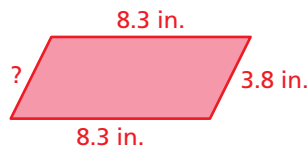**In Exercises 26–28, write an equation. Then solve.**

26. **DRY ICE** The temperature of dry ice is $-109.3°F$. This is $184.9°F$ less than the outside temperature. What is the outside temperature?

27. **PROFIT** A company makes a profit of $1.38 million. This is $2.54 million more than last year. What was the profit last year?

28. **HELICOPTER** The difference in elevation of a helicopter and a submarine is $18\frac{1}{2}$ meters. The elevation of the submarine is $-7\frac{3}{4}$ meters. What is the elevation of the helicopter?

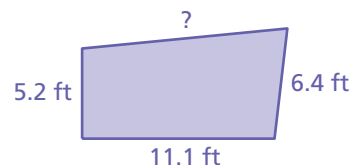**GEOMETRY** Write and solve an equation to find the unknown side length.

29. Perimeter = 12 cm

? | 3 cm
5 cm

30. Perimeter = 24.2 in.

8.3 in.
? | 3.8 in.
8.3 in.

31. Perimeter = 34.6 ft

?
5.2 ft | 6.4 ft
11.1 ft

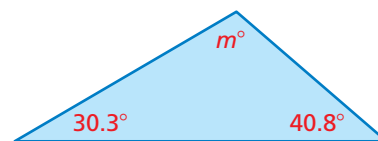**In Exercises 32–36, write an equation. Then solve.**

305 ft

32. **STATUE OF LIBERTY** The total height of the Statue of Liberty and its pedestal is 153 feet more than the height of the statue. What is the height of the statue?

33. **BUNGEE JUMPING** Your first jump is $50\frac{1}{6}$ feet higher than your second jump. Your first jump reaches $-200\frac{2}{5}$ feet. What is the height of your second jump?

34. **TRAVEL** Boatesville is $65\frac{3}{5}$ kilometers from Stanton. A bus traveling from Stanton is $24\frac{1}{3}$ kilometers from Boatesville. How far has the bus traveled?

35. **GEOMETRY** The sum of the measures of the angles of a triangle equals 180°. What is the measure of the missing angle?

$m°$
30.3° | 40.8°

36. **SKATEBOARDING** The table shows your scores in a skateboarding competition. The leader has 311.62 points. What score do you need in the fourth round to win?

Round	1	2	3	4
Points	63.43	87.15	81.96	?

37. **CRITICAL THINKING** Find the value of $2x - 1$ when $x + 6 = 2$.

Critical Thinking Find the values of x.

38. $|x| = 2$

39. $|x| - 2 = 4$

40. $|x| + 5 = 18$

Fair Game Review What you learned in previous grades & lessons

Multiply or divide. *(Section 1.4 and Section 1.5)*

41. -7×8

42. $6 \times (-12)$

43. $18 \div (-2)$

44. $-26 \div 4$

45. **MULTIPLE CHOICE** A class of 144 students voted for a class president. Three-fourths of the students voted for you. Of the students who voted for you, $\frac{5}{9}$ are female. How many female students voted for you? *(Section 2.4)*

Ⓐ 50   Ⓑ 60   Ⓒ 80   Ⓓ 108