

3-5

Solving Two-Step Equations

MAIN IDEA

Solve two-step equations.

New Vocabulary

two-step equation

Math Online

glencoe.com

- Concepts In Motion
- Extra Examples
- Personal Tutor
- Self-Check Quiz

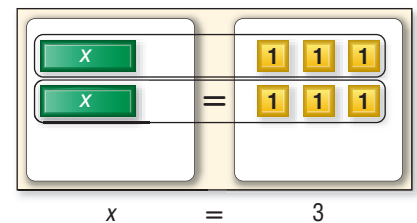
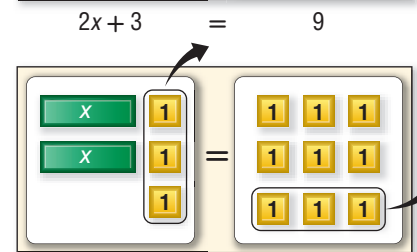
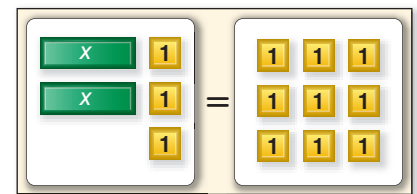
▶ MINI Lab

MONEY A florist charges \$2 for each balloon in an arrangement and a \$3 delivery fee. You have \$9 to spend. The model illustrates the equation $2x + 3 = 9$, where x represents the number of balloons.

To solve $2x + 3 = 9$, remove three 1-tiles from each side of the mat. Then divide the remaining tiles into two equal groups. The solution of $2x + 3 = 9$ is 3.

Solve each equation by using models or a drawing.

- $2x + 1 = 5$
- $3x + 2 = 8$
- $2 = 5x + 2$



A **two-step equation** has two different operations. To solve a two-step equation, undo the operations in reverse order of the order of operations. You can review the order of operations in Lesson 1-4.

EXAMPLE Solve a Two-Step Equation

1 Solve $2x + 3 = 9$. Check your solution.

$$2x + 3 = 9 \quad \text{Write the equation.}$$

$$\underline{-3 = -3} \quad \text{Undo the addition first by subtracting 3 from each side.}$$

$$2x = 6$$

$$\underline{\frac{2x}{2} = \frac{6}{2}} \quad \text{Next, undo the multiplication by dividing each side by 2.}$$

$$x = 3 \quad \text{Simplify.}$$

Check the solution. Since $2(3) + 3 = 9$, the solution is 3.

✓ CHECK Your Progress

Solve each equation. Check your solution.

a. $2x + 4 = 10$

b. $3x + 1 = 7$

c. $5 = 2 + 3x$

EXAMPLES**Solve Two-Step Equations****Study Tip****Order of Operations**

Multiplication comes before addition in the order of operations. To undo these operations, reverse the order. So, undo the addition first by subtracting. Then, undo the multiplication by dividing.

2 Solve $3x + 2 = 23$. Check your solution.

$$3x + 2 = 23$$

Write the equation.

$$\underline{-2 = -2}$$

Undo the addition first by subtracting 2 from each side.

$$3x = 21$$

Divide each side by 3.

$$\frac{3x}{3} = \frac{21}{3}$$

Simplify.

$$x = 7$$

Check $3x + 2 = 23$

Write the original equation.

$3(7) + 2 \stackrel{?}{=} 23$

Replace x with 7.

$21 + 2 \stackrel{?}{=} 23$

Simplify.

$23 = 23$ ✓

The sentence is true.

The solution is 7.

3 Solve $-2y - 7 = 3$. Check your solution.

$$-2y - 7 = 3$$

Write the equation.

$$\underline{+7 = +7}$$

Undo the subtraction first by adding 7 to each side.

$$-2y = 10$$

Divide each side by -2 .

$$\frac{-2y}{-2} = \frac{10}{-2}$$

Simplify.

$$y = -5$$

The solution is -5 .

Check the solution.

4 Solve $4 + 5r = -11$. Check your solution.

$$4 + 5r = -11$$

Write the equation.

$$\underline{-4 = -4}$$

Undo the addition of 4 first by subtracting 4 from each side.

$$5r = -15$$

Divide each side by 5.

$$\frac{5r}{5} = \frac{-15}{5}$$

Simplify.

$$r = -3$$

The solution is -3 .

Check the solution.

✓ CHECK Your Progress

Solve each equation. Check your solution.

d. $4x + 5 = 13$

e. $8y + 15 = 71$

f. $-3n - 8 = 7$

g. $-5s + 8 = -2$

h. $1 + 2y = -3$

i. $-2 + 6w = 10$

Study Tip**Equations**

Remember, solutions of the new equation are also solutions of the original equation.

Solving Two-Step Equations**Key Concept**To solve a two-step equation like $3x + 4 = 16$ or $2x - 1 = -3$:**Step 1** Undo the addition or subtraction first.**Step 2** Then undo the multiplication or division.

Some real-world situations start with a given amount and increase at a certain rate.

Real-World EXAMPLE



Real-World Link . . .
Most teenagers see more than 7 movies a year.
Source: Gallup News Service

- 5 MOVIES** Aisha wants to have her birthday party at the movies. It costs \$27 for pizza and \$8.50 per friend for the movie tickets. Since it is Aisha's birthday, she does not have to pay for her movie ticket. How many friends can Aisha have at her party if she has \$78 to spend?

Words	Cost of pizza	plus	cost of 1 friend	times	number of friends	equals \$78.
Variable					Let n represent the number of friends.	
Equation	27	+	8.50	·	n	= 78

$$\begin{array}{r}
 27 + 8.50n = 78 \\
 -27 \quad \quad = -27 \\
 \hline
 8.50n = 51 \\
 \frac{8.50n}{8.50} = \frac{51}{8.50} \\
 n = 6
 \end{array}$$

Write the equation.
Subtract 27 from each side.

Divide each side by 8.50.

$$51 \div 8.50 = 6$$

Check $27 + 8.50n = 78$
 $27 + 8.50(6) \stackrel{?}{=} 78$
 $27 + 51 \stackrel{?}{=} 78$
 $78 = 78 \checkmark$

Write the original equation.
Replace n with 6.
Simplify.
The sentence is true.

Aisha can have 6 friends at her party.

CHECK Your Progress

- j. **FITNESS** A fitness club is having a special offer where you pay \$22 to join plus a \$16 monthly fee. You have \$150 to spend. Write and solve an equation to find how many months you can use the fitness club.

CHECK Your Understanding

Examples 1–4
(pp. 151–152)

Solve each equation. Check your solution.

1. $3x + 1 = 7$

2. $4h - 6 = 22$

3. $-6r + 1 = -17$

4. $-3y - 5 = 10$

5. $13 = 1 + 4s$

6. $-7 = 1 + 2n$

Example 5
(p. 153)

7. **MONEY** Syreeta wants to buy some CDs, each costing \$14, and a DVD that cost \$23. She has \$65 to spend. Write and solve an equation to find how many CDs she can buy.

Practice and Problem Solving

HOMEWORK HELP

For Exercises	See Examples
8–11	1, 2
12–15	3
16–19	4
20–21	5

Solve each equation. Check your solution.

- | | | |
|--------------------|---------------------|---------------------|
| 8. $3x + 1 = 10$ | 9. $5x + 4 = 19$ | 10. $2t + 7 = -1$ |
| 11. $6m + 1 = -23$ | 12. $-4w - 4 = 8$ | 13. $-7y + 3 = -25$ |
| 14. $-8s + 1 = 33$ | 15. $-2x + 5 = -13$ | 16. $3 + 8n = -5$ |
| 17. $5 + 4d = 37$ | 18. $14 + 2p = 8$ | 19. $25 + 2y = 47$ |

For Exercises 20 and 21, write an equation. Then solve the equation.

20. **BICYCLES** Cristiano is saving money to buy a new bike that costs \$189. He has saved \$99 so far. He plans on saving \$10 each week. In how many weeks will Cristiano have enough money to buy a new bike?
21. **PETTING ZOOS** It cost \$10 to enter a petting zoo. Each cup of food to feed the animals is \$2. If you have \$14, how many cups of food can you buy?

Solve each equation. Check your solution.

- | | | |
|-----------------------|-----------------------|-----------------------|
| 22. $2r - 3.1 = 1.7$ | 23. $4t + 3.5 = 12.5$ | 24. $16b - 6.5 = 9.5$ |
| 25. $5w + 9.2 = 19.7$ | 26. $16 = 0.5r - 8$ | 27. $0.2n + 3 = 8.6$ |

For Exercises 28 and 29, write an equation. Then solve the equation.

28. **CELL PHONES** A cell phone company charges a monthly fee of \$39.99 for unlimited *off-peak* minutes on the nights and weekends but \$0.45 for each *peak* minute during the weekday. If Brad's monthly cell phone bill was \$62.49, for how many *peak* minutes did he get charged?
29. **PLANTS** In ideal conditions, bamboo can grow 47.6 inches each day. At this rate, how many days will it take a bamboo shoot that is 8 inches tall to reach a height of 80 feet?

TEMPERATURE For Exercises 30 and 31, use the following information and the table.

Temperature is usually measured on the Fahrenheit scale (°F) or the Celsius scale (°C). Use the formula $F = 1.8C + 32$ to convert from one scale to the other.

Alaska Record Low Temperatures (°F) by Month	
January	-80
April	-50
July	16
October	-48

30. Convert the temperature for Alaska's record low in July to Celsius. Round to the nearest degree.
31. Hawaii's record low temperature is -11°C . Find the difference in degrees Fahrenheit between Hawaii's record low temperature and the record low temperature for Alaska in January.



EXTRA PRACTICE
See pages 675, 706.

H.O.T. Problems

32. **CHALLENGE** Refer to Exercises 30 and 31. Is there a temperature at which the number of Celsius degrees is the same as the number of Fahrenheit degrees? If so, find it. If not, explain why not.
33. **CHALLENGE** Suppose your school is selling magazine subscriptions. Each subscription costs \$20. The company pays the school half of the total sales in dollars. The school must also pay a one-time fee of \$18. What is the fewest number of subscriptions that can be sold to earn a profit of \$200?
34. **SELECT A TECHNIQUE** Bianca rented a car for a flat fee of \$19.99 plus \$0.26 per mile. Which of the following techniques might she use to determine the approximate number of miles she can drive for \$50? Justify your selection(s). Then use the technique(s) to solve the problem.

Mental Math

Number Sense

Estimation

35. **WRITING IN MATH** Write a real-world problem that would be represented by the equation $2x + 5 = 15$.

**TEST PRACTICE**

36. A rental car company charges \$30 a day plus \$0.05 a mile. Which expression could be used to find the cost of renting a car for m miles?
- A $30.05m$
 B $30m + 0.05m$
 C $30 + 0.05m$
 D $30m + 0.05$
37. The Rodriguez family went on a vacation. They started with \$1,875. If they spent \$140 each day, which expression represents how much money they had after d days?
- F $1,735d$
 G $1,875 - 140d$
 H $140d$
 J $1,875 + 140d$

Spiral Review

38. **SCHEDULES** Jaime needs to be at the bus stop by 7:10 A.M. If it takes her 7 minutes to walk to the bus stop and 40 minutes to get ready in the morning, what is the latest time that she can set her alarm in order to be at the bus stop 5 minutes earlier than she needs to be? (Lesson 3-4)

ALGEBRA Solve each equation. Check your solution. (Lessons 3-2 and 3-3)

39. $4f = 28$

40. $-3y = -15$

41. $p - 14 = 27$

42. $-11 = n + 2$

43. **HIKING** Two people are hiking in the Grand Canyon. One is 987 feet below the rim and the other is 1,200 feet below the rim. Find the vertical distance between them (Lesson 2-5)

▶ GET READY for the Next Lesson**PREREQUISITE SKILL** Multiply or divide.

44. 2.5×20

45. 3.5×4

46. $4,200 \div 2.1$

47. $104 \div 6.5$