

Int
Alg

3 Solving Linear Equations



- 3.1 Solve One-Step Equations
- 3.2 Solve Two-Step Equations
- 3.3 Solve Multi-Step Equations
- 3.4 Solve Equations with Variables on Both Sides
- 3.5 Write Ratios and Proportions
- 3.6 Solve Proportions Using Cross Products
- 3.7 Solve Percent Problems
- 3.8 Rewrite Equations and Formulas

Before

In previous courses and chapters, you learned the following skills, which you'll use in Chapter 3: simplifying expressions, writing percents as decimals, and using formulas.

Prerequisite Skills

VOCABULARY CHECK

Copy and complete the statement.

1. In the expression $3x + 7 + 7x$, ? and ? are like terms.
2. The reciprocal of $\frac{5}{8}$ is ?.

SKILLS CHECK

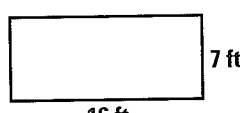
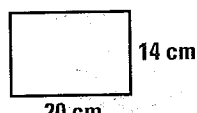
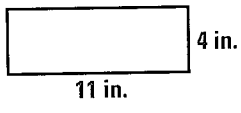
Simplify the expression. (Review p. 96 for 3.2–3.6.)

3. $5x - (6 - x)$ 4. $3(x - 9) - 16$ 5. $23 + 4(x + 2)$ 6. $x(7 + x) + 9x^2$

Write the percent as a decimal. (Review p. 916 for 3.7.)

7. 54% 8. 99% 9. 12.5% 10. 150%

Find the perimeter of the rectangle. (Review p. 924 for 3.8.)

11.  12.  13. 

@HomeTutor Prerequisite skills practice at classzone.com

Now

In Chapter 3, you will apply the big ideas listed below and reviewed in the Chapter Summary on page 191. You will also use the key vocabulary listed below.

Big Ideas

- 1 Solving equations in one variable
- 2 Solving proportion and percent problems
- 3 Rewriting equations in two or more variables

KEY VOCABULARY

- inverse operations, p. 134
- equivalent equations, p. 134
- identity, p. 156
- ratio, p. 162
- proportion, p. 163
- cross product, p. 168
- scale drawing, p. 170
- scale model, p. 170
- scale, p. 170
- literal equation, p. 184

Why?

Knowing how to solve a linear equation can help you solve problems involving distance, rate, and time. For example, you can solve an equation to find the time it takes a jellyfish to travel a given distance at a given rate.

Animated Algebra

The animation illustrated below for Exercise 59 on page 139 helps you answer this question: How long does it take the jellyfish to travel 26 feet?

You have to find the time it takes for the jellyfish to travel 26 feet.

Click the up or down arrows until you reach the desired distance.

Animated Algebra at classzone.com

Other animations for Chapter 3: pages 133, 154, 176, 185, and 187

3.1 Modeling One-Step Equations

MATERIALS • algebra tiles

QUESTION How can you use algebra tiles to solve one-step equations?

You can model one-step equations using algebra tiles.

1-tile

x-tile



A 1-tile represents the number 1. An x-tile represents the variable x .

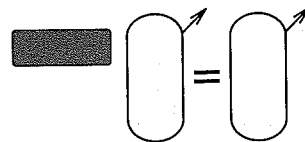
EXPLORE 1 Solve an equation using subtraction

Solve $x + 2 = 5$.

STEP 1 Model $x + 2 = 5$ using algebra tiles.



STEP 2 To find the value of x , isolate the x -tile on one side of the equation. You can do this by removing two 1-tiles from each side.



STEP 3 The x -tile is equal to three 1-tiles. So, the solution of $x + 2 = 5$ is 3.



PRACTICE

Write the equation modeled by the algebra tiles.

1. =

2. =

Use algebra tiles to model and solve the equation.

3. $x + 3 = 9$

4. $x + 2 = 7$

5. $x + 8 = 8$

6. $x + 3 = 7$

7. $x + 2 = 12$

8. $x + 7 = 12$

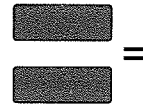
9. $15 = x + 5$

10. $13 = x + 10$

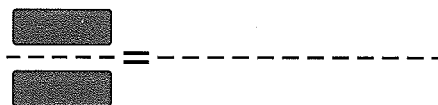
EXPLORE 2 Solve an equation using division

Solve $2x = 12$.

STEP 1 Model $2x = 12$ using algebra tiles.



STEP 2 There are two x -tiles, so divide the x -tiles and 1-tiles into two equal groups.

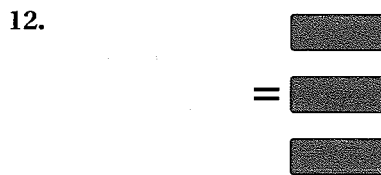


STEP 3 An x -tile is equal to six 1-tiles. So, the solution of $2x = 12$ is 6.



PRACTICE

Write the equation modeled by the algebra tiles.



Use algebra tiles to model and solve the equation.

13. $2x = 10$ 14. $3x = 12$ 15. $3x = 18$ 16. $4x = 16$
 17. $6 = 2x$ 18. $12 = 4x$ 19. $20 = 5x$ 20. $21 = 7x$

DRAW CONCLUSIONS Use your observations to complete these exercises

21. An equation and explanation that correspond to each step in Explore 1 are shown below. Copy and complete the equations and explanations.

$x + 2 = 5$	Original equation
$x + 2 - \underline{\quad ? \quad} = 5 - \underline{\quad ? \quad}$	Subtract $\underline{\quad ? \quad}$ from each side.
$x = \underline{\quad ? \quad}$	Simplify. Solution is $\underline{\quad ? \quad}$.

22. Write an equation that corresponds to the algebra tile equation in each step of Explore 2. Based on your results, describe an algebraic method that you can use to solve $12x = 180$. Then use your method to find the solution.

EXAMPLE 6 Write and solve an equation

OLYMPICS In the 2004 Olympics, Shawn Crawford won the 200 meter dash. His winning time was 19.79 seconds. Find his average speed to the nearest tenth of a meter per second.



Solution

Let r represent Crawford's speed in meters per second. Write a verbal model. Then write and solve an equation.

$$\begin{array}{rcccl}
 \text{Distance} & = & \text{Rate} & \cdot & \text{Time} \\
 \text{(meters)} & & \text{(meters/second)} & & \text{(seconds)} \\
 \downarrow & & \downarrow & & \downarrow \\
 200 & = & r & \cdot & 19.79 \\
 \\
 \frac{200}{19.79} = \frac{19.79r}{19.79} & & & & \\
 10.1 \approx r & & & &
 \end{array}$$

► Crawford's average speed was about 10.1 meters per second.

✓ GUIDED PRACTICE for Example 6

17. **WHAT IF?** In Example 6, suppose Shawn Crawford ran 100 meters at the same average speed he ran the 200 meters. How long would it take him to run 100 meters? Round your answer to the nearest tenth of a second.

3.1 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS5 for Exs. 13 and 55
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 15, 16, 57, 58, and 61
- ◆ = MULTIPLE REPRESENTATIONS Ex. 59

SKILL PRACTICE

- VOCABULARY** Copy and complete: Two operations that undo each other are called ? .
- ★ **WRITING** Which property of equality would you use to solve the equation $14x = 35$? *Explain.*

SOLVING ADDITION AND SUBTRACTION EQUATIONS Solve the equation. Check your solution.

- | | | | |
|------------------|-----------------|------------------|-------------------|
| 3. $x + 5 = 8$ | 4. $m + 9 = 2$ | 5. $11 = f + 6$ | 6. $13 = 7 + z$ |
| 7. $6 = 9 + h$ | 8. $-3 = 5 + a$ | 9. $y - 4 = 3$ | 10. $t - 5 = 7$ |
| 11. $14 = k - 3$ | 12. $6 = w - 7$ | 13. $-2 = n - 6$ | 14. $-11 = b - 9$ |

EXAMPLES
1 and 2
on pp. 134–135
for Exs. 3–14

EXAMPLES 1 and 2
 on pp. 134–135
 for Exs. 15, 16

15. ★ **MULTIPLE CHOICE** What is the solution of $-8 = d - 13$?
 (A) -21 (B) -5 (C) 5 (D) 21
16. ★ **MULTIPLE CHOICE** What is the solution of $22 + v = -65$?
 (A) -87 (B) -43 (C) 43 (D) 87


EXAMPLES 3 and 4
 on pp. 135–136
 for Exs. 17–30

SOLVING MULTIPLICATION AND DIVISION EQUATIONS Solve the equation. Check your solution.


17. $5g = 20$ 18. $-4q = 52$ 19. $48 = 8c$
 20. $-108 = 9j$ 21. $15 = -h$ 22. $187 = -17r$
 23. $\frac{y}{3} = 5$ 24. $\frac{m}{2} = 14$ 25. $8 = \frac{x}{6}$
 26. $7 = \frac{t}{-7}$ 27. $-11 = \frac{z}{-2}$ 28. $-3 = \frac{d}{14}$

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

29.

$$\begin{aligned} x + 3.8 &= 2.3 \\ x + 3.8 - 3.8 &= 2.3 + 3.8 \\ x &= 6.1 \end{aligned}$$


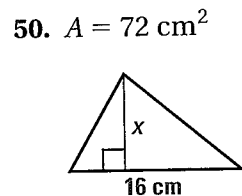
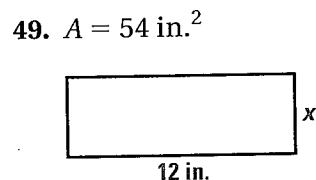
30.

$$\begin{aligned} \frac{x}{3} &= 27 \\ 3 \cdot \frac{x}{3} &= \frac{27}{3} \\ x &= 9 \end{aligned}$$


SOLVING EQUATIONS Solve the equation. Check your solution.

31. $b - 0.4 = 3.1$ 32. $-3.2 + z = -7.4$ 33. $-5.7 = w - 4.6$
 34. $-6.1 = p + 2.2$ 35. $8.2 = -4g$ 36. $-3.3a = 19.8$
 37. $\frac{3}{4} = \frac{1}{8} + v$ 38. $\frac{n}{4.6} = -2.5$ 39. $-0.12 = \frac{y}{-0.5}$
 40. $\frac{1}{2}m = 21$ 41. $\frac{1}{3}c = 32$ 42. $-7 = \frac{1}{5}x$
 43. $\frac{3}{2}k = 18$ 44. $-21 = -\frac{3}{5}t$ 45. $-\frac{2}{7}v = 16$
 46. $\frac{8}{5}x = \frac{4}{15}$ 47. $\frac{1}{3}y = \frac{1}{5}$ 48. $-\frac{4}{3} = \frac{2}{3}z$

GEOMETRY The rectangle or triangle has area A . Write and solve an equation to find the value of x .



CHALLENGE Find the value of b using the given information.

51. $4a = 6$ and $b = a - 2$ 52. $a - 6.7 = 3.1$ and $b = 5a$

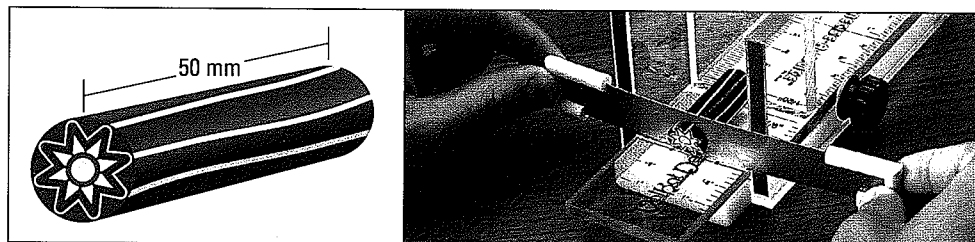
PROBLEM SOLVING

EXAMPLE 6
on p. 137
for Exs. 53–57

- 53. THE DEAD SEA** For the period 1999–2004, the maximum depth of the Dead Sea decreased by 9.9 feet. The maximum depth in 2004 was 1036.7 feet. What was the maximum depth in 1999?

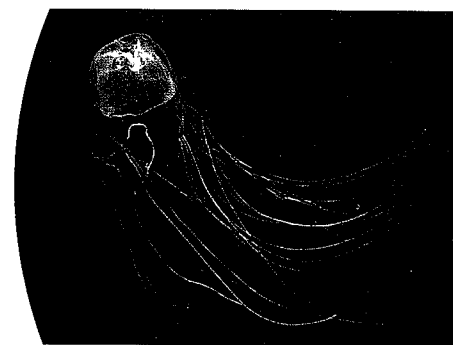
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- 54. CRAFTS** You purchase a cane of polymer clay to make pendants for necklaces. The cane is 50 millimeters long. How thick should you make each pendant so that you will have 20 pendants of uniform thickness?



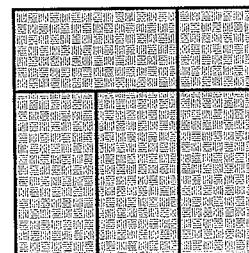
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- 55. TRAMPOLINES** A rectangular trampoline has an area of 187 square feet. The length of the trampoline is 17 feet. What is its width?
- 56. WHEELCHAIRS** The van used to transport patients to and from a rehabilitation facility is equipped with a wheelchair lift. The maximum lifting capacity for the lift is 300 pounds. The wheelchairs used by the facility weigh 55 pounds each. What is the maximum weight of a wheelchair occupant who can use the lift?
- 57. ★ SHORT RESPONSE** In Everglades National Park in Florida, there are 200 species of birds that migrate. This accounts for $\frac{4}{7}$ of all the species of birds sighted in the park.
- Write an equation to find the number of species of birds that have been sighted in Everglades National Park.
 - There are 600 species of plants in Everglades National Park. Are there more species of birds or of plants in the park? *Explain.*
- 58. ★ OPEN-ENDED** Describe a real-world situation that can be modeled by the equation $15x = 135$. Solve the equation and explain what the solution means in this situation.
- 59. ◆ MULTIPLE REPRESENTATIONS** A box jellyfish can travel at a rate of 6.5 feet per second.
- Making a Table** Make a table that shows the distance d the jellyfish can travel after 1, 2, 3, 4, and 5 seconds.
 - Drawing a Graph** Graph the ordered pairs from the table in a coordinate plane. How long does it take the jellyfish to travel 26 feet?
 - Writing an Equation** Write and solve an equation to find the time it takes the jellyfish to travel 26 feet.



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60. **MULTI-STEP PROBLEM** Tatami mats are a floor covering used in Japan. Tatami mats are equal in size, unless they are cut in half. The floor shown has an area of 81 square feet and is covered with 4.5 tatami mats.



- What is the area of one tatami mat?
- What is the length of one tatami mat if it has a width of 3 feet?

61. **★ EXTENDED RESPONSE** In baseball, a player's batting average is calculated by dividing the number of hits by the number of at bats.
- Calculate** Use the information in the table to find the number of hits Bill Mueller had in the 2003 Major League Baseball regular season. Round your answer to the nearest whole number.

Player	Team	Batting average	At bats
Bill Mueller	Boston Red Sox	0.326	524

- Calculate** The number of hits Bill Mueller had was 44 less than the number of hits Vernon Wells of the Toronto Blue Jays had in the 2003 regular season. How many hits did Vernon Wells have?
 - Compare** In the 2003 regular season, Mueller had a higher batting average than Wells. Did Wells have fewer at bats than Mueller? *Explain* your reasoning.
62. **AMERICAN FLAGS** An American flag has a length that is 1.9 times its width. What is the area of a flag that has a length of 9.5 feet?
63. **CHALLENGE** At a farm where you can pick your own strawberries, the cost of picked strawberries is calculated using only the weight of the strawberries. The total weight of a container full of strawberries is 2.1 pounds. The cost of the strawberries is \$4.68. The weight of the container is 0.3 pound. What is the cost per pound for strawberries?

MIXED REVIEW

Translate the verbal phrase into an expression. (p. 15)

- 4 more than a number k
- 40 divided by a number y
- The product of 8 and a number x
- 10 less than twice a number w

A verbal description for a function and its domain are given. Write an equation for the function. Then describe the range. (p. 35)

- The output is 9 more than the input.
Domain: $-1, 0, 1, 2$
- The output is 3 times the input.
Domain: $-4, -2, 0, 2$

Simplify the expression. (p. 103)

- $-9x + 15x$
- $5x - 4x$
- $12 + 3x - 3x$
- $5x + 8 - x - 2$
- $7.1x - 2.6x$
- $-0.7x + 11.3x$

PREVIEW
Prepare for
Lesson 3.2 in
Exs. 68–75.

3.2 EXERCISES

HOMework KEY

- = WORKED-OUT SOLUTIONS on p. WS5 for Exs. 13, 19, and 39
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 21, 40, 41, and 44
- ◆ = MULTIPLE REPRESENTATIONS Ex. 43

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: To solve the equation $2x + 3x = 20$, you would begin by combining $2x$ and $3x$ because they are ? .

2. ★ **WRITING** Describe the steps you would use to solve the equation $4x + 7 = 15$.

EXAMPLE 1

on p. 141
for Exs. 3–14

SOLVING TWO-STEP EQUATIONS Solve the equation. Check your solution.

3. $3x + 7 = 19$

4. $5h + 4 = 19$

5. $7d - 1 = 13$

6. $2g - 13 = 3$

7. $10 = 7 - m$

8. $11 = 12 - q$

9. $\frac{a}{3} + 4 = 6$

10. $17 = \frac{w}{5} + 13$

11. $\frac{b}{2} - 9 = 11$

12. $-6 = \frac{z}{4} - 3$

13. $7 = \frac{5}{6}c - 8$

14. $10 = \frac{2}{7}n + 4$

EXAMPLE 2

on p. 142
for Exs. 15–23

COMBINING LIKE TERMS Solve the equation. Check your solution.

15. $8y + 3y = 44$

16. $2p + 7p = 54$

17. $11x - 9x = 18$

18. $36 = 9x - 3x$

19. $-32 = -5k + 13k$

20. $6 = -7f + 4f$

21. ★ **MULTIPLE CHOICE** What is the first step you can take to solve the equation $6 + \frac{x}{3} = -2$?

(A) Subtract 2 from each side.

(B) Add 6 to each side.

(C) Divide each side by 3.

(D) Subtract 6 from each side.

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

22.

$$7 - 3x = 12$$

$$4x = 12$$

$$x = 3$$



23.

$$-2x + x = 10$$

$$\frac{-2x + x}{-2} = \frac{10}{-2}$$

$$x = -5$$



EXAMPLE 3

on p. 142
for Exs. 24–26

FINDING AN INPUT OF A FUNCTION Write an equation for the function described. Then find the input.

24. The output of a function is 7 more than 3 times the input. Find the input when the output is -8 .

25. The output of a function is 4 more than 2 times the input. Find the input when the output is -10 .

26. The output of a function is 9 less than 10 times the input. Find the input when the output is 11 .

SOLVING EQUATIONS Solve the equation. Check your solution.

27. $5.6 = 1.1p + 1.2$

28. $7.2y + 4.7 = 62.3$

29. $1.2j - 4.3 = 1.7$

30. $16 - 2.4d = -8$

31. $14.4m - 5.1 = 2.1$

32. $-5.3 = 2.2v - 8.6$

33. $\frac{c}{5.3} + 8.3 = 11.3$

34. $3.2 + \frac{x}{2.5} = 4.6$

35. $-1.2 = \frac{z}{4.6} - 2.7$

36. **CHALLENGE** Solve the equations $3x + 2 = 5$, $3x + 2 = 8$, and $3x + 2 = 11$. Predict the solution of the equation $3x + 2 = 14$. *Explain.*

PROBLEM SOLVING**EXAMPLE 4**

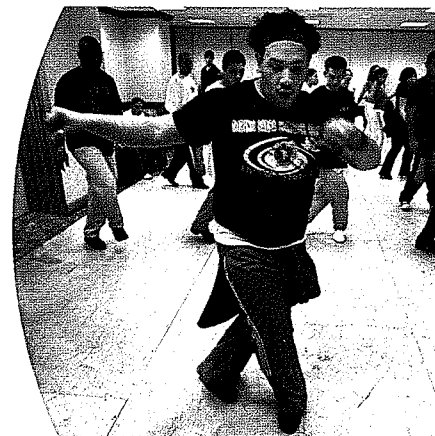
on p. 143
for Exs. 37–40

37. **DANCE CLASSES** A dance academy charges \$24 per class and a one-time registration fee of \$15. A student paid a total of \$687 to the academy. Find the number of classes the student took.

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38. **CAR REPAIR** Tyler paid \$124 to get his car repaired. The total cost for the repairs was the sum of the amount paid for parts and the amount paid for labor. Tyler was charged \$76 for parts and \$32 per hour for labor. Find the amount of time it took to repair his car.

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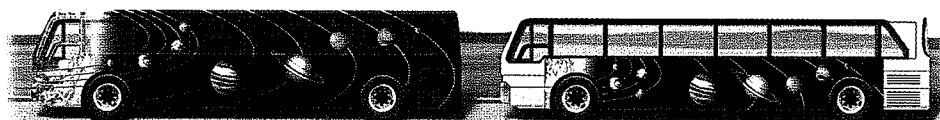
39. **ADVERTISING** A science museum wants to promote an upcoming exhibit by advertising on city buses for one month. The costs of the two types of advertisements being considered are shown. The museum has budgeted \$6000 for the advertisements. The museum decides to have 1 full bus wrap advertisement. How many half-side advertisements can the museum have?

Full bus wrap advertisement

\$2000 for one month

Half-side advertisement

\$800 for one month



40. **★ MULTIPLE CHOICE** A skateboarding park charges \$7 per session to skate and \$4 per session to rent safety equipment. Jared rents safety equipment every time he skates. During one year, he spends \$99 for skating charges and equipment rentals. Which equation can be used to find x , the number of sessions Jared attended?

(A) $99 = 7x$

(B) $99 = 7x + 4x$

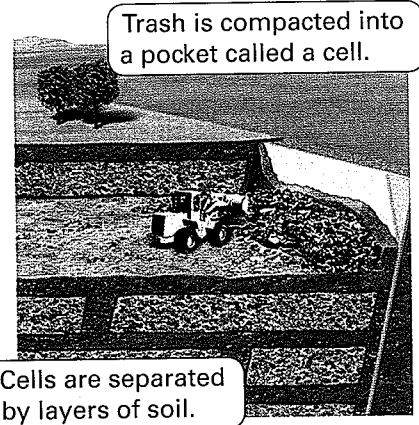
(C) $99 = 7x + 4$

(D) $99 = 4x + 7$

41. **★ SHORT RESPONSE** A guitar store offers a finance plan where you give a \$50 down payment on a guitar and pay the remaining balance in 6 equal monthly payments. You have \$50 and you can afford to pay up to \$90 per month for a guitar. Can you afford a guitar that costs \$542? *Explain.*

42. **MULTI-STEP PROBLEM** The capacity of a landfill is 4,756,505 tons. The landfill currently holds 2,896,112 tons. A cell is added to the landfill every day, and each cell averages 1600 tons.

- Write an equation that gives the amount y (in tons) in the landfill as a function of the number x of days from now.
- After how many days will the landfill reach capacity? Round your answer to the nearest day.
- Use estimation to check your answer to part (b).



43. **MULTIPLE REPRESENTATIONS** Two computer technicians are upgrading the software on the 54 computers in a school. On average, Marissa upgrades 5 computers in 1 hour and Ryan upgrades 7 computers in 1 hour.

- Writing an Equation** Write an equation that gives the total number y of computers upgraded as a function of the number x of hours worked.
- Making a Table** Make a table that shows the number of computers upgraded by each technician and the total number of computers upgraded after 1, 2, 3, 4, and 5 hours.
- Drawing a Graph** Graph the ordered pairs that represent the total number y of computers upgraded after x hours. Use the graph to estimate the number of hours it took to upgrade all of the computers.

44. **★ SHORT RESPONSE** At a restaurant, customers can dine inside the restaurant or pick up food at the take-out window. On an average day, 400 customers are served inside the restaurant, and 120 customers pick up food at the take-out window. After how many days will the restaurant have served 2600 customers? *Explain.*

45. **CHALLENGE** During a 1 mile race, one runner is running at a rate of 14.6 feet per second, and another runner is running at a rate of 11.3 feet per second. One lap around the track is 660 feet. After how many seconds will the faster runner be exactly one lap ahead of the other runner?

MIXED REVIEW

Find the sum, difference, or product.

46. $14 + (-6)$ (p. 74)

47. $-7 + (-13)$ (p. 74)

48. $16 - 21$ (p. 80)

49. $-9 - (-10)$ (p. 80)

50. $(3a)(-3a)(a)$ (p. 88)

51. $-2(-12)(2t)$ (p. 88)

Use the distributive property to write an equivalent expression. (p. 96)

52. $2(9z + 4)$

53. $-3(5b - 8)$

54. $(2k - 7)(-5)$

Solve the equation. Check your solution. (p. 134)

55. $x + 9 = 2$

56. $m + 2 = 5$

57. $y - 18 = 12$

58. $-7r = 56$

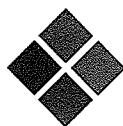
59. $30s = 1200$

60. $-\frac{1}{9}c = -8$

PREVIEW

Prepare for
Lesson 3.3
in Exs. 55–60.

Another Way to Solve Example 4, page 143



MULTIPLE REPRESENTATIONS In Example 4 on page 143, you saw how to solve a problem about scuba diving by using an equation. You can also solve the problem using a table.

PROBLEM

SCUBA DIVING As a scuba diver descends into deeper water, the pressure of the water on the diver's body steadily increases. The pressure at the surface of the water is 2117 pounds per square foot (lb/ft^2). The pressure increases at a rate of 64 pounds per square foot for each foot the diver descends. Find the depth at which a diver experiences a pressure of 8517 pounds per square foot.

METHOD

Making a Table An alternative approach is to make a table.

STEP 1 Make a table that shows the pressure as the depth increases. Because you are looking for a fairly high pressure, use larger increments in depth, such as 20 feet.

Every 1 ft of depth increases the pressure by $64 \text{ lb}/\text{ft}^2$.

Every 20 ft of depth increases the pressure by $64(20) = 1280 \text{ lb}/\text{ft}^2$.

Depth (ft)	Pressure (lb/ft^2)
0	2117
1	2181
2	2245
~~~~~	
20	3397
40	4677
60	5957
80	7237
100	8517

**STEP 2** Look for the depth at which the pressure reaches 8517 pounds per square foot. This happens at a depth of 100 feet.

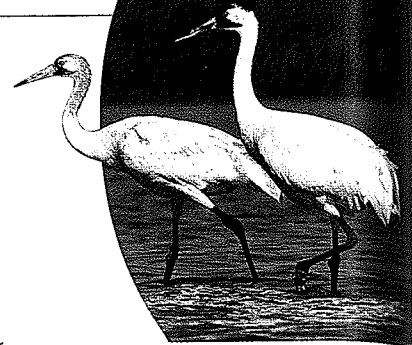
**PRACTICE**

**1. BASKETBALL** A sports club offers an organized basketball league. A team pays \$600 to join the league. In addition to paying their share of the \$600, team members who are not members of the sports club must pay a \$25 fee to play. A team pays a total of \$775. How many team members who are not club members are on the team? Solve this problem using two different methods.

**2. WHAT IF?** In Exercise 1, suppose you are on a team, but not a club member. The \$600 cost is divided equally among the team members. How many players must there be on your team for you to pay \$100 to play? Make a table to find the answer.

**3. FURNITURE** You have \$370 to spend on a dining table and chairs. A table costs \$220, and each chair costs \$35. How many chairs can you buy in addition to the table? Solve this problem using two different methods.

### EXAMPLE 5 Write and solve an equation



**BIRD MIGRATION** A flock of cranes migrates from Canada to Texas. The cranes take 14 days (336 hours) to travel 2500 miles. The cranes fly at an average speed of 25 miles per hour. How many hours of the migration are the cranes *not* flying?

#### Solution

Let  $x$  be the amount of time the cranes are not flying. Then  $336 - x$  is the amount of time the cranes are flying.

Distance (miles)	=	Rate (miles/hour)	•	Time spent flying (hours)	
↓		↓		↓	
2500	=	25	•	$(336 - x)$	
		$2500 = 25(336 - x)$			Write equation.
		$2500 = 8400 - 25x$			Distributive property
		$-5900 = -25x$			Subtract 8400 from each side.
		$236 = x$			Divide each side by $-25$ .

#### ANOTHER WAY

You can also begin solving the equation by dividing each side of the equation by 25.

▶ The cranes were not flying for 236 hours of the migration.



#### GUIDED PRACTICE for Example 5

7. **WHAT IF?** Suppose the cranes take 12 days (288 hours) to travel the 2500 miles. How many hours of this migration are the cranes *not* flying?

## 3.3 EXERCISES

#### HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS6 for Exs. 17 and 39
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 18, 35, 36, and 41
- ◆ = MULTIPLE REPRESENTATIONS Ex. 42

### SKILL PRACTICE

1. **VOCABULARY** What is the reciprocal of the fraction in the equation

$$\frac{3}{5}(2x + 8) = 18?$$

2. **★ WRITING** Describe the steps you would use to solve the equation

$$3(4y - 7) = 6.$$

#### COMBINING LIKE TERMS Solve the equation. Check your solution.

- |                        |                          |                         |
|------------------------|--------------------------|-------------------------|
| 3. $p + 2p - 3 = 6$    | 4. $12v + 14 + 10v = 80$ | 5. $11w - 9 - 7w = 15$  |
| 6. $5a + 3 - 3a = -7$  | 7. $6c - 8 - 2c = -16$   | 8. $9 = 7z - 13z - 21$  |
| 9. $-2 = 3y - 18 - 5y$ | 10. $23 = -4m + 2 + m$   | 11. $35 = -5 + 2x - 7x$ |

#### EXAMPLE 1

on p. 148  
for Exs. 3–11

**EXAMPLES 2 and 3**

on pp. 148–149  
for Exs. 12–18, 25

**USING THE DISTRIBUTIVE PROPERTY** Solve the equation. Check your solution.

12.  $3 + 4(z + 5) = 31$

13.  $14 + 2(4g - 3) = 40$

14.  $5m + 2(m + 1) = 23$

15.  $5h + 2(11 - h) = -5$

16.  $27 = 3c - 3(6 - 2c)$

17.  $-3 = 12y - 5(2y - 7)$

18. **★ MULTIPLE CHOICE** What is the solution of  $7v - (6 - 2v) = 12$ ?

(A) -3.6

(B) -2

(C) 2

(D) 3.6

**EXAMPLE 4**

on p. 149 for  
Exs. 19–24, 26

**MULTIPLYING BY A RECIPROCAL** Solve the equation. Check your solution.

19.  $\frac{1}{3}(d + 3) = 5$

20.  $\frac{3}{2}(x - 5) = -6$

21.  $\frac{4}{3}(7 - n) = 12$

22.  $4 = \frac{2}{9}(4y - 2)$

23.  $-32 = \frac{8}{7}(3w - 1)$

24.  $-14 = \frac{2}{5}(9 - 2b)$

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

25.

$5x - 3(x - 6) = 2$

$5x - 3x - 18 = 2$

$2x - 18 = 2$

$2x = 20$

$x = 10$



26.

$\frac{1}{2}(2x - 10) = 4$

$2x - 10 = 2$

$2x = 12$

$x = 6$



**SOLVING EQUATIONS** Solve the equation. Check your solution.

27.  $8.9 + 1.2(3a - 1) = 14.9$

28.  $-11.2 + 4(2.1 + q) = -0.8$

29.  $1.3t + 3(t + 8.2) = 37.5$

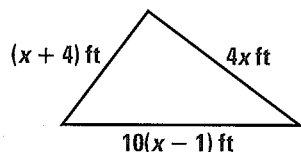
30.  $1.6 = 7.6 - 5(k + 1.1)$

31.  $0.5 = 4.1x - 2(1.3x - 4)$

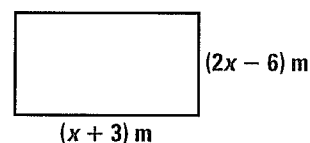
32.  $8.7 = 3.5m - 2.5(5.4 - 6m)$

**GEOMETRY** Find the value of  $x$  for the triangle or rectangle.

33. Perimeter = 24 feet



34. Perimeter = 26 meters



35. **★ WRITING** The length of a rectangle is 3.5 inches more than its width. The perimeter of the rectangle is 31 inches. Find the length and the width of the rectangle. *Explain* your reasoning.

36. **★ SHORT RESPONSE** Solve each equation by first dividing each side of the equation by the number outside the parentheses. When would you recommend using this method to solve an equation? *Explain*.

a.  $9(x - 4) = 72$


b.  $8(x + 5) = 60$

37. **CHALLENGE** An even integer can be represented by the expression  $2n$ . Find three consecutive even integers that have a sum of 54.

## PROBLEM SOLVING


**EXAMPLE 5**  
on p. 150  
for Exs. 38–40

- 38. BASKETBALL** A ticket agency sells tickets to a professional basketball game. The agency charges \$32.50 for each ticket, a convenience charge of \$3.30 for each ticket, and a processing fee of \$5.90 for the entire order. The total charge for an order is \$220.70. How many tickets were purchased?

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- 39. HANGING POSTERS** You want to hang 3 equally-sized travel posters on the wall in your room so that the posters on the ends are each 3 feet from the end of the wall. You want the spacing between posters to be equal. How much space should you leave between the posters?

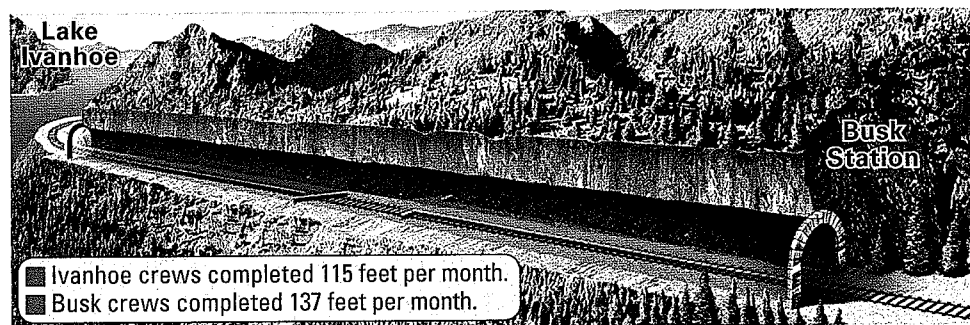


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- 40. LIFEGUARD TRAINING** To qualify for a lifeguard training course, you have to swim continuously for 500 yards using either the front crawl or the breaststroke. You swim the front crawl at a rate of 45 yards per minute and the breaststroke at a rate of 35 yards per minute. You take 12 minutes to swim 500 yards. How much time did you spend swimming the front crawl? Use the verbal model below.

$$\text{Distance} = \begin{matrix} \text{Rate for} \\ \text{front} \\ \text{crawl} \end{matrix} \cdot \begin{matrix} \text{Time} \\ \text{for front} \\ \text{crawl} \end{matrix} + \begin{matrix} \text{Rate for} \\ \text{breaststroke} \end{matrix} \left( \begin{matrix} \text{Total} \\ \text{time} \end{matrix} - \begin{matrix} \text{Time} \\ \text{for front} \\ \text{crawl} \end{matrix} \right)$$

- 41. ★ EXTENDED RESPONSE** The Busk-Ivanhoe Tunnel on the Colorado Midland Railway was built in the 1890s with separate work crews starting on opposite ends at different times. The crew working from Ivanhoe started 0.75 month later than the crew working from Busk.



Cutaway of Busk-Ivanhoe Tunnel

- Starting at the time construction began on the Busk end, find the time it took to complete a total of 8473 feet of the tunnel. Round your answer to the nearest month.
- After 8473 feet were completed, the work crews merged under the same supervision. The combined crew took 3 months to complete the remaining 921 feet of the tunnel. Find the rate at which the remainder of the tunnel was completed.
- Was the tunnel being completed more rapidly before or after the work crews merged? *Explain* your reasoning.

42. **MULTIPLE REPRESENTATIONS** A roofing contractor gives estimates for shingling a roof in cost per square, where a square is a 10 foot by 10 foot section of roof. The contractor estimates \$27.50 per square for materials, \$17 per square for labor, \$30 per square for overhead and profit, and a total of \$750 for miscellaneous expenses.

a. **Writing an Equation** Write an equation that gives the estimate  $y$  (in dollars) as a function of the number  $x$  of squares of a roof. The contractor gives an estimate of \$2314.50. About how many squares does the roof have?

b. **Making a Table** Make a table that shows the estimates for shingling a roof that has 5, 10, 15, 20, or 25 squares. Use your table to check your answer to part (a).

43. **CHALLENGE** A person has quarters and dimes that total \$2.80. The number of dimes is 7 more than the number of quarters. How many of each coin does the person have?

### MIXED REVIEW

Evaluate the expression for the given value(s) of the variable(s).

44.  $x - y$  when  $x = -7$  and  $y = 2$  (p. 80)

45.  $x - (-y)$  when  $x = -4$  and  $y = 5$  (p. 80)

46.  $\frac{x-9}{4}$  when  $x = 9$  (p. 103)

47.  $\frac{4y+7}{3}$  when  $y = 5$  (p. 103)

Solve the equation. Check your solution. (p. 141)

48.  $5x + 1 = 26$

49.  $-x + 4 = 13$

50.  $3x - 5 = -14$

51.  $3 - 2x = 19$

52.  $\frac{x}{3} - 4 = 1$

53.  $8 + \frac{x}{4} = -\frac{3}{4}$

54.  $11x + 5x = 48$

55.  $-4x + 11x = -28$

56.  $\frac{2}{5}x - \frac{3}{5}x = -7$

#### PREVIEW

Prepare for  
Lesson 3.4 in  
Exs. 48–56.

### QUIZ for Lessons 3.1–3.3

Solve the equation. Check your solution.

1.  $x + 9 = 7$  (p. 134)

2.  $y - 5 = -11$  (p. 134)

3.  $-7b = -56$  (p. 134)

4.  $\frac{z}{4} = 6$  (p. 134)

5.  $-\frac{4}{3}t = -12$  (p. 134)

6.  $9w - 4 = 14$  (p. 141)

7.  $23 = 1 - d$  (p. 141)

8.  $66 = 4m + 7m$  (p. 141)

9.  $-104 = -5p - 3p$  (p. 141)

10.  $2v + 5v - 8 = 13$  (p. 148)

11.  $2a - 6(a - 4) = -4$  (p. 148)

12.  $\frac{6}{5}(5 - 4g) = -18$  (p. 148)

13. **INTERNET SHOPPING** Dan purchases DVDs from a website. Each DVD costs \$11, and the shipping and handling fees are \$6.95. Dan is charged a total of \$50.95. How many DVDs did he purchase? (p. 141)





# 3.4 EXERCISES

## HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS6 for Exs. 13 and 51
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 15, 16, 17, 29, and 53
- ◆ = MULTIPLE REPRESENTATIONS Ex. 52

### SKILL PRACTICE

**EXAMPLES 1 and 2**  
on p. 154  
for Exs. 3–17

1. **VOCABULARY** Copy and complete: An equation that is true for all values of the variable is called a(n) ?.

2. ★ **WRITING** Explain why the equation  $4x + 3 = 4x + 1$  has no solution.

**SOLVING EQUATIONS** Solve the equation. Check your solution.

3.  $8t + 5 = 6t + 1$

4.  $k + 1 = 3k - 1$

5.  $8c + 5 = 4c - 11$

6.  $8 + 4m = 9m - 7$

7.  $10b + 18 = 8b + 4$

8.  $19 - 13p = -17p - 5$

9.  $9a = 6(a + 4)$

10.  $5h - 7 = 2(h + 1)$

11.  $3(d + 12) = 8 - 4d$

12.  $7(r + 7) = 5r + 59$

13.  $40 + 14j = 2(-4j - 13)$

14.  $5(n + 2) = \frac{3}{5}(5 + 10n)$

15. ★ **MULTIPLE CHOICE** What is the solution of the equation  $8x + 2x = 15x - 10$ ?

(A) -2

(B) 0.4

(C) 2

(D) 5

16. ★ **MULTIPLE CHOICE** What is the solution of the equation  $4y + y + 1 = 7(y - 1)$ ?

(A) -4

(B) -3

(C) 3

(D) 4

17. ★ **WRITING** Describe the steps you would use to solve the equation  $3(2z - 5) = 2z + 13$ .

**EXAMPLE 4**  
on p. 156  
for Exs. 18–28

**SOLVING EQUATIONS** Solve the equation, if possible.

18.  $w + 3 = w + 6$

19.  $16d = 22 + 5d$

20.  $8z = 4(2z + 1)$

21.  $12 + 5v = 2v - 9$

22.  $22x + 70 = 17x - 95$

23.  $2 - 15n = 5(-3n + 2)$

24.  $12y + 6 = 6(2y + 1)$

25.  $5(1 + 4m) = 2(3 + 10m)$

26.  $2(3g + 2) = \frac{1}{2}(12g + 8)$

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

27.

$$3(x + 5) = 3x + 15$$

$$3x + 5 = 3x + 15$$

$$5 = 15$$

The equation has no solution.



28.

$$6(2y + 6) = 4(9 + 3y)$$

$$12y + 36 = 36 + 12y$$

$$12y = 12y$$

$$0 = 0$$

The solution is  $y = 0$ .



29. ★ **OPEN-ENDED** Give an example of an equation that has no solution. Explain why your equation does not have a solution.

**SOLVING EQUATIONS** Solve the equation, if possible.

30.  $8w - 8 - 6w = 4w - 7$

31.  $3x - 4 = 2x + 8 - 5x$

32.  $-15c + 7c + 1 = 3 - 8c$

33.  $\frac{3}{2} + \frac{3}{4}a = \frac{1}{4}a - \frac{1}{2}$

34.  $\frac{5}{8}m - \frac{3}{8} = \frac{1}{2}m + \frac{7}{8}$

35.  $n - 10 = \frac{5}{6}n - 7 - \frac{1}{3}n$

36.  $3.7b + 7 = 8.1b - 19.4$

37.  $6.2h + 5 - 1.4h = 4.8h + 5$

38.  $0.7z + 1.9 + 0.1z = 5.5 - 0.4z$


39.  $5.4t + 14.6 - 10.1t = 12.8 - 3.5t - 0.6$

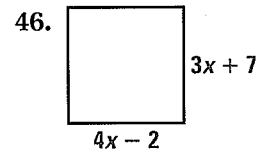
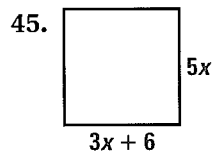
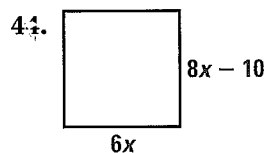
40.  $\frac{1}{8}(5y + 64) = \frac{1}{4}(20 + 2y)$

41.  $14 - \frac{1}{5}(j - 10) = \frac{2}{5}(25 + j)$

42.  $5(1.2k + 6) = 7.1k + 34.4$

43.  $-0.25(4v - 8) = 0.5(4 - 2v)$

 **GEOMETRY** Find the perimeter of the square.



**CHALLENGE** Find the value(s) of  $a$  for which the equation is an identity.


47.  $a(2x + 3) = 9x + 12 - x$

48.  $10x - 35 + 3ax = 5ax - 7a$


**PROBLEM SOLVING**

**EXAMPLE 3**  
on p. 155  
for Exs. 49–51

49. **CAMPING** The membership fee for joining a camping association is \$45. A local campground charges members of the camping association \$35 per night for a campsite and nonmembers \$40 per night for a campsite. After how many nights of camping is the total cost for members, including the membership fee, the same as the total cost for nonmembers?

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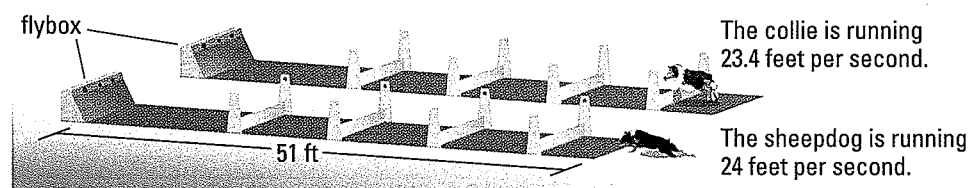
50. **HIGH-SPEED INTERNET** Dan and Sydney are getting high-speed Internet access at the same time. Dan's provider charges \$60 for installation and \$42.95 per month. Sydney's provider has free installation and charges \$57.95 per month. After how many months will Dan and Sydney have paid the same amount for high-speed Internet service?

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51. **LANGUAGES** Information about students who take Spanish and students who take French at a high school is shown in the table. If the trends continue, in how many years will there be 3 times as many students taking Spanish as French?

Language	Students enrolled this year	Average rate of change
Spanish	555	33 more students each year
French	230	2 fewer students each year

52. **MULTIPLE REPRESENTATIONS** For \$360, a rock-climbing gym offers a yearly membership where members can climb as many days as they want and pay \$4 per day for equipment rental. Nonmembers pay \$10 per day to use the gym and \$6 per day for equipment rental.
- Writing an Equation** Write an equation to find the number of visits after which the total cost for a member and the total cost for a nonmember are the same. Then solve the equation.
  - Making a Table** Make a table for the costs of members and nonmembers after 5, 10, 15, 20, 25, 30, and 35 visits. Use the table to check your answer to part (a).
53. **★ EXTENDED RESPONSE** Flyball is a relay race for dogs. In each of the four legs of the relay, a dog jumps over hurdles, retrieves a ball from a flybox, and runs back over the hurdles. The last leg of a relay is shown below. The collie starts the course 0.3 second before the sheepdog.



- Let  $t$  represent the time (in seconds) it takes the collie to run the last leg. Write and solve an equation to find the number of seconds after which the sheepdog would catch up with the collie.
- How long does it take the collie to run the last leg?
- Use your answers from parts (a) and (b) to determine whether the sheepdog catches up and passes the collie during the last leg of the relay. *Explain* your reasoning.

**CHALLENGE** Find the length and the width of the rectangle described.

- The length is 12 units more than the width. The perimeter is 7 times the width.
- The length is 4 units less than 3 times the width. The perimeter is 22 units more than twice the width.

## MIXED REVIEW

### PREVIEW

Prepare for  
Lesson 3.5  
in Exs. 56–64.

Write the fraction in simplest form. (p. 912)

56.  $\frac{5}{15}$

57.  $\frac{10}{12}$

58.  $\frac{4}{14}$

59.  $\frac{18}{48}$

Solve the equation. (p. 134)

60.  $\frac{w}{3} = 6$

61.  $\frac{x}{18} = 2$

62.  $-11 = \frac{m}{4}$

63.  $12 = \frac{z}{-9}$

64. **FOOTBALL** The average rushing yards per game for a football player is found by dividing the total rushing yards for the season by the number of games played. How many total rushing yards did a player have if he played in 12 games and averaged 22 yards per game? (p. 134)

## 3.4 Solve Equations Using Tables

**QUESTION** How can you use a spreadsheet to solve an equation with variables on both sides?

You can use a spreadsheet to solve an equation with variables on both sides by evaluating the left side of the equation and the right side of the equation using the same value of the variable. If the left side and right side are equal, then the value of the variable is a solution.

**EXAMPLE** Solve an equation using a spreadsheet

Solve  $19(x - 1) - 72 = 6x$ .

**STEP 1** Enter data and formulas

Label columns for possible solutions, left side, and right side in row 1. Enter the integers from 0 through 10 as possible solutions in column A. Then enter the formulas for the left side and the right side of the equation in columns B and C.

	A	B	C
1	Possible solutions	Left side	Right side
2	0	=19*(A2-1)-72	=6*A2
3	1	=19*(A3-1)-72	=6*A3
...	...	...	...
12	10	=19*(A12-1)-72	=6*A12

**STEP 2** Compare columns

Compare the values of the left side and the values of the right side. The left side and right side values are equal when  $x = 7$ . So, the solution is 7.

	A	B	C
1	Possible solutions	Left side	Right side
...	...	...	...
8	6	23	36
9	7	42	42
10	8	61	48

**DRAW CONCLUSIONS** Use your observations to complete these exercises

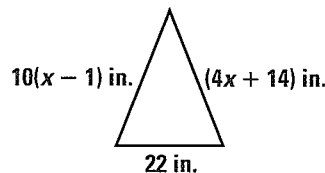
In Exercises 1–3, use a spreadsheet to solve the equation.

- $15x + 6 = 6x + 24$
- $8x - 17 = 5x + 70$
- $18 - 2(x + 3) = x$
- Not all equations have integer solutions. Consider the equation  $4.9 + 4.8(7 - x) = 6.2x$ .
  - Follow Step 1 above using  $4.9 + 4.8(7 - x) = 6.2x$ .
  - Add a fourth column that shows the difference of the value of the left side and the value of the right side. Find consecutive possible solutions between which the differences of the values of the left side and right side change sign.
  - Repeat Step 1. This time use the lesser of the two possible solutions from part (b) as the first possible solution, and increase each possible solution by 0.1. Can you identify a solution now? If so, what is it?



## Lessons 3.1–3.4

- MULTI-STEP PROBLEM** A phone company charges \$.25 for the first minute of a long-distance call and \$.07 for each additional minute.
  - Write an equation that gives the cost  $C$  of a long-distance call as a function of the length  $t$  (in minutes) of the call.
  - Find the duration of a long-distance call that costs \$2.
- GRIDDED ANSWER** A veterinary assistant steps on a scale while holding a cat. The weight of the cat and assistant is 175 pounds. The assistant weighs 162 pounds. Find the weight (in pounds) of the cat.
- EXTENDED RESPONSE** A bowling alley charges \$1.50 for bowling shoes and \$3.75 for each game. Paul and Brandon each have \$15 to spend at the bowling alley.
  - Paul brings his own bowling shoes. How many games can he bowl?
  - Brandon needs to pay for bowling shoes. How many games can he bowl? Round your answer down to the nearest whole number.
  - Both Paul and Brandon decide to bowl the number of games that Brandon can afford to bowl. Does Paul have enough money to buy a slice of pizza and a soda that cost a total of \$3.25? *Explain* your reasoning.
- GRIDDED ANSWER** The triangle has a perimeter of 82 inches. What is  $x$ ?



- SHORT RESPONSE** You are folding origami cranes that will be used as decorations at a wedding. If you make cranes for 1 hour without a break, you can make 40 cranes. During a 3 hour period, you make 100 cranes. How much time did you spend *not* making cranes? *Explain* your reasoning.

- SHORT RESPONSE** A ski resort offers a super-saver pass for \$90. The lift ticket rates with and without the super-saver pass are listed below.



Pass	Weekday lift ticket	Weekend/holiday lift ticket
With	\$22.50	\$36.00
Without	\$45.00	\$48.00

Suppose a skier skis only on weekdays. After how many visits to the ski resort will the cost for the super-saver pass and the lift tickets be equal to the cost of the lift tickets without the pass? *Explain* your reasoning.

- SHORT RESPONSE** The eruption of Mount St. Helens in 1980 decreased its elevation by 1313 feet. The current elevation is 8364 feet. What was the elevation of the volcano before the eruption? *Explain* your reasoning.
- EXTENDED RESPONSE** A garden supply store sells daffodil bulbs for \$.60 per bulb.
  - Jen spends \$24 on daffodil bulbs. How many daffodil bulbs did she purchase?
  - Jen decides to plant the daffodil bulbs along one side of her house that is 30 feet long. How many inches apart should she plant the bulbs so that they are equally spaced?
  - Jen thinks that the daffodils will look better if the bulbs are planted 6 inches apart. How many more bulbs does she need? *Explain* your reasoning.
- OPEN-ENDED** Describe a real-world situation that can be modeled by the equation  $4x + 15 = 47$ . Then solve the equation and explain what your solution means in this situation.

# 3.5 EXERCISES

**HOMEWORK KEY:**

- = WORKED-OUT SOLUTIONS on p. WS6 for Exs. 17 and 49
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 19, 20, 43, and 54
- ◆ = MULTIPLE REPRESENTATIONS Ex. 52

## SKILL PRACTICE

1. **VOCABULARY** Copy and complete: A proportion is an equation that states that two   ? are equivalent.

2. ★ **WRITING** Write a ratio of two quantities in three different ways.

**SIMPLIFYING RATIOS** Tell whether the ratio is in simplest form. If not, write it in simplest form.

3. 14 to 18

4. 5:13

5.  $\frac{24}{25}$

6. 28 to 32

**EXAMPLE 2**

on p. 163  
for Exs. 7–22

**SOLVING PROPORTIONS** Solve the proportion. Check your solution.

7.  $\frac{2}{5} = \frac{x}{3}$

8.  $\frac{4}{1} = \frac{z}{16}$

9.  $\frac{c}{8} = \frac{11}{4}$

10.  $\frac{36}{12} = \frac{x}{2}$

11.  $\frac{16}{7} = \frac{m}{21}$

12.  $\frac{k}{9} = \frac{10}{18}$

13.  $\frac{5}{8} = \frac{t}{24}$

14.  $\frac{d}{5} = \frac{80}{100}$

15.  $\frac{v}{20} = \frac{8}{4}$

16.  $\frac{r}{60} = \frac{40}{50}$

17.  $\frac{16}{48} = \frac{n}{36}$

18.  $\frac{49}{98} = \frac{s}{112}$

19. ★ **MULTIPLE CHOICE** What is the value of  $x$  in the proportion  $\frac{8}{5} = \frac{x}{20}$ ?

(A) 2

(B) 23

(C) 32

(D) 40

20. ★ **MULTIPLE CHOICE** What is the value of  $z$  in the proportion  $\frac{z}{15} = \frac{28}{35}$ ?

(A) 8

(B) 12

(C) 18.75

(D) 425

**ERROR ANALYSIS** Describe and correct the error in solving the proportion.

21.

$$\begin{aligned} \frac{3}{4} &= \frac{x}{6} \\ \frac{1}{6} \cdot \frac{3}{4} &= \frac{1}{6} \cdot \frac{x}{6} \\ \frac{1}{8} &= x \end{aligned}$$



22.

$$\begin{aligned} \frac{m}{10} &= \frac{50}{20} \\ 10 \cdot \frac{m}{10} &= 20 \cdot \frac{50}{20} \\ m &= 50 \end{aligned}$$



**WRITING AND SOLVING PROPORTIONS** Write the sentence as a proportion. Then solve the proportion.

23. 3 is to 8 as  $x$  is to 32.

24. 5 is to 7 as  $a$  is to 49.

25.  $x$  is to 4 as 8 is to 16.

26.  $y$  is to 20 as 9 is to 5.

27.  $b$  is to 10 as 7 is to 2.

28. 4 is to 12 as  $n$  is to 3.

29. 12 is to 18 as  $d$  is to 27.

30.  $t$  is to 21 as 40 is to 28.

**SOLVING PROPORTIONS** Solve the proportion. Check your solution.

31.  $\frac{b}{0.5} = \frac{9}{2.5}$

32.  $\frac{1.1}{1.2} = \frac{n}{3.6}$

33.  $\frac{2.1}{7.7} = \frac{v}{8.8}$

34.  $\frac{36}{54} = \frac{2x}{6}$

35.  $\frac{3a}{4} = \frac{36}{12}$

36.  $\frac{10h}{108} = \frac{5}{9}$

37.  $\frac{6r}{10} = \frac{36}{15}$

38.  $\frac{12}{42} = \frac{4w}{56}$

39.  $\frac{m+3}{8} = \frac{40}{64}$

40.  $\frac{5}{13} = \frac{k-4}{39}$

41.  $\frac{7}{112} = \frac{c-3}{8}$

42.  $\frac{6+n}{60} = \frac{15}{90}$

43. **★ SHORT RESPONSE** Is it possible to write a proportion using the numbers 3, 4, 6, and 8? *Explain* your reasoning.

44. **CHALLENGE** If  $\frac{a}{b} = \frac{c}{d}$  for nonzero numbers  $a$ ,  $b$ ,  $c$ , and  $d$ , is it also true that  $\frac{a}{c} = \frac{b}{d}$ ? *Explain*.

**PROBLEM SOLVING**

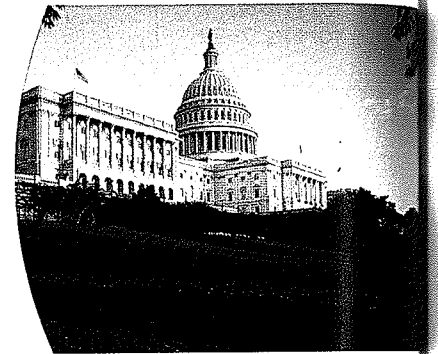
**EXAMPLE 1**  
on p. 162  
for Exs. 45–49

45. **GOVERNMENT** There are 435 representatives in the U.S. House of Representatives. Of the 435 representatives, 6 are from Kentucky. Find the ratio of the number of representatives from Kentucky to the total number of representatives.

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46. **CONTEST** Of the 30 champions of the National Spelling Bee from 1974 to 2003, 16 are boys. Find the ratio of the number of champions who are girls to the number who are boys.

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**PIZZA SALES** The table shows the number of pizzas sold at a pizzeria during a week. Use the information to find the specified ratio.

- 47. Small pizzas to large pizzas
- 48. Medium pizzas to large pizzas
- 49. Large pizzas to all pizzas

Size	Small	Medium	Large
Pizzas	96	144	240

**EXAMPLE 3**  
on p. 164  
for Exs. 50–52

- 50. **READING** A student can read 7 pages of a book in 10 minutes. How many pages of the book can the student read in 30 minutes?
- 51. **SOCCER** In the first 4 games of the season, a soccer team scored a total of 10 goals. If this trend continues, how many goals will the team score in the 18 remaining games of the season?
- 52. **◆ MULTIPLE REPRESENTATIONS** A movie is filmed so that the ratio of the length to the width of the image on the screen is 1.85 : 1.
  - a. **Writing a Proportion** Write and solve a proportion to find the length of the image on the screen when the width of the image is 38 feet.
  - b. **Making a Table** Make a table that shows the length of an image when the width of the image is 20, 25, 30, 35, and 40 feet. Use your table to check the reasonableness of your answer to part (a).

53. **MULTI-STEP PROBLEM** One day, the ratio of skiers to snowboarders on the mountain at a ski resort was 13 : 10. The resort sold a total of 253 lift tickets during the day.
- Find the ratio of snowboarders on the mountain to all of the skiers and snowboarders on the mountain.
  - Use the ratio from part (a) to find the number of lift tickets sold to snowboarders during the day.
  - During the same day, the ratio of snowboarders who rented snowboards to snowboarders that have their own snowboards is 4 : 7. Find the number of snowboarders who rented a snowboard.
54. ★ **EXTENDED RESPONSE** You and a friend are waiting in separate lines to purchase concert tickets.
- Interpret** Every 10 minutes, the cashier at the head of your line helps 3 people. There are 11 people in line in front of you. Write a proportion that can be used to determine how long you will have to wait to purchase tickets.
  - Interpret** Every 5 minutes, the cashier at the head of your friend's line helps 2 people. There are 14 people in line in front of your friend. Write a proportion that can be used to determine how long your friend will have to wait to purchase tickets.
  - Compare** Will you or your friend be able to purchase concert tickets first? *Explain.*
55. **CHALLENGE** A car traveling 50 miles per hour goes 15 miles farther in the same amount of time as a car traveling 30 miles per hour. Find the distance that each car travels.

## MIXED REVIEW

Tell whether the pairing is a function. (p. 35)

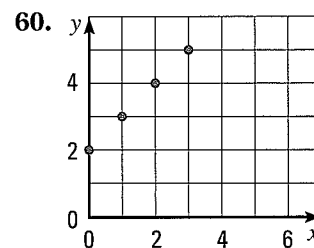
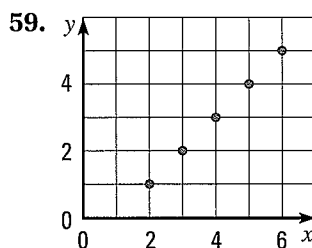
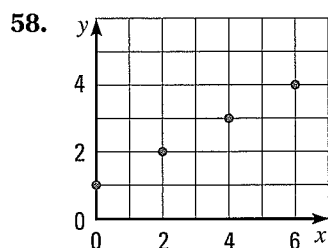
56.

Input	-4	-2	0	2	2
Output	2	2	0	-1	-2

57.

Input	-1	0	1	2	3
Output	5	5	5	5	5

Write a rule for the function represented by the graph. Identify the domain and range of the function. (p. 43)



Solve the equation. Check your solution.

61.  $-2y = 18$  (p. 134)

62.  $20x = 40$  (p. 134)

63.  $56 = 7(z + 5)$  (p. 148)

64.  $16(r + 3) = -48$  (p. 148)

65.  $5(c - 12) = 2c$  (p. 154)

66.  $b + 11 = 3(b - 1)$  (p. 154)

### PREVIEW

Prepare for  
Lesson 3.6  
in Exs. 61–66.





# 3.6 EXERCISES

## HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS7 for Exs. 13 and 39
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 15, 16, 41, and 42
- ◆ = MULTIPLE REPRESENTATIONS Ex. 40

### SKILL PRACTICE

1. **VOCABULARY** Copy and complete: In a proportion, a(n)   ? is the product of the numerator of one ratio and the denominator of the other ratio.
2. ★ **WRITING** A scale drawing has a scale of 1 cm : 3 m. *Explain* how the scale can be used to find the actual distance between objects in the drawing.

#### EXAMPLES 1 and 2

on pp. 168–169  
for Exs. 3–18

#### SOLVING PROPORTIONS Solve the proportion. Check your solution.

- |                                    |                                    |                                      |                                        |
|------------------------------------|------------------------------------|--------------------------------------|----------------------------------------|
| 3. $\frac{2}{3} = \frac{4}{x}$     | 4. $\frac{3}{y} = \frac{15}{35}$   | 5. $\frac{13}{6} = \frac{52}{z}$     | 6. $\frac{10}{45} = \frac{v}{27}$      |
| 7. $\frac{5m}{6} = \frac{10}{12}$  | 8. $\frac{3k}{27} = \frac{2}{3}$   | 9. $\frac{-49}{7} = \frac{a+7}{6}$   | 10. $\frac{6}{t+4} = \frac{42}{77}$    |
| 11. $\frac{8}{12} = \frac{r}{r+1}$ | 12. $\frac{n}{n-12} = \frac{9}{5}$ | 13. $\frac{11}{w} = \frac{33}{w+24}$ | 14. $\frac{18}{d+13} = \frac{6}{d-13}$ |

15. ★ **MULTIPLE CHOICE** What is the value of  $h$  in the proportion  $\frac{15}{-2h} = \frac{5}{12}$ ?

- (A) -36      (B) -18      (C) 18      (D) 36

16. ★ **MULTIPLE CHOICE** What is the value of  $s$  in the proportion  $\frac{7}{s-14} = \frac{21}{s+18}$ ?

- (A) -48      (B) -16      (C) 3      (D) 30


#### ERROR ANALYSIS Describe and correct the error in solving the proportion.

17.

$$\frac{4}{3} = \frac{16}{x}$$

$$4 \cdot 16 = 4 \cdot x$$

$$64 = 4x$$


$$16 = x$$


18.

$$\frac{18}{14} = \frac{b+2}{b}$$

$$18b = 14b + 2$$

$$4b = 2$$

$$b = 0.5$$


#### SOLVING PROPORTIONS Solve the proportion. Check your solution.

- |                                         |                                         |                                       |                                            |
|-----------------------------------------|-----------------------------------------|---------------------------------------|--------------------------------------------|
| 19. $\frac{7}{3} = \frac{2x+5}{x}$      | 20. $\frac{a}{9a-2} = \frac{1}{8}$      | 21. $\frac{24}{5z+4} = \frac{4}{z-1}$ | 22. $\frac{c-8}{-2} = \frac{11-4c}{11}$    |
| 23. $\frac{k-8}{7+k} = \frac{-1}{5}$    | 24. $\frac{2}{-3} = \frac{4v+4}{2v+14}$ | 25. $\frac{m+1}{4} = \frac{3m+6}{7}$  | 26. $\frac{6}{4+2w} = \frac{-2}{w-10}$     |
| 27. $\frac{n+0.3}{n-3.2} = \frac{9}{2}$ | 28. $\frac{-3}{11} = \frac{5-h}{h+1.4}$ | 29. $\frac{4}{b-3.9} = \frac{2}{b+1}$ | 30. $\frac{16.5+3t}{3} = \frac{0.9-t}{-5}$ |

31. **REASONING** The statements below justify the cross products property. Copy and complete the justification.

$$\frac{a}{b} = \frac{c}{d}$$

Given

$$bd \cdot \frac{a}{b} = bd \cdot \frac{c}{d}$$

a.     ?

$$\frac{bd \cdot a}{b} = \frac{bd \cdot c}{d}$$

b.     ?

$$ad = cb$$

c.     ?

32. **CHALLENGE** In the proportion  $\frac{5}{h} = \frac{k}{14}$ , what happens to the value of  $h$  as the value of  $k$  increases? *Explain.*

## PROBLEM SOLVING

### EXAMPLE 3

on p. 169

for Exs. 33–34

33. **RECIPES** A recipe that yields 12 buttermilk biscuits calls for 2 cups of flour. How much flour is needed to make 30 biscuits?

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34. **DIGITAL PHOTOGRAPHS** It took 7.2 minutes to upload 8 digital photographs from your computer to a website. At this rate, how long will it take to upload 20 photographs?

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### EXAMPLE 4

on p. 170

for Exs. 35–39

- MAPS** A map has a scale of 1 cm : 15 km. Use the given map distance to find the actual distance.

35. 6 cm

36. 3.2 cm

37. 0.5 cm

38. 4.7 cm

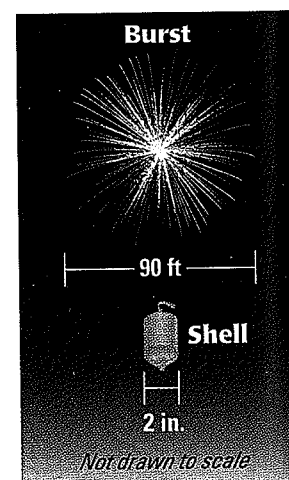
39. **SCALE MODEL** An exhibit at Tobu World Square in Japan includes a scale model of the Empire State Building. The model was built using a scale of 1 m : 25 m. The height of the actual Empire State Building is 443.2 meters. What is the height of the model?

40. **MULTIPLE REPRESENTATIONS** The diameter of the burst of a firework is proportional to the diameter of the shell of the firework.

a. **Writing a Proportion** Use the information in the diagram to find the burst diameter for a 4.75 inch shell.

b. **Making a Table** Make a table of burst diameters for 2, 3, 4, 5, and 6 inch shells. Use the table to check your answer to part (a).

41. **★ SHORT RESPONSE** The ratio of the length of a soccer field to the width of the field is 3 : 2. A scale drawing of a soccer field has a scale of 1 in. : 20 yd. The length of the field in the drawing is 6 inches. What is the actual width of the field? *Explain* your reasoning.



42. ★ **EXTENDED RESPONSE** A mole is a unit of measurement used in chemistry. The masses of one mole of three elements are in the table.

Element	Mass of 1 mole
Hydrogen	1.008 grams
Carbon	12.011 grams
Oxygen	15.999 grams

- a. A 100 gram sample of ascorbic acid contains 4.58 grams of hydrogen. To the nearest tenth, find the number of moles of hydrogen.
- b. A 100 gram sample of ascorbic acid contains 54.5 grams of oxygen. To the nearest tenth, find the number of moles of oxygen in the sample.
- c. The ratio of moles of hydrogen to moles of carbon in ascorbic acid is 4:3. How does this ratio compare with the ratio of moles of hydrogen to moles of oxygen in ascorbic acid? *Explain.*
43. **CHALLENGE** At a typical National Football League game, the ratio of females to males in attendance is 2:3. Estimate the number of male and female spectators at a game that has 75,000 spectators.

### MIXED REVIEW

Evaluate the expression for the given value of  $x$ . (p. 110)

44.  $16 + \sqrt{x}$  when  $x = 16$

45.  $27 - \sqrt{x}$  when  $x = 81$

46.  $-3 \cdot \sqrt{x}$  when  $x = 25$

47.  $2 \cdot \sqrt{x} + 11$  when  $x = 144$

Solve the proportion. Check your solution. (p. 162)

48.  $\frac{2}{3} = \frac{x}{21}$

49.  $\frac{m}{6} = \frac{9}{2}$

50.  $\frac{z}{11} = \frac{-10}{22}$

51.  $\frac{12}{5} = \frac{b}{25}$

52.  $\frac{12}{36} = \frac{2c}{6}$

53.  $\frac{9}{-8} = \frac{3w}{24}$

54.  $\frac{n-2}{50} = \frac{6}{30}$

55.  $\frac{4}{13} = \frac{a+4}{39}$

**PREVIEW**  
Prepare for  
Lesson 3.7 in  
Exs. 48–55.

### QUIZ for Lessons 3.4–3.6

Solve the equation, if possible. (p. 154)

1.  $y - 2 = y + 2$

2.  $2x - 14 = -3x + 6$

3.  $10z - 4 = 2(5z - 2)$

4.  $6m + 5 - 3m = 7(m - 1)$

5.  $2(7 - g) = 9g + 14 - 11g$

6.  $13k + 3(k + 11) = 8k - 7$

7.  $\frac{1}{4}(8j - 3) = 2j - 3$

8.  $8 - 4w = \frac{1}{3}(6w - 12)$

9.  $\frac{2}{5}(10t - 50) = 4(9 - 6t)$

Solve the proportion. Check your solution. (pp. 162, 168)

10.  $\frac{24}{20} = \frac{x}{5}$


11.  $\frac{6}{-7} = \frac{3z}{42}$

12.  $\frac{14}{12} = \frac{w + 11}{18}$

13.  $\frac{18}{5a} = \frac{3}{-5}$

14.  $\frac{10}{17} = \frac{k}{2k - 3}$

15.  $\frac{h - 1}{3} = \frac{2h + 1}{9}$

16.  **GEOMETRY** The ratio of the length to the width of a rectangle is 5:4. The length of the rectangle is 60 inches. What is the width? (p. 168)

# Extension

Use after Lesson 3.6

## Apply Proportions to Similar Figures

**GOAL** Use similar figures to solve problems.

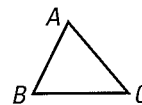
### Key Vocabulary

- congruent figures
- similar figures
- corresponding parts

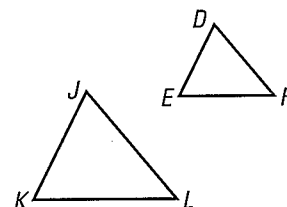
### NAME SIMILAR FIGURES

When naming similar figures, list the letters of the corresponding vertices (corner points) in the same order.

Two figures are **congruent figures** if they have the same shape and size. The symbol  $\cong$  indicates congruence. Of the triangles shown,  $\triangle ABC \cong \triangle DEF$ .



Two figures are **similar figures** if they have the same shape but not necessarily the same size. The symbol  $\sim$  indicates that two figures are similar. All the triangles shown are similar; in particular,  $\triangle ABC \sim \triangle JKL$ .



The sides or angles that have the same relative position within two figures are called **corresponding parts**.

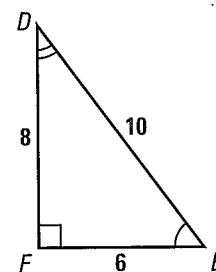
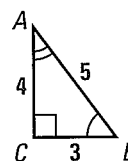
### KEY CONCEPT

For Your Notebook

#### Properties of Similar Figures

In the diagram,  $\triangle ABC \sim \triangle DEF$ .

1. Corresponding angles of similar figures are congruent.  
 $\angle A \cong \angle D, \angle B \cong \angle E, \angle C \cong \angle F$
2. The ratios of the lengths of corresponding sides of similar figures are equal.



### NAME LENGTHS OF SIDES

$AB$  represents the length of the side whose endpoints are  $A$  and  $B$ .

### EXAMPLE 1

#### Find an unknown side length

Given  $\triangle JKL \sim \triangle QRS$ , find  $QR$ .

#### Solution

Use the ratios of the lengths of corresponding sides to write a proportion.

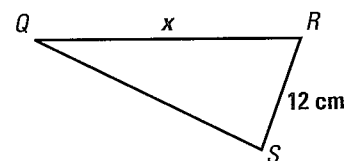
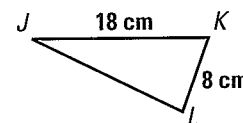
$$\frac{JK}{QR} = \frac{KL}{RS} \quad \text{Write proportion involving } QR.$$

$$\frac{18}{x} = \frac{8}{12} \quad \text{Substitute.}$$

$$216 = 8x \quad \text{Cross products property}$$

$$27 = x \quad \text{Divide each side by 8.}$$

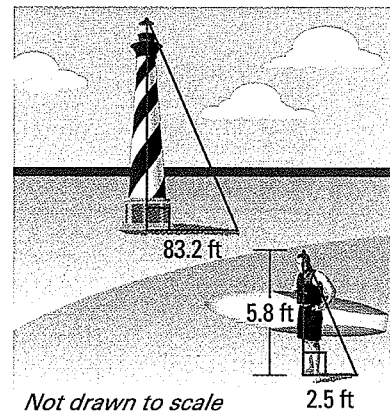
►  $QR$  is 27 centimeters.



**INDIRECT MEASUREMENT** You can use similar figures to find lengths that are difficult to measure directly.

**EXAMPLE 2** Use similar figures to measure indirectly

**CAPE HATTERAS LIGHTHOUSE** A man stands next to the Cape Hatteras Lighthouse in North Carolina. The lighthouse and the man are perpendicular to the ground. The sun's rays strike the lighthouse and the man at the same angle, forming two similar triangles. Use indirect measurement to approximate the height of the lighthouse.



**Solution**

Write and solve a proportion to find the height  $h$  (in feet) of the lighthouse.

**ANOTHER WAY**

You can also use the proportion below to find the height of the lighthouse.

$$\frac{5.8}{2.5} = \frac{h}{83.2}$$

$$\begin{array}{l} \text{height} \longrightarrow \frac{5.8}{h} = \frac{2.5}{83.2} \longleftarrow \text{length of shadow} \\ \text{height} \longrightarrow \frac{5.8}{h} = \frac{2.5}{83.2} \longleftarrow \text{length of shadow} \end{array}$$

$$2.5h = 5.8 \cdot 83.2 \quad \text{Cross products property}$$

$$2.5h = 482.56 \quad \text{Multiply.}$$

$$h = 193.024 \quad \text{Divide each side by 2.5.}$$

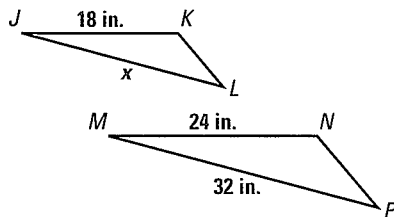
► The height of the lighthouse is about 193 feet.

**PRACTICE**

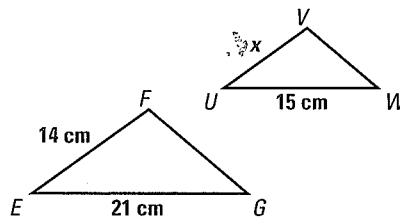
**EXAMPLE 1**

on p. 174  
for Exs. 1–4

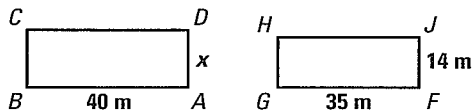
1. Given  $\triangle JKL \sim \triangle MNP$ , find  $JL$ .



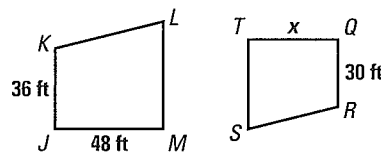
2. Given  $\triangle EFG \sim \triangle UVW$ , find  $UV$ .



3. Given  $ABCD \sim FGHI$ , find  $AD$ .



4. Given  $JKLM \sim QRST$ , find  $QT$ .



**EXAMPLE 2**

on p. 175  
for Ex. 5

5. **FLAGPOLES** A 5 foot tall student stands near a flagpole. The flagpole and the student are perpendicular to the ground. The sun's rays strike the flagpole and the student at the same angle, forming two similar triangles. The flagpole casts a 15 foot shadow, and the student casts a 2 foot shadow. Use indirect measurement to find the height of the flagpole.

**Types of Percent Problems**

Percent problem	Example	Equation
Find a percent.	What percent of 136 is 51?	$51 = p\% \cdot 136$
Find part of a base.	What number is 15% of 88?	$a = 15\% \cdot 88$
Find a base.	20 is 12.5% of what number?	$20 = 12.5\% \cdot b$

# 3.7 EXERCISES

**HOMEWORK KEY**

- = WORKED-OUT SOLUTIONS on p. WS7 for Exs. 13 and 35
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 19, 30, 31, 38, and 39

**SKILL PRACTICE**

1. **VOCABULARY** Identify the percent, the base, and the part of the base in the following statement: 54 is 15% of 360.

2. ★ **WRITING** Rewrite the statement "28 is 35% of 80" in the form  $\frac{a}{b} = \frac{p}{100}$ . Explain how you identified the values of  $a$ ,  $b$ , and  $p$ .

**EXAMPLE 1**  
on p. 176  
for Exs. 3–8

**USING PROPORTIONS** Use a proportion to answer the question.

- |                              |                               |
|------------------------------|-------------------------------|
| 3. What percent of 75 is 27? | 4. What percent of 120 is 66? |
| 5. What number is 35% of 80? | 6. What number is 60% of 85?  |
| 7. 81 is 54% of what number? | 8. 42 is 200% of what number? |

**EXAMPLES 2, 3, and 4**  
on pp. 177–178  
for Exs. 9–21

**USING THE PERCENT EQUATION** Use the percent equation to answer the question.

- |                                                           |                                 |
|-----------------------------------------------------------|---------------------------------|
| 9. What percent of 80 is 56?                              | 10. What percent of 225 is 99?  |
| 11. What percent of 153 is 9.18?                          | 12. What number is 18% of 150?  |
| 13. What number is 115% of 60?                            | 14. What number is 82% of 215?  |
| 15. 7 is 28% of what number?                              | 16. 189 is 90% of what number?  |
| 17. 41.8 is 44% of what number?                           | 18. 71.5 is 52% of what number? |
| 19. ★ <b>MULTIPLE CHOICE</b> What number is 87.5% of 512? |                                 |
| (A) 5.85                                                  | (B) 448                         |
| (C) 585                                                   | (D) 4480                        |

**ERROR ANALYSIS** Describe and correct the error in answering the question.

20. What percent of 95 is 19?                      21. 153 is 76.5% of what number?

$$\begin{aligned} 95 &= p\% \cdot 19 \\ 5 &= p\% \\ 500\% &= p\% \end{aligned}$$



$$\begin{aligned} 153 &= 76.5\% \cdot b \\ 153 &= 76.5 \cdot b \\ 2 &= b \end{aligned}$$



**SOLVING PERCENT PROBLEMS** Answer the question when  $n = 25$ .

22. What percent of 140 is  $(n + 94)$ ?                      23. What percent of  $(4n)$  is 96?  
 24. What number is 52% of  $(2n + 15)$ ?                      25. 25.5 is  $(n - 8)\%$  of what number?

**SOLVING PERCENT PROBLEMS** Find the percent. Round your answer to the nearest whole percent, if necessary.

26. \$3.00 tip for a \$18.70 taxi fare                      27. \$1.44 tax on an item priced at \$24.00  
 28. 90 rock CDs out of 125 CDs                      29. 241 freshmen out of 804 students  
 30. ★ **WRITING** Would you use a proportion or the percent equation to solve the following problem: What number is 25% of 600? *Explain.*  
 31. ★ **SHORT RESPONSE** The side length of a square is 40% of the side length of another square. Is the area of the smaller square 40% of the area of the larger square? *Explain.*  
 32. **CHALLENGE** Let  $y$  be 10% of a number. What is 50% of the number? Write your answer in terms of  $y$ .

**PROBLEM SOLVING**

**EXAMPLE 5**  
 on p. 178  
 for Exs. 33–36

33. **SCHOOL TRANSPORTATION** In a school transportation survey of 225 students, 18 of the students surveyed said that they walk to school. What percent of the students surveyed walk to school?

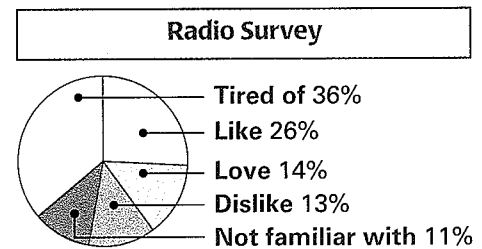
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34. **DAYTONA 500** After completing 10 laps in the Daytona 500, a driver has completed 5% of the race. How many laps does the race have?

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**REVIEW**  
**CIRCLE**  
**GRAPHS**  
 For help with using a circle graph, see p. 935.

35. **MUSIC** The circle graph shows the results of a radio survey in which 250 listeners were asked to rate a song.  
 a. How many of the listeners who participated in the survey are “tired of” the song?  
 b. How many of the listeners who participated in the survey “love” the song?



36. **HIKING** The table gives data about the number of people who started hiking the Appalachian Trail in Georgia and the number of those people who completed the trail in Maine. Copy and complete the table.

Year	Hikers who started	Hikers who completed	Percent completion
2001	2380	?	16.6%
2002	?	376	20%
2003	1750	352	?



37. **ART** The Louvre Museum, which is an art museum in France, has virtual tours of its exhibits on its website. The website can be viewed in four different languages. The table shows the number of hits received by each version of the website during one day. Find the percent of hits for each version of the website.

Version	English	French	Spanish	Japanese
Number of hits	4860	1350	1080	900

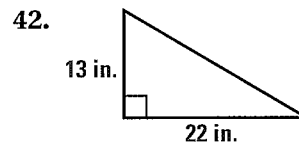
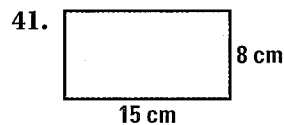
38. **★ OPEN-ENDED** Write a real-world percent problem that can be solved using the proportion  $\frac{x}{75} = \frac{15}{100}$ . Then find the value of  $x$  and explain what the solution means in this situation.
39. **★ EXTENDED RESPONSE** Two different stores are selling a bicycle that you want to buy.
- Solve** At one store, the bicycle is on sale for 20% off the original price of \$240. How much money will you save by purchasing the bicycle on sale at this store?
  - Solve** At the other store, the bicycle is on sale for 25% off the original price of \$265. How much money will you save by purchasing the bicycle on sale at this store?
  - Compare** Which bicycle should you buy? *Explain.*
40. **CHALLENGE** Julia deposits 20% of her paycheck in her savings account. Then she deposits 60% of the remaining money in her checking account. She deposits \$108.24 in her checking account. How much money did she deposit in her savings account?

## MIXED REVIEW

### PREVIEW

Prepare for  
Lesson 3.8 in  
Exs. 41–46.

Find the area of the triangle or rectangle. (p. 924)



Make a table for the function. Identify the range of the function. (p. 35)

43.  $y = x - 7$   
Domain:  $-5, -2, 1, 4$

44.  $y = x + 4$   
Domain:  $-6, -4, -2, 0$

45.  $y = 6x + 3$   
Domain:  $-1, 1, 3, 5$

46.  $y = 5x - 5$   
Domain:  $-2, -1, 0, 1$

Find the sum or difference.

47.  $-65 + (-27)$  (p. 74)

48.  $33 + (-58)$  (p. 74)

49.  $-43.9 + 89.4$  (p. 74)

50.  $91.2 - (-20.3)$  (p. 80)

51.  $-13 - 78$  (p. 80)

52.  $28 - (-35)$  (p. 80)



## Extension

Use after Lesson 3.7

# Find Percent of Change

**GOAL** Solve percent of change problems.

### Key Vocabulary

- percent of change
- percent of increase
- percent of decrease

A **percent of change** indicates how much a quantity increases or decreases with respect to the original amount. If the new amount is greater than the original amount, the percent of change is called a **percent of increase**. If the new amount is less than the original amount, the percent of change is called a **percent of decrease**.

### KEY CONCEPT

*For Your Notebook*

#### Percent of Change

The percent of change is the ratio of the amount of increase or decrease to the original amount.

$$\text{Percent of change, } p\% = \frac{\text{Amount of increase or decrease}}{\text{Original amount}}$$

The amount of increase is the new amount minus the original amount.  
The amount of decrease is the original amount minus the new amount.

### EXAMPLE 1 Find a percent of change

Identify the percent of change as an *increase* or *decrease*. Then find the percent of change.

a. Original: 140  
New: 189

b. Original: 70  
New: 59.5

#### Solution

a. Because the new amount is greater than the original amount, the percent of change is an increase.

$$\begin{aligned} p\% &= \frac{\text{Amount of increase}}{\text{Original amount}} \\ &= \frac{189 - 140}{140} \\ &= \frac{49}{140} \\ &= 0.35 \\ &= 35\% \end{aligned}$$

▶ The percent of increase is 35%.

b. Because the new amount is less than the original amount, the percent of change is a decrease.

$$\begin{aligned} p\% &= \frac{\text{Amount of decrease}}{\text{Original amount}} \\ &= \frac{70 - 59.5}{70} \\ &= \frac{10.5}{70} \\ &= 0.15 \\ &= 15\% \end{aligned}$$

▶ The percent of decrease is 15%.

#### CHECK

##### REASONABLENESS

Because 50 is one third (about 33%) of 150, it is reasonable that 49 is 35% of 140.

**FINDING A NEW AMOUNT** If you know the original amount and the percent of change, you can find the new amount.

- For a  $p\%$  increase, multiply the original amount by  $(100\% + p\%)$ .
- For a  $p\%$  decrease, multiply the original amount by  $(100\% - p\%)$ .

**EXAMPLE 2** Find a new amount

**SHOPPING** Find the sale price of the pair of jeans described in the table.

Original price	\$48.00
Discount	40%
Sale price	?

**Solution**

The sale price is a decrease from the original price, so multiply the original price by  $(100\% - p\%)$ .

$$\begin{aligned} \text{Sale price} &= \text{Original price} \cdot (100\% - p\%) \\ &= 48 \cdot (100\% - 40\%) && \text{Substitute.} \\ &= 48 \cdot 0.6 && \text{Subtract percents. Then write as a decimal.} \\ &= 28.8 && \text{Multiply.} \end{aligned}$$

▶ The sale price of the pair of jeans is \$28.80.

**ANOTHER WAY**

You can also find the sale price by first finding the change in price:

$$0.4 \cdot 48 = 19.2.$$

Then subtract the change in price from the original price:

$$\$48.00 - \$19.20 = \$28.80.$$

**PRACTICE**

**EXAMPLE 1**

on p. 182  
for Exs. 1–6

Identify the percent of change as an *increase* or *decrease*. Then find the percent of change.

- |                             |                                |                                |
|-----------------------------|--------------------------------|--------------------------------|
| 1. Original: 16<br>New: 20  | 2. Original: 35<br>New: 49     | 3. Original: 80<br>New: 44     |
| 4. Original: 120<br>New: 78 | 5. Original: 360<br>New: 241.2 | 6. Original: 170<br>New: 283.9 |

**EXAMPLE 2**

on p. 183  
for Exs. 7–14

Find the new amount.

- |                        |                          |
|------------------------|--------------------------|
| 7. Increase 14 by 45%. | 8. Increase 78 by 80%.   |
| 9. Decrease 44 by 20%. | 10. Decrease 108 by 90%. |

11. **SUBWAY** The price for a token to ride a city's subway system is changing from \$1.25 to \$1.50. Find the percent of change.

12. **DVDS** The average price of a new DVD in 1998 was \$24. In 2003, the average price was \$21.12. Find the percent of change.

13. **POPULATION** In Arizona, the population increased by 48.6% from 1990 to 2002. Use the information in the table to find the population density in Arizona in 2002.

Year	Population density
1990	32.3 people per square mile
2002	?

14. **DEPRECIATION** A new car is valued at \$14,500. In one year, the car's value will depreciate, or decrease, by 15%. Find the value of the car after one year.

# 3.8 EXERCISES

## HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS7 for Exs. 17 and 33
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 23, 29, 35, and 36
- ◆ = MULTIPLE REPRESENTATIONS Ex. 34

### SKILL PRACTICE

- VOCABULARY** Copy and complete: When you write the equation  $3x + 2 = 8$  as  $ax + b = c$ , the equation  $ax + b = c$  is called a(n) ? because the coefficients and constants have been replaced by letters.
- ★ **WRITING** Describe the steps you would take to solve  $I = prt$  for  $t$ .


**EXAMPLE 1**  
on p. 184  
for Exs. 3–10

**LITERAL EQUATIONS** Solve the literal equation for  $x$ . Then use the solution to solve the specific equation.


- $ax = bx - c$ ;  $8x = 3x - 10$
- $c = \frac{x+a}{b}$ ;  $2 = \frac{x+5}{7}$
- $\frac{x}{a} + b = c$ ;  $\frac{x}{4} + 6 = 13$
- $a(x+b) = c$ ;  $2(x+1) = 9$
- $\frac{x}{a} = \frac{b}{c}$ ;  $\frac{x}{8} = \frac{4.5}{12}$
- $ax + b = cx - d$ ;  $2x + 9 = 7x - 1$

**ERROR ANALYSIS** Describe and correct the error in solving the equation for  $x$ .

9.  $ax + b = 0$   
 $ax = b$   
 $x = \frac{b}{a}$



10.  $c = ax - bx$   
 $c = (a - b)x$   
 $c(a - b) = x$



**EXAMPLE 2**  
on p. 185  
for Exs. 11–19

**REWRITING EQUATIONS** Write the equation so that  $y$  is a function of  $x$ .

- $2x + y = 7$
- $5x + 4y = 10$
- $12 = 9x + 3y$
- $18x - 2y = 26$
- $14 = 7y - 6x$
- $8x - 8y = 5$
- $30 = 9x - 5y$
- $3 + 6x = 11 - 4y$
- $2 + 6y = 3x + 4$

**EXAMPLE 3**  
on p. 185  
for Exs. 20–23

**REWRITING FORMULAS** Solve the formula for the indicated variable.

- Volume of a rectangular prism:  $V = lwh$ . Solve for  $w$ .
- Surface area of a prism:  $S = 2B + Ph$ . Solve for  $h$ .
- Length of movie projected at 24 frames per second:  $l = 24f$ . Solve for  $f$ .

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23. ★ **MULTIPLE CHOICE** The formula for the area of a trapezoid is

$$A = \frac{1}{2}(b_1 + b_2)h. \text{ Which equation is not equivalent to the formula?}$$

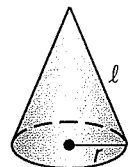
- (A)  $h = \frac{2A}{b_1 + b_2}$     (B)  $b_1 = \frac{2A}{h} - b_2$     (C)  $b_2 = \frac{2A}{b_1} - h$     (D)  $b_2 = \frac{2A}{h} - b_1$

**REWRITING EQUATIONS** Write the equation so that  $y$  is a function of  $x$ .

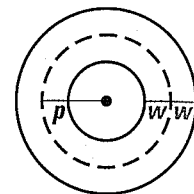
- $4.2x - 2y = 16.8$
- $9 - 0.5y = 2.5x$
- $8x - 5x + 21 = 36 - 6y$

 **GEOMETRY** Solve the formula for the indicated variable. Then evaluate the rewritten formula for the given values. (Use 3.14 for  $\pi$ .)

27. Surface area of a cone:  
 $S = \pi r\ell + \pi r^2$ .  
 Solve for  $\ell$ . Find  $\ell$  when  
 $S = 283 \text{ cm}^2$  and  $r = 5 \text{ cm}$ .



28. Area of a circular ring:  
 $A = 4\pi pw$ .  
 Solve for  $p$ . Find  $p$  when  
 $A = 905 \text{ ft}^2$  and  $w = 9 \text{ ft}$ .



29. **★ OPEN-ENDED** Describe a real-world situation where you would want to solve the distance traveled formula  $d = rt$  for  $t$ .

**CHALLENGE** Solve the literal equation for  $a$ .

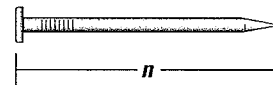
30.  $x = \frac{a + b + c}{ab}$

31.  $y = x \left( \frac{ab}{a - b} \right)$


## PROBLEM SOLVING

**EXAMPLE 4**  
 on p. 186  
 for Exs. 32–34

32. **CARPENTRY** The penny size  $d$  of a nail is given by  $d = 4n - 2$  where  $n$  is the length (in inches) of the nail.




- Solve the formula for  $n$ .
- Use the new formula to find the lengths of nails with the following penny sizes: 5, 12, 16, and 20.

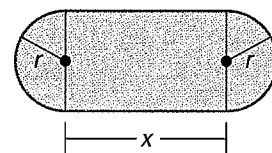
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33. **BOWLING** To participate in a bowling league, you pay a \$25 sign-up fee and \$12 for each league night that you bowl. So, the total cost  $C$  (in dollars) is given by the equation  $C = 12x + 25$  where  $x$  is the number of league nights you bowled.

- Solve the equation for  $x$ .
- How many league nights have you bowled if you spent a total of \$145? \$181? \$205?

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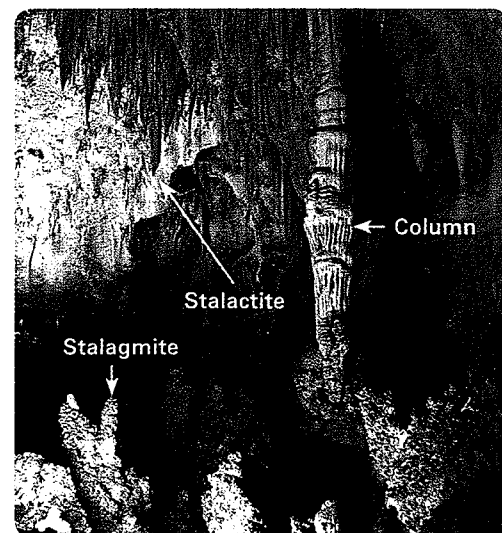
34. **◆ MULTIPLE REPRESENTATIONS** An athletic facility is building an indoor track like the one shown. The perimeter  $P$  (in feet) of the track is given by  $P = 2\pi r + 2x$ .



- Writing an Equation** Solve the formula for  $x$ .
- Making a Table** The perimeter of the track will be 660 feet. Use the rewritten formula to make a table that shows values of  $x$  to the nearest foot when  $r$  is 50 feet, 51 feet, 52 feet, and 53 feet. (Use 3.14 for  $\pi$ .)
- Drawing a Graph** Plot the ordered pairs from your table. Look for a pattern in the points. Use the pattern to find  $x$  when  $r$  is 54 feet.

35. **★ WRITING** You work as a server at a restaurant. During your shift, you keep track of the bills that you give the tables you serve and the tips you receive from the tables. You want to calculate the tip received from each table as a percent of the bill. *Explain* how to rewrite the percent equation to make it easier to calculate the percent tip from each table.

36. ★ **EXTENDED RESPONSE** One type of stone formation found in Carlsbad Caverns in New Mexico is called a column. This cylindrical stone formation is connected to the ceiling and the floor of a cave.
- Rewrite the formula for the circumference of a circle,  $C = 2\pi r$ , so that you can easily calculate the radius of a column given its circumference.
  - What is the radius, to the nearest tenth of a foot, of a column that has a circumference of 7 feet? 8 feet? 9 feet? (Use 3.14 for  $\pi$ .)
  - Explain* how you can find the *area* of a cross section of a column if you know its circumference.



37. **CHALLENGE** The distance  $d$  (in miles) traveled by a car is given by  $d = 55t$  where  $t$  is the time (in hours) the car has traveled. The distance  $d$  (in miles) traveled is also given by  $d = 20g$  where  $g$  is the number of gallons of gasoline used by the car. Write an equation that expresses  $g$  as a function of  $t$ .

## MIXED REVIEW

### PREVIEW

Prepare for  
Lesson 4.1 in  
Exs. 38–39.

**Graph the function.** (p. 43)

38.  $y = x + 4$ ; domain: 0, 2, 4, 6, and 8

39.  $y = 2x - 1$ ; domain: 1, 2, 3, 4, and 5

**Use the distributive property to write an equivalent expression.** (p. 96)

40.  $3(2x + 3)$

41.  $-2(x + 5)$

42.  $(3x - 5)(-5)$

43.  $(7x + 6)2$

**Use the percent equation to answer the question.** (p. 176)

44. What percent of 80 is 64?

45. What number is 95% of 120?

## QUIZ for Lessons 3.7–3.8

**Use the percent equation to answer the question.** (p. 176)

1. What percent of 150 is 72?

2. What percent of 310 is 93?

3. 31 is 5% of what number?


4. What number is 46% of 55?

**Write the equation so that  $y$  is a function of  $x$ .** (p. 184)

5.  $5x - 3y = 9$

6.  $3x + 2y + 5x = 12$

7.  $4(2x - y) = 6$

8.  **GEOMETRY** The volume  $V$  of a cylinder is given by the formula  $V = \pi r^2 h$  where  $r$  is the radius of the cylinder and  $h$  is the height of the cylinder. Solve the formula for  $h$ . (p. 184)

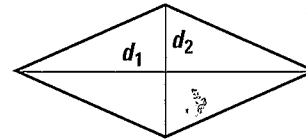


## Lessons 3.5–3.8

1. **MULTI-STEP PROBLEM** The table below shows the results of a survey in which students at a school were asked to name their favorite sport to watch on TV.

Sport	Students
Baseball	7
Basketball	6
Football	10
Other	8

- a. There are 1209 students at the school. Write a proportion that you can use to predict the number of students at the school who would name baseball as their favorite sport to watch on TV.
- b. Solve the proportion.
2. **MULTI-STEP PROBLEM** The ratio of male students to female students in the freshman class at a high school is 4:5. There are 216 students in the freshman class.
- a. Find the ratio of female students to all students.
- b. Use the ratio to find the number of female students in the freshman class.
3. **SHORT RESPONSE** During a vacation, your family's car used 7 gallons of gasoline to travel 154 miles. Your family is planning another vacation in which you will travel 770 miles by car. If gasoline costs about \$2 per gallon, how much money should your family budget for gasoline for this vacation? *Explain* your reasoning.
4. **SHORT RESPONSE** In biology, the surface-area-to-volume quotient  $Q$  of a single spherical cell is given by the formula  $Q = \frac{3}{r}$  where  $r$  is the radius of the cell. Suppose you need to calculate the diameters of cells given the surface-area-to-volume quotients of the cells. Given that  $d = 2r$ , explain how to write a formula for the diameter  $d$  of a cell given its surface-area-to-volume quotient.
5. **GRIDDED ANSWER** A basketball player made 60% of his free-throws during a season. The player made 84 free-throws. How many free-throw attempts did he have?
6. **EXTENDED RESPONSE** When a real estate agent sells a house, the agent receives 6% of the sale price as a commission. The agent lists the sale price for a house as \$208,000.
- a. How much of a commission should the agent expect to receive for selling this house at full price?
- b. The house actually sells for \$205,000. How much of a commission does the agent receive?
- c. The real estate agent gives 10% of her commission to her assistant. What percent of the selling price does the agent's assistant receive? *Explain* your reasoning.
7. **SHORT RESPONSE** The area  $A$  of a rhombus is given by the formula  $A = \frac{1}{2}d_1d_2$  where  $d_1$  and  $d_2$  are the lengths of the diagonals.



Suppose you need to find  $d_1$  for different values of  $A$  and  $d_2$ . *Explain* how to rewrite the area formula to make it easier to find values for  $d_1$ .

8. **OPEN-ENDED** Describe how the dimensions of the rectangular garden below can be altered to increase the area of the garden by 25%.



10 ft

16 ft

## BIG IDEAS

*For Your Notebook*

### Big Idea 1

#### Solving Equations in One Variable

You can solve equations in one variable by adding, subtracting, multiplying by, or dividing by the same number on each side.

Property	Words	Algebra
Addition Property of Equality	Add the same number to each side.	If $x - a = b$ , then $x - a + a = b + a$ , or $x = b + a$ .
Subtraction Property of Equality	Subtract the same number from each side.	If $x + a = b$ , then $x + a - a = b - a$ , or $x = b - a$ .
Multiplication Property of Equality	Multiply each side by the same nonzero number.	If $\frac{x}{a} = b$ and $a \neq 0$ , then $a \cdot \frac{x}{a} = a \cdot b$ , or $x = ab$ .
Division Property of Equality	Divide each side by the same nonzero number.	If $ax = b$ and $a \neq 0$ , then $\frac{ax}{a} = \frac{b}{a}$ , or $x = \frac{b}{a}$ .

### Big Idea 2

#### Solving Proportion and Percent Problems

When solving a proportion, you can take the cross products, then use properties of equality.

$$\frac{x - 3}{40} = \frac{4}{5}$$

Original proportion

$$5(x - 3) = 40 \cdot 4$$

Cross products property

$$5x - 15 = 160$$

Simplify.

$$5x = 175$$

Addition property of equality: Add 15 to each side.

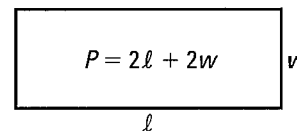
$$x = 35$$

Division property of equality: Divide each side by 5.

### Big Idea 3

#### Rewriting Equations in Two or More Variables

If you have an equation in two or more variables, you can solve for one variable in terms of the others using properties of equality. For example, the formula for the perimeter  $P$  of a rectangle can be solved for the length  $\ell$ .



$$P = 2\ell + 2w$$

Original formula

$$P - 2w = 2\ell$$

Subtraction property of equality:  
Subtract  $2w$  from each side.

$$\frac{P - 2w}{2} = \ell$$

Division property of equality:  
Divide each side by 2.

## REVIEW KEY VOCABULARY

- inverse operations, p. 134
- equivalent equations, p. 134
- identity, p. 156
- ratio, p. 162
- proportion, p. 163
- cross product, p. 168
- scale drawing, p. 170
- scale model, p. 170
- scale, p. 170
- literal equation, p. 184

## VOCABULARY EXERCISES

1. Copy and complete: A(n) ? is a two-dimensional drawing of an object in which the dimensions of the drawing are in proportion to the dimensions of the object.
2. Copy and complete: When you perform the same inverse operation on each side of an equation, you produce a(n) ? equation.
3. Explain why the equation  $2x + 8x = 3x + 7x$  is an identity.
4. Copy and complete: In the proportion  $\frac{7}{8} = \frac{28}{32}$ ,  $7 \cdot 32$  and  $8 \cdot 28$  are ?.
5. Describe the steps you would take to write the equation  $6x - 2y = 16$  in function form.

## REVIEW EXAMPLES AND EXERCISES

Use the review examples and exercises below to check your understanding of the concepts you have learned in each lesson of Chapter 3.

## 3.1 Solve One-Step Equations

pp. 134–140

## EXAMPLE

Solve  $\frac{x}{5} = 14$ .

$$\frac{x}{5} = 14 \quad \text{Write original equation.}$$

$$5 \cdot \frac{x}{5} = 5 \cdot 14 \quad \text{Multiply each side by 5.}$$

$$x = 70 \quad \text{Simplify.}$$

## EXERCISES

Solve the equation. Check your solution.

6.  $x - 4 = 3$

7.  $-8 + a = 5$

8.  $4m = -84$

9.  $-5z = 75$

10.  $11 = \frac{r}{6}$

11.  $-27 = \frac{3}{4}w$

12. **PARKS** A rectangular city park has an area of 211,200 square feet. If the length of the park is 660 feet, what is the width of the park?

**EXAMPLES**  
1, 2, 3, 4 and 5  
on pp. 134–136  
for Exs. 6–12



### 3.2 Solve Two-Step Equations

pp. 141–146

#### EXAMPLE

Solve  $4x - 9 = 3$ .

$$4x - 9 = 3$$

Write original equation.

$$4x - 9 + 9 = 3 + 9$$

Add 9 to each side.

$$4x = 12$$

Simplify.

$$\frac{4x}{4} = \frac{12}{4}$$

Divide each side by 4.

$$x = 3$$

Simplify.

#### EXERCISES

Solve the equation. Check your solution.

13.  $9b + 5 = 23$

14.  $11 = 5y - 4$

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

16.  $\frac{3}{2}v + 2 = 20$

17.  $3t + 9t = 60$

18.  $-110 = -4c - 6c$

EXAMPLES  
1 and 2  
on pp. 141–142  
for Exs. 13–18

### 3.3 Solve Multi-Step Equations

pp. 148–153

#### EXAMPLE

Solve  $5x - 2(4x + 3) = 9$ .

$$5x - 2(4x + 3) = 9$$

Write original equation.

$$5x - 8x - 6 = 9$$

Distributive property

$$-3x - 6 = 9$$

Combine like terms.

$$-3x = 15$$

Add 6 to each side.

$$x = -5$$

Divide each side by  $-3$ .

#### EXERCISES

Solve the equation. Check your solution.

19.  $3w + 4w - 2 = 12$

20.  $z + 5 - 4z = 8$

21.  $c + 2c - 5 - 5c = 7$

22.  $4y - (y - 4) = -20$

23.  $8a - 3(2a + 5) = 13$

24.  $16h - 4(5h - 7) = 4$

25.  $\frac{3}{2}(b + 1) = 3$

26.  $\frac{4}{3}(2x - 1) = -12$

27.  $\frac{6}{5}(8k + 2) = -36$

28. **FOOTBALL** You purchase 5 tickets to a football game from an Internet ticket agency. In addition to the cost per ticket, the agency charges a convenience charge of \$2.50 per ticket. You choose to pay for rush delivery, which costs \$15. The total cost of your order is \$352.50. What is the price per ticket not including the convenience charge?

EXAMPLES  
1, 2, 3 and 4  
on pp. 148–149  
for Exs. 19–28

## 3.4 Solve Equations with Variables on Both Sides

pp. 154–159

**EXAMPLE**

Solve the equation, if possible.

a.  $-2(x - 5) = 7 - 2x$       Original equation  
 $-2x + 10 = 7 - 2x$       Distributive property  
 $-2x + 3 = -2x$       Subtract 7 from each side.

► The equation  $-2x + 3 = -2x$  is not true because the number  $-2x$  cannot be equal to 3 more than itself. So, the equation has no solution.


b.  $5(3 - 2x) = -(10x - 15)$       Original equation  
 $15 - 10x = -10x + 15$       Distributive property  
 $15 - 10x = 15 - 10x$       Rearrange terms.

► The statement  $15 - 10x = 15 - 10x$  is true for all values of  $x$ . So, the equation is an identity.

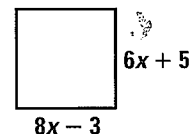
**EXERCISES**

Solve the equation, if possible.

29.  $-3z - 1 = 8 - 3z$       30.  $16 - 2m = 5m + 9$   
 31.  $2.9w + 5 = 4.7w - 7.6$       32.  $2y + 11.4 = 2.6 - 0.2y$   
 33.  $4(x - 3) = -2(6 - 2x)$       34.  $6(2a + 10) = 5(a + 5)$   
 35.  $\frac{1}{12}(48 + 24b) = 2(17 - 4b)$       36.  $1.5(n + 20) = 0.5(3n + 60)$

37.  **GEOMETRY** Refer to the square shown.

- a. Find the value of  $x$ .  
 b. Find the perimeter of the square.



**EXAMPLES**  
**1, 2, and 4**  
 on pp. 154–156  
 for Exs. 29–37

## 3.5 Write Ratios and Proportions

pp. 162–167

**EXAMPLE**

You know that 5 pizzas will feed 20 people. How many pizzas do you need to order to feed 88 people?

$$\frac{5}{20} = \frac{x}{88} \quad \leftarrow \begin{array}{l} \text{number of pizzas} \\ \text{number of people} \end{array}$$

$$88 \cdot \frac{5}{20} = 88 \cdot \frac{x}{88} \quad \text{Multiply each side by 88.}$$

$$22 = x \quad \text{Simplify.}$$

► You need to order 22 pizzas.

**EXAMPLES**  
**2 and 3**  
on pp. 163–164  
for Exs. 38–44

### EXERCISES

Solve the proportion. Check your solution.

$$38. \frac{56}{16} = \frac{x}{2}$$

$$39. \frac{y}{9} = \frac{25}{15}$$

$$40. \frac{2}{7} = \frac{m}{91}$$

$$41. \frac{5z}{3} = \frac{105}{6}$$

$$42. \frac{9}{4} = \frac{3a}{20}$$

$$43. \frac{c+2}{45} = \frac{8}{5}$$

44. **PAINTING** The label on a can of paint states that one gallon of the paint will cover 560 square feet. How many gallons of that paint are needed to cover 1400 square feet?

## 3.6 Solve Proportions Using Cross Products

pp. 168–173

### EXAMPLE

Solve the proportion  $\frac{3}{10} = \frac{12}{x}$ .

$$\frac{3}{10} = \frac{12}{x}$$

Write original proportion.

$$3 \cdot x = 10 \cdot 12$$

Cross products property

$$3x = 120$$

Simplify.

$$x = 40$$

Divide each side by 3.

### EXAMPLE

A map has a scale of 1 cm : 15 km. The distance between two cities on the map is 7.2 centimeters. Estimate the actual distance between the cities.

$$\frac{1}{15} = \frac{7.2}{d}$$

← centimeters

← kilometers

$$1 \cdot d = 15 \cdot 7.2$$

Cross products property

$$d = 108$$

Simplify.

► The distance between the two cities is about 108 kilometers.

### EXERCISES

Solve the proportion. Check your solution.

$$45. \frac{5}{7} = \frac{20}{r}$$

$$46. \frac{6}{z} = \frac{12}{5}$$

$$47. \frac{126}{56} = \frac{9}{4b}$$

$$48. \frac{10}{3m} = \frac{-5}{6}$$

$$49. \frac{n+8}{5n-2} = \frac{3}{8}$$

$$50. \frac{5-c}{3} = \frac{2c+2}{-4}$$

51. **TYPING RATES** A student can type 65 words in 2 minutes. How many words can the student type in 20 minutes?
52. **MAPS** A map has a scale of 1 cm : 12 km. The distance between two cities on the map is 6.8 centimeters. Estimate the actual distance between the cities.

**EXAMPLES**  
**1, 3, and 4**  
on pp. 168–170  
for Exs. 45–52

## 3.7 Solve Percent Problems

pp. 176–181

## EXAMPLE

42 is 40% of what number?

$$a = p\% \cdot b \quad \text{Write percent equation.}$$

$$42 = 40\% \cdot b \quad \text{Substitute 42 for } a \text{ and 40 for } p.$$

$$42 = 0.4 \cdot b \quad \text{Write percent as decimal.}$$

$$105 = b \quad \text{Divide each side by 0.4.}$$

▶ 42 is 40% of 105.

## EXERCISES

Use the percent equation to answer the question.

53. What number is 30% of 55?

54. 117 is 78% of what number?

55. What percent of 56 is 21?

56. What percent of 60 is 18?

57. **CONCERTS** There were 7500 tickets sold for a concert, 20% of which were general admission tickets. How many general admission tickets were sold?

EXAMPLES  
2, 3, 4, and 5  
on pp. 177–179  
for Exs. 53–57

## 3.8 Rewrite Equations and Formulas

pp. 184–189

## EXAMPLE

Write  $5x + 4y - 7 = 5$  so that  $y$  is a function of  $x$ .

$$5x + 4y - 7 = 5 \quad \text{Write original equation.}$$

$$5x + 4y = 12 \quad \text{Add 7 to each side.}$$

$$4y = 12 - 5x \quad \text{Subtract } 5x \text{ from each side.}$$

$$y = 3 - \frac{5}{4}x \quad \text{Divide each side by 4.}$$

## EXERCISES

Write the equation so that  $y$  is a function of  $x$ .

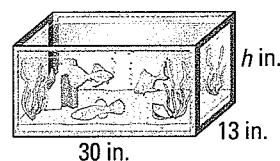
58.  $x + 7y = 0$

59.  $3x = 2y - 18$

60.  $4y - x = 20 - y$

61. **AQUARIUMS** A pet store sells aquariums that are rectangular prisms. The volume  $V$  of an aquarium is given by the formula  $V = lwh$  where  $l$  is the length,  $w$  is the width, and  $h$  is the height.a. Solve the formula for  $h$ .

b. Use the rewritten formula to find the height of the aquarium shown, which has a volume of 5850 cubic inches.



EXAMPLES  
2 and 3  
on p. 185  
for Exs. 58–61

Solve the equation. Check your solution.

- |                                 |                            |                                       |
|---------------------------------|----------------------------|---------------------------------------|
| 1. $5 + r = -19$                | 2. $z - 8 = -12$           | 3. $-11x = -77$                       |
| 4. $\frac{a}{9} = 6$            | 5. $15q - 17 = 13$         | 6. $3y + 2 = 26$                      |
| 7. $\frac{b}{4} + 5 = 14$       | 8. $\frac{m}{10} - 6 = 20$ | 9. $6j + 5j = 33$                     |
| 10. $4k - 9k = 10$              | 11. $14c - 8c + 7 = 37$    | 12. $4w - 21 + 5w = 51$               |
| 13. $-19.4 - 15d + 22d = 4.4$   | 14. $-12h + 39 = -4h - 17$ | 15. $-5.7v - 44.2 = -8.3v$            |
| 16. $-6.5t + 15 = -9.7t + 43.8$ | 17. $3(3n + 4) = 54 + 6n$  | 18. $\frac{1}{3}(24p - 66) = 3p + 43$ |

Solve the proportion. Check your solution.

- |                                    |                                       |                                          |
|------------------------------------|---------------------------------------|------------------------------------------|
| 19. $\frac{3}{4} = \frac{z}{16}$   | 20. $\frac{72}{45} = \frac{8}{w}$     | 21. $\frac{k}{9} = \frac{63}{81}$        |
| 22. $\frac{-5n}{4} = \frac{15}{2}$ | 23. $\frac{34}{6} = \frac{2x + 1}{3}$ | 24. $\frac{-4a - 1}{-10a} = \frac{3}{8}$ |

Use the percent equation to answer the question.

- |                                |                                 |
|--------------------------------|---------------------------------|
| 25. What percent of 84 is 21?  | 26. What percent of 124 is 93?  |
| 27. What number is 15% of 64?  | 28. What number is 44% of 24.5? |
| 29. 90 is what percent of 250? | 30. 79.8 is what percent of 95? |

Write the equation so that  $y$  is a function of  $x$ .

- |                   |                     |                     |
|-------------------|---------------------|---------------------|
| 31. $8x + y = 14$ | 32. $-9x + 3y = 18$ | 33. $4x = -2y + 26$ |
|-------------------|---------------------|---------------------|

34. **MOVIES** The ticket prices at a movie theater are shown in the table. A family purchases tickets for 2 adults and 3 children, and the family purchases 3 boxes of popcorn of the same size. The family spent a total of \$40.25. How much did each box of popcorn cost?

Ticket	Price
Adults	\$8.50
Children	\$5.50

35. **ICE SKATING** To become a member of an ice skating rink, you have to pay a \$30 membership fee. The cost of admission to the rink is \$5 for members and \$7 for nonmembers. After how many visits to the rink is the total cost for members, including the membership fee, the same as the total cost for nonmembers?
36. **SCALE DRAWING** You are making a scale drawing of your classroom using the scale 1 inch : 3 feet. The floor of your classroom is a rectangle with a length of 21 feet and a width of 18 feet. What should the length and width of the floor in your drawing be?
37. **SURVEYS** A survey asks high school seniors whether they would be willing to pay \$5 for their yearbook. Out of the 225 seniors surveyed, 198 said "yes." What percent of the seniors said "yes"?