HOLT McDOUGAL

LARSON ALGEBRA 1

Larson Boswell Kanold Stiff

CHAPTER

1

Unit 1
Equations in
One Variable

Problem Solving, p. 29
$0.1s + 0.6 = 2$

Expressions, Equations, and Functions

Chapter 1 Highlights

PROBLEM SOLVING

- Mixed Review of Problem Solving, 27, 51
- Multiple Representations, 33, 39
- Multi-Step Problems, 6, 11, 19, 27, 40, 51
- Using Alternative Methods, 34
- Real-World Problem Solving Examples, 4, 10, 17, 23, 28, 30, 35, 37, 45

★ ASSESSMENT

- Standardized Test Practice Examples, 10, 30
- Multiple Choice, 5, 6, 11, 18, 24, 25, 31, 38, 46
- Short Response/Extended Response, 7, 12, 20, 26, 27, 32, 33, 40, 48, 51, 58
- Writing/Open-Ended, 5, 10, 12, 18, 19, 24, 25, 27, 31, 38, 39, 46, 47, 51, 53

TECHNOLOGY

At classzone.com:

- Animated Algebra 1, 7, 9, 14, 21, 29, 34, 37, 50
- @Home Tutor, xxii, 6, 11, 13, 19, 25, 32, 39, 41, 47, 53
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CHAPTER

2

Unit 1
Equations in
One Variable

Multiplying Real Numbers, p. 90
Elevation = 6416 + (−0.12)(50)

Properties of Real Numbers

Chapter 2 Highlights

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- **Multiple Representations,** 83, 93, 116
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- **Short Response/Extended Response,** 70, 79, 83, 86, 92, 93, 100, 101, 108, 115, 119, 126
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TECHNOLOGY

At classzone.com:

- Animated Algebra 63, 73, 80, 90, 93, 98
- **@Home Tutor,** 62, 69, 78, 83, 92, 100, 107, 115, 121
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- **State Test Practice,** 86, 119, 129

CHAPTER

3

Unit 1

Equations in One Variable

Solving Equations, p. 143
$8517 = 2117 + 64d$

Solving Linear Equations

Chapter 3 Highlights

PROBLEM SOLVING

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- **Multiple Representations,** 139, 146, 147, 153, 159, 166, 172, 188
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TECHNOLOGY

At classzone.com:

- Animated Algebra 131, 133, 139, 154, 176, 185, 187
- **@Home Tutor,** 130, 139, 145, 152, 158, 160, 166, 172, 180, 188, 192
- **Online Quiz,** 140, 146, 153, 159, 167, 173, 181, 189
- **State Test Practice,** 161, 190, 201

3.1 Solve One-Step Equations

Before You solved equations using mental math.

Now You will solve one-step equations using algebra.

Why? So you can determine a weight limit, as in Ex. 56.

Key Vocabulary
- **inverse operations**
- **equivalent equations**
- **reciprocal,** *p. 915*

Inverse operations are two operations that undo each other, such as addition and subtraction. When you perform the same inverse operation on each side of an equation, you produce an *equivalent equation*. **Equivalent equations** are equations that have the same solution(s).

KEY CONCEPT *For Your Notebook*

Addition Property of Equality

Words Adding the same number to each side of an equation produces an equivalent equation.

Algebra If $x - a = b$, then $x - a + a = b + a$, or $x = b + a$.

Subtraction Property of Equality

Words Subtracting the same number from each side of an equation produces an equivalent equation.

Algebra If $x + a = b$, then $x + a - a = b - a$, or $x = b - a$.

EXAMPLE 1 Solve an equation using subtraction

Solve $x + 7 = 4$.

$x + 7 = 4$	Write original equation.
$x + 7 - 7 = 4 - 7$	Use subtraction property of equality: Subtract 7 from each side.
$x = -3$	Simplify.

▶ The solution is −3.

AVOID ERRORS
To obtain an equivalent equation, be sure to subtract the same number from each side.

CHECK Substitute −3 for x in the original equation.

$x + 7 = 4$	Write original equation.
$-3 + 7 \overset{?}{=} 4$	Substitute −3 for x.
$4 = 4$ ✓	Simplify. Solution checks.

EXAMPLE 2 Solve an equation using addition

Solve $x - 12 = 3$.

Horizontal format		Vertical format
$x - 12 = 3$	Write original equation.	$x - 12 = 3$
$x - 12 + 12 = 3 + 12$	Add 12 to each side.	$+12 \quad +12$
$x = 15$	Simplify.	$x = 15$

USE HORIZONTAL FORMAT

In Example 2, both horizontal and vertical formats are used. In the rest of the book, equations will be solved using the horizontal format.

MULTIPLICATION AND DIVISION EQUATIONS Multiplication and division are inverse operations. So, the multiplication property of equality can be used to solve equations involving division, and the division property of equality can be used to solve equations involving multiplication.

KEY CONCEPT *For Your Notebook*

Multiplication Property of Equality

Words Multiplying each side of an equation by the same nonzero number produces an equivalent equation.

Algebra 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

Words Dividing each side of an equation by the same nonzero number produces an equivalent equation.

Algebra If $ax = b$ and $a \neq 0$, then $\frac{ax}{a} = \frac{b}{a}$, or $x = \frac{b}{a}$.

EXAMPLE 3 Solve an equation using division

Solve $-6x = 48$.

$-6x = 48$ Write original equation.

$\frac{-6x}{-6} = \frac{48}{-6}$ Divide each side by -6.

$x = -8$ Simplify.

✓ GUIDED PRACTICE for Examples 1, 2, and 3

Solve the equation. Check your solution.

1. $y + 7 = 10$
2. $x - 5 = 3$
3. $q - 11 = -5$
4. $6 = t - 2$
5. $4x = 48$
6. $-65 = -5y$
7. $6w = -54$
8. $24 = -8n$

EXAMPLE 4 Solve an equation using multiplication

Solve $\frac{x}{4} = 5$.

Solution

$\frac{x}{4} = 5$ Write original equation.

$4 \cdot \frac{x}{4} = 4 \cdot 5$ Multiply each side by 4.

$x = 20$ Simplify.

✓ GUIDED PRACTICE for Example 4

Solve the equation. Check your solution.

9. $\frac{t}{-3} = 9$ **10.** $6 = \frac{c}{7}$ **11.** $13 = \frac{z}{-2}$ **12.** $\frac{a}{5} = -11$

USING RECIPROCALS Recall that the product of a number and its reciprocal is 1. You can isolate a variable with a fractional coefficient by multiplying each side of the equation by the reciprocal of the fraction.

EXAMPLE 5 Solve an equation by multiplying by a reciprocal

Solve $-\frac{2}{7}x = 4$.

REVIEW RECIPROCALS
For help with finding reciprocals, see p. 915.

Solution

The coefficient of x is $-\frac{2}{7}$. The reciprocal of $-\frac{2}{7}$ is $-\frac{7}{2}$.

$-\frac{2}{7}x = 4$ Write original equation.

$-\frac{7}{2}\left(-\frac{2}{7}x\right) = -\frac{7}{2}(4)$ Multiply each side by the reciprocal, $-\frac{7}{2}$.

$x = -14$ Simplify.

▶ The solution is −14. Check by substituting −14 for x in the original equation.

CHECK $-\frac{2}{7}x = 4$ Write original equation.

$-\frac{2}{7}(-14) \overset{?}{=} 4$ Substitute −14 for x.

$4 = 4$ ✓ Simplify. Solution checks.

✓ GUIDED PRACTICE for Example 5

Solve the equation. Check your solution.

13. $\frac{5}{6}w = 10$ **14.** $\frac{2}{3}p = 14$ **15.** $9 = -\frac{3}{4}m$ **16.** $-8 = -\frac{4}{5}v$

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.

Distance (meters)	=	Rate (meters/second)	•	Time (seconds)
↓		↓		↓
200	**=**	$\boldsymbol{r}$	**•**	**19.79**

$$\frac{200}{19.79} = \frac{19.79r}{19.79}$$

$$10.1 \approx r$$

▶ 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

1. **VOCABULARY** Copy and complete: Two operations that undo each other are called _?_.

2. ★ **WRITING** Which property of equality would you use to solve the equation $14x = 35$? *Explain.*

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

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. 15, 16

15. ★ **MULTIPLE CHOICE** What is the solution of $-8 = d - 13$?

Ⓐ -21 Ⓑ -5 Ⓒ 5 Ⓓ 21

16. ★ **MULTIPLE CHOICE** What is the solution of $22 + v = -65$?

Ⓐ -87 Ⓑ -43 Ⓒ 43 Ⓓ 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. $-3 = \frac{d}{14}$

In Exercises 29 and 30, refer to the method shown, which a student used to write a repeating decimal as a fraction.

Let $x = 0.\overline{63}$. Then $100x = 63.\overline{63}$.

Subtract: $100x = 63.636363\ldots$

$-x = -0.636363\ldots$

$99x = 63$

$x = \frac{63}{99} = \frac{7}{11}$

29. *Explain* the student's method.

30. Write the repeating decimal as a fraction.

a. $0.\overline{7}$ b. $0.\overline{18}$

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. $-0.12 = \frac{y}{-0.5}$

EXAMPLE 5
on p. 136
for Exs. 40–48

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.**

49. $A = 54 \text{ in.}^2$

50. $A = 72 \text{ cm}^2$

CHALLENGE **Find the value of b using the given information.**

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

3.2 Solve Two-Step Equations

Before You solved one-step equations.

Now You will solve two-step equations.

Why? So you can find a scuba diver's depth, as in Example 4.

Key Vocabulary
- **like terms,** *p. 97*
- **input,** *p. 35*
- **output,** *p. 35*

The equation $\frac{x}{2} + 5 = 11$ involves two operations performed on x: division by 2 and addition by 5. You typically solve such an equation by applying the inverse operations in the reverse order of the order of operations. This is shown in the table below.

Operations performed on x	Operations to isolate x
1. Divide by 2. 2. Add 5.	1. Subtract 5. 2. Multiply by 2.

EXAMPLE 1 Solve a two-step equation

Solve $\frac{x}{2} + 5 = 11$.

$\frac{x}{2} + 5 = 11$ Write original equation.

$\frac{x}{2} + 5 - 5 = 11 - 5$ Subtract 5 from each side.

$\frac{x}{2} = 6$ Simplify.

$2 \cdot \frac{x}{2} = 2 \cdot 6$ Multiply each side by 2.

$x = 12$ Simplify.

▶ The solution is 12. Check by substituting 12 for x in the original equation.

CHECK $\frac{x}{2} + 5 = 11$ Write original equation.

$\frac{12}{2} + 5 \overset{?}{=} 11$ Substitute 12 for x.

$11 = 11$ ✓ Simplify. Solution checks.

✓ GUIDED PRACTICE for Example 1

Solve the equation. Check your solution.

1. $5x + 9 = 24$ **2.** $4y - 4 = 16$ **3.** $-1 = \frac{z}{3} - 7$

EXAMPLE 2 Solve a two-step equation by combining like terms

REVIEW LIKE TERMS
For help with combining like terms, see p. 97.

Solve $7x - 4x = 21$.

$7x - 4x = 21$ Write original equation.

$3x = 21$ Combine like terms.

$\frac{3x}{3} = \frac{21}{3}$ Divide each side by 3.

$x = 7$ Simplify.

EXAMPLE 3 Find an input of a function

The output of a function is 3 less than 5 times the input. Find the input when the output is 17.

Solution

STEP 1 **Write** an equation for the function. Let x be the input and y be the output.

$y = 5x - 3$ y is 3 less than 5 times x.

STEP 2 **Solve** the equation for x when $y = 17$.

$y = 5x - 3$ Write original function.

$17 = 5x - 3$ Substitute 17 for y.

$17 + 3 = 5x - 3 + 3$ Add 3 to each side.

$20 = 5x$ Simplify.

$\frac{20}{5} = \frac{5x}{5}$ Divide each side by 5.

$4 = x$ Simplify.

▶ An input of 4 produces an output of 17.

CHECK $y = 5x - 3$ Write original function.

$17 \stackrel{?}{=} 5(4) - 3$ Substitute 17 for y and 4 for x.

$17 \stackrel{?}{=} 20 - 3$ Multiply 5 and 4.

$17 = 17$ ✓ Simplify. Solution checks.

✓ GUIDED PRACTICE for Examples 2 and 3

Solve the equation. Check your solution.

4. $4w + 2w = 24$

5. $8t - 3t = 35$

6. $-16 = 5d - 9d$

7. The output of a function is 5 more than −2 times the input. Find the input when the output is 11.

8. The output of a function is 4 less than 4 times the input. Find the input when the output is 3.

EXAMPLE 4 Solve a multi-step 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.

ANOTHER WAY
For an alternative method for solving Example 4, turn to page 147 for the **Problem Solving Workshop**.

Solution

STEP 1 **Write** a verbal model. Then write an equation.

Pressure at given depth (lb/ft^2)	=	Pressure at surface (lb/ft^2)	+	Rate of change of pressure (lb/ft^2 per foot of depth)	•	Diver's depth (ft)
↓		↓		↓		↓
P	=	2117	+	64	•	d

STEP 2 **Find** the depth at which the pressure is 8517 pounds per square foot.

$$P = 2117 + 64d$$ Write equation.

$$8517 = 2117 + 64d$$ Substitute 8517 for P.

$$8517 - 2117 = 2117 - 2117 + 64d$$ Subtract 2117 from each side.

$$6400 = 64d$$ Simplify.

$$\frac{6400}{64} = \frac{64d}{64}$$ Divide each side by 64.

$$100 = d$$ Simplify.

▶ A diver experiences a pressure of 8517 pounds per square foot at a depth of 100 feet.

CHECK

$$P = 2117 + 64d$$ Write original equation.

$$8517 \stackrel{?}{=} 2117 + 64(100)$$ Substitute 8517 for P and 100 for d.

$$8517 \stackrel{?}{=} 2117 + 6400$$ Multiply 64 and 100.

$$8517 = 8517 \checkmark$$ Simplify. Solution checks.

✓ GUIDED PRACTICE for Example 4

9. **WHAT IF?** In Example 4, suppose the diver experiences a pressure of 5317 pounds per square foot. Find the diver's depth.

10. **JOBS** Kim has a job where she makes $8 per hour plus tips. Yesterday, Kim made $53 dollars, $13 of which was from tips. How many hours did she work?

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 $6 + \frac{x}{3} = -2$?

Ⓐ Subtract 2 from each side.
Ⓑ Add 6 to each side.
Ⓒ Divide each side by 3.
Ⓓ 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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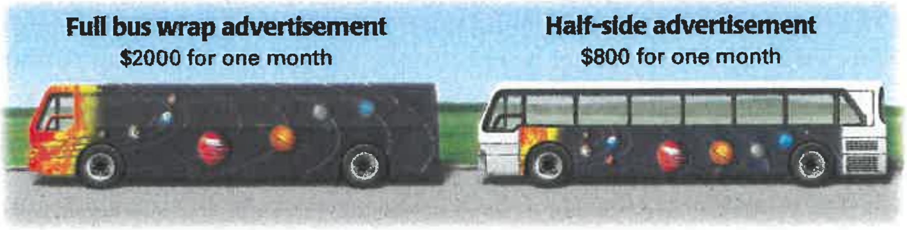
39. **ADVERTISING** A science museum wants to promote an upcoming exhibit by advertising on city buses for one month. The costs of the two types of advertisements being considered are shown. The museum has budgeted $6000 for the advertisements. The museum decides to have 1 full bus wrap advertisement. How many half-side advertisements can the museum have?



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?

Ⓐ $99 = 7x$
Ⓑ $99 = 7x + 4x$
Ⓒ $99 = 7x + 4$
Ⓓ $99 = 4x + 7$

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.*

3.3 Solve Multi-Step Equations

Before You solved one-step and two-step equations.

Now You will solve multi-step equations.

Why? So you can solve a problem about lifeguarding, as in Ex. 40.

Key Vocabulary
- **like terms,** *p. 97*
- **distributive property,** *p. 96*
- **reciprocal,** *p. 915*

Solving a linear equation may take more than two steps. Start by simplifying one or both sides of the equation, if possible. Then use inverse operations to isolate the variable.

EXAMPLE 1 Solve an equation by combining like terms

Solve $8x - 3x - 10 = 20$.

$8x - 3x - 10 = 20$	Write original equation.
$5x - 10 = 20$	Combine like terms.
$5x - 10 + 10 = 20 + 10$	Add 10 to each side.
$5x = 30$	Simplify.
$\frac{5x}{5} = \frac{30}{5}$	Divide each side by 5.
$x = 6$	Simplify.

EXAMPLE 2 Solve an equation using the distributive property

Solve $7x + 2(x + 6) = 39$.

Solution

When solving an equation, you may feel comfortable doing some steps mentally. Method 2 shows a solution where some steps are done mentally.

REVIEW PROPERTIES
For help with using the distributive property, see p. 96.

METHOD 1 Show All Steps

$$7x + 2(x + 6) = 39$$
$$7x + 2x + 12 = 39$$
$$9x + 12 = 39$$
$$9x + 12 - 12 = 39 - 12$$
$$9x = 27$$
$$\frac{9x}{9} = \frac{27}{9}$$
$$x = 3$$

METHOD 2 Do Some Steps Mentally

$$7x + 2(x + 6) = 39$$
$$7x + 2x + 12 = 39$$
$$9x + 12 = 39$$
$$9x = 27$$
$$x = 3$$

EXAMPLE 3 Standardized Test Practice

Which equation represents Step 2 in the solution process?

Step 1 $5x - 4(x - 3) = 17$

Step 2 $\boxed{\qquad\qquad}$

Step 3 $x + 12 = 17$

Step 4 $x = 5$

ELIMINATE CHOICES
You can eliminate choices B and C because −4 has not been distributed to *both* terms in the parentheses.

Ⓐ $5x - 4x - 12 = 17$ Ⓑ $5x - 4x - 3 = 17$

Ⓒ $5x - 4x + 3 = 17$ Ⓓ $5x - 4x + 12 = 17$

Solution

In Step 2, the distributive property is used to simplify the left side of the equation. Because $-4(x - 3) = -4x + 12$, Step 2 should be $5x - 4x + 12 = 17$.

▶ The correct answer is D. Ⓐ Ⓑ Ⓒ Ⓓ

✓ GUIDED PRACTICE for Examples 1, 2, and 3

Solve the equation. Check your solution.

1. $9d - 2d + 4 = 32$ **2.** $2w + 3(w + 4) = 27$ **3.** $6x - 2(x - 5) = 46$

USING RECIPROCALS Although you can use the distributive property to solve an equation such as $\frac{3}{2}(3x + 5) = -24$, it is easier to multiply each side of the equation by the reciprocal of the fraction.

EXAMPLE 4 Multiply by a reciprocal to solve an equation

Solve $\frac{3}{2}(3x + 5) = -24$.

$\frac{3}{2}(3x + 5) = -24$ Write original equation.

$\frac{2}{3} \cdot \frac{3}{2}(3x + 5) = \frac{2}{3}(-24)$ Multiply each side by $\frac{2}{3}$, the reciprocal of $\frac{3}{2}$.

$3x + 5 = -16$ Simplify.

$3x = -21$ Subtract 5 from each side.

$x = -7$ Divide each side by 3.

✓ GUIDED PRACTICE for Example 4

Solve the equation. Check your solution.

4. $\frac{3}{4}(z - 6) = 12$ **5.** $\frac{2}{5}(3r + 4) = 10$ **6.** $-\frac{4}{5}(4a - 1) = 28$

EXAMPLE 5 Write and solve an equation

SUMMER CAMP You are planning a scavenger hunt for 21 campers. You plan to have 5 teams. One camper from each team will be the recorder and the rest will be searchers. How many searchers will each team have?

Solution

Let s be the number of searchers on each team. Then $1 + s$ is the total number of campers on each team.

Number of campers = Number of teams · Number of campers on each team

↓ ↓ ↓

$$21 = 5 \cdot (1 + s)$$

$21 = 5(1 + s)$ Write equation.

$21 = 5 + 5s$ Distributive property

$16 = 5s$ Subtract 5 from each side.

$3.2 = s$ Divide each side by 5.

CHECK REASONABLENESS The number of searchers must be a whole number.

▸ Because 4 searchers per team would require a total of $5(1 + 4) =$ 25 campers, 4 teams will have 3 searchers and 1 team will have 4 searchers.

✓ GUIDED PRACTICE for Example 5

7. **WHAT IF?** In Example 5, suppose you decide to use only 4 teams. How many searchers should there be on each team?

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

EXAMPLE 1 on p. 148 for Exs. 3–11

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. $35 = -5 + 2x - 7x$

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 $7v - (6 - 2v) = 12$?

Ⓐ -3.6 Ⓑ -2 Ⓒ 2 Ⓓ 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.** $-11.2 + 4(2.1 + q) = -0.8$

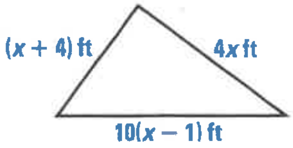
29. $1.3t + 3(t + 8.2) = 37.5$ **30.** $1.6 = 7.6 - 5(k + 1.1)$

31. $0.5 = 4.1x - 2(1.3x - 4)$ **32.** $8.7 = 3.5m - 2.5(5.4 - 6m)$

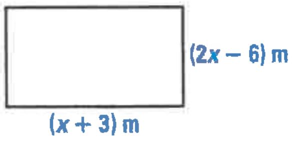
REVIEW CONVERTING UNITS
For help with converting units of measurement, see p. 927.

GEOMETRY **Find the value of x for the triangle or rectangle. Be sure to use the same units for the side lengths and the perimeters.**

33. Perimeter = 288 inches



34. Perimeter = 2600 centimeters



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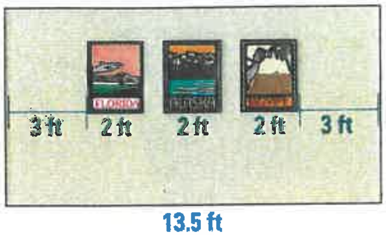
39. HANGING POSTERS You want to hang 3 equally-sized travel posters on the wall in your room so that the posters on the ends are each 3 feet from the end of the wall. You want the spacing between posters to be equal. How much space should you leave between the posters?



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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.

Distance = Rate for front crawl • Time for front crawl + Rate for breaststroke (Total time − Time for front crawl)

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

a. 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.

b. 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.

c. Was the tunnel being completed more rapidly before or after the work crews merged? *Explain* your reasoning.

3.4 Solve Equations with Variables on Both Sides

Before You solved equations with variables on one side.

Now You will solve equations with variables on both sides.

Why? So you can find the cost of a gym membership, as in Ex. 52.

Key Vocabulary
- **identity**

Some equations have variables on both sides. To solve such equations, you can collect the variable terms on one side of the equation and the constant terms on the other side of the equation.

EXAMPLE 1 Solve an equation with variables on both sides

Solve $7 - 8x = 4x - 17$.

$7 - 8x = 4x - 17$	**Write original equation.**
$7 - 8x + 8x = 4x - 17 + 8x$	**Add $8x$ to each side.**
$7 = 12x - 17$	**Simplify each side.**
$24 = 12x$	**Add 17 to each side.**
$2 = x$	**Divide each side by 12.**

▶ The solution is 2. Check by substituting 2 for x in the original equation.

CHECK $7 - 8x = 4x - 17$	**Write original equation.**
$7 - 8(2) \stackrel{?}{=} 4(2) - 17$	**Substitute 2 for x.**
$-9 \stackrel{?}{=} 4(2) - 17$	**Simplify left side.**
$-9 = -9$ ✓	**Simplify right side. Solution checks.**

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ANOTHER WAY

You could also begin solving the equation by subtracting $4x$ from each side to obtain $7 - 12x = -17$. When you solve this equation for x, you get the same solution, 2.

EXAMPLE 2 Solve an equation with grouping symbols

Solve $9x - 5 = \frac{1}{4}(16x + 60)$.

$9x - 5 = \frac{1}{4}(16x + 60)$	**Write original equation.**
$9x - 5 = 4x + 15$	**Distributive property**
$5x - 5 = 15$	**Subtract $4x$ from each side.**
$5x = 20$	**Add 5 to each side.**
$x = 4$	**Divide each side by 5.**

✓ GUIDED PRACTICE for Examples 1 and 2

Solve the equation. Check your solution.

1. $24 - 3m = 5m$
2. $20 + c = 4c - 7$
3. $9 - 3k = 17 - 2k$
4. $5z - 2 = 2(3z - 4)$
5. $3 - 4a = 5(a - 3)$
6. $8y - 6 = \frac{2}{3}(6y + 15)$

EXAMPLE 3 Solve a real-world problem

CAR SALES A car dealership sold 78 new cars and 67 used cars this year. The number of new cars sold by the dealership has been increasing by 6 cars each year. The number of used cars sold by the dealership has been decreasing by 4 cars each year. If these trends continue, in how many years will the number of new cars sold be twice the number of used cars sold?

Solution

Let x represent the number of years from now. So, $6x$ represents the increase in the number of new cars sold over x years and $-4x$ represents the decrease in the number of used cars sold over x years. Write a verbal model.

New cars sold this year + Increase in new cars sold over *x* years = 2 (Used cars sold this year + Decrease in used cars sold over *x* years)

$$78 + 6x = 2(\ 67 + (-4x)\ )$$

$78 + 6x = 2(67 - 4x)$ **Write equation.**

$78 + 6x = 134 - 8x$ **Distributive property**

$78 + 14x = 134$ **Add 8x to each side.**

$14x = 56$ **Subtract 78 from each side.**

$x = 4$ **Divide each side by 14.**

▶ The number of new cars sold will be twice the number of used cars sold in 4 years.

CHECK You can use a table to check your answer.

Year	0	1	2	3	4
Used cars sold	67	63	59	55	51
New cars sold	78	84	90	96	102

The number of new cars sold is twice the number of used cars sold in 4 years.

✓ GUIDED PRACTICE for Example 3

7. WHAT IF? In Example 3, suppose the car dealership sold 50 new cars this year instead of 78. In how many years will the number of new cars sold be twice the number of used cars sold?

NUMBER OF SOLUTIONS Equations do not always have one solution. An equation that is true for all values of the variable is an **identity**. So, the solution of an identity is all real numbers. Some equations have no solution.

EXAMPLE 4 Identify the number of solutions of an equation

Solve the equation, if possible.

a. $3x = 3(x + 4)$

b. $2x + 10 = 2(x + 5)$

Solution

a. $3x = 3(x + 4)$ Original equation

$3x = 3x + 12$ Distributive property

The equation $3x = 3x + 12$ is not true because the number $3x$ cannot be equal to 12 more than itself. So, the equation has no solution. This can be demonstrated by continuing to solve the equation.

$3x - 3x = 3x + 12 - 3x$ Subtract $3x$ from each side.

$0 = 12$ ✗ Simplify.

▶ The statement $0 = 12$ is not true, so the equation has no solution.

b. $2x + 10 = 2(x + 5)$ Original equation

$2x + 10 = 2x + 10$ Distributive property

▶ Notice that the statement $2x + 10 = 2x + 10$ is true for all values of x. So, the equation is an identity, and the solution is all real numbers.

✓ GUIDED PRACTICE for Example 4

Solve the equation, if possible.

8. $9z + 12 = 9(z + 3)$

9. $7w + 1 = 8w + 1$

10. $3(2a + 2) = 2(3a + 3)$

SOLVING LINEAR EQUATIONS You have learned several ways to transform an equation to an equivalent equation. These methods are combined in the steps listed below.

CONCEPT SUMMARY

For Your Notebook

Steps for Solving Linear Equations

STEP 1 **Use** the distributive property to remove any grouping symbols.

STEP 2 **Simplify** the expression on each side of the equation.

STEP 3 **Use** properties of equality to collect the variable terms on one side of the equation and the constant terms on the other side of the equation.

STEP 4 **Use** properties of equality to solve for the variable.

STEP 5 **Check** your solution in the original equation.

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

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.

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

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 $8x + 2x = 15x - 10$?

Ⓐ -2 Ⓑ 0.4 Ⓒ 2 Ⓓ 5

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

Ⓐ -4 Ⓑ -3 Ⓒ 3 Ⓓ 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. $\frac{1}{8}(5y + 64) = \frac{1}{4}(20 + 2y)$

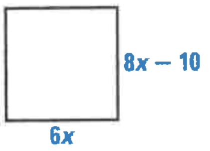
41. $14 - \frac{1}{5}(j - 10) = \frac{2}{5}(25 + j)$

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.**

44.



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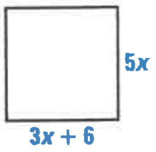

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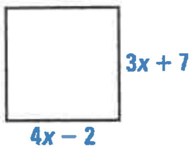

CHALLENGE **Find the value(s) of *a* for which the equation is an identity.**

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

1.1 Evaluate Expressions

Before You used whole numbers, fractions, and decimals.
Now You will evaluate algebraic expressions and use exponents.
Why So you can calculate sports statistics, as in Ex. 50.

Key Vocabulary
- **variable**
- **algebraic expression**
- **power**
- **base**
- **exponent**

A **variable** is a letter used to represent one or more numbers. The numbers are the values of the variable. *Expressions* consist of numbers, variables, and operations. An **algebraic expression**, or *variable expression*, is an expression that includes at least one variable.

Algebraic expression	Meaning	Operation
$5(n)$ $5 \cdot n$ $5n$	5 times n	Multiplication
$\frac{14}{y}$ $14 \div y$	14 divided by y	Division
$6 + c$	6 plus c	Addition
$8 - x$	8 minus x	Subtraction

To **evaluate an algebraic expression**, substitute a number for each variable, perform the operation(s), and simplify the result, if necessary.

EXAMPLE 1 Evaluate algebraic expressions

Evaluate the expression when $n = 3$.

a. $13 \cdot n = 13 \cdot 3$ Substitute 3 for n.

$= 39$ Multiply.

b. $\frac{9}{n} = \frac{9}{3}$ Substitute 3 for n.

$= 3$ Divide.

c. $n - 1 = 3 - 1$ Substitute 3 for n.

$= 2$ Subtract.

d. $n + 8 = 3 + 8$ Substitute 3 for n.

$= 11$ Add.

USE A PROPERTY

Part (a) of Example 1 illustrates the transitive property of equality: If $a = b$ and $b = c$, then $a = c$. Because $13 \cdot n = 13 \cdot 3$ and $13 \cdot 3 = 39$, $13 \cdot n = 39$. Two other properties of equality are the reflexive property ($a = a$) and the symmetric property (if $a = b$, then $b = a$).

✓ GUIDED PRACTICE for Example 1

Evaluate the expression when $y = 2$.

1. $6y$ **2.** $\frac{8}{y}$ **3.** $y + 4$ **4.** $11 - y$

EXAMPLE 2 Evaluate an expression

MOVIES The total cost of seeing a movie at a theater can be represented by the expression $a + r$ where a is the cost (in dollars) of admission and r is the cost (in dollars) of refreshments. Suppose you pay $7.50 for admission and $7.25 for refreshments. Find the total cost.

Solution

Total cost $= a + r$ Write expression.

$= 7.50 + 7.25$ Substitute 7.50 for a and 7.25 for r.

$= 14.75$ Add.

▶ The total cost is $14.75.

EXPRESSIONS USING EXPONENTS A **power** is an expression that represents repeated multiplication of the same factor. For example, 81 is a power of 3 because $81 = 3 \cdot 3 \cdot 3 \cdot 3$. A power can be written in a form using two numbers, a **base** and an **exponent**. The exponent represents the number of times the base is used as a factor, so 81 can be written as 3^4.

$$\underbrace{\overset{\text{base}}{3}{}^{\overset{\text{exponent}}{4}}}_{\text{power}} = \underbrace{3 \cdot 3 \cdot 3 \cdot 3}_{\text{4 factors of 3}}$$

EXAMPLE 3 Read and write powers

Write the power in words and as a product.

Power	Words	Product
a. 7^1	seven to the first power	7
b. 5^2	five to the second power, or five *squared*	$5 \cdot 5$
c. $\left(\frac{1}{2}\right)^3$	one half to the third power, or one half *cubed*	$\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2}$
d. z^5	z to the fifth power	$z \cdot z \cdot z \cdot z \cdot z$

VRITE EXPONENTS
or a number raised to
he first power, you
sually do not write
he exponent 1. For
nstance, you write 7^1
imply as 7.

✓ GUIDED PRACTICE for Examples 2 and 3

5. **WHAT IF?** In Example 2, suppose you go back to the theater with a friend to see an afternoon movie. You pay for both admissions. Your total cost (in dollars) can be represented by the expression $2a$. If each admission costs $4.75, what is your total cost?

Write the power in words and as a product.

6. 9^5
7. 2^8
8. n^4

EXAMPLE 4 Evaluate powers

USE A PROPERTY

Example 4 illustrates the substitution property of equality: If $a = b$, then a can be substituted for b in any expression or equation. Because $x = 2$, $x^4 = 2^4$.

Evaluate the expression.

a. x^4 when $x = 2$

b. n^3 when $n = 1.5$

Solution

a. $x^4 = 2^4$

$= 2 \cdot 2 \cdot 2 \cdot 2$

$= 16$

b. $n^3 = 1.5^3$

$= (1.5)(1.5)(1.5)$

$= 3.375$

✓ GUIDED PRACTICE for Example 4

Evaluate the expression.

9. x^3 when $x = 8$

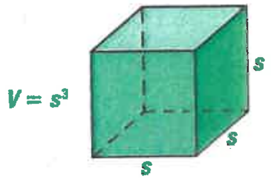
10. k^2 when $k = 2.5$

11. d^4 when $d = \frac{1}{3}$

REVIEW AREA AND VOLUME

For help with area and volume, see pp. 922 and 925.

AREA AND VOLUME Exponents are used in the formulas for the area of a square and the volume of a cube. In fact, the words *squared* and *cubed* come from the formula for the area of a square and the formula for the volume of a cube.



EXAMPLE 5 Evaluate a power

STORAGE CUBES Each edge of the medium-sized pop-up storage cube shown is 14 inches long. The storage cube is made so that it can be folded flat when not in use. Find the volume of the storage cube.

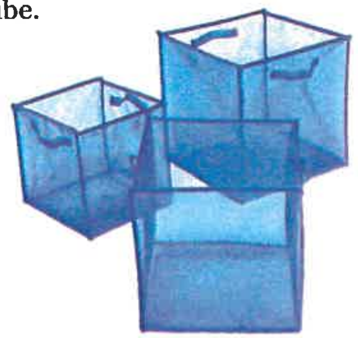
Solution

$V = s^3$ Write formula for volume.

$= 14^3$ Substitute 14 for s.

$= 2744$ Evaluate power.

▶ The volume of the storage cube is 2744 cubic inches.



✓ GUIDED PRACTICE for Example 5

12. WHAT IF? In Example 5, suppose the storage cube is folded flat to form a square. Find the area of the square.

1.1 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS1 for Exs. 19, 35, and 51

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 15, 44, 45, 52, and 54

SKILL PRACTICE

1. **VOCABULARY** Identify the exponent and the base in the expression 6^{12}.

2. ★ **WRITING** *Describe* the steps you would take to evaluate the expression n^5 when $n = 3$. Then evaluate the expression.

EXAMPLE 1
on p. 2
for Exs. 3–15

EVALUATING EXPRESSIONS Evaluate the expression.

3. $15x$ when $x = 4$
4. $0.4r$ when $r = 6$
5. $w - 8$ when $w = 20$
6. $1.6 - g$ when $g = 1.2$
7. $5 + m$ when $m = 7$
8. $0.8 + h$ when $h = 3.7$
9. $\frac{24}{f}$ when $f = 8$
10. $\frac{t}{5}$ when $t = 4.5$
11. $2.5m$ when $m = 4$
12. $\frac{1}{2}k$ when $k = \frac{2}{3}$
13. $y - \frac{1}{2}$ when $y = \frac{5}{6}$
14. $h + \frac{1}{3}$ when $h = 1\frac{1}{3}$

15. ★ **MULTIPLE CHOICE** What is the value of $2.5m$ when $m = 10$?

Ⓐ 0.25 Ⓑ 2.5 Ⓒ 12.5 Ⓓ 25

EXAMPLE 3
on p. 3
for Exs. 16–25

WRITING POWERS Write the power in words and as a product.

16. 12^5
17. 7^3
18. $(3.2)^2$
19. $(0.3)^4$
20. $\left(\frac{1}{2}\right)^8$
21. n^7
22. y^6
23. t^4

ERROR ANALYSIS *Describe* and correct the error in evaluating the power.

24. $(0.4)^2 = 2(0.4) = 0.8$ ✗

25. $5^4 = 4 \cdot 4 \cdot 4 \cdot 4 \cdot 4 = 1024$ ✗

EXAMPLE 4
on p. 4
for Exs. 26–37

EVALUATING POWERS Evaluate the power.

26. 3^2
27. 10^2
28. 1^5
29. 11^3
30. 5^3
31. 3^5
32. 2^6
33. 6^4
34. $\left(\frac{1}{4}\right)^2$
35. $\left(\frac{3}{5}\right)^3$
36. $\left(\frac{2}{3}\right)^4$
37. $\left(\frac{1}{6}\right)^3$

EVALUATING EXPRESSIONS Evaluate the expression.

38. x^2 when $x = \frac{3}{4}$
39. p^2 when $p = 1.1$
40. $x + y$ when $x = 11$ and $y = 6.4$
41. kn when $k = 9$ and $n = 4.5$
42. $w - z$ when $w = 9.5$ and $z = 2.8$
43. $\frac{b}{c}$ when $b = 24$ and $c = 2.5$

44. ★ **MULTIPLE CHOICE** Which expression has the greatest value when $x = 10$ and $y = 0.5$?

Ⓐ xy Ⓑ $x - y$ Ⓒ $\frac{x}{y}$ Ⓓ $\frac{y}{x}$

45. ★ **MULTIPLE CHOICE** Let b be the number of tokens you bought at an arcade, and let u be the number you have used. Which expression represents the number of tokens remaining?

Ⓐ $b + u$ Ⓑ $b - u$ Ⓒ bu Ⓓ $\frac{b}{u}$

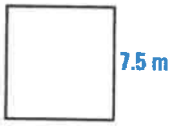
46. **COMPARING POWERS** Let x and y be whole numbers greater than 0 with $y > x$. Which has the greater value, 3^x or 3^y? *Explain.*

47. **CHALLENGE** For which whole number value(s) of x greater than 0 is the value of x^2 greater than the value of 2^x? *Explain.*

PROBLEM SOLVING

EXAMPLE 2
on p. 3
for Exs. 48–50

48. **GEOMETRY** The perimeter of a square with a side length of s is given by the expression $4s$. What is the perimeter of the square shown?



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49. **LEOPARD FROG** You can estimate the distance (in centimeters) that a leopard frog can jump using the expression 13ℓ where ℓ is the frog's length (in centimeters). What distance can a leopard frog that is 12.5 centimeters long jump?

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50. **MULTI-STEP PROBLEM** Jen was the leading scorer on her soccer team. She scored 120 goals and had 20 assists in her high school career.

a. The number n of points awarded for goals is given by $2g$ where g is the number of goals scored. How many points did Jen earn for goals?

b. The point total is given by $n + a$ where a is the number of assists. Use your answer from part (a) to find Jen's point total.

EXAMPLE 5
on p. 4
for Exs. 51–52

(51) **MULTI-STEP PROBLEM** You are buying a tank for three fish. You have a flame angel that is 3.5 inches long, a yellow sailfin tang that is 5.5 inches long, and a coral beauty that is 3 inches long. The area (in square inches) of water surface the fish need is given by the expression $12f$ where f is the sum of the lengths (in inches) of all the fish in the tank.

a. What is the total length of the three fish?

b. How many square inches of water surface do the fish need?

52. ★ **MULTIPLE CHOICE** For a snow sculpture contest, snow is packed into a cube-shaped box with an edge length of 8 feet. The box is frozen and removed, leaving a cube of snow. One cubic foot of the snow weighs about 30 pounds. You can estimate the weight (in pounds) of the cube using the expression $30V$ where V is the volume (in cubic feet) of the snow. About how much does the uncarved cube weigh?

Ⓐ 240 pounds Ⓑ 1920 pounds

Ⓒ 15,360 pounds Ⓓ 216,000 pounds

1.2 Apply Order of Operations

Before You evaluated algebraic expressions and used exponents.

Now You will use the order of operations to evaluate expressions.

Why? So you can determine online music costs, as in Ex. 35.

Key Vocabulary
- **order of operations**

Mathematicians have established an **order of operations** to evaluate an expression involving more than one operation.

KEY CONCEPT *For Your Notebook*

Order of Operations

STEP 1 **Evaluate** expressions inside grouping symbols.

STEP 2 **Evaluate** powers.

STEP 3 **Multiply** and **divide** from left to right.

STEP 4 **Add** and **subtract** from left to right.

EXAMPLE 1 Evaluate expressions

Evaluate the expression $27 \div 3^2 \times 2 - 3$.

STEP 1 There are no grouping symbols, so go to Step 2.

STEP 2 **Evaluate** powers.

$27 \div 3^2 \times 2 - 3 = 27 \div 9 \times 2 - 3$ Evaluate power.

STEP 3 **Multiply** and **divide** from left to right.

$27 \div 9 \times 2 - 3 = 3 \times 2 - 3$ Divide.

$3 \times 2 - 3 = 6 - 3$ Multiply.

STEP 4 **Add** and **subtract** from left to right.

$6 - 3 = 3$ Subtract.

▶ The value of the expression $27 \div 3^2 \times 2 - 3$ is 3.

✓ **GUIDED PRACTICE** for Example 1

Evaluate the expression.

1. $20 - 4^2$ **2.** $2 \cdot 3^2 + 4$ **3.** $32 \div 2^3 + 6$ **4.** $15 + 6^2 - 4$

GROUPING SYMBOLS Grouping symbols such as parentheses ( ) and brackets [ ] indicate that operations inside the grouping symbols should be performed first. For example, to evaluate $2 \cdot 4 + 6$, you multiply first, then add. To evaluate $2(4 + 6)$, you add first, then multiply.

EXAMPLE 2 Evaluate expressions with grouping symbols

Evaluate the expression.

a. $7(13 - 8) = 7(5)$ Subtract within parentheses.

$= 35$ Multiply.

b. $24 - (3^2 + 1) = 24 - (9 + 1)$ Evaluate power.

$= 24 - 10$ Add within parentheses.

$= 14$ Subtract.

c. $2[30 - (8 + 13)] = 2[30 - 21]$ Add within parentheses.

$= 2[9]$ Subtract within brackets.

$= 18$ Multiply.

AVOID ERRORS
When grouping symbols appear inside other grouping symbols, work from the innermost grouping symbols outward.

FRACTION BARS A fraction bar can act as a grouping symbol. Evaluate the numerator and denominator before you divide:

$$\frac{8+4}{5-2} = (8 + 4) \div (5 - 2) = 12 \div 3 = 4$$

EXAMPLE 3 Evaluate an algebraic expression

Evaluate the expression when $x = 4$.

$\frac{9x}{3(x+2)} = \frac{9 \cdot 4}{3(4+2)}$ Substitute 4 for x.

$= \frac{9 \cdot 4}{3 \cdot 6}$ Add within parentheses.

$= \frac{36}{18}$ Multiply.

$= 2$ Divide.

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✓ GUIDED PRACTICE for Examples 2 and 3

Evaluate the expression.

5. $4(3 + 9)$

6. $3(8 - 2^2)$

7. $2[(9 + 3) \div 4]$

Evaluate the expression when $y = 8$.

8. $y^2 - 3$

9. $12 - y - 1$

10. $\frac{10y + 1}{y + 1}$

★ EXAMPLE 4 Standardized Test Practice

A group of 12 students volunteers to collect litter for one day. A sponsor provides 3 juice drinks and 2 sandwiches for each student and pays $30 for trash bags. The sponsor's cost (in dollars) is given by the expression $12(3j + 2s) + 30$ where j is the cost of a juice drink and s is the cost of a sandwich. A juice drink costs $1.25. A sandwich costs $2. What is the sponsor's cost?

Ⓐ $79 Ⓑ $123 Ⓒ $129 Ⓓ $210

ELIMINATE CHOICES
You can eliminate choices A and D by estimating. When j is about 1 and s is 2, the value of the expression is about 12(3 + 4) + 30, or $114.

Solution

$$\begin{aligned} 12(3j + 2s) + 30 &= 12(3 \cdot 1.25 + 2 \cdot 2) + 30 && \text{Substitute 1.25 for } j \text{ and 2 for } s. \\ &= 12(3.75 + 4) + 30 && \text{Multiply within parentheses.} \\ &= 12(7.75) + 30 && \text{Add within parentheses.} \\ &= 93 + 30 && \text{Multiply.} \\ &= 123 && \text{Add.} \end{aligned}$$

▶ The sponsor's cost is $123. The correct answer is B. Ⓐ Ⓑ Ⓒ Ⓓ.

✓ GUIDED PRACTICE for Example 4

11. **WHAT IF?** In Example 4, suppose the number of volunteers doubles. Does the sponsor's cost double as well? *Explain.*

1.2 EXERCISES

HOMEWORK KEY
○ = **WORKED-OUT SOLUTIONS** on p. WS1 for Exs. 16 and 35
★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 19, 31, 37, 39, and 40

SKILL PRACTICE

1. **VOCABULARY** According to the order of operations, which operation would you perform first in simplifying $50 - 5 \times 4^2 \div 2$?

2. ★ **WRITING** *Describe* the steps you would use to evaluate the expression $2(3x + 1)^2$ when $x = 3$.

EXAMPLES 1 and 2
on pp. 8–9
for Exs. 3–21

EVALUATING EXPRESSIONS Evaluate the expression.

3. $13 - 8 + 3$ 4. $8 - 2^2$ 5. $3 \cdot 6 - 4$ 6. $5 \cdot 2^3 + 7$

7. $48 \div 4^2 + \frac{3}{5}$ 8. $1 + 5^2 \div 50$ 9. $2^4 \cdot 4 - 2 \div 8$ 10. $4^3 \div 8 + 8$

11. $(12 + 72) \div 4$ 12. $24 + 4(3 + 1)$ 13. $12(6 - 3.5)^2 - 1.5$ 14. $24 \div (8 + 4^2)$

15. $\frac{1}{2}(21 + 2^2)$ 16. $\frac{1}{6}(6 + 18) - 2^2$ 17. $\frac{3}{4}[13 - (2 + 3)]^2$ 18. $8[20 - (9 - 5)^2]$

19. ★ **MULTIPLE CHOICE** What is the value of $3[20 - (7 - 5)^2]$?

Ⓐ 48   Ⓑ 56   Ⓒ 192   Ⓓ 972

ERROR ANALYSIS ***Describe*** **and correct the error in evaluating the expression.**

20.

$$\begin{aligned}(1 + 13) \div 7 + 7 &= 14 \div 7 + 7\\ &= 14 \div 14\\ &= 1\end{aligned}$$

✗

21.

$$\begin{aligned}20 - \frac{1}{2} \cdot 6^2 &= 20 - 3^2\\ &= 20 - 9\\ &= 11\end{aligned}$$

✗

EXAMPLE 3
on p. 9
for Exs. 22–31

EVALUATING EXPRESSIONS **Evaluate the expression.**

22. $4n - 12$ when $n = 7$

23. $2 + 3x^2$ when $x = 3$

24. $6t^2 - 13$ when $t = 2$

25. $11 + r^3 - 2r$ when $r = 5$

26. $5(w - 4)$ when $w = 7$

27. $3(m^2 - 2)$ when $m = 1.5$

28. $\frac{9x + 4}{3x + 1}$ when $x = 7$

29. $\frac{k^2 - 1}{k + 3}$ when $k = 5$

30. $\frac{b^3 - 21}{5b + 9}$ when $b = 3$

31. ★ **MULTIPLE CHOICE** What is the value of $\frac{x^2}{25} + 3x$ when $x = 10$?

Ⓐ 26   Ⓑ 34   Ⓒ 43   Ⓓ 105

CHALLENGE **Insert grouping symbols in the expression so that the value of the expression is 14.**

32. $9 + 39 + 22 \div 11 - 9 + 3$

33. $2 \times 2 + 3^2 - 4 + 3 \times 5$

PROBLEM SOLVING

EXAMPLE 4
on p. 10
for Exs. 34–37

34. **SALES** Your school's booster club sells school T-shirts. Half the T-shirts come from one supplier at a cost of \$5.95 each, and half from another supplier at a cost of \$6.15 each. The average cost (in dollars) of a T-shirt is given by the expression $\frac{5.95 + 6.15}{2}$. Find the average cost.

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35. **MULTI-STEP PROBLEM** You join an online music service. The total cost (in dollars) of downloading 3 singles at \$.99 each and 2 albums at \$9.95 each is given by the expression $3 \cdot 0.99 + 2 \cdot 9.95$.

a. Find the total cost.

b. You have \$25 to spend. How much will you have left?

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36. **PHYSIOLOGY** If you know how tall you were at the age of 2, you can estimate your adult height (in inches). Girls can use the expression $25 + 1.17h$ where h is the height (in inches) at the age of 2. Boys can use the expression $22.7 + 1.37h$. Estimate the adult height of each person to the nearest inch.

a. A girl who was 34 inches tall at age 2

b. A boy who was 33 inches tall at age 2

1.3 Write Expressions

Before You evaluated expressions.

Now You will translate verbal phrases into expressions.

Why? So you can find a bicycling distance, as in Ex. 36.

Key Vocabulary
- verbal model
- rate
- unit rate

To translate verbal phrases into expressions, look for words that indicate mathematical operations.

KEY CONCEPT *For Your Notebook*

Translating Verbal Phrases

Operation	Verbal Phrase	Expression
Addition: sum, plus, total, more than, increased by	The sum of 2 and a number x	$2 + x$
	A number n plus 7	$n + 7$
Subtraction: difference, less than, minus, decreased by	The difference of a number n and 6	$n - 6$
	A number y minus 5	$y - 5$
Multiplication: times, product, multiplied by, of	12 times a number y	$12y$
	$\frac{1}{3}$ of a number x	$\frac{1}{3}x$
Division: quotient, divided by, divided into	The quotient of a number k and 2	$\frac{k}{2}$

Order is important when writing subtraction and division expressions. For instance, "the difference of a number n and 6" is written $n - 6$, *not* $6 - n$, and "the quotient of a number k and 2" is written $\frac{k}{2}$, *not* $\frac{2}{k}$.

EXAMPLE 1 Translate verbal phrases into expressions

AVOID ERRORS

When you translate verbal phrases, the words "the quantity" tell you what to group. In part (a), you write $6n - 4$, *not* $(6 - 4)n$.

	Verbal Phrase	Expression
a.	4 less than the quantity 6 times a number n	$6n - 4$
b.	3 times the sum of 7 and a number y	$3(7 + y)$
c.	The difference of 22 and the square of a number m	$22 - m^2$

✓ **GUIDED PRACTICE** for Example 1

1. Translate the phrase "the quotient when the quantity 10 plus a number x is divided by 2" into an expression.

EXAMPLE 2 Write an expression

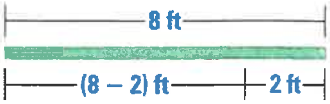
CHOOSE A VARIABLE
To write an expression for a real-world problem, choose a letter that reminds you of the quantity represented, such as ℓ for length.

CUTTING A RIBBON A piece of ribbon ℓ feet long is cut from a ribbon 8 feet long. Write an expression for the length (in feet) of the remaining piece.

Solution

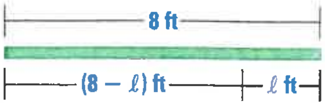
Draw a diagram and use a specific case to help you write the expression.

Suppose the piece cut is 2 feet long.



The remaining piece is (8 − 2) feet long.

Suppose the piece cut is ℓ feet long.



The remaining piece is $(8 - \ell)$ feet long.

▶ The expression $8 - \ell$ represents the length (in feet) of the remaining piece.

VERBAL MODEL A **verbal model** describes a real-world situation using words as labels and using math symbols to relate the words. You can replace the words with numbers and variables to create a *mathematical model*, such as an expression, for the real-world situation.

EXAMPLE 3 Use a verbal model to write an expression

TIPS You work with 5 other people at an ice cream stand. All the workers put their tips into a jar and share the amount in the jar equally at the end of the day. Write an expression for each person's share (in dollars) of the tips.

AVOID ERRORS
Read the statement of the problem carefully. The number of people sharing tips is 6.

Solution

STEP 1 **Write** a verbal model.

STEP 2 **Translate** the verbal model into an algebraic expression. Let a represent the amount (in dollars) in the jar.

Amount in jar ÷ Number of people
↓ ↓
$a \div 6$

▶ An expression that represents each person's share (in dollars) is $\frac{a}{6}$.

✓ GUIDED PRACTICE for Examples 2 and 3

2. **WHAT IF?** In Example 2, suppose that you cut the original ribbon into p pieces of equal length. Write an expression that represents the length (in feet) of each piece.

3. **WHAT IF?** In Example 3, suppose that each of the 6 workers contributes an equal amount for an after-work celebration. Write an expression that represents the total amount (in dollars) contributed.

RATES A **rate** is a fraction that compares two quantities measured in different units. If the denominator of the fraction is 1 unit, the rate is called a **unit rate**.

EXAMPLE 4 Find a unit rate

READING
Per means "for each" or "for every" and can also be represented using the symbol /, as in mi/h.

A car travels 120 miles in 2 hours. Find the unit rate in feet per second.

$$\frac{120\text{ miles}}{2\text{ hours}} = \frac{120\cancel{\text{ miles}}}{2\cancel{\text{ hours}}} \cdot \frac{5280\text{ feet}}{1\cancel{\text{ mile}}} \cdot \frac{1\cancel{\text{ hour}}}{60\cancel{\text{ minutes}}} \cdot \frac{1\cancel{\text{ minute}}}{60\text{ seconds}} = \frac{88\text{ feet}}{1\text{ second}}$$

▶ The unit rate is 88 feet per second.

EXAMPLE 5 Solve a multi-step problem

TRAINING For a training program, each day you run a given distance and then walk to cool down. One day you run 2 miles and then walk for 20 minutes at a rate of 0.1 mile per 100 seconds. What total distance do you cover?

Solution

STEP 1 **Convert** your walking rate to miles per minute.

$$\frac{0.1\text{ mile}}{100\cancel{\text{ seconds}}} \cdot \frac{60\cancel{\text{ seconds}}}{1\text{ minute}} = \frac{6\text{ miles}}{100\text{ minutes}} = \frac{0.06\text{ mile}}{1\text{ minute}}$$

STEP 2 **Write** a verbal model and then an expression. Let m be the number of minutes you walk.

Distance run (miles)	+	Walking rate (miles/minute)	•	Time spent walking (minutes)
↓		↓		↓
2	+	**0.06**	•	m

USE UNIT ANALYSIS
You expect the answer to be a distance in miles. You can use unit analysis, also called *dimensional analysis*, to check that the expression produces an answer in miles.

Use *unit analysis* to check that the expression $2 + 0.06m$ is reasonable.

$$\text{miles} + \frac{\text{miles}}{\cancel{\text{minute}}} \cdot \cancel{\text{minutes}} = \text{miles} + \text{miles} = \text{miles}$$

Because the units are miles, the expression is reasonable.

STEP 3 **Evaluate** the expression when $m = 20$.

$2 + 0.06(20) = 3.2$

▶ You cover a total distance of 3.2 miles.

✓ GUIDED PRACTICE for Examples 4 and 5

4. **WHAT IF?** In Example 5, suppose tomorrow you run 3 miles and then walk for 15 minutes at a rate of 0.1 mile per 90 seconds. What total distance will you cover?

1.3 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS1 for Exs. 11, 21, and 33

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 13, 14, 34, and 37

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: A(n) __?__ is a fraction that compares two quantities measured in different units.

2. ★ **WRITING** *Explain* how to write $\frac{20 \text{ miles}}{4 \text{ hours}}$ as a unit rate.

EXAMPLE 1 on p. 15 for Exs. 3–14

TRANSLATING PHRASES Translate the verbal phrase into an expression.

3. 8 more than a number x
4. The product of 6 and a number y
5. $\frac{1}{2}$ of a number m
6. 50 divided by a number h
7. The difference of 7 and a number n
8. The sum of 15 and a number x
9. The quotient of twice a number t and 12
10. 3 less than the square of a number p
11. 7 less than twice a number k
12. 5 more than 3 times a number w

13. ★ **MULTIPLE CHOICE** Which expression represents the phrase "the product of 15 and the quantity 12 more than a number x"?

Ⓐ $15 + 12 \cdot x$ Ⓑ $(15 + 12)x$ Ⓒ $15(x + 12)$ Ⓓ $15 \cdot 12 + x$

14. ★ **MULTIPLE CHOICE** Which expression represents the phrase "twice the quotient of 50 and the sum of a number y and 8"?

Ⓐ $\frac{2 \cdot 50}{y} + 8$ Ⓑ $2\left(\frac{50 + y}{8}\right)$ Ⓒ $2\left(\frac{50}{y + 8}\right)$ Ⓓ $\frac{2}{50} + (y + 8)$

EXAMPLES 2 and 3 on p. 16 for Exs. 15–21

WRITING EXPRESSIONS Write an expression for the situation.

15. Number of tokens needed for v video games if each game takes 4 tokens
16. Number of pages of a 5 page article left to read if you've read p pages
17. Each person's share if p people share 16 slices of pizza equally
18. Amount you spend if you buy a shirt for \$20 and jeans for j dollars
19. Number of days left in the week if d days have passed so far
20. Number of hours in m minutes
21. Number of months in y years

EXAMPLE 4 on p. 17 for Exs. 22–27

UNIT RATES Find the unit rate in feet per second.

22. $\frac{300 \text{ yards}}{1 \text{ minute}}$

23. $\frac{240 \text{ yards}}{1 \text{ hour}}$

24. $\frac{180 \text{ miles}}{2 \text{ hours}}$

25. $\frac{171 \text{ miles}}{3 \text{ hours}}$

ERROR ANALYSIS ***Describe*** **and correct the error in the units.**

26. $\frac{\$2}{\text{foot}} \cdot 24 \text{ feet} = \frac{\$48}{\text{ft}^2}$ ✗

27. $9 \text{ yards} \cdot \frac{3 \text{ feet}}{1 \text{ yard}} \cdot \frac{\$2}{\text{foot}} = \frac{\$54}{\text{ft}}$ ✗

1.4 Write Equations and Inequalities

Before	You translated verbal phrases into expressions.
Now	You will translate verbal sentences into equations or inequalities.
Why	So you can calculate team competition statistics, as in Ex. 41.

Key Vocabulary
- equation
- inequality
- open sentence
- solution of an equation
- solution of an inequality

An **equation** is a mathematical sentence formed by placing the symbol = between two expressions. An **inequality** is a mathematical sentence formed by placing one of the symbols <, ≤, >, or ≥ between two expressions.

An **open sentence** is an equation or an inequality that contains an algebraic expression.

KEY CONCEPT *For Your Notebook*

Symbol	Meaning	Associated Words
=	is equal to	the same as
<	is less than	fewer than
≤	is less than or equal to	at most, no more than
>	is greater than	more than
≥	is greater than or equal to	at least, no less than

COMBINING INEQUALITIES Sometimes two inequalities are combined. For example, the inequalities $x > 4$ and $x < 9$ can be combined to form the inequality $4 < x < 9$, which is read "x is greater than 4 and less than 9."

EXAMPLE 1 Write equations and inequalities

	Verbal Sentence	Equation or Inequality
a.	The difference of twice a number k and 8 is 12.	$2k - 8 = 12$
b.	The product of 6 and a number n is at least 24.	$6n \geq 24$
c.	A number y is no less than 5 and no more than 13.	$5 \leq y \leq 13$

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✓ GUIDED PRACTICE for Example 1

1. Write an equation or an inequality: The quotient of a number p and 12 is at least 30.

SOLUTIONS When you substitute a number for the variable in an open sentence like $x + 2 = 5$ or $2y > 6$, the resulting statement is either true or false. If the statement is true, the number is a **solution of the equation** or a **solution of the inequality**.

EXAMPLE 2 Check possible solutions

Check whether 3 is a solution of the equation or inequality.

READING
A question mark above a symbol indicates a question. For instance, $8 - 2(3) \overset{?}{=} 2$ means "Is $8 - 2(3)$ equal to 2?"

Equation/Inequality	Substitute	Conclusion
a. $8 - 2x = 2$	$8 - 2(3) \overset{?}{=} 2$	$2 = 2$ ✓ 3 is a solution.
b. $4x - 5 = 6$	$4(3) - 5 \overset{?}{=} 6$	$7 = 6$ ✗ 3 is *not* a solution.
c. $2z + 5 > 12$	$2(3) + 5 \overset{?}{>} 12$	$11 > 12$ ✗ 3 is *not* a solution.
d. $5 + 3n \leq 20$	$5 + 3(3) \overset{?}{\leq} 20$	$14 \leq 20$ ✓ 3 is a solution.

USING MENTAL MATH Some equations are simple enough to solve using mental math. Think of the equation as a question. Once you answer the question, check the solution.

EXAMPLE 3 Use mental math to solve an equation

Equation	Think	Solution	Check
a. $x + 4 = 10$	What number plus 4 equals 10?	6	$6 + 4 = 10$ ✓
b. $20 - y = 8$	20 minus what number equals 8?	12	$20 - 12 = 8$ ✓
c. $6n = 42$	6 times what number equals 42?	7	$6(7) = 42$ ✓
d. $\frac{a}{5} = 9$	What number divided by 5 equals 9?	45	$\frac{45}{5} = 9$ ✓

✓ GUIDED PRACTICE for Examples 2 and 3

Check whether the given number is a solution of the equation or inequality.

2. $9 - x = 4$; 5

3. $b + 5 < 15$; 7

4. $2n + 3 \geq 21$; 9

Solve the equation using mental math.

5. $m + 6 = 11$

6. $5x = 40$

7. $\frac{r}{4} = 10$

EXAMPLE 4 Solve a multi-step problem

MOUNTAIN BIKING The last time you and 3 friends went to a mountain bike park, you had a coupon for \$10 off and paid \$17 for 4 tickets. What is the regular price of 4 tickets? If you pay the regular price this time and share it equally, how much does each person pay?

Solution

STEP 1 **Write** a verbal model. Let p be the regular price of 4 tickets. Write an equation.

Regular price − Amount of coupon = Amount paid

$$p - 10 = 17$$

STEP 2 **Use** mental math to solve the equation $p - 10 = 17$. Think: 10 less than what number is 17? Because $27 - 10 = 17$, the solution is 27.

▶ The regular price for 4 tickets is \$27.

STEP 3 **Find** the cost per person: $\frac{\$27}{4 \text{ people}} = \$6.75$ per person

▶ Each person pays \$6.75.

EXAMPLE 5 Write and check a solution of an inequality

BASKETBALL A basketball player scored 351 points last year. If the player plays 18 games this year, will an average of 20 points per game be enough to beat last year's total?

Solution

STEP 1 **Write** a verbal model. Let p be the average number of points per game. Write an inequality.

Number of games • Points per game > Total points last year

$$18 \cdot p > 351$$

STEP 2 **Check** that 20 is a solution of the inequality $18p > 351$. Because $18(20) = 360$ and $360 > 351$, 20 is a solution. ✓

▶ An average of 20 points per game will be enough.

USE UNIT ANALYSIS
Unit analysis shows that games • $\frac{\text{points}}{\text{games}}$ = points, so the inequality is reasonable.

✓ GUIDED PRACTICE for Examples 4 and 5

8. **WHAT IF?** In Example 4, suppose that the price of 4 tickets with a half-off coupon is \$15. What is each person's share if you pay full price?

9. **WHAT IF?** In Example 5, suppose that the player plays 16 games. Would an average of 22 points per game be enough to beat last year's total?

1.4 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS1 for Exs. 7 and 41

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 16, 37, 44, 45, and 46

SKILL PRACTICE

1. **VOCABULARY** Give an example of an open sentence.

2. ★ **WRITING** *Describe* the difference between an expression and an equation.

EXAMPLE 1
on p. 21
for Exs. 3–16

WRITING OPEN SENTENCES **Write an equation or an inequality.**

3. The sum of 42 and a number n is equal to 51.
4. The difference of a number z and 11 is equal to 35.
5. The difference of 9 and the quotient of a number t and 6 is 5.
6. The sum of 12 and the quantity 8 times a number k is equal to 48.
⑦ The product of 9 and the quantity 5 more than a number t is less than 6.
8. The product of 4 and a number w is at most 51.
9. The sum of a number b and 3 is greater than 8 and less than 12.
10. The product of 8 and a number k is greater than 4 and no more than 16.
11. The difference of a number t and 7 is greater than 10 and less than 20.

STORE SALES **Write an inequality for the price p (in dollars) described.**

12.

13.

ERROR ANALYSIS ***Describe* and correct the error in writing the verbal sentence as an equation or an inequality.**

14. The sum of a number n and 4 is no more than 13.

$n + 4 < 13$ ✗

15. The quotient of a number t and 4.2 is at most 15.

$\frac{t}{4.2} > 15$ ✗

16. ★ **MULTIPLE CHOICE** Which inequality corresponds to the sentence "The product of a number b and 3 is no less than 12"?

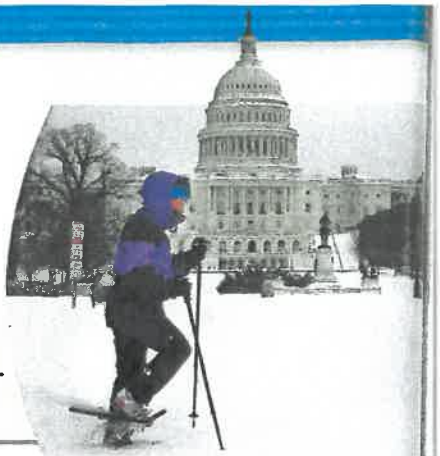
Ⓐ $3b < 12$ Ⓑ $3b \le 12$ Ⓒ $3b > 12$ Ⓓ $3b \ge 12$

EXAMPLE 2
on p. 22
for Exs. 17–28

CHECK POSSIBLE SOLUTIONS **Check whether the given number is a solution of the equation or inequality.**

17. $x + 9 = 17; 8$
18. $9 + 4y = 17; 1$
19. $6f - 7 = 29; 5$
20. $\frac{k}{5} + 9 = 11; 10$
21. $\frac{r}{3} - 4 = 4; 12$
22. $\frac{x - 5}{3} \ge 2.8; 11$
23. $15 - 4y > 6; 2$
24. $y - 3.5 < 6; 9$
25. $2 + 3x \le 8; 2$
26. $2p - 1 \ge 7; 3$
27. $4z - 5 < 3; 2$
28. $3z + 7 > 20; 4$

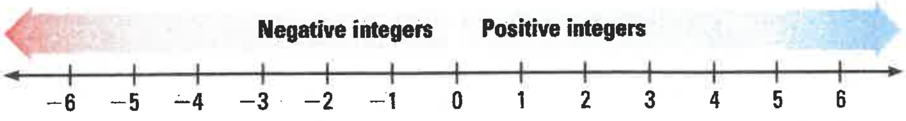
2.1 Use Integers and Rational Numbers



Before You performed operations with whole numbers.
Now You will graph and compare positive and negative numbers.
Why? So you can compare temperatures, as in Ex. 58.

Key Vocabulary
- whole numbers
- integers
- rational number
- opposites
- absolute value
- conditional statement

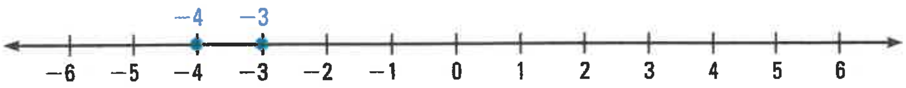
Whole numbers are the numbers 0, 1, 2, 3, . . . and **integers** are the numbers . . . , −3, −2, −1, 0, 1, 2, 3, ... (The dots indicate that the numbers continue without end in both directions.) **Positive integers** are integers that are greater than 0. **Negative integers** are integers that are less than 0. The integer 0 is neither negative nor positive.



Zero is neither negative nor positive.

EXAMPLE 1 Graph and compare integers

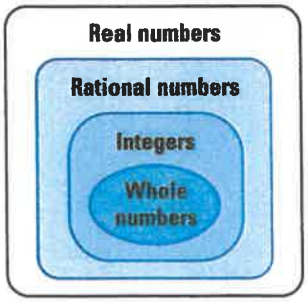
Graph −3 and −4 on a number line. Then tell which number is greater.



▶ On the number line, −3 is to the right of −4. So, −3 > −4.

RATIONAL NUMBERS The integers belong to the set of *rational numbers*. A **rational number** is a number $\frac{a}{b}$ where a and b are integers and $b \neq 0$. For example, $-\frac{1}{2}$ is a rational number because it can be written as $\frac{-1}{2}$ or $\frac{1}{-2}$. The rational numbers belong to the set of numbers called the *real numbers*.

READING
Although you can write a negative fraction in different ways, you usually write it with the negative sign in front of the fraction.



✓ GUIDED PRACTICE for Example 1

Graph the numbers on a number line. Then tell which number is greater.

1. 4 and 0

2. 2 and −5

3. −1 and −6

REVIEW FRACTIONS
For help with writing fractions as decimals, see p. 916.

DECIMALS In decimal form, a rational number either terminates or repeats. For example, $\frac{3}{4} = 0.75$ is a *terminating decimal*, and $\frac{1}{3} = 0.333\ldots$ is a *repeating decimal.*

EXAMPLE 2 Classify numbers

Tell whether each of the following numbers is a whole number, an integer, or a rational number: 5, 0.6, $-2\frac{2}{3}$, and −24.

JUSTIFY AN ANSWER
The number 0.6 is a rational number because it can be written as a quotient of two integers: $\frac{3}{5}$.

Number	Whole number?	Integer?	Rational number?
5	Yes	Yes	Yes
0.6	No	No	Yes
$-2\frac{2}{3}$	No	No	Yes
−24	No	Yes	Yes

EXAMPLE 3 Order rational numbers

ASTRONOMY A star's color index is a measure of the temperature of the star. The greater the color index, the cooler the star. Order the stars in the table from hottest to coolest.

Star	Rigel	Arneb	Denebola	Shaula
Color index	−0.03	0.21	0.09	−0.22

Solution

Begin by graphing the numbers on a number line.

Read the numbers from left to right: −0.22, −0.03, 0.09, 0.21.

▶ From hottest to coolest, the stars are Shaula, Rigel, Denebola, and Arneb.

✓ GUIDED PRACTICE for Examples 2 and 3

Tell whether each number in the list is a whole number, an integer, or a rational number. Then order the numbers from least to greatest.

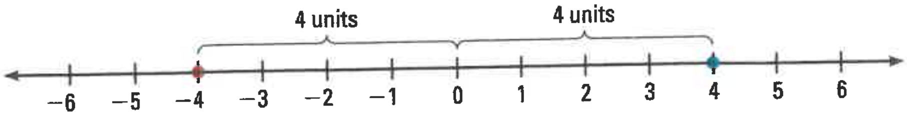
4. 3, −1.2, −2, 0

5. 4.5, $-\frac{3}{4}$, −2.1, 0.5

6. 3.6, −1.5, −0.31, −2.8

7. $\frac{1}{6}$, 1.75, $-\frac{2}{3}$, 0

OPPOSITES Two numbers that are the same distance from 0 on a number line but are on opposite sides of 0 are called **opposites**. For example, 4 and −4 are opposites because they are both 4 units from 0 but are on opposite sides of 0. The opposite of 0 is 0. You read the expression $-a$ as "the opposite of a."



EXAMPLE 4 Find opposites of numbers

a. If $a = -2.5$, then $-a = -(-2.5) = 2.5$.

b. If $a = \frac{3}{4}$, then $-a = -\frac{3}{4}$.

READING
The absolute value of a number is also called its *magnitude*.

ABSOLUTE VALUE The **absolute value** of a number a is the distance between a and 0 on a number line. The symbol $|a|$ represents the absolute value of a.

KEY CONCEPT *For Your Notebook*

Absolute Value of a Number

Words If a is positive, then $\lvert a\rvert = a$.	**Example** $\lvert 2\rvert = 2$
Words If a is 0, then $\lvert a\rvert = 0$.	**Example** $\lvert 0\rvert = 0$
Words If a is negative, then $\lvert a\rvert = -a$.	**Example** $\lvert -2\rvert = -(-2) = 2$

EXAMPLE 5 Find absolute values of numbers

AVOID ERRORS
The absolute value of a number is never negative. If a number a is negative, then its absolute value, $-a$, is positive.

a. If $a = -\frac{2}{3}$, then $|a| = \left|-\frac{2}{3}\right| = -\left(-\frac{2}{3}\right) = \frac{2}{3}$.

b. If $a = 3.2$, then $|a| = |3.2| = 3.2$.

CONDITIONAL STATEMENTS A **conditional statement** has a hypothesis and a conclusion. An **if-then statement** is a form of a conditional statement. The *if* part contains the hypothesis. The *then* part contains the conclusion.

$$\overbrace{\text{If } \underbrace{a \text{ is a positive number}}_{\textbf{hypothesis}}\text{, then } \underbrace{|a| = a}_{\textbf{conclusion}}.}^{\textbf{conditional statement}}$$

In mathematics, if-then statements are either true or false. An if-then statement is true if the conclusion is always true when the hypothesis is satisfied. An if-then statement is false if for just one example, called a **counterexample**, the conclusion is false when the hypothesis is satisfied.

EXAMPLE 6 Analyze a conditional statement

Identify the hypothesis and the conclusion of the statement "If a number is a rational number, then the number is an integer." Tell whether the statement is *true* or *false*. If it is false, give a counterexample.

Solution

Hypothesis: a number is a rational number

Conclusion: the number is an integer

The statement is false. The number 0.5 is a counterexample, because 0.5 is a rational number but not an integer.

✓ GUIDED PRACTICE for Examples 4, 5, and 6

For the given value of a, find $-a$ and $|a|$.

8. $a = 5.3$

9. $a = -7$

10. $a = -\frac{4}{9}$

Identify the hypothesis and the conclusion of the statement. Tell whether the statement is *true* or *false*. If it is false, give a counterexample.

11. If a number is a rational number, then the number is positive.

12. If the absolute value of a number is positive, then the number is positive.

2.1 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS3 for Exs. 7, 29, and 53

★ = **STANDARDIZED TEST PRACTICE** Exs. 3, 4, 39, 50, 56, and 59

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: A number is a(n) _?_ if it can be written in the form $\frac{a}{b}$ where a and b are integers and $b \neq 0$.

2. **VOCABULARY** What is the opposite of -2?

3. ★ **WRITING** *Describe* the difference between whole numbers and positive integers.

4. ★ **WRITING** For a negative number x, is the absolute value of x a *positive number* or a *negative number*? *Explain.*

EXAMPLE 1
on p. 64
for Exs. 5–13

GRAPHING AND COMPARING INTEGERS **Graph the numbers on a number line. Then tell which number is greater.**

5. 0 and 7

6. 0 and -4

7. -5 and -6

8. -2 and -3

9. 5 and -2

10. -12 and 8

11. -1 and -5

12. 3 and -13

13. -20 and -2

EXAMPLES
2 and 3
on p. 65
for Exs. 14–22

CLASSIFYING AND ORDERING NUMBERS **Tell whether each number in the list is a whole number, an integer, or a rational number. Then order the numbers from least to greatest.**

14. 3, −5, −2.4, 1

15. 1.6, 1, −4, 0

16. 0.25, −0.5, 0.2, −2

17. $-\frac{2}{3}$, −0.6, −1, $\frac{1}{3}$

18. −0.01, 0.1, 0, $-\frac{1}{10}$

19. 16, −1.66, $\frac{5}{3}$, −1.6

20. −2.7, $\frac{1}{2}$, 0.3, −7

21. −4.99, 5, $\frac{16}{3}$, −5.1

22. $-\frac{3}{5}$, −0.4, −1, −0.5

EXAMPLES
4 and 5
on p. 66
for Exs. 23–34

FINDING OPPOSITES AND ABSOLUTE VALUES **For the given value of a, find $-a$ and $|a|$.**

23. $a = 6$

24. $a = -3$

25. $a = -18$

26. $a = 0$

27. $a = 13.4$

28. $a = 2.7$

29. $a = -6.1$

30. $a = -7.9$

31. $a = -1\frac{1}{9}$

32. $a = -\frac{5}{6}$

33. $a = \frac{3}{4}$

34. $a = 1\frac{1}{3}$

EXAMPLE 6
on p. 67
for Exs. 35–38

ANALYZING CONDITIONAL STATEMENTS **Identify the hypothesis and the conclusion of the conditional statement. Tell whether the statement is *true* or *false*. If it is false, give a counterexample.**

35. If a number is a positive integer, then the number is a whole number.

36. If a number is negative, then its absolute value is negative.

37. If a number is positive, then its opposite is positive.

38. If a number is an integer, then the number is a rational number.

39. ★ **MULTIPLE CHOICE** Which number is a whole number?

(A) $\left|-\frac{18}{9}\right|$ (B) $-\frac{4}{3}$ (C) 1.6 (D) −(−7.963)

ERROR ANALYSIS ***Describe*** **and correct the error in the statement.**

40. The numbers −(−2), −4, −|8|, and −0.3 are negative numbers.

41. The numbers |−3.4|, −(−8), −|−0.2|, and 0.87 are positive numbers.

EVALUATING EXPRESSIONS **Evaluate the expression when $x = -0.75$.**

42. $-x$

43. $|x| + 0.25$

44. $|x| - 0.75$

45. $1 + |-x|$

46. $2 \cdot (-x)$

47. $(-x) \cdot 3$

48. $|x| + |x|$

49. $-x + |x|$

50. ★ **MULTIPLE CHOICE** Which number is a solution of $|x| + 1 = 1.3$?

(A) −2.3 (B) −0.3 (C) 1.3 (D) 2.3

51. **CHALLENGE** What can you conclude about the opposite of the opposite of a number? *Explain* your reasoning.

52. **CHALLENGE** For what values of a is the opposite of a greater than a? less than a? equal to a?

○ = **WORKED-OUT SOLUTIONS on p. WS1**

★ = **STANDARDIZED TEST PRACTICE**

2.2 Add Real Numbers

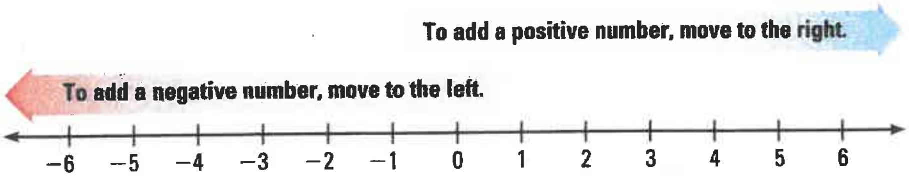
Before You added positive numbers.

Now You will add positive and negative numbers.

Why? So you can calculate a sports score, as in Ex. 57.

Key Vocabulary
- additive identity
- additive inverse

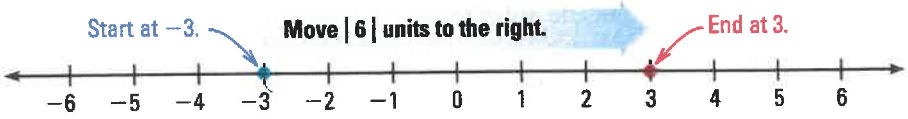
One way to add two real numbers is to use a number line. Start at the first number. Use the sign of the second number to decide whether to move left or right. Then use the absolute value of the second number to decide how many units to move. The number where you stop is the sum of the two numbers.



EXAMPLE 1 Add two integers using a number line

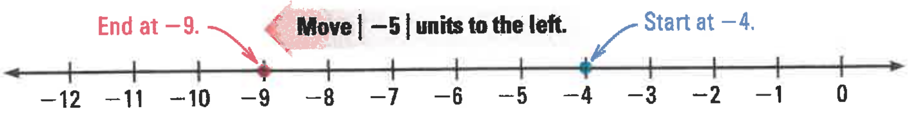
Use a number line to find the sum.

a. $-3 + 6$



▸ The final position is 3. So, $-3 + 6 = 3$.

b. $-4 + (-5)$



▸ The final position is −9. So, $-4 + (-5) = -9$.

✓ GUIDED PRACTICE for Example 1

Use a number line to find the sum.

1. $7 + (-2)$

2. $8 + (-11)$

3. $-8 + 4$

4. $-1 + (-4)$

KEY CONCEPT **For Your Notebook**

Rules of Addition

Words To add two numbers with the *same* sign, add their absolute values. The sum has the same sign as the numbers added.

Examples $8 + 7 = 15$ $-6 + (-10) = -16$

Words To add two numbers with *different* signs, subtract the lesser absolute value from the greater absolute value. The sum has the same sign as the number with the greater absolute value.

Examples $-12 + 7 = -5$ $18 + (-4) = 14$

EXAMPLE 2 Add real numbers

Find the sum.

a. $-5.3 + (-4.9) = -(|-5.3| + |-4.9|)$ **Rule of same signs**

$= -(5.3 + 4.9)$ **Take absolute values.**

$= -10.2$ **Add.**

b. $19.3 + (-12.2) = |19.3| - |-12.2|$ **Rule of different signs**

$= 19.3 - 12.2$ **Take absolute values.**

$= 7.1$ **Subtract.**

PROPERTIES OF ADDITION Notice that both $3 + (-2)$ and $-2 + 3$ have the same sum, 1. So, $3 + (-2) = -2 + 3$. This is an example of the *commutative property of addition*. The properties of addition are listed below.

KEY CONCEPT **For Your Notebook**

Properties of Addition

COMMUTATIVE PROPERTY The order in which you add two numbers does not change the sum.

Algebra $a + b = b + a$ **Example** $3 + (-2) = -2 + 3$

ASSOCIATIVE PROPERTY The way you group three numbers in a sum does not change the sum.

Algebra $(a + b) + c = a + (b + c)$ **Example** $(-3 + 2) + 1 = -3 + (2 + 1)$

IDENTITY PROPERTY The sum of a number and 0 is the number.

Algebra $a + 0 = 0 + a = a$ **Example** $-5 + 0 = -5$

INVERSE PROPERTY The sum of a number and its opposite is 0.

Algebra $a + (-a) = -a + a = 0$ **Example** $-6 + 6 = 0$

The identity property states that the sum of a number a and 0 is a. The number 0 is the **additive identity**. The inverse property states that the sum of a number a and its opposite is 0. The opposite of a is its **additive inverse**.

EXAMPLE 3 Identify properties of addition

Statement	**Property illustrated**
a. $(x + 9) + 2 = x + (9 + 2)$	Associative property of addition
b. $8.3 + (-8.3) = 0$	Inverse property of addition
c. $-y + 0.7 = 0.7 + (-y)$	Commutative property of addition

EXAMPLE 4 Solve a multi-step problem

BUSINESS The table shows the annual profits of two piano manufacturers. Which manufacturer had the greater total profit for the three years?

Year	Profit (millions) for manufacturer A	Profit (millions) for manufacturer B
1	−$5.8	−$6.5
2	$8.7	$7.9
3	$6.8	$8.2

Solution

STEP 1 **Calculate** the total profit for each manufacturer.

Manufacturer A:

$$\begin{aligned} \text{Total profit} &= -5.8 + 8.7 + 6.8 \\ &= -5.8 + (8.7 + 6.8) \\ &= -5.8 + 15.5 \\ &= 9.7 \end{aligned}$$

Manufacturer B:

$$\begin{aligned} \text{Total profit} &= -6.5 + 7.9 + 8.2 \\ &= -6.5 + (7.9 + 8.2) \\ &= -6.5 + 16.1 \\ &= 9.6 \end{aligned}$$

STEP 2 **Compare** the total profits: $9.7 > 9.6$.

▶ Manufacturer A had the greater total profit.

CHECK REASONABLENESS

Use estimation to check reasonableness. Manufacturer A: about $-6 + 9 + 7$, or 10. Manufacturer B: about $-7 + 8 + 8$, or 9. Because $10 > 9$, the solution is reasonable.

✓ GUIDED PRACTICE for Examples 2, 3, and 4

Find the sum.

5. $-0.6 + (-6.7)$

6. $10.1 + (-16.2)$

7. $-13.1 + 8.7$

Identify the property being illustrated.

8. $7 + (-7) = 0$

9. $-12 + 0 = -12$

10. $4 + 8 = 8 + 4$

11. **WHAT IF?** In Example 4, suppose that the profits for year 4 are −$1.7 million for manufacturer A and −$2.1 million for manufacturer B. Which manufacturer has the greater total profit for the four years?

2.2 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS3 for Exs. 13, 35, and 55

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 50, 56, 57, and 58

SKILL PRACTICE

1. **VOCABULARY** What number is called the additive identity?

2. ★ **WRITING** Without actually adding, how can you tell if the sum of two numbers will be zero?

EXAMPLE 1 on p. 74 for Exs. 3–11

USING A NUMBER LINE **Use a number line to find the sum.**

3. $-11 + 3$
4. $-1 + 6$
5. $13 + (-7)$
6. $5 + (-10)$
7. $-9 + (-4)$
8. $-8 + (-2)$
9. $-14 + 8$
10. $6 + (-12)$
11. $-11 + (-9)$

EXAMPLE 2 on p. 75 for Exs. 12–25

FINDING SUMS **Find the sum.**

12. $-2.4 + 3.9$
13. $-8.7 + 4.2$
14. $4.3 + (-10.2)$
15. $9.1 + (-2.5)$
16. $-6.5 + (-7.1)$
17. $-11.4 + (-3.8)$
18. $4\frac{1}{5} + \left(-9\frac{1}{2}\right)$
19. $8\frac{2}{3} + \left(-1\frac{3}{5}\right)$
20. $-12\frac{3}{4} + 6\frac{9}{10}$
21. $-\frac{4}{9} + 1\frac{4}{5}$
22. $-3\frac{3}{7} + \left(-14\frac{3}{4}\right)$
23. $-7\frac{1}{12} + \left(-13\frac{7}{8}\right)$

ERROR ANALYSIS ***Describe*** **and correct the error in finding the sum.**

24. $-13 + (-15) = 28$ ✗

25. $17 + (-31) = -48$ ✗

EXAMPLE 3 on p. 76 for Exs. 26–31

IDENTIFYING PROPERTIES **Identify the property being illustrated.**

26. $-3 + 3 = 0$
27. $(-6 + 1) + 7 = -6 + (1 + 7)$
28. $9 + (-1) = -1 + 9$
29. $-8 + 0 = -8$
30. $(x + 2) + 3 = x + (2 + 3)$
31. $y + (-4) = -4 + y$

EXAMPLE 4 on p. 76 for Exs. 32–37

FINDING SUMS **Find the sum.**

32. $-13 + 5 + (-7)$
33. $-18 + (-12) + (-19)$
34. $0.47 + (-1.8) + (-3.8)$
35. $-2.6 + (-3.4) + 7.6$
36. $-3\frac{1}{2} + \left(-7\frac{2}{5}\right) + \left(-9\frac{3}{10}\right)$
37. $8\frac{2}{3} + \left(-6\frac{3}{5}\right) + 3\frac{1}{4}$

EVALUATING EXPRESSIONS **Evaluate the expression for the given value of** x.

38. $3 + x + (-7);\ x = 6$
39. $x + (-5) + 5;\ x = -3$
40. $9.6 + (-x) + 2.3;\ x = -8.5$
41. $-1.7 + (-5.4) + (-x);\ x = 2.4$
42. $1\frac{1}{4} + |x| + \left(-3\frac{1}{2}\right);\ x = -8\frac{2}{5}$
43. $|x| + \left(-3\frac{1}{4}\right) + \left(7\frac{3}{10}\right);\ x = -3\frac{1}{3}$

2.3 Subtract Real Numbers

Before You added real numbers.

Now You will subtract real numbers.

Why? So you can find a change in temperature, as in Ex. 43.

Key Vocabulary
- **opposites,** *p. 66*

Because the expressions 12 − 3 and 12 + (−3) have the same value, 9, you can conclude that 12 − 3 = 12 + (−3). Subtracting 3 from 12 is equivalent to adding the opposite of 3 to 12. This example illustrates the *subtraction rule.*

KEY CONCEPT

For Your Notebook

Subtraction Rule

Words To subtract b from a, add the opposite of b to a.

Algebra $a - b = a + (-b)$ **Example** $14 - 8 = 14 + (-8)$

EXAMPLE 1 Subtract real numbers

Find the difference.

a. $-12 - 19 = -12 + (-19)$

$= -31$

b. $18 - (-7) = 18 + 7$

$= 25$

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✓ GUIDED PRACTICE for Example 1

Find the difference.

1. $-2 - 7$

2. $11.7 - (-5)$

3. $\frac{1}{3} - \frac{1}{2}$

EXAMPLE 2 Evaluate a variable expression

Evaluate the expression $y - x + 6.8$ when $x = -2$ and $y = 7.2$.

$y - x + 6.8 = 7.2 - (-2) + 6.8$ Substitute −2 for x and 7.2 for y.

$= 7.2 + 2 + 6.8$ Add the opposite of −2.

$= 16$ Add.

EVALUATING CHANGE You can use subtraction to find the change in a quantity, such as elevation or temperature. The change in a quantity is the difference of the new amount and the original amount. If the new amount is greater than the original amount, the change is positive. If the new amount is less than the original amount, the change is negative.

EXAMPLE 3 Evaluate change

TEMPERATURES One of the most extreme temperature changes in United States history occurred in Fairfield, Montana, on December 24, 1924. At noon, the temperature was 63°F. By midnight, the temperature fell to −21°F. What was the change in temperature?

Solution

The change C in temperature is the difference of the temperature m at midnight and the temperature n at noon.

STEP 1 **Write** a verbal model. Then write an equation.

$$\begin{array}{ccccc} \text{Change in temperature} & = & \text{Temperature at midnight} & - & \text{Temperature at noon} \\ \downarrow & & \downarrow & & \downarrow \\ C & = & m & - & n \end{array}$$

STEP 2 **Find** the change in temperature.

$C = m - n$ **Write equation.**

$= -21 - 63$ **Substitute values.**

$= -21 + (-63)$ **Add the opposite of 63.**

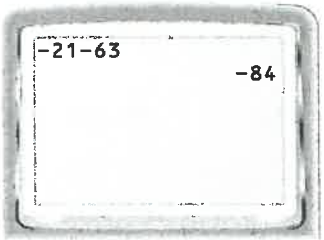
$= -84$ **Add −21 and −63.**

▶ The change in temperature was −84°F.

AVOID ERRORS
When a quantity decreases, the change is negative. So, the change found in Example 3 should be a negative number.

USING A CALCULATOR To enter a negative number on a calculator, use the (−) key. To enter a subtraction sign, use the − key. You can use a calculator to check your answer in Example 3 using the following keystrokes.

(−) 21 − 63 ENTER



```
-21-63
                 -84
```

✓ GUIDED PRACTICE for Examples 2 and 3

Evaluate the expression when $x = -3$ and $y = 5.2$.

4. $x - y + 8$
5. $y - (x - 2)$
6. $(y - 4) - x$
7. **CAR VALUES** A new car is valued at $15,000. One year later, the car is valued at $12,300. What is the change in the value of the car?

2.3 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 3, 21, and 43

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 38, 39, 40, and 46

◆ = **MULTIPLE REPRESENTATIONS** Ex. 45

SKILL PRACTICE

1. **VOCABULARY** Use the subtraction rule to rewrite the expression $-3 - 6$ as an addition expression.

2. ★ **WRITING** Without actually subtracting, how can you tell whether a change in a quantity will be negative?

EXAMPLE 1 on p. 80 for Exs. 3–14

FINDING DIFFERENCES **Find the difference.**

3. $13 - (-5)$
4. $16 - 32$
5. $-11 - (-3)$
6. $-15 - 29$
7. $-35.9 - (-50)$
8. $14.7 - (-2.3)$
9. $-3.6 - 22.2$
10. $-18.2 - (-15.4)$
11. $\frac{1}{2} - \frac{5}{6}$
12. $-\frac{5}{3} - \frac{8}{3}$
13. $\frac{1}{2} - \left(-\frac{1}{4}\right)$
14. $-\frac{7}{10} - \left(-\frac{2}{5}\right)$

EXAMPLE 2 on p. 80 for Exs. 15–25

ERROR ANALYSIS ***Describe*** **and correct the error in evaluating the expression when $x = 3$ and $y = -8$.**

15.

$$\begin{aligned} x - y + 2 &= 3 - 8 + 2 \\ &= 3 + (-8) + 2 \\ &= -5 + 2 \\ &= -3 \end{aligned}$$

✗

16.

$$\begin{aligned} x - (-4 + y) &= 3 - [-4 + (-8)] \\ &= 3 - (-12) \\ &= 3 - 12 \\ &= -9 \end{aligned}$$

✗

EVALUATING EXPRESSIONS **Evaluate the expression when $x = 7.1$ and $y = -2.5$.**

17. $x - (-y)$
18. $y - x - 12$
19. $x - (-6) + y$
20. $x - (y - 13)$
21. $-y - (1.9 - x)$
22. $-y - x$
23. $x - y - 2$
24. $5.3 - (y - x)$
25. $x + y - 2.8$

EXAMPLE 3 on p. 81 for Exs. 26–31

EVALUATING CHANGE **Find the change in temperature or elevation.**

26. From −5°C to −13°C
27. From −45°F to 62°F
28. From −300 feet to −100 feet
29. From 1200 meters to −80 meters
30. From 4.8°F to −12.6°F
31. From −90.7 miles to 36.4 miles

EVALUATING EXPRESSIONS **Evaluate the expression when $x = 3.6$, $y = 6.6$, and $z = -11$.**

32. $(x - y) - |z|$
33. $(x - |-y|) - z$
34. $x - |y - z|$
35. $(-x - y) - z - 5$
36. $x + y - z + 12.9$
37. $-z + y - x - (-2.4)$

38. ★ **MULTIPLE CHOICE** If the value of the expression $a - b$ is negative, which statement must be true?

Ⓐ $a > b$　Ⓑ $a = 0$　Ⓒ $a < b$　Ⓓ $b = 0$

2.4 Multiply Real Numbers

Before You added and subtracted real numbers.

Now You will multiply real numbers.

Why So you can calculate an elevation, as in Example 4.

Key Vocabulary
- **multiplicative identity**

In the activity on page 87, you saw that $a \cdot (-1) = -a$ for any integer a. This rule not only lets you write the product of a and -1 as $-a$, but it also lets you write $-a$ as $(-1)a$ and $a(-1)$. Using this rule, you can multiply any two real numbers. Here are two examples:

$$\begin{aligned} -2(3) &= -1(2)(3) \\ &= -1(6) \\ &= -6 \end{aligned} \qquad \begin{aligned} (-2)(-3) &= -2(3)(-1) \\ &= -6(-1) \\ &= 6 \end{aligned}$$

KEY CONCEPT *For Your Notebook*

The Sign of a Product

Words The product of two real numbers with the *same* sign is positive.

Examples $3(4) = 12$ $\quad -6(-3) = 18$

Words The product of two real numbers with *different* signs is negative.

Examples $2(-5) = -10$ $\quad -7(2) = -14$

EXAMPLE 1 Multiply real numbers

MULTIPLY NEGATIVES
- A product is negative if it has an *odd* number of negative numbers.
- A product is positive if it has an *even* number of negative numbers.

Find the product.

a. $-3(6) = -18$ — Different signs; product is negative.

b. $2(-5)(-4) = (-10)(-4)$ — Multiply 2 and -5.

$= 40$ — Same signs; product is positive.

c. $-\frac{1}{2}(-4)(-3) = 2(-3)$ — Multiply $-\frac{1}{2}$ and -4.

$= -6$ — Different signs; product is negative.

✓ GUIDED PRACTICE for Example 1

Find the product.

1. $-2(-7)$ **2.** $-0.5(-4)(-9)$ **3.** $\frac{4}{3}(-3)(7)$

PROPERTIES OF MULTIPLICATION Notice that both $4(-5)$ and $-5(4)$ have a product of -20, so $4(-5) = -5(4)$. This equation is an example of the *commutative property of multiplication.* Properties of multiplication are listed below.

KEY CONCEPT *For Your Notebook*

Properties of Multiplication

COMMUTATIVE PROPERTY The order in which you multiply two numbers does not change the product.

Algebra $a \cdot b = b \cdot a$ **Example** $4 \cdot (-5) = -5 \cdot 4$

ASSOCIATIVE PROPERTY The way you group three numbers in a product does not change the product.

Algebra $(a \cdot b) \cdot c = a \cdot (b \cdot c)$ **Example** $(-2 \cdot 7) \cdot 4 = -2 \cdot (7 \cdot 4)$

IDENTITY PROPERTY The product of a number and 1 is that number.

Algebra $a \cdot 1 = 1 \cdot a = a$ **Example** $(-5) \cdot 1 = -5$

PROPERTY OF ZERO The product of a number and 0 is 0.

Algebra $a \cdot 0 = 0 \cdot a = 0$ **Example** $-3 \cdot 0 = 0$

PROPERTY OF −1 The product of a number and −1 is the opposite of the number.

Algebra $a \cdot (-1) = -1 \cdot a = -a$ **Example** $-2 \cdot (-1) = 2$

The identity property states that the product of a number a and 1 is a. The number 1 is called the **multiplicative identity**.

EXAMPLE 2 Identify properties of multiplication

Statement	Property illustrated
a. $(x \cdot 7) \cdot 0.5 = x \cdot (7 \cdot 0.5)$	Associative property of multiplication
b. $8 \cdot 0 = 0$	Multiplicative property of zero
c. $-6 \cdot y = y \cdot (-6)$	Commutative property of multiplication
d. $9 \cdot (-1) = -9$	Multiplicative property of −1
e. $1 \cdot v = v$	Identity property of multiplication

GUIDED PRACTICE for Example 2

Identify the property illustrated.

4. $-1 \cdot 8 = -8$

5. $12 \cdot x = x \cdot 12$

6. $(y \cdot 4) \cdot 9 = y \cdot (4 \cdot 9)$

7. $0 \cdot (-41) = 0$

8. $-5 \cdot (-6) = -6 \cdot (-5)$

9. $-13 \cdot (-1) = 13$

EXAMPLE 3 Use properties of multiplication

JUSTIFY STEPS

To justify a step, you name the property used. Sometimes a step is a calculation, as when you multiply 0.25 and −4 in Example 3.

Find the product $(-4x) \cdot 0.25$. Justify your steps.

$(-4x) \cdot 0.25 = 0.25 \cdot (-4x)$ **Commutative property of multiplication**

$= [0.25 \cdot (-4)]x$ **Associative property of multiplication**

$= -1 \cdot x$ **Product of 0.25 and −4 is −1.**

$= -x$ **Multiplicative property of −1**

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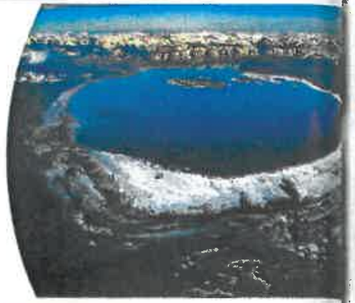
EXAMPLE 4 Solve a multi-step problem

READING

The average rate of change in elevation is the total change in elevation divided by the number of years that have passed.

LAKES In 1900 the elevation of Mono Lake in California was about 6416 feet. From 1900 to 1950, the average rate of change in elevation was about −0.12 foot per year. From 1950 to 2000, the average rate of change was about −0.526 foot per year. Approximate the elevation in 2000.



Solution

STEP 1 **Write** a verbal model.

New elevation (feet) = Original elevation (feet) + Average rate of change (feet/year) • Time passed (years)

STEP 2 **Calculate** the elevation in 1950. Use the elevation in 1900 as the original elevation. The time span is 1950 − 1900 = 50 years.

New elevation $= 6416 + (-0.12)(50)$ **Substitute values.**

$= 6416 + (-6)$ **Multiply −0.12 and 50.**

$= 6410$ **Add 6416 and −6.**

STEP 3 **Calculate** the elevation in 2000. Use the elevation in 1950 as the original elevation. The time span is 2000 − 1950 = 50 years.

New elevation $= 6410 + (-0.526)(50)$ **Substitute values.**

$= 6410 + (-26.3)$ **Multiply −0.526 and 50.**

$= 6383.7$ **Add 6410 and −26.3.**

▶ The elevation in 2000 was about 6383.7 feet above sea level.

CHECK REASONABLENESS

In Step 2, note that $-0.12(50) \approx -0.1(50) = -5$, and $6416 + (-5) = 6411$, so 6410 is reasonable. In Step 3, $-0.526(50) \approx -0.5(50) = -25$, and $6410 + (-25) = 6385$, so 6383.7 is reasonable.

✓ GUIDED PRACTICE for Examples 3 and 4

Find the product. *Justify* your steps.

10. $\frac{3}{10}(5y)$

11. $0.8(-x)(-1)$

12. $(-y)(-0.5)(-6)$

13. Using the data in Example 4, approximate the elevation of Mono Lake in 1925 and in 1965.

2.4 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 11, 31, and 51

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 48, 52, 53, and 55

◆ = **MULTIPLE REPRESENTATIONS** Ex. 54

SKILL PRACTICE

1. **VOCABULARY** What number is called the multiplicative identity?

2. ★ **WRITING** *Describe* the difference between the identity property of multiplication and the multiplicative property of -1.

EXAMPLE 1 on p. 88 for Exs. 3–18

FINDING PRODUCTS **Find the product.**

3. $-4(7)$
4. $11(-2)$
5. $-9(-10)$
6. $-8(-11)$
7. $5(-7.2)$
8. $(-2.5)(-1.3)$
9. $-42\left(-\frac{1}{6}\right)$
10. $-\frac{1}{2}(-32)$

⑪ $-1.9(3.3)(7)$

12. $0.5(-20)(-3)$
13. $-\frac{5}{6}(-12)(-4)$
14. $-\frac{3}{4}(2)(-6)$
15. $-8(-4)(-2.5)$
16. $-1.6(-2)(-10)$
17. $18\left(-\frac{2}{3}\right)\left(-\frac{1}{5}\right)$
18. $-\frac{3}{4}\left(-\frac{1}{3}\right)\left(-\frac{8}{9}\right)$

EXAMPLE 2 on p. 89 for Exs. 19–27

IDENTIFYING PROPERTIES **Identify the property illustrated.**

19. $-\frac{2}{5} \cdot 0 = 0$
20. $0.3 \cdot (-3) = -3 \cdot 0.3$
21. $-143 \cdot 1 = -143$
22. $-1 \cdot (-6) = 6$
23. $(-2 \cdot 5) \cdot 4 = -2 \cdot (5 \cdot 4)$
24. $0 \cdot (-76.3) = 0$
25. $1 \cdot (ab) = ab$
26. $(3x)y = 3(xy)$
27. $s \cdot (-1) = -s$

EXAMPLE 3 on p. 90 for Exs. 28–36

USING PROPERTIES **Find the product. *Justify* your steps.**

28. $y(-2)(-8)$
29. $-18(-x)$
30. $\frac{3}{5}(-5q)$

㉛ $-2(-6)(-7z)$

32. $-5(-4)(-2.1)(-z)$
33. $-\frac{1}{5}(-10)(4)(-5c)$
34. $-5t(-t)$
35. $-6r(-2.8r)$
36. $\frac{1}{3}\left(-\frac{9}{10}\right)(-m)(-m)$

EVALUATING EXPRESSIONS **Evaluate the expression when $x = -2$ and $y = 3.6$.**

37. $2x + y$
38. $-x - 3y$
39. $xy - 5.4$
40. $|y| - 4x$
41. $1.5x - |-y|$
42. $x^2 - y^2$

ERROR ANALYSIS ***Describe*** **and correct the error in finding the product.**

43.

$$\begin{aligned} -1(7)(-3)(-2x) &= 7(-3)(-2x) \\ &= -21(-2x) \\ &= [-21 \cdot (-2)]x \\ &= 42x \end{aligned}$$

44.

$$\begin{aligned} (-5z)(-8)(z) &= (-8)(-5z)(z) \\ &= (-8)(-5)(z)(z) \\ &= -40(z \cdot z) \\ &= -40z^2 \end{aligned}$$

2.5 Apply the Distributive Property

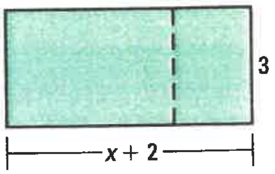
Before You used properties to add and multiply real numbers.

Now You will apply the distributive property.

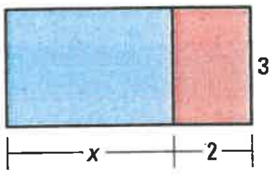
Why? So you can find calories burned, as in Example 5.

Key Vocabulary
- equivalent expressions
- distributive property
- term
- coefficient
- constant term
- like terms

The models below show two methods for finding the area of a rectangle that has a length of $(x + 2)$ units and a width of 3 units.



Area = 3(x + 2)



Area = 3(x) + 3(2)

The expressions $3(x + 2)$ and $3(x) + 3(2)$ are equivalent because they represent the same area. Two expressions that have the same value for all values of the variable are called **equivalent expressions**. The equation $3(x + 2) = 3(x) + 3(2)$ illustrates the **distributive property**, which can be used to find the product of a number and a sum or difference.

KEY CONCEPT *For Your Notebook*

The Distributive Property

Let a, b, and c be real numbers.

Words	Algebra	Examples
The product of a and $(b + c)$:	$a(b + c) = ab + ac$	$3(4 + 2) = 3(4) + 3(2)$
	$(b + c)a = ba + ca$	$(3 + 5)2 = 3(2) + 5(2)$
The product of a and $(b - c)$:	$a(b - c) = ab - ac$	$5(6 - 4) = 5(6) - 5(4)$
	$(b - c)a = ba - ca$	$(8 - 6)4 = 8(4) - 6(4)$

EXAMPLE 1 Apply the distributive property

AVOID ERRORS
Be sure to distribute the factor outside of the parentheses to *all* of the numbers inside the parentheses, not just to the first number.

Use the distributive property to write an equivalent expression.

a. $4(y + 3) = 4y + 12$

b. $(y + 7)y = y^2 + 7y$

c. $n(n - 9) = n^2 - 9n$

d. $(2 - n)8 = 16 - 8n$

EXAMPLE 2 Distribute a negative number

Use the distributive property to write an equivalent expression.

a. $-2(x + 7) = -2(x) + (-2)(7)$ Distribute -2.

$= -2x - 14$ Simplify.

b. $(5 - y)(-3y) = 5(-3y) - y(-3y)$ Distribute $-3y$.

$= -15y + 3y^2$ Simplify.

c. $-(2x - 11) = (-1)(2x - 11)$ Multiplicative property of -1

$= (-1)(2x) - (-1)(11)$ Distribute -1.

$= -2x + 11$ Simplify.

TERMS AND COEFFICIENTS The parts of an expression that are added together are called **terms**. The number part of a term with a variable part is called the **coefficient** of the term.

READING
Note that $-x$ has a coefficient of -1 even though the 1 isn't written. Similarly, x has a coefficient of 1.

Terms

$$-x + 2x + 8$$

Coefficients are -1 and 2.

A **constant term** has a number part but no variable part, such as 8 in the expression above. **Like terms** are terms that have the same variable parts, such as $-x$ and $2x$ in the expression above. Constant terms are also like terms.

EXAMPLE 3 Identify parts of an expression

Identify the terms, like terms, coefficients, and constant terms of the expression $3x - 4 - 6x + 2$.

Solution

Write the expression as a sum: $3x + (-4) + (-6x) + 2$

Terms: $3x, -4, -6x, 2$

Coefficients: $3, -6$

Like terms: $3x$ and $-6x$; -4 and 2

Constant terms: $-4, 2$

✓ GUIDED PRACTICE for Examples 1, 2, and 3

Use the distributive property to write an equivalent expression.

1. $2(x + 3)$

2. $-(4 - y)$

3. $(m - 5)(-3m)$

4. $(2n + 6)\left(\frac{1}{2}\right)$

5. Identify the terms, like terms, coefficients, and constant terms of the expression $-7y + 8 - 6y - 13$.

COMBINING LIKE TERMS The distributive property allows you to combine like terms that have variable parts. For example, $5x + 6x = (5 + 6)x = 11x$. A quick way to combine like terms with variable parts is to mentally add the coefficients and use the common variable part. An expression is *simplified* if it has no grouping symbols and if all of the like terms have been combined.

★ EXAMPLE 4 Standardized Test Practice

ANOTHER WAY

In Example 4, you can rewrite the expression $4(n + 9) - 3(2 + n)$ as $4(n + 9) + (-3)(2 + n)$ and then distribute -3 to the terms in $2 + n$.

Simplify the expression $4(n + 9) - 3(2 + n)$.

Ⓐ $5n + 30$ Ⓑ $n + 30$ Ⓒ $5n + 3$ Ⓓ $n + 3$

$4(n + 9) - 3(2 + n) = 4n + 36 - 6 - 3n$ Distributive property

$= n + 30$ Combine like terms.

▶ The correct answer is B. Ⓐ Ⓑ Ⓒ Ⓓ

EXAMPLE 5 Solve a multi-step problem

EXERCISING Your daily workout plan involves a total of 50 minutes of running and swimming. You burn 15 calories per minute when running and 9 calories per minute when swimming. Let r be the number of minutes that you run. Find the number of calories you burn in your 50 minute workout if you run for 20 minutes.

ANOTHER WAY

For an alternative method for solving the problem in Example 5, turn to page 102 for the **Problem Solving Workshop**.

Solution

The workout lasts 50 minutes, and your running time is r minutes. So, your swimming time is $(50 - r)$ minutes.

STEP 1 **Write** a verbal model. Then write an equation.

Amount burned (calories)	=	Burning rate when running (calories/minute)	•	Running time (minutes)	+	Burning rate when swimming (calories/minute)	•	Swimming time (minutes)
↓		↓		↓		↓		↓
C	=	15	•	r	+	9	•	$(50 - r)$

$C = 15r + 9(50 - r)$ Write equation.

$= 15r + 450 - 9r$ Distributive property

$= 6r + 450$ Combine like terms.

STEP 2 **Find** the value of C when $r = 20$.

$C = 6r + 450$ Write equation.

$= 6(20) + 450 = 570$ Substitute 20 for r. Then simplify.

▶ You burn 570 calories in your 50 minute workout if you run for 20 minutes.

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✓ GUIDED PRACTICE for Examples 4 and 5

6. Simplify the expression $5(6 + n) - 2(n - 2)$.

7. **WHAT IF?** In Example 5, suppose your workout lasts 45 minutes. How many calories do you burn if you run for 20 minutes? 30 minutes?

2.5 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 9, 23, and 51

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 27, 52, and 54

SKILL PRACTICE

1. **VOCABULARY** What are the coefficients of the expression $4x + 8 - 9x + 2$?

2. ★ **WRITING** Are the expressions $2(x + 1)$ and $2x + 1$ equivalent? *Explain.*

ERROR ANALYSIS ***Describe*** **and correct the error in simplifying the expression.**

3.
$$5y - (2y - 8) = 5y - 2y - 8$$
$$= 3y - 8$$

4.
$$8 + 2(4 + 3x) = 8 + 8 + 6x$$
$$= 22x$$

EXAMPLES 1 and 2 on pp. 96–97 for Exs. 5–20

USING THE DISTRIBUTIVE PROPERTY **Use the distributive property to write an equivalent expression.**

5. $4(x + 3)$
6. $8(y + 2)$
7. $(m + 5)5$
8. $(n + 6)3$
9. $(p - 3)(-8)$
10. $-4(q - 4)$
11. $2(2r - 3)$
12. $(s - 9)9$
13. $6v(v + 1)$
14. $-w(2w + 7)$
15. $-2x(3 - x)$
16. $3y(y - 6)$
17. $\frac{1}{2}\left(\frac{1}{2}m - 4\right)$
18. $-\frac{3}{4}(p - 1)$
19. $\frac{2}{3}(6n - 9)$
20. $\frac{5}{6}r(r - 1)$

EXAMPLE 3 on p. 97 for Exs. 21–26

IDENTIFYING PARTS OF AN EXPRESSION **Identify the terms, like terms, coefficients, and constant terms of the expression.**

21. $-7 + 13x + 2x + 8$
22. $9 + 7y - 2 - 5y$
23. $7x^2 - 10 - 2x^2 + 5$
24. $-3y^2 + 3y^2 - 7 + 9$
25. $2 + 3xy - 4xy + 6$
26. $6xy - 11xy + 2xy - 4xy + 7xy$

27. ★ **MULTIPLE CHOICE** Which two terms are like terms?

Ⓐ $-2, -5x$ Ⓑ $4x, -x$ Ⓒ $-2, -2y$ Ⓓ $5x, -3y$

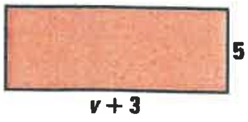
EXAMPLE 4 on p. 98 for Exs. 28–39

SIMPLIFYING EXPRESSIONS **Simplify the expression.**

28. $7x + (-11x)$
29. $6y - y$
30. $5 + 2n + 2$
31. $(4a - 1)2 + a$
32. $3(2 - c) - c$
33. $6r + 2(r + 4)$
34. $15t - (t - 4)$
35. $3(m + 5) - 10$
36. $-6(v + 1) + v$
37. $7(w - 5) + 3w$
38. $6(5 - z) + 2z$
39. $(s - 3)(-2) + 17s$

GEOMETRY **Find the perimeter and area of the rectangle.**

40.



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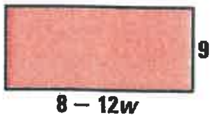
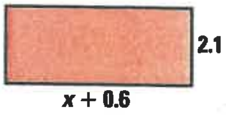


42.



USING MENTAL MATH **In Exercises 43–46, use the example below to find the total cost.**

EXAMPLE **Use the distributive property and mental math**

Use the distributive property and mental math to find the total cost of 5 picture frames at $1.99 each.

Total cost $= 5(1.99)$ **Write expression for total cost.**

$= 5(2 - 0.01)$ **Rewrite 1.99 as 2 − 0.01.**

$= 5(2) - 5(0.01)$ **Distributive property**

$= 10 - 0.05$ **Multiply using mental math.**

$= 9.95$ **Subtract. The total cost is $9.95.**

43. 3 CDs at $12.99 each

44. 5 magazines at $3.99 each

45. 6 pairs of socks at $1.98 per pair

46. 25 baseballs at $2.98 each

TRANSLATING PHRASES **In Exercises 47 and 48, translate the verbal phrase into an expression. Then simplify the expression.**

47. Twice the sum of 6 and x, increased by 5 less than x

48. Three times the difference of x and 2, decreased by the sum of x and 10

49. **CHALLENGE** How can you use $a(b + c) = ab + ac$ to show that $(b + c)a = ba + ca$ is also true? *Justify* your steps.

PROBLEM SOLVING

EXAMPLE 5
on p. 98
for Exs. 50–52

50. **SPORTS** An archer shoots 6 arrows at a target. Some arrows hit the 9 point ring, and the rest hit the 10 point bull's-eye. Write an equation that gives the score s as a function of the number a of arrows that hit the 9 point ring. Then find the score if 2 arrows hit the 9 point ring.

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51. **MOVIES** You have a coupon for $2 off the regular cost per movie rental. You rent 3 movies, and the regular cost of each rental is the same. Write an equation that gives the total cost C (in dollars) as a function of the regular cost r (in dollars) of a rental. Then find the total cost if a rental regularly costs $3.99.

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52. ★ **SHORT RESPONSE** Each day you use your pay-as-you-go cell phone you pay $.25 per minute for the first 10 minutes and $.10 per minute for any time over 10 minutes. Write an equation that gives the daily cost C (in dollars) as a function of the time t (in minutes) when usage exceeds 10 minutes. Which costs more, using the phone for 10 minutes today and 15 minutes tomorrow, or using the phone for 25 minutes today? *Explain.*

○ = **WORKED-OUT SOLUTIONS on p. WS1**

★ = **STANDARDIZED TEST PRACTICE**

2.6 Divide Real Numbers

Before You multiplied real numbers.

Now You will divide real numbers.

Why? So you can calculate volleyball statistics, as in Ex. 57.

Key Vocabulary
- **multiplicative inverse**
- **reciprocal,** *p. 915*
- **mean,** *p. 918*

Reciprocals like $\frac{2}{3}$ and $\frac{3}{2}$ have the property that their product is 1:

$$\frac{2}{3} \cdot \frac{3}{2} = 1$$

The reciprocal of a nonzero number a, written $\frac{1}{a}$, is called the **multiplicative inverse** of a. Zero does not have a multiplicative inverse because there is no number a such that $0 \cdot a = 1$.

READING

The symbol ≠ is read "is not equal to."

KEY CONCEPT *For Your Notebook*

Inverse Property of Multiplication

Words The product of a nonzero number and its multiplicative inverse is 1.

Algebra $a \cdot \frac{1}{a} = \frac{1}{a} \cdot a = 1, a \neq 0$ **Example** $8 \cdot \frac{1}{8} = 1$

EXAMPLE 1 Find multiplicative inverses of numbers

a. The multiplicative inverse of $-\frac{1}{5}$ is -5 because $-\frac{1}{5} \cdot (-5) = 1$.

b. The multiplicative inverse of $-\frac{6}{7}$ is $-\frac{7}{6}$ because $-\frac{6}{7} \cdot \left(-\frac{7}{6}\right) = 1$.

WRITE INVERSES

You can find the inverse of $-\frac{6}{7}$ as follows:

$$\frac{1}{-\frac{6}{7}} \cdot 1 = \frac{1}{-\frac{6}{7}} \cdot \frac{7}{7}$$
$$= -\frac{7}{6}$$

DIVISION Because the expressions $6 \div 3$ and $6 \cdot \frac{1}{3}$ have the same value, 2, you can conclude that $6 \div 3 = 6 \cdot \frac{1}{3}$. This example illustrates the *division rule.*

KEY CONCEPT *For Your Notebook*

Division Rule

Words To divide a number a by a nonzero number b, multiply a by the multiplicative inverse of b.

Algebra $a \div b = a \cdot \frac{1}{b}, b \neq 0$ **Example** $5 \div 2 = 5 \cdot \frac{1}{2}$

SIGN OF A QUOTIENT Because division can be expressed as multiplication, the sign rules for division are the same as the sign rules for multiplication.

AVOID ERRORS

You cannot divide a real number by 0, because 0 does not have a multiplicative inverse.

KEY CONCEPT *For Your Notebook*

The Sign of a Quotient

- The quotient of two real numbers with the *same* sign is positive.
- The quotient of two real numbers with *different* signs is negative.
- The quotient of 0 and any nonzero real number is 0.

EXAMPLE 2 Divide real numbers

Find the quotient.

a. $-16 \div 4 = -16 \cdot \frac{1}{4}$

$= -4$

b. $-20 \div \left(-\frac{5}{3}\right) = -20 \cdot \left(-\frac{3}{5}\right)$

$= 12$

✓ GUIDED PRACTICE for Examples 1 and 2

Find the multiplicative inverse of the number.

1. -27 **2.** -8 **3.** $-\frac{4}{7}$ **4.** $-\frac{1}{3}$

Find the quotient.

5. $-64 \div (-4)$ **6.** $-\frac{3}{8} \div \left(\frac{3}{10}\right)$ **7.** $18 \div \left(-\frac{2}{9}\right)$ **8.** $-\frac{2}{5} \div 18$

EXAMPLE 3 Find the mean

TEMPERATURES The table gives the daily minimum temperatures (in degrees Fahrenheit) in Barrow, Alaska, for the first 5 days of February 2004. Find the mean daily minimum temperature.

Day in February	1	2	3	4	5
Minimum temperature (°F)	−21	−29	−39	−39	−22

Point Barrow Observatory

Solution

To find the mean daily minimum temperature, find the sum of the minimum temperatures for the 5 days and then divide the sum by 5.

$$\text{Mean} = \frac{-21 + (-29) + (-39) + (-39) + (-22)}{5}$$

$$= -\frac{150}{5} = -30$$

▶ The mean daily minimum temperature was −30°F.

CHECK REASONABLENESS

The sum of the temperatures is about $-20 + (-30) + (-40) + (-40) + (-20) = -150$, and $-150 \div 5 = -30$, so the solution is reasonable.

EXAMPLE 4 Simplify an expression

Simplify the expression $\frac{36x - 24}{6}$.

$$\frac{36x - 24}{6} = (36x - 24) \div 6$$ **Rewrite fraction as division.**

$$= (36x - 24) \cdot \frac{1}{6}$$ **Division rule**

$$= 36x \cdot \frac{1}{6} - 24 \cdot \frac{1}{6}$$ **Distributive property**

$$= 6x - 4$$ **Simplify.**

ANOTHER WAY

You can simplify the expression by first rewriting it as a difference of two fractions: $\frac{36x - 24}{6} = \frac{36x}{6} - \frac{24}{6} = 6x - 4$.

✓ GUIDED PRACTICE for Examples 3 and 4

9. Find the mean of the numbers −3, 4, 2.8, and −1.5.

10. **TEMPERATURES** Find the mean daily maximum temperature (in degrees Fahrenheit) in Barrow, Alaska, for the first 5 days of February 2004.

Day in February	1	2	3	4	5
Maximum temperature (°F)	−3	−20	−21	−22	−18

Simplify the expression.

11. $\frac{2x - 8}{-4}$

12. $\frac{-6y + 18}{3}$

13. $\frac{-10z - 20}{-5}$

OPERATIONS ON REAL NUMBERS In this chapter, you saw how to find the sum, difference, product, and quotient of two real numbers a and b. You can use the values of a and b to determine whether the result is positive, negative, or 0.

CONCEPT SUMMARY *For Your Notebook*

Rules for Addition, Subtraction, Multiplication, and Division

Let a and b be real numbers.

Expression	$a + b$	$a - b$	$a \cdot b$	$a \div b$
Positive if...	the number with the greater absolute value is positive.	$a > b$.	a and b have the same sign ($a \neq 0, b \neq 0$).	a and b have the same sign ($a \neq 0, b \neq 0$).
Negative if...	the number with the greater absolute value is negative.	$a < b$.	a and b have different signs ($a \neq 0, b \neq 0$).	a and b have different signs ($a \neq 0, b \neq 0$).
Zero if...	a and b are additive inverses.	$a = b$.	$a = 0$ or $b = 0$.	$a = 0$ and $b \neq 0$.

2.6 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 13, 35, and 53

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 23, 48, 49, 55, 56, and 57

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: The product of a nonzero number and its __?__ is 1.

2. ★ **WRITING** How can you tell whether the mean of n numbers is negative without actually dividing the sum of the numbers by n? *Explain.*

EXAMPLE 1
on p. 103
for Exs. 3–10, 23

FINDING INVERSES **Find the multiplicative inverse of the number.**

3. -18
4. -9
5. -1
6. $-\frac{1}{2}$
7. $-\frac{3}{4}$
8. $-\frac{5}{9}$
9. $-4\frac{1}{3}$
10. $-2\frac{2}{5}$

EXAMPLE 2
on p. 104
for Exs. 11–22

FINDING QUOTIENTS **Find the quotient.**

11. $-21 \div 3$
12. $-18 \div (-6)$
13. $-1 \div \left(-\frac{7}{2}\right)$
14. $15 \div \left(-\frac{3}{4}\right)$
15. $13 \div \left(-4\frac{1}{3}\right)$
16. $-\frac{2}{3} \div 2$
17. $-\frac{1}{2} \div \frac{1}{5}$
18. $-\frac{1}{5} \div (-6)$
19. $-\frac{4}{7} \div (-2)$
20. $-1 \div \left(-\frac{6}{5}\right)$
21. $8 \div \left(-\frac{4}{11}\right)$
22. $-\frac{1}{3} \div \frac{5}{3}$

23. ★ **MULTIPLE CHOICE** If $-\frac{5}{7}x = 1$, what is the value of x?

Ⓐ $-1\frac{2}{5}$ Ⓑ $\frac{5}{7}$ Ⓒ 1 Ⓓ $\frac{12}{5}$

EXAMPLE 3
on p. 104
for Exs. 24–32

FINDING MEANS **Find the mean of the numbers.**

24. −10, −8, 3
25. 12, −8, −9
26. 18, −9, 0, −5
27. −2, 9, −3, 5
28. −1, −4, −5, 10
29. 7, −4, 1, −9, −6
30. −5.3, −2, 1.3
31. 0.25, −4, −0.75, −1, 6
32. −0.6, 0.18, −2, 5, −0.5

EXAMPLE 4
on p. 105
for Exs. 33–43

SIMPLIFYING EXPRESSIONS **Simplify the expression.**

33. $\frac{6x - 14}{2}$
34. $\frac{12y - 8}{-4}$
35. $\frac{9z - 6}{-3}$
36. $\frac{-6p + 15}{6}$
37. $\frac{5 - 25q}{10}$
38. $\frac{-18 - 21r}{-12}$
39. $\frac{-24a - 10}{-8}$
40. $\frac{-20b + 12}{-5}$
41. $\frac{36 - 27c}{9}$

ERROR ANALYSIS ***Describe*** **and correct the error in simplifying the expression.**

42.

$$\frac{12 - 18x}{6} = (12 - 18x) \cdot \left(-\frac{1}{6}\right)$$
$$= 12\left(-\frac{1}{6}\right) - 18x\left(-\frac{1}{6}\right)$$
$$= -2 + 3x$$

✗

43.

$$\frac{-15x - 10}{-5} = (-15x - 10) \cdot \left(-\frac{1}{5}\right)$$
$$= -15x\left(-\frac{1}{5}\right) - 10\left(-\frac{1}{5}\right)$$
$$= 3x - 2$$

✗

EVALUATING EXPRESSIONS **Evaluate the expression.**

44. $\frac{2y - x}{x}$ when $x = 1$ and $y = -4$

45. $\frac{4x}{3y + x}$ when $x = 6$ and $y = -8$

46. $\frac{-9x}{y^2 - 1}$ when $x = -3$ and $y = -2$

47. $\frac{y - x}{xy}$ when $x = -6$ and $y = -2$

48. ★ **WRITING** Tell whether division is commutative and associative. Give examples to support your answer.

49. ★ **MULTIPLE CHOICE** Let a and b be positive numbers, and let c and d be negative numbers. Which quotient has a value that is always negative?

Ⓐ $\frac{a}{b} \div \frac{c}{d}$ Ⓑ $\frac{a}{c} \div \frac{b}{d}$ Ⓒ $\frac{c^2}{a} \div \frac{b}{d}$ Ⓓ $\frac{a}{cd} \div b$

50. **CHALLENGE** Find the mean of the integers from −410 to 400. *Explain* how you got your answer.

51. **CHALLENGE** What is the mean of a number and three times its opposite? *Explain* your reasoning.

PROBLEM SOLVING

EXAMPLE 2
on p. 104
for Ex. 52

52. **SPORTS** Free diving means diving without the aid of breathing equipment. Suppose that an athlete free dives to an elevation of −42 meters in 60 seconds. Find the average rate of change in the diver's elevation.

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EXAMPLE 3
on p. 104
for Exs. 53–54

53. **WEATHER** The daily mean temperature is the mean of the high and low temperatures for a given day. The high temperature for Boston, Massachusetts, on January 10, 2004, was −10.6°C. The low temperature was −18.9°C. Find the daily mean temperature for that day.

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54. **MULTI-STEP PROBLEM** The table shows the changes in the values of one share of stock A and one share of stock B over 5 days.

Day of week	Monday	Tuesday	Wednesday	Thursday	Friday
Change in share value for stock A (dollars)	−0.45	−0.32	0.66	−1.12	1.53
Change in share value for stock B (dollars)	−0.37	0.14	0.59	−0.53	1.02

a. Find the average daily change in share value for each stock. Use estimation to check that your answers are reasonable.

b. Which stock performed better over the 5 days? How much more money did the better performing stock earn, on average, per day?

c. Can you conclude that the stock that performed better over all 5 days also performed better over the first 4 days of the week? *Explain* your reasoning.

2.7 Find Square Roots and Compare Real Numbers

Before You found squares of numbers and compared rational numbers.

Now You will find square roots and compare real numbers.

Why? So you can find side lengths of geometric shapes, as in Ex. 52.

Key Vocabulary
- **square root**
- **radicand**
- **perfect square**
- **irrational number**
- **real numbers**

Recall that the square of 4 is $4^2 = 16$ and the square of -4 is $(-4)^2 = 16$. The numbers 4 and -4 are called the *square roots* of 16. In this lesson, you will find the square roots of nonnegative numbers.

KEY CONCEPT *For Your Notebook*

Square Root of a Number

Words If $b^2 = a$, then b is a **square root** of a.

Example $3^2 = 9$ and $(-3)^2 = 9$, so 3 and -3 are square roots of 9.

All positive real numbers have two square roots, a positive square root (or *principal* square root) and a negative square root. A square root is written with the radical symbol $\sqrt{}$. The number or expression inside a radical symbol is the **radicand.**

$$\text{radical symbol} \longrightarrow \sqrt{a} \longleftarrow \text{radicand}$$

Zero has only one square root, 0. Negative real numbers do not have real square roots because the square of every real number is either positive or 0.

EXAMPLE 1 Find square roots

Evaluate the expression.

a. $\pm\sqrt{36} = \pm 6$ The positive and negative square roots of 36 are 6 and -6.

b. $\sqrt{49} = 7$ The positive square root of 49 is 7.

c. $-\sqrt{4} = -2$ The negative square root of 4 is -2.

READING
The symbol ± is read as "plus or minus" and refers to both the positive square root and the negative square root.

✓ GUIDED PRACTICE for Example 1

Evaluate the expression.

1. $-\sqrt{9}$ **2.** $\sqrt{25}$ **3.** $\pm\sqrt{64}$ **4.** $-\sqrt{81}$

PERFECT SQUARES The square of an integer is called a **perfect square**. As shown in Example 1, the square root of a perfect square is an integer. As you will see in Example 2, you need to approximate a square root if the radicand is a whole number that is *not* a perfect square.

EXAMPLE 2 Approximate a square root

FURNITURE The top of a folding table is a square whose area is 945 square inches. Approximate the side length of the tabletop to the nearest inch.

Solution

You need to find the side length s of the tabletop such that $s^2 = 945$. This means that s is the positive square root of 945. You can use a table to determine whether 945 is a perfect square.

Number	28	29	30	31	32
Square of number	784	841	900	961	1024

As shown in the table, 945 is *not* a perfect square. The greatest perfect square less than 945 is 900. The least perfect square greater than 945 is 961.

$900 < 945 < 961$ **Write a compound inequality that compares 945 with both 900 and 961.**

$\sqrt{900} < \sqrt{945} < \sqrt{961}$ **Take positive square root of each number.**

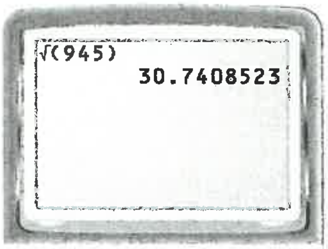
$30 < \sqrt{945} < 31$ **Find square root of each perfect square.**

The average of 30 and 31 is 30.5, and $(30.5)^2 = 930.25$. Because $945 > 930.25$, $\sqrt{945}$ is closer to 31 than to 30.

▶ The side length of the tabletop is about 31 inches.

USING A CALCULATOR In Example 2, you can use a calculator to obtain a better approximation of the side length of the tabletop.

2nd √ 945) ENTER



```
√(945)
                30.7408523
```

The value shown can be rounded to the nearest hundredth, 30.74, or to the nearest tenth, 30.7. In either case, the length is closer to 31 than to 30.

✓ GUIDED PRACTICE for Example 2

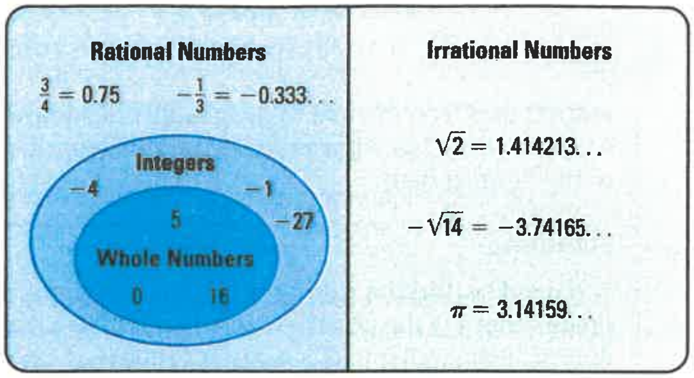
Approximate the square root to the nearest integer.

5. $\sqrt{32}$ **6.** $\sqrt{103}$ **7.** $-\sqrt{48}$ **8.** $-\sqrt{350}$

IRRATIONAL NUMBERS The square root of a whole number that is not a perfect square is an example of an *irrational number*. An **irrational number**, such as $\sqrt{945} = 30.74085\ldots$, is a number that cannot be written as a quotient of two integers. The decimal form of an irrational number neither terminates nor repeats.

REAL NUMBERS The set of **real numbers** is the set of all rational and irrational numbers, as illustrated in the Venn diagram below. Every point on the real number line represents a real number.

REAL NUMBERS



READING
If you exclude 0 from the whole numbers, the resulting set is called the *natural numbers*.

EXAMPLE 3 Classify numbers

Tell whether each of the following numbers is a real number, a rational number, an irrational number, an integer, or a whole number: $\sqrt{24}$, $\sqrt{100}$, $-\sqrt{81}$.

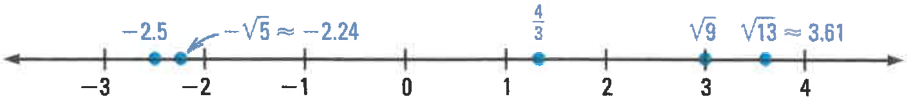
Number	Real number?	Rational number?	Irrational number?	Integer?	Whole number?
$\sqrt{24}$	Yes	No	Yes	No	No
$\sqrt{100}$	Yes	Yes	No	Yes	Yes
$-\sqrt{81}$	Yes	Yes	No	Yes	No

EXAMPLE 4 Graph and order real numbers

Order the numbers from least to greatest: $\frac{4}{3}$, $-\sqrt{5}$, $\sqrt{13}$, -2.5, $\sqrt{9}$.

Solution

Begin by graphing the numbers on a number line.



▸ Read the numbers from left to right: -2.5, $-\sqrt{5}$, $\frac{4}{3}$, $\sqrt{9}$, $\sqrt{13}$.

✓ GUIDED PRACTICE for Examples 3 and 4

9. Tell whether each of the following numbers is a real number, a rational number, an irrational number, an integer, or a whole number: $-\frac{9}{2}$, 5.2, 0, $\sqrt{7}$, 4.1, $-\sqrt{20}$. Then order the numbers from least to greatest.

CONDITIONAL STATEMENTS In the activity on page 109, you saw that a conditional statement not in if-then form can be written in that form.

EXAMPLE 5 Rewrite a conditional statement in if-then form

Rewrite the given conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.

Solution

a. Given: No fractions are irrational numbers.

If-then form: If a number is a fraction, then it is not an irrational number.

The statement is true.

b. Given: All real numbers are rational numbers.

If-then form: If a number is a real number, then it is a rational number.

The statement is false. For example, $\sqrt{2}$ is a real number but *not* a rational number.

✓ GUIDED PRACTICE for Example 5

Rewrite the conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.

10. All square roots of perfect squares are rational numbers.

11. All repeating decimals are irrational numbers.

12. No integers are irrational numbers.

2.7 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS5 for Exs. 9, 19, and 47

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 23, 41, 42, 48, and 51

◆ = **MULTIPLE REPRESENTATIONS** Ex. 52

SKILL PRACTICE

1. VOCABULARY Copy and complete: The set of all rational and irrational numbers is called the set of _?_.

2. ★ **WRITING** Without calculating, how can you tell whether the square root of a whole number is rational or irrational?

EXAMPLE 1 on p. 110 for Exs. 3–14

EVALUATING SQUARE ROOTS Evaluate the expression.

3. $\sqrt{4}$ **4.** $-\sqrt{49}$ **5.** $-\sqrt{9}$ **6.** $\pm\sqrt{1}$

7. $\sqrt{196}$ **8.** $\pm\sqrt{121}$ **9.** $\pm\sqrt{2500}$ **10.** $-\sqrt{256}$

11. $-\sqrt{225}$ **12.** $\sqrt{361}$ **13.** $\pm\sqrt{169}$ **14.** $-\sqrt{1600}$

EXAMPLE 2
on p. 111
for Exs. 15–22

APPROXIMATING SQUARE ROOTS **Approximate the square root to the nearest integer.**

15. $\sqrt{10}$

16. $-\sqrt{18}$

17. $-\sqrt{3}$

18. $\sqrt{150}$

19. $-\sqrt{86}$

20. $\sqrt{40}$

21. $\sqrt{200}$

22. $-\sqrt{65}$

23. ★ **MULTIPLE CHOICE** Which number is between -30 and -25?

(A) $-\sqrt{1610}$ (B) $-\sqrt{680}$ (C) $-\sqrt{410}$ (D) $-\sqrt{27}$

EXAMPLES 3 and 4
on p. 112
for Exs. 24–29

CLASSIFYING AND ORDERING REAL NUMBERS **Tell whether each number in the list is a real number, a rational number, an irrational number, an integer, or a whole number. Then order the numbers from least to greatest.**

24. $\sqrt{49}, 8, -\sqrt{4}, -3$

25. $-\sqrt{12}, -3.7, \sqrt{9}, 2.9$

26. $-11.5, -\sqrt{121}, -10, \frac{25}{2}, \sqrt{144}$

27. $\sqrt{8}, -\frac{2}{5}, -1, 0.6, \sqrt{6}$

28. $-\frac{8}{3}, -\sqrt{5}, 2.6, -1.5, \sqrt{5}$

29. $-8.3, -\sqrt{80}, -\frac{17}{2}, -8.25, -\sqrt{100}$

EXAMPLE 5
on p. 113
for Exs. 30–33

ANALYZING CONDITIONAL STATEMENTS **Rewrite the conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.**

30. All whole numbers are real numbers.

31. All real numbers are irrational numbers.

32. No perfect squares are whole numbers.

33. No irrational numbers are whole numbers.

EVALUATING EXPRESSIONS **Evaluate the expression for the given value of x.**

34. $3 + \sqrt{x}$ when $x = 9$

35. $11 - \sqrt{x}$ when $x = 81$

36. $4 \cdot \sqrt{x}$ when $x = 49$

37. $-7 \cdot \sqrt{x}$ when $x = 36$

38. $-3 \cdot \sqrt{x} - 7$ when $x = 121$

39. $6 \cdot \sqrt{x} + 3$ when $x = 100$

40. **REASONING** Tell whether each of the following sets of numbers has an additive identity, additive inverses, a multiplicative identity, and multiplicative inverses: whole numbers, integers, rational numbers, real numbers. Use a table similar to the one on page 112 to display your results.

41. ★ **MULTIPLE CHOICE** If $x = 36$, the value of which expression is a perfect square?

(A) $\sqrt{x} + 17$ (B) $87 - \sqrt{x}$ (C) $5 \cdot \sqrt{x}$ (D) $8 \cdot \sqrt{x} + 2$

42. ★ **WRITING** Let $x > 0$. Compare the values of x and $\sqrt{x}$ for $0 < x < 1$ and for $x > 1$. Give examples to justify your thinking.

43. **CHALLENGE** Find the first five perfect squares x such that $2 \cdot \sqrt{x}$ is also a perfect square. *Describe* your method.

44. **CHALLENGE** Let n be any whole number from 1 to 1000. For how many values of n is $\sqrt{n}$ a rational number? *Explain* your reasoning.

2 CHAPTER SUMMARY

BIG IDEAS

For Your Notebook

Big Idea ①

Performing Operations with Real Numbers

To add or multiply two real numbers a and b, you can use the following rules:

Expression	Rule when a and b have the same sign	Rule when a and b have different signs
$a + b$	Add $\|a\|$ and $\|b\|$. The sum has the same sign as a and b.	Subtract the lesser absolute value from the greater absolute value. The sum has the same sign as the number with the greater absolute value.
ab	The product is positive.	The product is negative.

You can use these rules to subtract or divide numbers, but first you rewrite the difference or quotient using the subtraction rule or the division rule.

Big Idea ②

Applying Properties of Real Numbers

You can apply the properties of real numbers to evaluate and simplify expressions. Many of the properties of addition and multiplication are similar.

Property	Addition	Multiplication
Commutative property	$a + b = b + a$	$ab = ba$
Associative property	$(a + b) + c = a + (b + c)$	$(ab)c = a(bc)$
Identity property	$a + 0 = 0 + a = a$	$a \cdot 1 = 1 \cdot a = a$
Inverse property	$a + (-a) = -a + a = 0$	$a \cdot \frac{1}{a} = \frac{1}{a} \cdot a = 1, a \neq 0$
Distributive property	$a(b + c) = ab + ac$ (and three variations)	

Big Idea ③

Classifying and Reasoning with Real Numbers

Being able to classify numbers can help you tell whether a conditional statement about real numbers is true or false. For example, the following statement is false: "All real numbers are integers." A counterexample is 3.5.

Numbers	Description
Whole numbers	The numbers 0, 1, 2, 3, 4, . . .
Integers	The numbers . . . , −3, −2, −1, 0, 1, 2, 3, . . .
Rational numbers	Numbers of the form $\frac{a}{b}$ where a and b are integers and $b \neq 0$
Irrational numbers	Numbers that cannot be written as a quotient of two integers
Real numbers	All rational and irrational numbers

Worked-Out Solutions

This section of the book provides step-by-step solutions to exercises with circled exercise numbers. These solutions provide models that can help guide your work with the homework exercises.

The separate **Selected Answers** section follows this section. It provides numerous answers that you can use to check your own answers.

Chapter 1

Lesson 1.1 (pp. 5–7)

19. three tenths to the fourth power; $(0.3)^4 = 0.3 \cdot 0.3 \cdot 0.3 \cdot 0.3$

35. $\left(\frac{3}{5}\right)^3 = \frac{3}{5} \cdot \frac{3}{5} \cdot \frac{3}{5} = \frac{27}{125}$

51. a. Total length $= 3.5 + 5.5 + 3 = 12$

The total length is 12 inches.

b. Evaluate $12f$ for $f = 12$: $12(12) = 144$

The area of water surface needed is 144 square inches.

Lesson 1.2 (pp. 10–12)

16.
$$\begin{aligned} \frac{1}{6}(6+18) - 2^2 &= \frac{1}{6}(24) - 2^2 \\ &= \frac{1}{6}(24) - 4 \\ &= 4 - 4 = 0 \end{aligned}$$

35. a. Total cost $= 3 \cdot 0.99 + 2 \cdot 9.95$

$= 2.97 + 19.90 = 22.87$

The total cost is $22.87.

b. Amount of money left $= 25 - 22.87 = 2.13$

The amount you have left is $2.13.

Lesson 1.3 (pp. 18–20)

11. 7 less than twice a number k

Less than is subtraction after the next term, and twice a number is two times a number. The expression is $2k - 7$.

21.
$$\boxed{\begin{array}{c}\text{Number of}\\\text{months in}\\y\text{ years}\end{array}} = \boxed{\begin{array}{c}\text{Number of}\\\text{months in}\\\text{one year}\end{array}} \cdot \boxed{\begin{array}{c}\text{Number of}\\\text{years}\end{array}}$$

$= 12y$

The number of months is $12y$.

33. a. 48 ounce container:

$$\frac{\$2.64}{48 \text{ ounces}} = \frac{\$2.64 \div 48}{48 \text{ ounces} \div 48} = \frac{\$.055}{1 \text{ ounce}}$$

The unit rate is $.055 per ounce.

64 ounce container:

$$\frac{\$3.84}{64 \text{ ounces}} = \frac{\$3.84 \div 64}{64 \text{ ounces} \div 64} = \frac{\$.06}{1 \text{ ounce}}$$

The unit rate is $.06 per ounce.

b. Since $.055 is less than $.06, the 48 ounce container costs less per ounce.

c. Write a verbal model and an expression. Let n be the number of ounces.

$$\boxed{\text{Savings}} = \boxed{\begin{array}{c}\text{Unit rate for}\\\text{64 ounce}\\\text{container}\end{array}} \cdot \boxed{\begin{array}{c}\text{Number}\\\text{of}\\\text{ounces}\end{array}} - \boxed{\begin{array}{c}\text{Unit rate for}\\\text{48 ounce}\\\text{container}\end{array}} \cdot \boxed{\begin{array}{c}\text{Number}\\\text{of}\\\text{ounces}\end{array}}$$

$= 0.06n - 0.055n$

Evaluate the expression when $n = 192$.

$0.06(192) - 0.055(192) = 0.96$

The amount of money you save is $.96.

Lesson 1.4 (pp. 24–26)

7. 5 more than a number t is written as $t + 5$.

The product of 9 and the quantity 5 more than a number t is written as $9(t + 5)$.

The product of 9 and the quantity 5 more than a number t is less than 6 is written as $9(t + 5) < 6$.

41. Write a verbal model. Then write an equation. Let w be the winning team's time.

U.S. team's time − Winning team's time = Difference in time

$173 - w = 6$

Use mental math to solve the equation. Think: 173 less what number is 6?

Because $173 - 167 = 6$, the solution is 167 hours.

Lesson 1.5 (pp. 31–33)

5. You know that the temperature in Rome, Italy, is 30°C, and the temperature in Dallas, Texas, is 83°F.

You want to find out which temperature is higher.

17. Step 1: You know the total weight of your backpack and its contents is $13\frac{3}{8}$ pounds. The total weight you want to carry is no more than 15 pounds. The weight of each bottle of water is $\frac{3}{4}$ pound. You want to find out how many extra bottles of water you can add to your backpack. First find the additional weight you can add to your backpack.

Step 2: Write a verbal model that represents what you want to find out. Then write an equation and solve it.

Step 3: Let w be the additional weight (in pounds) you can add to your backpack.

Desired weight of backpack − Current weight of backpack = Additional weight possible

$$15 - 13\frac{3}{8} = w$$

$$1\frac{5}{8} = w$$

You can carry an additional $1\frac{5}{8}$ pounds, and each bottle weighs $\frac{3}{4}$ pound.

$$1\frac{5}{8} \div \frac{3}{4} = \frac{13}{8} \times \frac{4}{3} = \frac{52}{24} = 2\frac{1}{6}$$

Since you cannot carry a fraction of a bottle, round down to 2 bottles.

Step 4: You know that 2 is a solution; check to see if 3 could be a solution. The additional bottle of water weighs $\frac{3}{4}$ pound. Since $14\frac{7}{8}$ pounds is only $\frac{1}{8}$ pound less than the maximum of 15 pounds, and $\frac{3}{4} > \frac{1}{8}$, adding another bottle weighing $\frac{3}{4}$ pound would make the total weight more than 15 pounds. Therefore, the number of extra bottles of water you can add to your backpack is 2 bottles.

Lesson 1.6 (pp. 38–40)

7. The pairing is not a function because the input $\frac{3}{4}$ is paired with two outputs, 3 and 5.

23. You have 10 quarters that you can use for a parking meter.

a. Each time you put 1 quarter in the meter, you have 1 less quarter, so the number of quarters left is a function of the number of quarters used.

b. Let y represent the number of quarters you have left.

Number of quarters you have left = Total number of quarters − Number of quarters you have used so far

$y = 10 - x$

The domain of the function is: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

c. Make a table of inputs, x, and use $y = 10 - x$ to find the corresponding outputs.

Input, *x*	0	1	2	3	4	5
Output, *y*	10	9	8	7	6	5

Input, *x*	6	7	8	9	10
Output, *y*	4	3	2	1	0

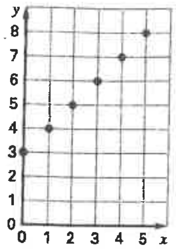
The range of the function is: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

Lesson 1.7 (pp. 46–48)

3. Make an input-output table using the given domain values.

x	0	1	2	3	4	5
y	3	4	5	6	7	8

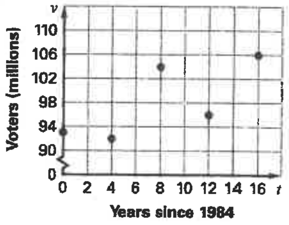
Plot a point for each ordered pair (x, y).



17. Number of voters v as a function of time t in years since 1984.

Years since 1984	Voters	Voters (millions)
0	92,652,680	93
4	91,594,693	92
8	104,405,155	104
12	96,456,345	96
16	105,586,274	106

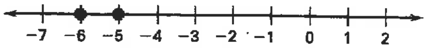
The t-values range from 0 to 16, so label the t-axis from 0 to 18 in increments of 2 units. The v-values (in millions) range from 93 to 106, so label the v-axis from 90 to 114 in increments of 4 units.



Chapter 2

Lesson 2.1 (pp. 67–70)

7. Graph −5 and −6 on a number line.

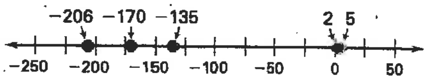


On the number line, −5 is to the right of −6, so $-5 > -6$. The number −5 is greater.

29. If $a = -6.1$, then $-a = -(-6.1) = 6.1$.

If $a = -6.1$, then $|a| = |-6.1| = 6.1$.

53. Graph the numbers on a number line.



Read the numbers from left to right: −206, −170, −135, 2, 5.

From lowest elevation to highest elevation, the locations are Fondo, Frink, Alamorio, Calexico, and Date City.

Lesson 2.2 (pp. 77–79)

13. $-8.7 + 4.2 = -(|8.7| - |4.2|)$

$= -(8.7 - 4.2) = -4.5$

35. $-2.6 + (-3.4) + 7.6 = [-2.6 + (-3.4)] + 7.6$

$= -6 + 7.6 = 1.6$

55. a. You know the first lens has a strength of −4.75 diopters and the second lens has a strength of 6.25 diopters.

You want to know the strength of the new lens.

Calculate the sum of −4.75 and 6.25:

$-4.75 + 6.25 = 1.5$

The strength of the new lens is 1.5 diopters.

b. You know the first lens has a strength of −2.5 diopters and the second lens has a strength of −1.25 diopters.

You want to know the strength of the new lens.

Calculate the sum of −2.5 and −1.25:

$-2.5 + (-1.25) = -3.75$

The strength of the new lens is −3.75 diopters.

c. You know the first lens has a strength of 1.5 diopters and the second lens has a strength of −3.75 diopters. The greater the absolute value of the strength of a lens, the stronger the lens.

You want to know which new lens is stronger.

Find the absolute value of each lens in part (a) and part (b) and choose the greater.

$|1.5| = 1.5$ $\quad |-3.75| = 3.75$

The new lens in part (b) has a greater absolute value, and is therefore stronger.

Lesson 2.3 (pp. 82–84)

3. $13 - (-5) = 13 + 5 = 18$

21. When $x = 7.1$ and $y = -2.5$,

$$\begin{aligned} -y - (1.9 - x) &= -(-2.5) - (1.9 - 7.1) \\ &= 2.5 - [1.9 + (-7.1)] \\ &= 2.5 - (-5.2) \\ &= 2.5 + 5.2 = 7.7 \end{aligned}$$

43. Write a verbal model. Then write an equation.

$$\boxed{\text{Change in temperature}} = \boxed{\text{Temperature inside}} - \boxed{\text{Temperature outside}}$$

$C = i - t$

Substitute 12.2 for i and -2.4 for t.

$C = 12.2 - (-2.4)$

$C = 12.2 + 2.4 = 14.6$

The change in temperature is 14.6°C.

Lesson 2.4 (pp. 91–93)

11. $-1.9(3.3)(7) = (-6.27)(7) = -43.89$

31.
$$\begin{aligned} -2(-6)(-7z) &= [-2(-6)](-7z) \\ &= 12(-7z) \\ &= [12 \cdot (-7)]z \\ &= -84z \end{aligned}$$

51. Write a verbal model.

$$\boxed{\text{Total value}} = \boxed{\text{Original price per share}} \cdot \boxed{\text{Number of shares}} + \boxed{\text{Change in price per share}} \cdot \boxed{\text{Number of shares}}$$

Calculate the original price.

Original price = $(\$3.50)(50) = \$175$

Calculate the change in price.

Change in price = $(-\$.25)(50) = -\$12.50$

Calculate the total value.

$$\begin{aligned} \text{Total value} &= (3.50)(50) + (-0.25)(50) \\ &= 175 + (-12.50) = 162.50 \end{aligned}$$

The total value is $162.50.

Lesson 2.5 (pp. 99–101)

9. $(p - 3)(-8) = p(-8) - 3(-8) = -8p + 24$

23. Write the expression as a sum:
$7x^2 + (-10) + (-2x^2) + 5$

Terms: $7x^2, -10, -2x^2, 5$

Like terms: $7x^2$ and $-2x^2$; -10 and 5

Coefficients: 7, −2

Constant terms: −10, 5

51. Write a verbal model. Then write an equation.

$$\boxed{\text{Total cost}} = \boxed{\text{Number of movies rented}} \cdot \left(\boxed{\text{Regular cost of a rental}} - \boxed{\text{Discount per movie}}\right)$$

$C = 3(r - 2)$ or $C = 3r - 6$

Find the value of C when $r = 3.99$.

$$\begin{aligned} C &= 3(3.99 - 2) \\ &= 3(3.99) - 3(2) \\ &= 11.97 - 6 = 5.97 \end{aligned}$$

The total cost is $5.97.

Lesson 2.6 (pp. 106–108)

13. $-1 \div \left(-\frac{7}{2}\right) = -1 \cdot \left(-\frac{2}{7}\right) = \frac{2}{7}$

35.
$$\begin{aligned} \frac{9z - 6}{-3} &= (9z - 6) \div (-3) \\ &= (9z - 6) \cdot \left(-\frac{1}{3}\right) \\ &= 9z \cdot \left(-\frac{1}{3}\right) - 6 \cdot \left(-\frac{1}{3}\right) \\ &= -3z + 2 \end{aligned}$$

53. To find the daily mean temperature for a day, find the sum of the high and low temperatures for that day and then divide the sum by 2.

$$\text{Mean} = \frac{-10.6 + (-18.9)}{2} = \frac{-29.5}{2} = -14.75$$

The daily mean temperature was −14.75°C.

Lesson 2.7 (pp. 113–116)

9. Since $50^2 = 2500$, $\pm\sqrt{2500} = \pm 50$.

19. Write a compound inequality that compares $-\sqrt{86}$ with both $-\sqrt{100}$ and $-\sqrt{81}$.

$$-\sqrt{100} < -\sqrt{86} < -\sqrt{81}$$

Take the square root of each number.

$$-10 < -\sqrt{86} < -9$$

Because 86 is closer to 81 than to 100, $-\sqrt{86}$ is closer to -9 than to -10. So $-\sqrt{86}$ is about -9.

47. You need to find the side length s of the mazes such that s^2 is the given area in square feet, so s is the positive square root of the area. Then identify the side length as rational or irrational.

Dallas: $s^2 = 1225$, $s = 35$; rational

San Francisco: $s^2 = 576$, $s = 24$; rational

Corona: $s^2 = 2304$, $s = 48$; rational

Waterville: $s^2 = 900$, $s = 30$; rational

The side lengths are 35 feet, 24 feet, 48 feet, and 30 feet. All the lengths are rational numbers.

Chapter 3

Lesson 3.1 (pp. 137–140)

13.
$$-2 = n - 6$$
$$-2 + 6 = n - 6 + 6$$
$$4 = n$$

55. Let w represent the width of the trampoline.

$$A = \ell \cdot w$$
$$187 = 17 \cdot w$$
$$\frac{187}{17} = \frac{17w}{17}$$
$$11 = w$$

The width of the trampoline is 11 feet.

Lesson 3.2 (pp. 144–146)

13.
$$7 = \frac{5}{6}c - 8$$
$$7 + 8 = \frac{5}{6}c - 8 + 8$$
$$15 = \frac{5}{6}c$$
$$\frac{6}{5} \cdot 15 = \frac{6}{5} \cdot \frac{5}{6}c$$
$$18 = c$$

19.
$$-32 = -5k + 13k$$
$$-32 = 8k$$
$$\frac{-32}{8} = \frac{8k}{8}$$
$$-4 = k$$

39. Write a verbal model. Then write an equation. Let h be the number of half-side advertisements.

Total budget = Cost per month • Number of full bus wrap advertisements + Cost per month • Number of half-side advertisements

$$6000 = 2000(1) + 800h$$
$$6000 = 2000 + 800h$$

Solve the equation.

$$6000 = 2000 + 800h$$
$$6000 - 2000 = 2000 - 2000 + 800h$$
$$4000 = 800h$$
$$\frac{4000}{800} = \frac{800h}{800}$$
$$5 = h$$

The museum can have 5 half-side advertisements.

Lesson 3.3 (pp. 150–153)

17.

$$\begin{aligned} -3 &= 12y - 5(2y - 7) \\ -3 &= 12y - 10y + 35 \\ -3 &= 2y + 35 \\ -3 - 35 &= 2y + 35 - 35 \\ -38 &= 2y \\ \frac{-38}{2} &= \frac{2y}{2} \\ -19 &= y \end{aligned}$$

39. Let x be the amount of space you should leave between posters (in feet).

$$\boxed{\text{Total wall space}} = \boxed{\text{Width of poster}} \cdot \boxed{\text{Number of posters}} + 2 \cdot \boxed{\text{Space at end of wall}} + \boxed{\text{Amount of space between posters}} \cdot \boxed{\text{Number of spaces between posters}}$$

$$\begin{aligned} 13.5 &= 2(3) + 2(3) + x(2) \\ 13.5 &= 6 + 6 + 2x \\ 13.5 &= 12 + 2x \\ 13.5 - 12 &= 12 - 12 + 2x \\ 1.5 &= 2x \\ 0.75 &= x \end{aligned}$$

You should leave 0.75 foot between each poster.

Lesson 3.4 (pp. 157–159)

13.

$$\begin{aligned} 40 + 14j &= 2(-4j - 13) \\ 40 + 14j &= -8j - 26 \\ 40 + 14j + 8j &= -8j + 8j - 26 \\ 40 + 22j &= -26 \\ 40 - 40 + 22j &= -26 - 40 \\ 22j &= -66 \\ j &= -3 \end{aligned}$$

51. Let x represent the number of years. So $33x$ represents the increase in the number of students taking Spanish, and $2x$ represents the decreased number of students who are taking French.

$$\boxed{\text{Number of students taking Spanish this year}} + \boxed{\text{Number of additional students each year}} \cdot \boxed{\text{Number of years}} = 3 \cdot \left(\boxed{\text{Number of students taking French this year}} - \boxed{\text{Number of students each year}} \cdot \boxed{\text{Number of years}} \right)$$

$$\begin{aligned} 555 + 33x &= 3(230 - 2x) \\ 555 + 33x &= 690 - 6x \\ 555 + 33x + 6x &= 690 - 6x + 6x \\ 555 + 39x &= 690 \\ 555 - 555 + 39x &= 690 - 555 \\ 39x &= 135 \\ x &\approx 3.5 \end{aligned}$$

So it will be after 3 more school years, or in about 4 years, when the number of students taking Spanish will be 3 times the number of students taking French.

Lesson 3.5 (pp. 165–167)

17.

$$\begin{aligned} \frac{16}{48} &= \frac{n}{36} \\ 36 \cdot \frac{16}{48} &= 36 \cdot \frac{n}{36} \\ \frac{576}{48} &= n \\ 12 &= n \end{aligned}$$

49. Find the total number of pizzas: $96 + 144 + 240 = 480$.

The ratio of large pizzas to all pizzas is

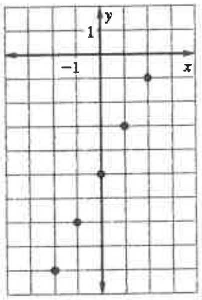
$$\frac{\text{number of large pizzas}}{\text{total number of pizzas}} = \frac{240}{480} = \frac{1}{2}.$$

25. First create a table of values by substituting the domain values into the function.

x	$y = 2x - 5$
-2	$y = 2(-2) - 5 = -9$
-1	$y = 2(-1) - 5 = -7$
0	$y = 2(0) - 5 = -5$
1	$y = 2(1) - 5 = -3$
2	$y = 2(2) - 5 = -1$

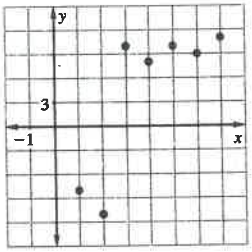
The table gives the ordered pairs $(-2, -9)$, $(-1, -7)$, $(0, -5)$, $(1, -3)$, and $(2, -1)$.

Graph the function by plotting these points. The range of the function is the y-values from the table: $-9, -7, -5, -3, -1$.



37. The table represents a function because there is exactly one low temperature for each day in the first week of February.

To graph the data, plot the ordered pairs (day, record low).



Lesson 4.2 (pp. 219–221)

3. Test $(-2, 3)$:

$$2y + x = 4$$

$$2(3) + (-2) \stackrel{?}{=} 4 \quad \text{Substitute } -2 \text{ for } x \text{ and } 3 \text{ for } y.$$

$$6 + (-2) \stackrel{?}{=} 4$$

$$4 = 4 \checkmark$$

So, $(-2, 3)$ is a solution of $2y + x = 4$.

11. First, solve the equation for y.

$$y + x = 2$$

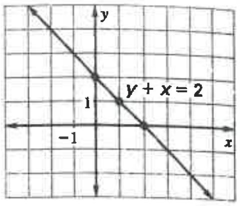
$$y + x - x = 2 - x$$

$$y = 2 - x$$

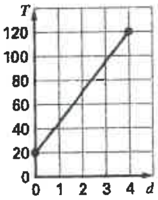
Use this equation to create a table of values.

x	-2	-1	0	1	2
y	4	3	2	1	0

Plot at least three of the points whose ordered pairs (x, y) are indicated by the table. Draw a line through the plotted points.

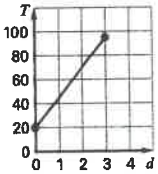


37. a.



Since the scientist is studying the organisms in the first 4 kilometers of Earth's crust, the domain of the function is $0 \le d \le 4$. The range of the function is $20 \le T \le 120$. The temperature 4 kilometers from the surface is 120°C.

b. Notice in the table for part (a) that the temperatures between 20°C and 95°C occur when the distance from the surface is between 0 kilometers and 3 kilometers.



The domain of the function is now $0 \le d \le 3$ and the range is $20 \le T \le 95$. So this section of crust is 3 kilometers deep.

Lesson 4.3 (pp. 229–232)

21. Substitute 0 for y in $y = -4x + 3$ and solve for x.

$$0 = -4x + 3$$

$$-3 = -4x$$

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

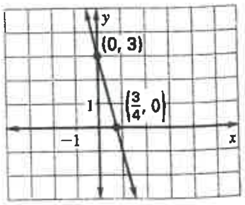
The x-intercept is $\frac{3}{4}$.

Substitute 0 for x in $y = -4x + 3$ and solve for y.

$$y = -4(0) + 3 = 0 + 3 = 3$$

The y-intercept is 3.

Plot the two points that correspond to the intercepts and draw a line through them.



Lesson 3.6 (pp. 171–173)

13.

$$\begin{aligned} \frac{11}{w} &= \frac{33}{w+24} \\ 11(w+24) &= 33w \\ 11w + 264 &= 33w \\ 11w - 11w + 264 &= 33w - 11w \\ 264 &= 22w \\ 12 &= w \end{aligned}$$

39. The ratio of model to height is $\frac{\text{height of model}}{\text{actual height}}$. Write and solve a proportion.

$$\begin{aligned} \frac{1}{25} &= \frac{x}{443.2} \\ 443.2 &= 25x \\ 17.728 &= x \end{aligned}$$

The height of the model is 17.728 meters.

Lesson 3.7 (pp. 179–181)

13.

$$\begin{aligned} a &= p\% \cdot b \\ &= 115\% \cdot 60 \\ &= 1.15 \cdot 60 \\ &= 69 \end{aligned}$$

69 is 115% of 60.

35. a. The survey shows that 36% of the 250 listeners who participated in the survey are "tired of" the song.

$$\begin{aligned} a &= p\% \cdot b \\ &= 36\% \cdot 250 \\ &= 0.36 \cdot 250 \\ &= 90 \end{aligned}$$

90 listeners are "tired of" the song.

b. The survey shows that 14% of the 250 listeners who participated in the survey "love" the song.

$$\begin{aligned} a &= p\% \cdot b \\ &= 14\% \cdot 250 \\ &= 0.14 \cdot 250 \\ &= 35 \end{aligned}$$

35 listeners "love" the song.

Lesson 3.8 (pp. 187–189)

17.

$$\begin{aligned} 30 &= 9x - 5y \\ 30 + 5y &= 9x - 5y + 5y \\ 30 + 5y &= 9x \\ 30 - 30 + 5y &= 9x - 30 \\ 5y &= 9x - 30 \\ y &= \frac{9}{5}x - 6 \end{aligned}$$

33. a.

$$\begin{aligned} C &= 12x + 25 \\ C - 25 &= 12x + 25 - 25 \\ C - 25 &= 12x \\ \frac{C-25}{12} &= x \end{aligned}$$

b. $145: $\frac{C-25}{12} = x$

$$\begin{aligned} \frac{145-25}{12} &= x \\ 10 &= x \end{aligned}$$

For $145, you bowled 10 league nights.

$181: $\frac{C-25}{12} = x$

$$\begin{aligned} \frac{181-25}{12} &= x \\ 13 &= x \end{aligned}$$

For $181, you bowled 13 league nights.

$205: $\frac{C-25}{12} = x$

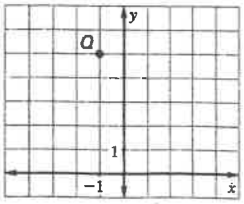
$$\begin{aligned} \frac{205-25}{12} &= x \\ 15 &= x \end{aligned}$$

For $205, you bowled 15 league nights.

Chapter 4

Lesson 4.1 (pp. 209–212)

15. To plot $Q(-1, 5)$, begin at the origin. First move 1 unit to the left, then 5 units up. Point Q is in Quadrant II.



Selected Answers

Chapter 1

1.1 Skill Practice (pp. 5–6) **1.** exponent: 12, base: 6 **3.** 60 **5.** 12 **7.** 12 **9.** 3 **11.** 10 **13.** $\frac{1}{3}$ **17.** seven to the third power, $7 \cdot 7 \cdot 7$ **19.** three tenths to the fourth power, $0.3 \cdot 0.3 \cdot 0.3 \cdot 0.3$ **21.** n to the seventh power, $n \cdot n \cdot n \cdot n \cdot n \cdot n \cdot n$ **23.** t to the fourth power, $t \cdot t \cdot t \cdot t$ **25.** The base was used as the exponent and the exponent was used as the base; $5^4 = 5 \cdot 5 \cdot 5 \cdot 5 = 625$. **27.** 100 **29.** 1331 **31.** 243 **33.** 1296 **35.** $\frac{27}{125}$ **37.** $\frac{1}{216}$ **39.** 1.21 **41.** 40.5 **43.** 9.6

1.1 Problem Solving (pp. 6–7) **49.** 162.5 cm **51. a.** 12 in. **b.** 144 in.^2 **53.** New England Patriots

1.2 Skill Practice (pp. 10–11) **1.** Square 4. **3.** 8 **5.** 14 **7.** $3\frac{3}{5}$ **9.** $63\frac{3}{4}$ **11.** 21 **13.** 73.5 **15.** $12\frac{1}{2}$ **17.** 48 **21.** $\frac{1}{2}$ was multiplied by 6 before squaring 6; $20 - \frac{1}{2} \cdot 6^2 = 20 - \frac{1}{2} \cdot 36 = 20 - 18 = 2$. **23.** 29 **25.** 126 **27.** 0.75 **29.** 3 **33.** $(2 \times 2 + 3)^2 - (4 + 3) \times 5$

1.2 Problem Solving (pp. 11–12) **35. a.** \$22.87 **b.** \$2.13 **37.** *Sample answer:* $(3 \times 4) + 5$ **39. a.** \$380, \$237.99; \$142.01 **b.** *Sample answer:* You could write an expression showing the difference of your income and expenses as $10s - (4.50m + 12.99)$.

1.2 Graphing Calculator Activity (p. 13) **1.** 5 **3.** 0.429 **5.** 0.188 **7.** 40.9 BMI units

1.3 Skill Practice (pp. 18–19) **1.** rate **3.** $x + 8$ **5.** $\frac{1}{2}m$ **7.** $7 - n$ **9.** $\frac{2t}{12}$ **11.** $2k - 7$ **15.** $4v$ **17.** $\frac{16}{p}$ **19.** $7 - d$ **21.** $12y$ **23.** 0.2 ft/sec **25.** 83.6 ft/sec **27.** Feet should cancel out; \$54. **29.** \$19.50 for 1 h

1.3 Problem Solving (pp. 19–20) **31.** $19.95t + 3$; \$102.75 **33. a.** \$.055, \$.06 **b.** 48 oz container **c.** \$.96 **35.** \$500 **37. a.** $12g + h + \frac{1}{4}c$ **b.** 247; 376.75; 242

1.4 Skill Practice (pp. 24–25) **1.** *Sample answer:* $3x + 5 = 20$ **3.** $42 + n = 51$ **5.** $9 - \frac{t}{6} = 5$ **7.** $9(t + 5) < 6$ **9.** $8 < b + 3 < 12$ **11.** $10 < t - 7 < 20$ **13.** $p \geq 12.99$ **15.** The wrong inequality symbol is used; $\frac{t}{4.2} \leq 15$. **17.** solution **19.** not a solution **21.** not a solution **23.** solution **25.** solution **27.** not a solution **29.** 5 **31.** 12 **33.** 9 **35.** $3x - 2 = x + 5$; solution

1.4 Problem Solving (pp. 25–26) **39.** 7.5 mi **41.** 167 h **43.** \$100 **45. a.** $6r + 5(10 - r) \geq 55$ **b.** Yes; you will earn \$30 running errands and \$25 walking dogs; $30 + 25 = 55$. **c.** Yes; if you work 10 hours running errands, you will earn \$60. You will not meet your goal if you work all 10 hours walking dogs.

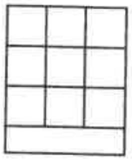
1.5 Skill Practice (p. 31) **1.** *Sample answer:* $d = rt$ **3.** You know the cost of materials and the amount you hope to make. You need to find the amount you should charge for each collar. You need to know the number of collars you made, which is missing. **5.** You know the temperature in Rome and the temperature in Dallas. You know the formula to convert Fahrenheit temperatures to Celsius temperatures. You need to find the higher temperature. **7.** The formula for perimeter should be used, not area; $P = 2\ell + 2w$; $P = 2(200) + 2(150) = 700$; $\$10(700) = \$7000$. **9.** $P = I - E$

1.5 Problem Solving (pp. 32–33) **15.** 46.25 in.^2 **17.** 2 water bottles **19. a.** 960 ft **b.** 480 ft **21. a.**

Room size (feet)	1 by 1	2 by 2	3 by 3	4 by 4	5 by 5
Remaining area (square feet)	431	428	423	416	407

b. $1 \leq s \leq 5$; 5 ft

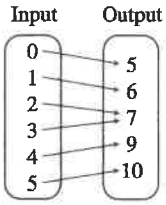
1.5 Problem Solving Workshop (p. 34)



1. 9 pieces of cake; Equation: Let c be the number of pieces of cake; $9c = 99$, $c = 11$. Diagram: Draw a diagram of a 9 inch by 11 inch pan and cut the cake into 3 inch by 3 inch pieces. From the diagram you see that you can cut 9 such pieces. The diagram shows that you cannot actually cut 11 square pieces because of the shape of the pan. **3.** The equation should be $3x + 6 = 12$ because there are only 3 spaces between the 4 floats; $3(2) + 6 = 12$.

1.6 Skill Practice (pp. 38–39) **1.** input; output **3.** domain: 0, 1, 2, and 3, range: 5, 7, 15, and 44 **5.** domain: 6, 12, 21, and 42, range: 5, 7, 10, and 17 **7.** not a function **9.** The pairing is a function. Each input is paired with only one output.

11. *Sample:*



Input	Output
0	5
1	6
2	7
3	7
4	9
5	10

15.

Input	4	5	7	8	12
Output	7.5	8.5	10.5	11.5	15.5

range: 7.5, 8.5, 10.5, 11.5, and 15.5

17.

Input	4	6	9	11
Output	5	6	7.5	8.5

range: 5, 6, 7.5, and 8.5

19.

Input	0	2	4	6
Output	$\frac{1}{2}$	1	$1\frac{1}{2}$	2

range: $\frac{1}{2}$, 1, $1\frac{1}{2}$, and 2

21. $y = x - 8$

1.6 Problem Solving (pp. 39–40) **23. a.** the number of quarters left; the number of quarters used **b.** $y = 10 - x$; domain: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10

c.

Input	0	1	2	3	4	5	6	7	8	9	10
Output	10	9	8	7	6	5	4	3	2	1	0

range: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10

25. $y = 100 + 20m$; independent variable: m, the number of months; dependent variable: y, the amount of money saved; domain: $m > 0$, range: $y \geq 100$; $340

27. a.

2	3	4	5
A, B, C	D, E, F	G, H, I	J, K, L

6	7	8	9
M, N, O	P, Q, R, S	T, U, V	W, X, Y, Z

No; because there is more than one output for each input.

b.

A	B	C	D	E	F	G	H	I	J	K	L
2	2	2	3	3	3	4	4	4	5	5	5

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
6	6	6	7	7	7	7	8	8	8	9	9	9	9

Yes; because there is only one output for each input.

1.6 Graphing Calculator Activity (p. 41) **1.** 50°F; scroll down until you see the output 10, look to see that the input is 50.

3.

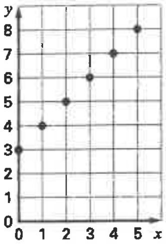
Input	0	1	2	3
Output	5	5.75	6.5	7.25

5.

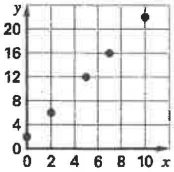
Input	1	2	3	4
Output	7	14.5	22	29.5

1.7 Skill Practice (pp. 46–47) **1.** domain; range

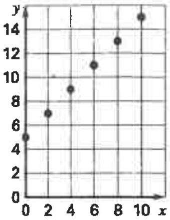
3.



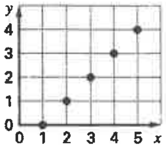
5.



7.



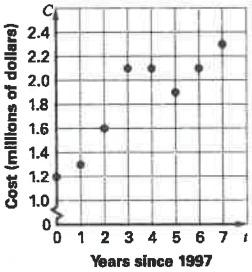
9. The domain and range are graphed backwards.



11. $y = 2x - 2$; domain: 1, 2, 3, and 4, range: 0, 2, 4, and 6

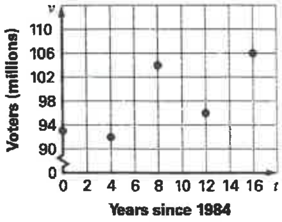
1.7 Problem Solving (pp. 47–48)

15.



17.

Years since 1984	Voters	Voters (millions)
0	92,652,680	93
4	91,594,693	92
8	104,405,155	104
12	96,456,345	96
16	105,586,274	106



19. a. increases **b.** Yes; 27.5 grams is between the mass of an egg that is just under 38 millimeters long and an egg that is just over 38 millimeters long.

Extension (p. 50) **1.** function **3.** not a function **5.** function **7.** Not a function. *Sample answer:* There could be many students whose first names have 4 letters, for instance, but their last names could all have a different number of letters. **9.** Function; for each of your birthdays, you have only one height.

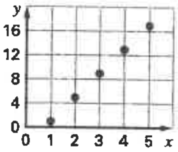
Chapter Review (pp. 53–56) **1.** 7, 12 **3.** algebraic expression **5.** 16 **7.** 10 **9.** 400 **11.** 25 in.^{2} **13.** 9 **15.** 8 **17.** $\frac{1}{3}$ **19.** 52 **21.** 18 **23.** $z - 5$ **25.** $3x^2$ **27.** $2.95n + 2.19$ **29.** $13 + t \geq 24$ **31.** solution **33.** 240 ft^2

35.

Input	10	12	15	20	21
Output	5	7	10	15	16

range: 5, 7, 10, 15, and 16

37. $y = x + 4$ **39.**



Chapter 2

2.1 Skill Practice (pp. 67–68) **1.** rational number **3.** Zero is in the set of whole numbers, but not in the set of positive integers. **5–13.** Check students' graphs. **5.** 7 **7.** -5 **9.** 5 **11.** -1 **13.** -2 **15.** 1.6: rational number, 1: whole number, integer, rational number, -4: integer, rational number, 0: whole number, integer, rational number; -4, 0, 1, 1.6 **17.** $-\frac{2}{3}$: rational number, -0.6: rational number, -1: integer, rational number, $\frac{1}{3}$: rational number; -1, $-\frac{2}{3}$, -0.6, $\frac{1}{3}$ **19.** 16: whole number, integer, rational number, -1.66: rational number, $\frac{5}{3}$: rational number, -1.6: rational number; -1.66, -1.6, $\frac{5}{3}$, 16 **21.** -4.99: rational number, 5: whole number, integer, rational number, $\frac{16}{3}$: rational number, -5.1: rational number; -5.1, -4.99, 5, $\frac{16}{3}$ **23.** -6, 6 **25.** 18, 18 **27.** -13.4, 13.4 **29.** 6.1, 6.1 **31.** $1\frac{1}{9}$, $1\frac{1}{9}$ **33.** $-\frac{3}{4}$, $\frac{3}{4}$ **35.** Hypothesis: a number is a positive integer, conclusion: the number is a whole number; true. **37.** Hypothesis: a number is positive, conclusion: its opposite is positive; false. *Sample answer:* The opposite of 2 is -2, a negative number. **41.** $-|-0.2|$ is a negative number. *Sample answer:* In the number $-|-0.2|$, remove both negative signs. **43.** 1 **45.** 1.75 **47.** 2.25 **49.** 1.5

2.1 Problem Solving (pp. 69–70) **53.** Fondo, Frink, Alamorio, Calexico, Date City **55.** -3.4; the absolute value of -3.4 is less than the absolute value of -3.8, so it is closer to 0, the exact pitch. **57. a.** 500 Hz **b.** The intensity decreases until 500 Hz and then increases. **59. a.** Sun, Sirius, Canopus, Arcturus, Capella, Achernar; Canopus, Achernar, Arcturus, Capella, Sirius, Sun **b.** Rigel's apparent magnitude is greater than the Sun's apparent magnitude, so it is dimmer than the Sun; Rigel's absolute magnitude is less than the Sun's absolute magnitude, so it is brighter than the Sun. **c.** No. *Sample answer:* The apparent magnitude of Arcturus is less than the apparent magnitude of Achernar, but the absolute magnitude of Arcturus is greater than the absolute magnitude of Achernar.

Extension (p. 72) **1.** {1, 3, 5, 6, 7, 9}, {3, 9} **3.** {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}, ∅ **5.** $R = \{2, 4, 6, 8, 10\}$, $f = \{(1, 2), (2, 4), (3, 6), (4, 8), (5, 10)\}$ **7.** $R = \{4, 8, 12, 16, 20\}$, $f = \{(1, 4), (5, 8), (9, 12), (13, 16), (17, 20)\}$ **9.** the set of integers, ∅

2.2 Skill Practice (pp. 77–78) **1.** 0 **3.** -8 **5.** 6 **7.** -13 **9.** -6 **11.** -20 **13.** -4.5 **15.** 6.6 **17.** -15.2 **19.** $7\frac{1}{15}$ **21.** $1\frac{16}{45}$ **23.** $-20\frac{23}{24}$ **25.** The numbers have different signs, so their absolute values should have been subtracted, $17 + (-31) = -14$. **27.** Associate property of addition **29.** Identity property of addition **31.** Commutative property of addition **33.** -49 **35.** 1.6 **37.** $5\frac{19}{60}$ **39.** -3 **41.** -9.5 **43.** $7\frac{23}{60}$ **45.** 0 **47.** 7.4 **49.** $-(-18) + (-18)$; 0

2.2 Problem Solving (pp. 78–79) **53.** 7°F **55. a.** 1.5 diopters **b.** -3.75 diopters **c.** part (b) **57. a.** your friend **b.** No, if you score 2 double eagles, you will have the same score.

2.3 Skill Practice (pp. 82–83) **1.** $-3 + (-6)$ **3.** 18 **5.** -8 **7.** 14.1 **9.** -25.8 **11.** $-\frac{1}{3}$ **13.** $\frac{3}{4}$ **15.** 8 was substituted for y instead of -8; $3 - (-8) + 2 = 3 + 8 + 2 = 13$. **17.** 4.6 **19.** 10.6 **21.** 7.7 **23.** 7.6 **25.** 1.8 **27.** 107°F **29.** -1280 m **31.** 127.1 mi **33.** 8 **35.** -4.2 **37.** 16.4 **39.** No; *Sample answer:* $5 - (3 - 2) = 4$, but $(5 - 3) - 2 = 0$ and $5 - 3 = 2$, but $3 - 5 = -2$.

2.3 Problem Solving (pp. 83–84)
43. 14.6°C **45. a.** $d = t - 342$

b.

t	d
341.7	−0.3
343.8	1.8
340.9	−1.1
342.7	0.7

341.7 and 340.9; you can tell if $t - 342$ is negative.
47. a. 6°; 19° **b.** −4°

2.3 Spreadsheet Activity (p. 85) **1.** 6 hand grips **3.** 4.902; the difference in the lengths has the smallest absolute value.

2.4 Skill Practice (pp. 91–92) **1.** 1 **3.** −28 **5.** 90 **7.** −36 **9.** 7 **11.** −43.89 **13.** −40 **15.** −80 **17.** $2\frac{2}{5}$ **19.** Multiplicative property of zero **21.** Identity property of multiplication **23.** Associative property of multiplication **25.** Identity property of multiplication **27.** Multiplicative property of −1
29. $18x$; $18x$, same signs, product is positive.
31. $-84z$; $12(-7z)$, product of −2 and −6 is 12; $[12 \cdot (-7)]z$, associative property of multiplication; $-84(z)$, product of 12 and −7 is −84; $-84z$, multiply.
33. $-40c$; $2(4)(-5c)$, product of $-\frac{1}{5}$ and −10 is 2; $8(-5c)$, product of 2 and 4 is 8; $[8 \cdot (-5)]c$, associative property of multiplication; $-40(c)$, product of 8 and −5 is −40; $-40c$, multiply.
35. $16.8r^2$; $[-6r \cdot (-2.8)]r$, associative property of multiplication; $[-6 \cdot (-2.8) \cdot r]r$, commutative property of multiplication; $(16.8r)r$, product of −6 and −2.8 is 16.8; $16.8(r \cdot r)$, associative property of multiplication; $16.8r^2$, multiply **37.** −0.4 **39.** −12.6
41. −6.6 **43.** $-1(7) = -7$, not 7; $-1(7)(-3)(-2x) = -7(-3)(-2x) = 21(-2x) = -42x$ **45.** true **47.** true

2.4 Problem Solving (pp. 92–93) **51.** \$162.50
55. a. $f = 11{,}250 + (-30t)$, $f = 135{,}000 + (-240t)$
b. 11,160 gal, 134,280 gal **c.** Rhododendron; 45,000 gal; the Rhododendron takes 375 hours to burn all of its fuel; the Spokane takes 562.5 hours to burn all of its fuel; to find the number of hours the Rhododendron will take to burn all its fuel, use the equations in part (a) and find the additive inverse of 11,250, then divide it by −30; to find the number of hours the Spokane will take to burn all its fuel, use the equations in part (a) and find the additive inverse of 135,000, then divide it by −240.

Extension (p. 95) **1.** $\begin{bmatrix} 16 & 4 \\ 8 & 12 \end{bmatrix}$ **3.** $\begin{bmatrix} -15 & -4 & -9 \\ -2 & 2 & -5 \end{bmatrix}$

5. Cannot be performed. **7.** $\begin{bmatrix} -28 & -49 \\ 3\frac{1}{2} & 3\frac{1}{9} \end{bmatrix}$ **9.** $\begin{bmatrix} -72 \\ 20.4 \\ 4.2 \end{bmatrix}$

11. $\begin{array}{cc} \text{Calcium (mg)} & \text{Potassium (mg)} \\ \left[\begin{matrix} 263.52 \\ 270.84 \\ 246.44 \end{matrix}\right. & \left.\begin{matrix} 290.36 \\ 341.6 \\ 324.52 \end{matrix}\right] \end{array}$ **13.** $\begin{bmatrix} -41 & -99 \\ 78 & 91 \end{bmatrix}$

2.5 Skill Practice (pp. 99–100) **1.** 4, −9 **3.** The negative was not distributed to the −8; $5y - (2y - 8) = 5y - 2y + 8 = 3y + 8$. **5.** $4x + 12$ **7.** $5m + 25$ **9.** $-8p + 24$ **11.** $4r - 6$ **13.** $6v^2 + 6v$ **15.** $2x^2 - 6x$ **17.** $\frac{1}{4}m - 2$ **19.** $4n - 6$ **21.** terms: $-7, 13x, 2x, 8$; like terms: −7 and 8, $13x$ and $2x$; coefficients: 13, 2; constant terms: −7, 8 **23.** terms: $7x^2, -10, -2x^2, 5$; like terms: $7x^2$ and $-2x^2$, −10 and 5; coefficients: 7, −2; constant terms: −10, 5 **25.** terms: $2, 3xy, -4xy, 6$; like terms: 2 and 6, $3xy$ and $-4xy$; coefficients: 3, −4; constant terms: 2, 6 **29.** $5y$ **31.** $9a - 2$ **33.** $8r + 8$ **35.** $3m + 5$ **37.** $10w - 35$ **39.** $15s + 6$ **41.** $34 - 24w$; $72 - 108w$ **43.** \$38.97 **45.** \$11.88 **47.** $2(6 + x) + (x - 5)$; $3x + 7$

2.5 Problem Solving (pp. 100–101)
51. $C = 3r - 6$; \$5.97
53. $s = d(x + y + z) = dx + dy + dz$

2.5 Problem Solving Workshop (p. 102)
1. \$330 **3.** \$287.50

2.6 Skill Practice (pp. 106–107) **1.** multiplicative inverse **3.** $-\frac{1}{18}$ **5.** −1 **7.** $-1\frac{1}{3}$ **9.** $-\frac{3}{13}$ **11.** −7 **13.** $\frac{2}{7}$ **15.** −3 **17.** $-2\frac{1}{2}$ **19.** $\frac{2}{7}$ **21.** −22 **25.** $-1\frac{2}{3}$ **27.** $2\frac{1}{4}$ **29.** $-2\frac{1}{5}$ **31.** 0.1 **33.** $3x - 7$ **35.** $-3z + 2$ **37.** $\frac{1}{2} - \frac{5}{2}q$ **39.** $3a + 1\frac{1}{4}$ **41.** $4 - 3c$ **43.** −2 was added instead of subtracted; $\frac{-15x - 10}{-5} = (-15x - 10) \cdot \left(-\frac{1}{5}\right) = -15x\left(-\frac{1}{5}\right) - 10\left(-\frac{1}{5}\right) = 3x + 2$ **45.** $-1\frac{1}{3}$ **47.** $\frac{1}{3}$

2.6 Problem Solving (pp. 107–108) **53.** −14.75°C
57. a. −0.034 **b.** Yes; it will improve to −0.012.
c. If the player had the same number of aces as service errors, then $a = e$, so $f = \frac{a - a}{s} = 0$; if all the serves were aces, a would be equal to s and e would be 0, so $f = \frac{s - 0}{s} = \frac{s}{s} = 1$; if all the serves were errors, then $e = s$ and $a = 0$, so $f = \frac{0 - s}{s} = \frac{-s}{s} = -1$.

2.7 Skill Practice (pp. 113–114) **1.** real numbers **3.** 2 **5.** −3 **7.** 14 **9.** ±50 **11.** −15 **13.** ±13 **15.** 3 **17.** −2 **19.** −9 **21.** 14 **25.** $-\sqrt{12}$: real number, irrational number, −3.7: real number, rational number, $\sqrt{9}$: real number, rational number, integer, whole number, 2.9: real number, rational number; $-3.7, -\sqrt{12}, 2.9, \sqrt{9}$

27. $\sqrt{8}$: real number, irrational number, $-\frac{2}{5}$: real number, rational number, -1: real number, rational number, integer, 0.6: real number, rational number, $\sqrt{6}$: real number, irrational number; -1, $-\frac{2}{5}$, 0.6, $\sqrt{6}$, $\sqrt{8}$ **29.** -8.3: real number, rational number, $-\sqrt{80}$: real number, irrational number, $-\frac{17}{2}$: real number, rational number, -8.25: real number, rational number, $-\sqrt{100}$: real number, rational number, integer; $-\sqrt{100}$, $-\sqrt{80}$, $-\frac{17}{2}$, -8.3, -8.25 **31.** If a number is a real number, then it is an irrational number; false. *Sample answer:* 3 is a real number and a rational number. **33.** If a number is an irrational number, then it is not a whole number; true. **35.** 2 **37.** -42 **39.** 63 **41.** B

2.7 Problem Solving **(pp. 115–116)** **45.** 60 in. **47.** 35 ft **49.** 2.2 ft **51. a.** 144 tiles **b.** 16 ft. *Sample answer:* If the homeowner can buy 144 tiles that are each 256 square inches, then the total area is (144 tiles)(256 square inches per tile) = 36,864 square inches. Divide 36,864 square inches by 144 square inches to find the number of square feet, 256 square feet. If the area of the square is 256 square feet, take the square root of 256 to find the side length, 16 feet.

Extension **(p. 118)** **1.** The sum is even. **3.** The sum is odd. **5.** Not closed **7.** Identity property of multiplication; Distributive property; Inverse property of multiplication; Property of zero

Chapter Review **(pp. 121–124)** **1.** terms: $-3x$, -5, $-7x$, -9; coefficients: -3, -7; constant terms: -5, -9; like terms: $-3x$ and $-7x$, -5 and -9 **3.** real number, rational number **5.** real number, rational number, integer **7.** -6, -5.2, $-\frac{3}{8}$, $-\frac{1}{4}$, 0.3 **9.** 0.2, 0.2 **11.** $-\frac{7}{8}$, $\frac{7}{8}$ **13.** 3 **15.** -3.5 **17.** $-1\frac{3}{14}$ **19.** $-\$.23$ million **21.** -10 **23.** -6.1 **25.** $-\frac{31}{36}$ **27.** $2\frac{1}{2}$ **29.** -60 **31.** -18 **33.** $6x$; $x \cdot (-18) = -\frac{1}{3}(-18)(x)$, commutative property of multiplication; $6(x)$, product of $-\frac{1}{3}$ and -18; $6x$, multiply **35.** 2.74 ft **37.** $-3y - 27$ **39.** $3x + 8$

41. $9n - 3\frac{1}{2}$ **43.** -14 **45.** $\frac{2}{3}$ **47.** $3x - 5$ **49.** $2n + 1$ **51.** -6 **53.** ± 15 **55.** -7 **57.** 17 **59.** $-\sqrt{4}$, -0.3, 0, 1.25, $\sqrt{11}$

Chapter 3

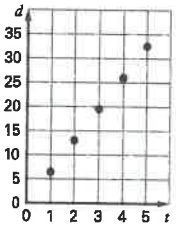
3.1 Skill Practice **(pp. 137–138)** **1.** inverse operations **3.** 3 **5.** 5 **7.** -3 **9.** 7 **11.** 17 **13.** 4 **17.** 4 **19.** 6 **21.** -15 **23.** 15 **25.** 48 **27.** 22 **29.** The student multiplied x by 100 to produce a number with a decimal part identical to the decimal part of x. When the student subtracted, the result was a whole number. **35.** -2.05 **37.** $\frac{5}{8}$ **39.** 0.06 **41.** 96 **43.** 12 **45.** -56 **47.** $\frac{3}{5}$ **49.** $54 = 12x$; 4.5 in.

3.1 Problem Solving **(pp. 139–140)** **53.** 1046.6 ft **55.** 11 ft **57. a.** $\frac{4}{7}x = 200$ **b.** Plants; if you solve the equation in part (a) you find that there are 350 species of birds.

59. a.

t	*d*
1	6.5
2	13
3	19.5
4	26
5	32.5

b.



4 sec

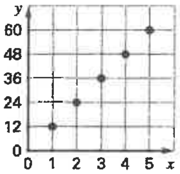
c. $26 = 6.5t$; 4 sec **61. a.** 171 hits **b.** 215 hits **c.** No; if Mueller had fewer hits than Wells but had a higher batting average, he must have had fewer at bats than Wells.

3.2 Skill Practice **(pp. 144–145)** **1.** like terms **3.** 4 **5.** 2 **7.** -3 **9.** 6 **11.** 40 **13.** 18 **15.** 4 **17.** 9 **19.** -4 **23.** The division of $-2x + x$ by -2 is done incorrectly. *Sample answer:* If like terms are combined as the first step, the second line would be $-x = 10$ and the final result would be $x = -10$. **25.** $y = 2x + 4$; -7 **27.** 4 **29.** 5 **31.** 0.5 **33.** 15.9 **35.** 6.9

3.2 Problem Solving **(pp. 145–146)** **37.** 28 classes **39.** 5 half-side advertisements **41.** Yes; the equation $\$542 = \$50 + 6x$ gives the monthly cost of a guitar that costs \$542. Solving the equation gives $x = \$82$ per month, so you can afford the guitar. **43. a.** $y = 12x$

b.

x (hours)	Marissa	Ryan	Total
1	5	7	12
2	10	14	24
3	15	21	36
4	20	28	48
5	25	35	60

c. 

about 4.5 h

3.2 Problem Solving Workshop (p. 147) **1.** 7 players **3.** 4 chairs

3.3 Skill Practice (pp. 150–151) **1.** $\frac{5}{3}$ **3.** 3 **5.** 6 **7.** −2 **9.** −8 **11.** −8 **13.** 4 **15.** −9 **17.** −19 **19.** 12 **21.** −2 **23.** −9 **25.** −3 times −6 is 18, not −18; $5x - 3x + 18 = 2$, $2x + 18 = 2$, $2x = -16$, $x = -8$. **27.** 2 **29.** 3 **31.** −5 **33.** 2 **35.** 9.5 in., 6 in.; if you use the perimeter formula $P = 2\ell + 2w$ and substitute $3.5 + w$ for ℓ, the solution is $w = 6$.

3.3 Problem Solving (pp. 152–153) **39.** 0.75 ft **41. a.** 34 mo **b.** 307 ft per mo **c.** After the work crews merged; before the work crews merged they were working at a rate of 115 + 137 = 252 feet per month, and after merging at a rate of 307 feet per month.

3.4 Skill Practice (pp. 157–158) **1.** identity **3.** −2 **5.** −4 **7.** −7 **9.** 8 **11.** −4 **13.** −3 **17.** *Sample answer:* Distribute the 3 to get $6z - 15 = 2z + 13$, then subtract $2z$ from each side to get $4z - 15 = 13$, next add 15 to each side to get $4z = 28$, finally divide each side by 4 to get $z = 7$. **19.** 2 **21.** −7 **23.** no solution **25.** no solution **27.** The 3 was not distributed to both terms; $3x + 15 = 3x + 15$, $15 = 15$, so the equation is an identity. **29.** *Sample answer:* $5x + 4 = 5x$; the number $5x$ cannot be equal to 4 more than itself. **31.** 2 **33.** −4 **35.** 6 **37.** identity **39.** 2 **41.** 10 **43.** identity **45.** 60

3.4 Problem Solving (pp. 158–159) **49.** 9 nights **51.** about 4 yr **53. a.** $23.4t = 24(t - 0.3)$; 12 sec **b.** about 4.4 sec **c.** No; it would take 12 seconds for the sheepdog to catch up to the collie and it only takes 4.4 seconds for the collie to complete the last leg.

3.4 Spreadsheet Activity (p. 160) **1.** 2 **3.** 4

3.5 Skill Practice (pp. 165–166) **1.** ratios **3.** no; 7 to 9 **5.** yes **7.** $\frac{6}{5}$ **9.** 22 **11.** 48 **13.** 15 **15.** 40 **17.** 12 **21.** Multiply each side by 6, not $\frac{1}{6}$; $6 \cdot \frac{3}{4} = 6 \cdot \frac{x}{6}$, $4\frac{1}{2} = x$. **23.** $\frac{3}{8} = \frac{x}{32}$; 12 **25.** $\frac{x}{4} = \frac{8}{16}$; 2 **27.** $\frac{b}{10} = \frac{7}{2}$; 35 **29.** $\frac{12}{18} = \frac{d}{27}$; 18 **31.** 1.8 **33.** 2.4 **35.** 4 **37.** 4 **39.** 2 **41.** 3.5 **43.** Yes. *Sample answer:* $\frac{3}{6} = \frac{4}{8}$

3.5 Problem Solving (pp. 166–167) **45.** $\frac{2}{145}$ **47.** $\frac{2}{5}$ **49.** $\frac{1}{2}$ **51.** 45 goals **53. a.** $\frac{10}{23}$ **b.** 110 lift tickets **c.** 40 snowboarders

3.6 Skill Practice (pp. 171–172) **1.** cross product **3.** 6 **5.** 24 **7.** 1 **9.** −49 **11.** 2 **13.** 12 **17.** Use the cross products property to multiply 4 by x and 16 by 3; $4 \cdot x = 3 \cdot 16$, $4x = 48$, $x = 12$. **19.** 15 **21.** 10 **23.** 5.5 **25.** −3.4 **27.** 4.2 **29.** −5.9 **31. a.** Multiplication property of equality **b.** Multiply **c.** Simplify

3.6 Problem Solving (pp. 172–173) **33.** 5 c **35.** 90 km **37.** 7.5 km **39.** 17.728 m **41.** 80 yd; find the actual length of the field by using the ratio 1 in. : 20 yd, then use that number to find the width of the soccer field by using the ratio 3 : 2.

Extension (p. 175) **1.** 24 in. **3.** 16 m **5.** 37.5 ft

3.7 Skill Practice (pp. 179–180) **1.** percent: 15, base: 360, part: 54 **3.** 36% **5.** 28 **7.** 150 **9.** 70% **11.** 6% **13.** 69 **15.** 25 **17.** 95 **21.** 76.5% needs to be changed to 0.765; $153 = 0.765 \cdot b$, $b = 200$. **23.** 96% **25.** 150 **27.** 6% **29.** 30% **31.** No. *Sample answer:* The area of the smaller square would be 16% of the area of the larger square because the percent needs to be squared.

3.7 Problem Solving (pp. 180–181) **33.** 8% **35. a.** 90 listeners **b.** 35 listeners **37.** 59.3%; 16.5%; 13.2%; 11.0% **39. a.** \$48 **b.** \$66.25 **c.** The bicycle in part (a); it will cost \$192, the bicycle in part (b) will cost \$198.75.

Extension (p. 183) **1.** increase; 25% **3.** decrease; 45% **5.** decrease; 33% **7.** 20.3 **9.** 35.2 **11.** 20% increase **13.** 48.0 people per square mile

3.8 Skill Practice (pp. 187–188) **1.** literal equation **3.** $x = \frac{c}{b - a}$; −2 **5.** $x = bc - a$; 9 **7.** $x = a(c - b)$; 28 **9.** b should have been subtracted from both sides, not added; $ax = -b$, $x = -\frac{b}{a}$. **11.** $y = 7 - 2x$ **13.** $4 - 3x = y$ **15.** $2 + \frac{6}{7}x = y$ **17.** $\frac{9}{5}x - 6 = y$ **19.** $y = \frac{1}{2}x + \frac{1}{3}$ **21.** $h = \frac{S - 2B}{P}$ **25.** $y = 18 - 5x$ **27.** $\ell = \frac{S}{\pi r} - r$; 13.03 cm **29.** *Sample answer:* You want to find how long it will take to drive 150 miles if you drive at an average rate of 55 miles per hour.

3.8 Problem Solving (pp. 188–189) **33. a.** $x = \frac{C - 25}{12}$ **b.** 10 nights; 13 nights; 15 nights **35.** Divide each side by the total bill, b, to get $\frac{a}{b} = p\%$.