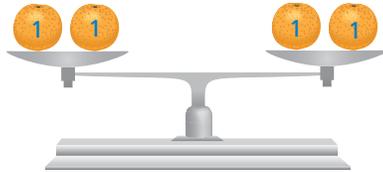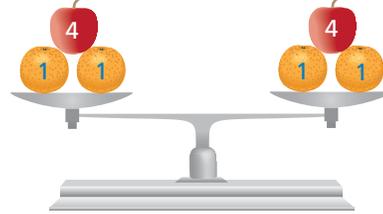**STATE STANDARDS**

MA.6.A.3.2

Essential Question How can you use addition or subtraction to solve an equation?

If two sides of a scale weigh the same, the scale will balance.
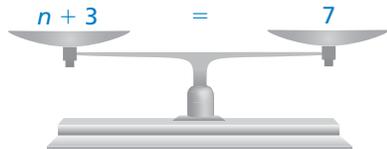
If you add or subtract the same amount on each side of the scale, it will still balance.

1 EXAMPLE: Solving an Equation Using Subtraction

Use a scale to model and solve $n + 3 = 7$.

Think of a scale with both sides in balance. Whatever you add to or subtract from one side, you need to do the same on the other side to keep the scale in balance.

$n + 3 \quad = \quad 7$

When $n + 3$ is on one side and 7 is on the other side, the scale is balanced.

$n + 3 \quad = \quad 7$
$- 3 \quad = \quad - 3$
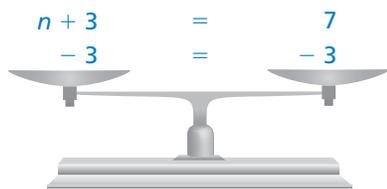
Your goal is to get n by itself on one side. To do this, subtract 3 from each side.

$n \quad = \quad 4$
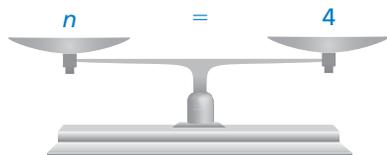
Simplify each side. The remaining value is the solution.

So, $n = 4$.

Check
You can check the solution by substituting 4 for n in the original equation.

$4 + 3 = 7$ ✔

2 ACTIVITY: Solving Equations Using Mental Math

Work with a partner. Write a question that represents the equation. Use mental math to answer the question. Then check your solution.

	Equation	Question	Solution	Check
Sample:	**a.** $x + 3 = 7$	What number plus 3 equals 7?	$x = 4$	$4 + 3 = 7$ ✓
	b. $4 + m = 11$			
	c. $8 = a + 3$			
	d. $x - 9 = 21$			
	e. $13 = p - 4$			

3 ACTIVITY: Solving Equations Using Addition or Subtraction

Work with a partner. Solve the equation using Example 1 as a sample.

a. $n + 5 \quad = \quad 10$

b. $x - 4 \quad = \quad 2$

c. $6 \quad = \quad x - 3$

d. $1 \quad = \quad m - 5$

What Is Your Answer?

4. Decide whether the statement is *true* or *false*. If false, explain your reasoning.

    a. In an equation, any letter can be used as a variable.

    b. The goal in solving an equation is to get the variable by itself.

    c. In the solution, the variable must always be on the left side of the equal sign.

    d. If you add a number to one side, you should subtract it from the other side.

    e. If you add a number to one side, you should add it to the other side.

5. IN YOUR OWN WORDS How can you use addition or subtraction to solve an equation? Give two examples to show how your procedure works.

Practice

Use what you learned about solving equations to complete Exercises 12–17 on page 287.

Key Vocabulary
solution, *p. 284*
inverse operations,
p. 285

A **solution** of an equation is a value that makes the equation true.

Value of x	$x + 3 = 7$	Are both sides equal?
3	$3 + 3 \overset{?}{=} 7$ $6 \neq 7$ ✗	no
4	$4 + 3 \overset{?}{=} 7$ $7 = 7$ ✓	yes
5	$5 + 3 \overset{?}{=} 7$ $8 \neq 7$ ✗	no

Reading

The symbol $\neq$ means "is not equal to."

So, the value $x = 4$ is a solution of the equation $x + 3 = 7$.

EXAMPLE 1 **Checking Solutions**

Tell whether the given value is a solution of the equation.

a. $p + 10 = 38$; $p = 18$

$$18 + 10 \overset{?}{=} 38 \qquad \text{Substitute 18 for } p.$$
$$28 \neq 38 \quad ✗ \qquad \text{Sides are } not \text{ equal.}$$

28   38

So, $p = 18$ is not a solution.

b. $4y = 56$; $y = 14$

$$4(14) \overset{?}{=} 56 \qquad \text{Substitute 14 for } y.$$
$$56 = 56 \quad ✓ \qquad \text{Sides are equal.}$$

56   56

So, $y = 14$ is a solution.

On Your Own

Now You're Ready
Exercises 6–11

Tell whether the given value is a solution of the equation.

1. $a + 6 = 17$; $a = 9$

2. $9 - g = 5$; $g = 3$

3. $35 = 7n$; $n = 5$

4. $\dfrac{q}{2} = 28$; $q = 14$

Multi-Language Glossary at BigIdeasMath.com.

You can use *inverse operations* to solve equations. **Inverse operations** "undo" each other. Addition and subtraction are inverse operations.

🔑 Key Ideas

Addition Property of Equality

Words If you add the same number to each side of an equation, the two sides remain equal.

Numbers
$$
\begin{array}{cc}
8 = & 8 \\
+\,5 & +\,5 \\
\hline
13 & 13
\end{array}
$$

Algebra
$$
\begin{array}{rr}
x - 4 = & 5 \\
+\,4 & +\,4 \\
\hline
x = & 9
\end{array}
$$

Subtraction Property of Equality

Words If you subtract the same number from each side of an equation, the two sides remain equal.

Numbers
$$
\begin{array}{cc}
8 = & 8 \\
-\,5 & -\,5 \\
\hline
3 & 3
\end{array}
$$

Algebra
$$
\begin{array}{rr}
x + 4 = & 5 \\
-\,4 & -\,4 \\
\hline
x = & 1
\end{array}
$$

EXAMPLE 2   Solving Equations Using Addition

a. Solve $x - 2 = 6$.

$x - 2 = 6$	Write the equation.
Undo the subtraction. ⟶ $+\,2 \quad +\,2$	Add 2 to each side.
$x = 8$	Simplify.

The solution is $x = 8$.

Check

$x - 2 = 6$

$8 - 2 \overset{?}{=} 6$

$6 = 6$ ✓

Study Tip

You can check your solution by substituting it for the variable in the original equation.

b. Solve $18 = x - 7$.

$18 = x - 7$	Write the equation.
$+\,7 \quad +\,7$	Add 7 to each side.
$25 = x$	Simplify.

The solution is $x = 25$.

Check

$18 = x - 7$

$18 \overset{?}{=} 25 - 7$

$18 = 18$ ✓

🔴 On Your Own

Now You're Ready
Exercises 18–20

Solve the equation. Check your solution.

5. $k - 3 = 1$ **6.** $n - 10 = 4$ **7.** $15 = r - 6$

EXAMPLE 3 — Solving Equations Using Subtraction

a. Solve $x + 2 = 9$.

$$x + 2 = 9$$ Write the equation.

Undo the addition. → $\underline{-2 \quad -2}$ Subtract 2 from each side.

$$x = 7$$ Simplify.

⁖ The solution is $x = 7$.

Check

$x + 2 = 9$

$7 + 2 \overset{?}{=} 9$

$9 = 9$ ✓

b. Solve $26 = 11 + x$.

$$26 = 11 + x$$ Write the equation.

$\underline{-11 \quad -11}$ Subtract 11 from each side.
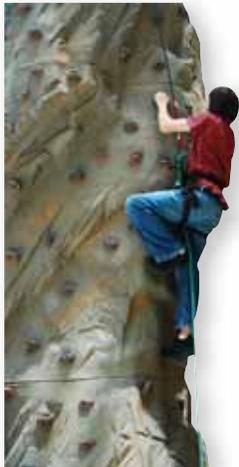
$$15 = x$$ Simplify.

⁖ The solution is $x = 15$.

Check

$26 = 11 + x$

$26 \overset{?}{=} 11 + 15$

$26 = 26$ ✓

EXAMPLE 4 — Real-Life Application

You climb 23 feet on a rock climbing wall. Write and solve an equation to find the distance to the top.

Words   The distance plus the distance is the height of
climbed   to the top   the wall.

Variable   Let d be the distance to the top.

Equation $\quad$ 23 $\quad$ + $\quad$ d $\quad$ = $\quad$ 48

$$23 + d = 48$$ Write the equation.

$\underline{-23 \qquad -23}$ Subtract 23 from each side.

$$d = 25$$ Simplify.

⁖ The distance to the top is 25 feet.

Wall height: 48 ft

On Your Own

Solve the equation. Check your solution.

8. $s + 8 = 17$

9. $9 = y + 6$

10. $13 + m = 20$

11. You eat 8 blueberries from a package. There are 31 blueberries left. Write and solve an equation to find the number of blueberries in a full package.

✓ Vocabulary and Concept Check

1. **WRITING** How can you check the solution of an equation?

Name the inverse operation you can use to solve the equation.

2. $x - 8 = 12$ 3. $n + 3 = 13$ 4. $b + 14 = 33$

5. **WRITING** When solving $x + 5 = 16$, why do you subtract 5 from the left side of the equation? Why do you subtract 5 from the right side of the equation?

Practice and Problem Solving

Tell whether the given value is a solution of the equation.

① 6. $x + 42 = 85$; $x = 43$ 7. $8b = 48$; $b = 6$

8. $19 - g = 7$; $g = 15$ 9. $\dfrac{m}{4} = 16$; $m = 4$

10. $w + 23 = 41$; $w = 28$ 11. $s - 68 = 11$; $s = 79$

Use a scale to model and solve the equation.

12. $n + 7 = 9$ 13. $t - 4 = 5$ 14. $c + 2 = 8$

Write a question that represents the equation. Use mental math to answer the question. Then check your solution.

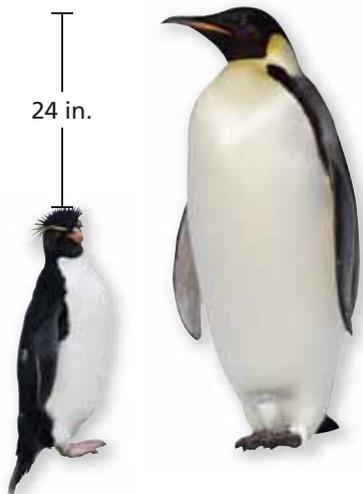15. $a + 5 = 12$ 16. $v + 9 = 18$ 17. $20 = d - 6$

Solve the equation. Check your solution.

② 18. $y - 7 = 3$ 19. $z - 3 = 13$ 20. $8 = r - 14$

③ 21. $p + 5 = 8$ 22. $k + 6 = 18$ 23. $64 = h + 30$

24. $f - 27 = 19$ 25. $25 = q + 14$ 26. $\dfrac{3}{4} = j - \dfrac{1}{2}$

27. $x + \dfrac{2}{3} = \dfrac{9}{10}$ 28. $1.2 = m - 2.5$ 29. $a + 5.5 = 17.3$

ERROR ANALYSIS Describe and correct the error in solving the equation.

30.
$$
\begin{array}{rl}
x + 7 &= 13 \\
+ 7 & + 7 \\
\hline
x & = 20
\end{array}
$$

31.
$$
\begin{array}{rl}
34 &= y - 12 \\
- 12 & + 12 \\
\hline
22 &= y
\end{array}
$$

32. PENGUINS An emperor penguin is 45 inches tall. It is 24 inches taller than a rockhopper penguin. Write and solve an equation to find the height of a rockhopper penguin.

24 in.

33. ELEVATOR You get in an elevator and go down 8 floors. You exit on the 16th floor. Write and solve an equation to find what floor you got on the elevator.

34. AREA The area of Jamaica is 6460 square miles less than the area of Haiti. Write and solve an equation to find the area of Haiti.

HAITI · DOMINICAN REPUBLIC

JAMAICA

Kingston

Port-au-Prince

Santo Domingo

Area = 4181 mi²

35. REASONING The solution of the equation $x + 3 = 12$ is shown. Write the property used for each step.

$x + 3 = 12$	Write the equation.
$x + 3 - 3 = 12 - 3$	
$x + 0 = 9$	
$x = 9$	

**Write the word sentence as an equation. Then solve the equation.**

36. 13 subtracted from a number w is 15.

37. A number k increased by 7 is 34.

38. 9 is the difference of a number n and 7.

39. 93 is the sum of a number g and 58.

Solve the equation. Check your solution.

40. $b + 7 + 12 = 30$

41. $y + 4 - 1 = 18$

42. $m + 18 + 23 = 71$

43. $v - 7 = 9 + 12$

44. $5 + 44 = 2 + r$

45. $22 + 15 = d - 17$

GEOMETRY Write and solve an addition equation to find x.

46. Perimeter = 48 ft

x 20 ft   12 ft

47. Perimeter = 132 in.

16 in.   34 in.   34 in. x

48. Perimeter = 93 ft

18 ft   18 ft   15 ft   15 ft x
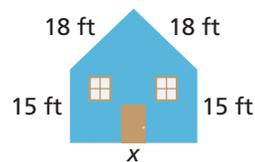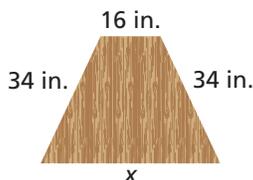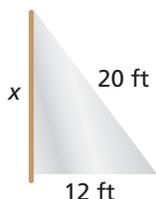
49. REASONING Explain why the equations $x + 4 = 13$ and $4 + x = 13$ have the same solution.

50. REASONING Explain why the equations $x - 13 = 4$ and $13 - x = 4$ do *not* have the same solution.

51. SIMPLIFYING AND SOLVING Compare and contrast the two problems.

> Simplify the expression $2(x + 3) - 4$.
> $$2(x + 3) - 4 = 2x + 6 - 4$$
> $$= 2x + 2$$

> Solve the equation $x + 3 = 4$.
> $$x + 3 = \quad 4$$
> $$\underline{-3 = -3}$$
> $$x = \quad 1$$

a	37	16
19	25	b
34	c	28

52. PUZZLE In a *magic square*, the sum of the numbers in each row, column, and diagonal is the same. Write and solve equations to find the values of a, b, and c.

Bumper Cars: $1.75
Roller Coaster: $1.25 more than Ferris Wheel
Giant Slide: $0.50 less than Bumper Cars
Ferris Wheel: $1.50 more than Giant Slide

53. AMUSEMENT PARK You have $15.

a. Write and solve three equations to find the cost r of the roller coaster, the cost g of the giant slide, and the cost f of the Ferris wheel.

b. How much money do you have left if you ride each ride once?

54. *Critical Thinking* Consider the equation $x + y = 15$. The value of x increases by 3. What has to happen to the value of y so that $x + y = 15$ remains true?

Fair Game Review *What you learned in previous grades & lessons*

Find the product or quotient.

55. 12×8

56. 13×16

57. $75 \div 15$

58. $72 \div 3$

59. MULTIPLE CHOICE The figure is made up of a trapezoid and a semicircle. What is the perimeter of the figure? Use 3.14 for π.

Ⓐ 32 in.

Ⓑ 39.41 in.

Ⓒ 52.41 in.

Ⓓ 59.82 in.

10 in.
4 in.
5 in.
13 in.