

# Answer Key

## Chapter 1: Real Numbers

### 1.1 Exercises

#### Concept Check

1. Cubed
3. Base, exponent
5. 0
7. False; nine squared equals 81.
9. False; if a whole number is divisible by 2, then it is even.

#### Practice

1.  $11^3$       3.  $7^4$
5.  $2^3 \cdot 3^2$       7.  $5^3 \cdot 7^2$
9.  $2 \cdot 3^2 \cdot 11^2$
11. a. 4    b. 2    c. 16
13. a. 2    b. 3    c. 8
15. a. 1    b. 6    c. 1
17. a. 5    b. 3    c. 125
19. a. 2    b. 4    c. 16
21. a. 9    b. 2    c. 81
23. a. 7    b. 2    c. 49
25. a. 3    b. 5    c. 243
27. a. 30    b. 2    c. 900
29. a. 20    b. 3    c. 8000
31. a. 1    b. 57    c. 1
33. a. 4    b. 0    c. 1
35. a. 13    b. 1    c. 13
37. a. 22    b. 0    c. 1
39. 13, 17    41. 2
43. 8, 9    45. 4, 17
47. 2, 251    49. 10, 17
51. 4, 111    53.  $2^2 \cdot 13$
55.  $2^3 \cdot 7 \cdot 11$
57.  $-1 \cdot 2^2 \cdot 7 \cdot 11$
59. 79 is prime.
61.  $17^2$     63.  $5^3$

65.  $-1 \cdot 2^4 \cdot 5^2$
67.  $2^3 \cdot 3 \cdot 5$
69.  $3 \cdot 7 \cdot 11$
71.  $2^2 \cdot 3^2 \cdot 47$
73. a. 5, 10, 15, 20, 25, 30, 35, 40, 45, 50  
b. 6, 12, 18, 24, 30, 36, 42, 48, 54, 60  
c. 10, 20, 30, 40, 50, 60, 70, 80, 90, 100  
d. 15, 30, 45, 60, 75, 90, 105, 120, 135, 150

75. 105      77. 40
79. 66      81. 140
83. 150      85. 180
87. 196      89. 210
91. 90      93. 100
95. 150      97. 364
99. 2520    101. 924
103. 7623    105. 2880
107. 7840

#### Applications

109. a. 90 hours  
b. 6 and 5 orbits, respectively
111. a. 840 days  
b. 105, 70, 60, and 56 trips, respectively
113. a. 840 seconds  
b. 24 laps, 21 laps, and 20 laps, respectively

#### Writing & Thinking

115. a. 1    b. 1  
c. 1; So far, it appears that any number raised to the 0<sup>th</sup> power is equal to 1.

117. First, find the prime factorization of each number. Next, identify the prime factors that appear in any one of the prime factorizations. Finally, form the product of these primes using each prime the most number of times it appears in any one of the prime factorizations.

#### Collaborative Learning

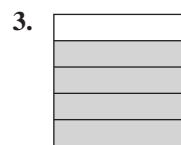
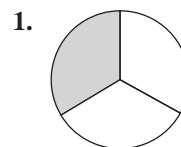
119. 1.024E13, 1E20; Answers will vary.

### 1.2 Exercises

#### Concept Check

1. improper
3. 1
5. 1
7. False; The numerator is 11.
9. True

#### Practice



5.  $\frac{5}{4}$       7.  $\frac{10}{4}$
9.  $\frac{1}{49}$       11. 0
13.  $\frac{12}{35}$       15.  $\frac{15}{32}$

17.  $-\frac{27}{28}$       19.  $\frac{343}{216}$

21.  $\frac{4}{45}$       23.  $\frac{2}{9}$

25.  $\frac{3}{4} = \frac{3}{4} \cdot \frac{3}{3} = \frac{9}{12}$

27.  $\frac{6}{7} = \frac{6}{7} \cdot \frac{2}{2} = \frac{12}{14}$

29.  $\frac{3}{16} = \frac{3}{16} \cdot \frac{5}{5} = \frac{15}{80}$

31.  $\frac{7}{26} = \frac{7}{26} \cdot \frac{2}{2} = \frac{14}{52}$

33.  $\frac{18}{1} = \frac{18}{1} \cdot \frac{3}{3} = \frac{54}{3}$

35.  $\frac{1}{3}$       37.  $-\frac{3}{4}$

39.  $\frac{5}{11}$       41. 0

43.  $\frac{12}{35}$       45.  $-\frac{1}{2}$

47.  $\frac{2}{3}$       49. 4

51.  $\frac{6}{25}$       53.  $-\frac{10}{9}$

55.  $\frac{1}{4}$       57.  $\frac{8}{9}$

59.  $\frac{1}{3}$       61.  $\frac{9}{16}$

63.  $\frac{5}{77}$       65.  $\frac{1}{6}$

67.  $\frac{10}{3}$  or  $3\frac{1}{3}$

69.  $-\frac{28}{45}$

71.  $\frac{21}{16}$  or  $1\frac{5}{16}$

73.  $\frac{9}{4}$       75.  $\frac{25}{24}$

77.  $\frac{10}{3}$       79. 1

81.  $\frac{9}{16}$       83.  $\frac{1}{4}$

85.  $\frac{1}{16}$

87. Undefined  
 89. 0      91.  $\frac{8}{5}$

93.  $\frac{9}{20}$

Applications

95.  $\frac{9}{20}; \frac{11}{20}$

97.  $\frac{23}{45}$       99.  $\frac{43}{60}$

101. a.  $\frac{2}{5}$       b.  $\frac{12}{25}$

103. a. more than 90  
 b. less than 90  
 c. 100 passengers

105. a. Yes, it would pass  
 b. Pass by 5 votes.

107. a.  $\frac{1}{8}$       b.  $\frac{1}{512}$   
 c.  $\frac{159}{512}$

109. a.  $\frac{35}{12}$       b.  $2\frac{11}{12}$

Writing & Thinking

111. The two parts are the numerator and the denominator. The denominator represents the number of pieces in a whole and the numerator represents the number of these pieces being considered.

1.3 Exercises

Concept Check

- denominators
- denominators
- equivalent
- True
- False; When subtracting fractions, subtract the numerators and keep the common denominator.

Practice

- |                       |                        |
|-----------------------|------------------------|
| 1. $\frac{5}{14}$     | 3. -2                  |
| 5. $\frac{1}{5}$      | 7. $\frac{3}{4}$       |
| 9. $\frac{7}{9}$      | 11. $\frac{11}{8}$     |
| 13. $\frac{62}{45}$   | 15. $\frac{13}{12}$    |
| 17. $-\frac{3}{4}$    | 19. $\frac{7}{10}$     |
| 21. 1                 | 23. $\frac{17}{20}$    |
| 25. $\frac{11}{15}$   | 27. $\frac{11}{20}$    |
| 29. $-\frac{11}{20}$  | 31. $\frac{317}{1000}$ |
| 33. $\frac{631}{100}$ | 35. $\frac{3}{5}$      |
| 37. $\frac{1}{3}$     | 39. $-\frac{2}{3}$     |
| 41. $\frac{1}{2}$     | 43. $-\frac{5}{16}$    |
| 45. $\frac{3}{5}$     | 47. $\frac{3}{5}$      |
| 49. $\frac{5}{16}$    | 51. $\frac{13}{20}$    |
| 53. $-\frac{1}{4}$    | 55. $\frac{1}{10}$     |
| 57. $\frac{23}{16}$   | 59. 0                  |
| 61. $\frac{3}{50}$    | 63. $\frac{1}{50}$     |

Applications

65. 1 ounce
67.  $\frac{23}{20}$  inches
69.  $\frac{5}{8}$  inch
71. a.  $\frac{5}{18}$       b. \$6000
73.  $\frac{7}{24}$       75.  $\frac{11}{36}$
77. a.  $\frac{3}{4}$   
 b. 0 (the pie is totally consumed)
79.  $\frac{23}{45}$  of the assignment

Writing & Thinking

81. The LCM finds the least common multiple of a set of numbers. The LCD does the same thing for the set of numbers determined by the denominators.
83. Answers will vary. Adding with fractions may be used when cooking or when measuring sewing or construction materials. Subtracting with fractions may be used when cooking or when measuring sewing or construction materials.

27. <      29. >

31. <      33. =  
 35. >      37. <  
 39. =      41. >

43. True  
 45. False;  $-9 < -8.5$   
 47. True      49. True

51. False;  $-|-3| > -|4|$   
 53.  $x = -5, 5$

55.  $x = -2, 2$   
 57. No solution

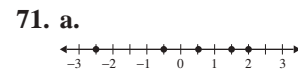
59.  $x = -23, 23$

61. Sometimes. Examples will vary.

63. Always. Examples will vary.

Applications

65. -4500 meters  
 67. +8844 meters  
 69. a.  $|x| \leq 3$



- b.  $-\frac{5}{2}$  has the furthest distance from zero.

73. a.  $x = -5$  millimeters, 5 millimeters

- b. The length of the board can be 5 mm longer or 5 mm shorter than 1 meter.

- c. 1.05 m or 0.95 m

75. a. Fresno  
 b. El Centro

Writing & Thinking

77. If  $y$  is a negative number then  $-y$  represents a positive number. For example, if  $y = -2$ , then  $-y = -(-2) = 2$ .

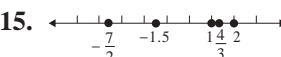
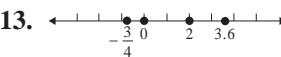
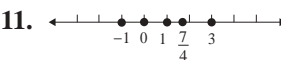
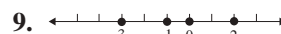
1.4 Exercises

Concept Check

- integers
- irrational
- graph
- True
- True

Practice

1. 3      3. 0  
 5. -2



21. 4, 8  
 23. -7, -2, 0, 4, 8

25. -7, -2,  $-\frac{5}{3}$ , -1.4, 0,  
 $\frac{3}{5}$ , 4, 5.9, 8

**1.5 Exercises**

Concept Check

- 1. positive
- 3. negative
- 5. equation
- 7. True

Practice

- 1. 13      3. -4
- 5. 0      7. 5
- 9. -13    11. -8
- 13. -10   15. 0
- 17. 17    19. -4.6
- 21. -29   23. -9
- 25. -15.4   27. -3
- 29. -54    31. -2.5
- 33.  $\frac{3}{7}$     35.  $\frac{5}{8}$
- 37.  $-\frac{7}{4}$     39. -7
- 41. -0.5   43. 76
- 45. -310   47. 27
- 49. 2.3    51. 18
- 53. 14    55. 35
- 57. 84    59. 3807
- 61. -97,714

Applications

- 63. Profit: \$6000
- 65. a. -0.3 cm, -0.1 cm  
b. 0.02 cm  
c. Increase
- 67. 275 feet
- 69. 8 feet
- 71. 8
- 73. The solution is -\$97.86.

Writing & Thinking

- 75.  $|0| + |0| = 0$
- 77. Sometimes. Examples will vary.
- 79. Sometimes. Examples will vary.

81. Never. Examples will vary.

83. Never. Examples will vary.

**1.6 Exercises**

Concept Check

- 1. additive inverse
- 3. left
- 5. subtract
- 7. False; The sum of a number and its additive inverse is zero.
- 9. True

Practice

- 1. -11      3. 6
- 5. -4.7    7. 0
- 9.  $\frac{5}{7}$       11. 5
- 13. -10    15. 7
- 17. 3      19. 12
- 21. 24    23. 5.9
- 25. -4    27. 10
- 29.  $-\frac{7}{20}$    31.  $-\frac{1}{4}$
- 33.  $\frac{3}{40}$     35. -15
- 37. -1      39. -3
- 41. 1      43. 0
- 45.  $-8 < -5$
- 47.  $-3.1 < 3.1$
- 49.  $\frac{19}{4} = \frac{19}{4}$
- 51.  $0 > -27$
- 53.  $-237 > -248$
- 55.  $1044 > -39$
- 57.  $-15,254 > -35,090$

59. 1      61. -7

63. -26    65. 11

Applications

67. -18°F (a decrease of 18 degrees Fahrenheit)

69. \$7 (an increase of 7 dollars)

71. -14,787 ft (a decrease of 14,787 feet)

73. a. Negative

b. Positive

c. May and June

d. Answer will vary. March and April or April and May

75. \$250,404

77. \$847

79. \$165

81. -6 °C (or 6 °C below 0 °C)

83. 2316 points

85. 1220 gallons

87. a. 1454 people

b. 198,580 people

89. The solution is 90.85 g

91. 3 °F

93. 4238 points

Writing & Thinking

- 95. Add the opposite of the second number to the first number.
- 97. Answers will vary. When the absolute value of the number being subtracted is greater than the absolute value of the other number, the difference will be positive.

**1.7 Exercises**

Concept Check

- 1. average, mean
- 3. positive
- 5. 0
- 7. True

9. False; The product and quotient will be positive.

Practice

- 1. -12      3. 48
- 5. 56      7. -21
- 9. 56      11. 26
- 13. -70    15. -24
- 17. -288   19. 0
- 21. -9      23. -7.31

25.  $-\frac{1}{6}$     27.  $\frac{18}{5}$

29.  $-\frac{12}{5}$     31.  $-\frac{9}{2}$

33. 4      35. -6

37. 2      39. 0

41. -3      43. -17

45. Undefined

47. 5      49. -0.6

51. 20      53. -2.3

55.  $-\frac{1}{12}$     57.  $\frac{9}{22}$

59.  $-\frac{5}{12}$

61. False;  $(-4)(6) < 3 \cdot 8$

63. True

65. False;  $6(-3) = (-14) + (-4)$

67. True

69. True

71. 116,640

73. 22,032

75. 1682

77. -45.5

79. -9.5

81. -54.605

Applications

- 83. -12
- 85. \$2975
- 87. 8928 slices of bread
- 89. \$442,800
- 91. 3 cookies

- 93. 22 teams
- 95. 17 grams
- 97. \$10,740 per year
- 99. 1152 bags
- 101. 427 sq ft
- 103. 5423 dozen
- 105. 2 slices
- 107. 33,087.5 accidents
- 109. a. -8 psi  
b. -10.5 psi  
c. 5.25 hours (or 5 hours 15 minutes)

- 111. 26.6 calls
- 113. 80
- 115. 78.6 inches
- 117. 31.5 hours
- 119. 18,631.8 square miles

Writing & Thinking

- 121. Positive; The product of two negative numbers will be positive so an even number of negatives will give a positive product.
- 123. Answers will vary.

1.8 Exercises

Concept Check

- 1. grouping symbols
- 3. left, right
- 5. -1
- 7. True
- 9. True

Practice

- 1. a. 36 b. 16
- 3. -25 5. -10
- 7. -45 9. -137
- 11. 152 13. -189

- 15. 143 17. -36
- 19. -10 21.  $\frac{11}{30}$
- 23.  $\frac{1}{24}$  25.  $\frac{31}{24}$
- 27.  $\frac{10}{3}$  29.  $\frac{41}{32}$
- 31.  $\frac{3}{5}$  33. -5.7
- 35. -3.5 37. 24
- 39. -5 41. 1
- 43.  $-\frac{13}{64}$  45. 42.45
- 47. 67.77 49. 15.41

Applications

- 51. a.  $\$11 \cdot \left(1\frac{1}{4}\right) + \$8.50$   
b. \$22.25  
c. \$31
- 53. a.  $-\$42 - \$35 - (3 \cdot \$5)$   
b.  $-\$92$
- 55. a.  $\left(12\frac{1}{2} + 15\frac{3}{4} + 11\frac{3}{4} - 1\frac{1}{4}\right) \div 6$   
b.  $6\frac{11}{24}$  pounds of potatoes
- 57. a.  $2 \cdot \$225 + 4 \cdot \$20 + 4 \cdot \$15$   
b. \$147.50

Writing & Thinking

- 59. Smaller; When any positive number is multiplied by a fraction (or decimal) between 0 and 1, the result will be smaller. This is what is happening when a number between 0 and 1 is squared. Answers will vary.

1.9 Exercises

Concept Check

- 1. reciprocal
- 3. zero-factor
- 5. opposite
- 7. False; The commutative property of addition allows the order to change.
- 9. False; The additive identity of all numbers is 0.

Practice

- 1. 3 + 7
- 3. 4 · 19
- 5. 30 + 48
- 7. (2 · 3) · x
- 9. (3 + x) + 7
- 11. 0
- 13. x + 7
- 15. 2x - 24
- 17. 0
- 19. Commutative property of addition
- 21. Multiplicative identity
- 23. Associative property of addition
- 25. Commutative property of multiplication
- 27. Commutative property of multiplication
- 29. Multiplicative inverse
- 31. Additive inverse
- 33. Multiplicative identity
- 35. Zero-factor law
- 37. Associative property of addition
- 39. 6(11) = 66 and 6 · 3 + 6 · 8 = 66

- 41.  $10(-7) = -70$  and  $10 \cdot 2 - 10 \cdot 9 = -70$
- 43. Commutative property of multiplication;  $6 \cdot 4 = 4 \cdot 6 = 24$
- 45. Associative property of addition;  $8 + (5 + (-2)) = (8 + 5) + (-2) = 11$
- 47. Distributive property;  $5(4 + 18) = 5(4) + 90 = 110$
- 49. Associative property of multiplication;  $(6 \cdot (-2)) \cdot 9 = 6 \cdot (-2 \cdot 9) = -108$
- 51. Commutative property of addition;  $3 + (-34) = (-34) + 3 = -31$
- 53. Commutative property of addition;  $2(3 + 4) = 2(4 + 3) = 14$
- 55. Commutative property of addition;  $5 + (4 - 15) = (4 - 15) + 5 = -6$
- 57. Associative property of multiplication;  $(3 \cdot 4) \cdot 5 = 3 \cdot (4 \cdot 5) = 60$

Applications

- 59. a. \$118.25  
b.  $\$11 \cdot \left(6\frac{1}{2}\right) + \$11 \cdot \left(4\frac{1}{4}\right)$   
c. Distributive property
- 61. a.  $\$85.04 - \$28.79 - \$50.00 - \$12.16$  or  $\$85.04 - (\$28.79 + \$50.00 + \$12.16)$   
b.  $-\$5.91$   
c.  $-\$5.91 + \$5.91 = 0$   
d. The additive inverse property

## Chapter 2: Solving Linear Equations and Inequalities

### 2.1 Exercises

#### Concept Check

1. 1
3. constant
5. coefficients
7. True
9. False; In the term  $12a$ , 12 is the coefficient.

#### Practice

1.  $-5$ , 3, and 8 are like terms;  $7x$  and  $9x$  are like terms.
3.  $-x^2$  and  $2x^2$  are like terms;  $-6xy$  and  $5xy$  are like terms;  $3x^2y$  and  $5x^2y$  are like terms.
5. 24,  $-6$ , and 8.3 are like terms;  $1.5xyz$ ,  $-1.4xyz$ , and  $xyz$  are like terms.
7.  $15x$       9.  $3x$
11.  $5y^2$       13.  $10x$
15.  $-2c$       17.  $7x + 2$
19.  $2x^2 + 2x$
21.  $3x^2 + 20$
23.  $13x^2 - 2y$
25.  $7x - 1$
27.  $-2n^2 + 2n - 3$
29.  $-x^2 + 3x + 45$
31.  $4n + 3$
33.  $7a - 8b$
35.  $8x + y$
37.  $-2y$       39.  $\frac{8x}{3}$
41.  $-4$       43. 4
45.  $-2$
47.  $3x + 4$ ; 13
49.  $5y + 1$ ; 16
51.  $-3.1a^2 + 4a$ ;  $-20.4$
53.  $3.7x + 1.1$ ; 15.9
55.  $8a$ ;  $-16$

57.  $3b$ ;  $-3$
59.  $-x^2 + 5x - 7$ ;  $-21$
61.  $3y^2 - y$ ; 4
63.  $4y^3 - 4y^2 + 5y + 1$ ;  $-12$
65.  $5x^2 + 9x - 22$ ;  $-20$
67.  $2a^2 - 2a$ ; 4
69.  $9ab - 7a + 2b$ ; 21
71.  $14a - 15b + 2c + 2$ ; 24
73.  $10a + 10b + 10c$ ; 0

#### Applications

75. \$50,000
77. 375 pounds
79. a.  $47s + 143m$   
b. 6170 boxes

#### Writing & Thinking

81. A number is a constant and its value does not change regardless of where it appears in an expression or equation. A variable, usually represented by a letter, represents an unknown number or numbers.

83. a. For  $x = 3$ ,  

$$4x^2 - 5(x + 2) + 3x + 10 + 2x$$

$$= 4(3)^2 - 5(3 + 2) + 3(3) + 10 + 2(3)$$

$$= 4(9) - 5(5) + 9 + 10 + 6$$

$$= 36 - 25 + 9 + 10 + 6$$

$$= 36$$
- b.  

$$4x^2 - 5(x + 2) + 3x + 10 + 2x$$

$$= 4x^2 - 5x - 10 + 3x + 10 + 2x$$

$$= 4x^2$$

For  $x = 3$ ,

$$4x^2 = 4(3)^2$$

$$= 4(9) = 36$$

The second method, as it requires fewer calculations.

### 2.2 Exercises

#### Concept Check

1. ambiguous
3. subtraction
5. multiplication
7. True
9. False; Subtraction is indicated by the phrase "five less than a number."

#### Practice

1.  $x + 6$
3.  $y - 4$
5.  $\frac{2m}{10}$
7.  $6y - 4$
9.  $4x + 2x$
11.  $15 - 2y$
13.  $3x - 5x$
15.  $9(x + 2)$
17.  $4(x + 1) - 13$
19.  $3(x + 6) + 8$
21.  $3(7 - x) - 4$
23.  $\frac{x}{2} - 18$
25. a.  $x - 6$   
b.  $6 - x$
27. a.  $3x - 5$   
b.  $5 - 3x$
29.  $24d$
31.  $\$3.15x$
33.  $365y$
35.  $7t + 3$
37.  $7t + 3$
39.  $\$20 + \$0.15m$
41.  $2w + 2(2w - 3)$   
 $= 6w - 6$
43. Four times a number
45. A number increased by five

47. Four times a number decreased by seven
49. Seven times the sum of a number and one
51. Negative two times the difference between a number and eight
53. Five times the sum of twice a number and three
55. The quotient of six and the difference between a number and one
57. Six times a number plus the number minus one
59. Eight increased by twice the difference between a number and one
61. The sum of three times a number and seven; three times the sum of a number and seven
63. The product of seven and a number minus three; seven times the difference between a number and three

#### Writing & Thinking

65. The Commutative Property of Addition and Multiplication permits the order of items being added or multiplied to change and still have the same result. This property does not hold true for subtraction or division. Therefore, order is important for subtraction and division problems or the answer will change or be incorrect.
67. Answers will vary.

## 2.3 Exercises

## Concept Check

- equation
- addition, equality
- dividing
- True
- True

## Practice

- $x = -2$  is a solution
- $x = 4$  is not a solution
- $x = -4$  is a solution
- $x = -18$  is a solution
- $x = -28$  is a solution
- $x = 7$
- $y = -4$
- $x = -19$
- $n = 37$
- $z = -6$
- $x = 5$
- $y = -5.9$
- $x = -1.2$
- $x = \frac{11}{20}$
- $x = 9$
- $y = 8$
- $x = 20$
- $y = 10$
- $x = -8$
- $x = 12$
- $n = 8$
- $y = 2.1$
- $x = \frac{20}{9}$
- $x = -13.3$
- $y = -12$
- $x = -\frac{2}{5}$
- $x = -4$
- $x = \frac{5}{8}$
- $n = 9.7$

59.  $x = -4$

61.  $y = -50.753$

63.  $x = -17.214$

65.  $x = 246$

67.  $x = -153.17$

## Applications

- 1945 *kanji* characters
- a. Answers will vary.  
b.  $x = 12.5$   
c. The garden should be 12.5 feet wide.
- 4.24 light years
- 11,500 words
- 2250 students
- a. Answers will vary.  
b.  $x = 11,550$   
c. Clara will need a loan for \$11,550.

## Writing &amp; Thinking

- a. Yes. It is stating that  $6 + 3$  is equal to 9.  
b. No. If we substitute 4 for  $x$ , we get the statement  $9 = 10$ , which is not true.

## 2.4 Exercises

## Concept Check

- like
- multiplication
- substituting
- False; Subtract 3 from both sides.
- True

## Practice

- $x = -3$
- $x = 2$
- $x = 2$
- $y = -1$
- $t = -1$
- $x = -0.12$
- $x = 4$
- $x = 0$
- $y = 0$
- $x = -2$
- $y = -6$
- $n = 6$
- $n = 8$
- $x = 0$

31.  $x = -7$

33.  $x = -\frac{1}{8}$

35.  $x = -\frac{13}{2}$

37.  $x = -\frac{21}{5}$

39.  $x = -\frac{8}{15}$

41.  $y = \frac{28}{5}$

43.  $x = 2$

45.  $y = \frac{7}{5}$

47.  $x = -4.5$

49.  $x = -44$

51.  $x = 2$

53.  $x = -4$

55.  $y = 0.5$

57.  $x = 1.5$

59.  $x = 0.2$

61.  $x = 6.1$

63.  $x = 1.12$

## Applications

- 14,000 tickets per hour
- 52 pages
- 240 cookies of each remaining variety
- 135 yards
- 379.7 feet
- a. Lowest temperature; Change in temperature per hour; Current temperature  
b.  $x = 4$   
c. The low temperature occurred 4 hours ago.

## Writing &amp; Thinking

- a. The 4 should have been multiplied by 3 so that the 3 was distributed over the entire left-hand side of the equation; Correct answer is  $x = 15$ .

- 3 should be subtracted from each side, not from each term, and  $5x - 3$  doesn't simplify to  $2x$ ; Correct answer is  $x = \frac{8}{5}$ .

## 2.5 Exercises

## Concept Check

- identity
- conditional
- real,  $\mathbb{R}$
- True
- True

## Practice

- $x = -5$
- $n = 3$
- $y = 6$
- $x = 3$
- $n = 0$
- $y = 0$
- $z = -1$
- $y = \frac{1}{5}$
- $x = -3$
- $x = -4$
- $x = -21$
- $y = 0$
- $y = 1$
- $x = -\frac{3}{2}$
- $x = \frac{1}{4}$
- $x = \frac{3}{17}$
- $x = -\frac{1}{4}$
- $x = \frac{8}{5}$
- $x = \frac{2}{3}$
- $x = 6$

41.  $x = -11$

43.  $x = \frac{1}{2}$

45.  $x = -5$

47.  $n = -1.5$

49.  $x = 0$

51. Conditional

53. Conditional

55. Contradiction

57. Identity

59. Conditional

61.  $x = -50.21$

63.  $x = 1.067$

Applications

65. 20 guests

67. 0.34 hours

69. a. The area of the first flyer  
 b. The width of the second flyer  
 c.  $x = 5$   
 d. Solution should be correct if part c. is correct.  
 e. The first flyer has a width of 5 inches.

71. 1800 square feet

73. 240 sundaes

Writing & Thinking

75. a.  $5x + 1$  b.  $x = 6$   
 c. Answers will vary.

2.6 Exercises

Concept Check

- consecutive
- $n + 2, n + 4$
- 2
- True
- False; Integers that are not even

Practice

- $x =$  savings account balance in dollars (or other unit of money);  $\frac{3}{5}x$
- $s =$  the length of a side of the square;  $4s = 20$
- $x - 5 = 13 - x$ ; 9
- $36 = 2x + 4$ ; 16
- $7x = 2x + 35$ ; 7
- $3x + 14 = 6 - x$ ; -2
- $\frac{2x}{5} = x + 6$ ; -10
- $4(x - 5) = x + 4$ ; 8
- $\frac{2x + 5}{11} = 4 - x$ ; 3
- $2x + 3x = 4(x + 3)$ ; 12
- $n + (n + 2) = 60$ ; 29, 31
- $n + (n + 1) + (n + 2) = 69$ ; 22, 23, 24
- $n + (n + 1) + (n + 2) + (n + 3) = 74$ ; 17, 18, 19, 20
- $171 - n = (n + 1) + (n + 2)$ ; 56, 57, 58
- $208 - 3n = (n + 1) + (n + 2) + (n + 3) - 50$ ; 42, 43, 44, 45
- $n + 2(n + 2) = 4(n + 4) - 54$ ; 42, 44, 46
- $(n + 2) + (n + 4) - n = 66$ ; 60, 62, 64
- $2n + 3(n + 2) = 2(n + 4) + 7$ ; 3, 5, 7

Applications

37. a. The unknown value is the number of postcards purchased.  
 b.  $p = 9$   
 c. Brooke purchased 9 postcards.

39. a. The number of slices each pizza was cut into  
 b.  $\frac{1}{4}p + \frac{1}{2}p + \frac{3}{8}p = 9$   
 c.  $p = 8$   
 d. Each pizza was cut into 8 slices.
41.  $(c - 58.96) + c = 96.94$ ;  
 Flash drive: \$18.99;  
 Printer: \$77.95
43.  $7x = 91,399$ ; 13,057
45.  $x + x + (x + 3) + (x + 3 + 5) = 19$ ;  
 2 magazines

47.  $50 - 2x = 10.50$ ; \$19.75
49.  $800 + 50(x - 2) = 1450$ ;  
 15 hours
51.  $19.99 + 0.65x = 127.24$ ;  
 165 miles
53.  $n + 4n - 4 + 2n + 7 = 59$ ; 8 cm, 28 cm, 23 cm
55.  $x + 3x - 1 + 2x + 5 = 64$ ; 10 inches, 29 inches, 25 inches

Note: Answers for 57 through 61 will vary.

57. Twice a number increased by 3 equals 9;  $x = 3$
59. Find 3 consecutive even integers such that the sum of the first and the third is 3 times the second;  $n = -2, 0, 2$
61. Find a number such that twice the sum of the number and 2, decreased by 6 is equal to the sum of the number and 4 minus the number;  $n = 3$

2.7 Exercises

Concept Check

1. look back or check

3. (total) sale or selling  
 5. appreciation  
 7. True  
 9. True

Practice

1. 91% 3. 137%  
 5. 37.5% 7. 150%  
 9. 0.69 11. 0.113  
 13. 0.005 15. 0.82  
 17.  $\frac{7}{20}$  19.  $\frac{13}{10}$   
 21. 7 23. 11.4  
 25. 50

Applications

27. a. \$30 b. \$270  
 29. a. \$465 b. \$15,035  
 31. \$16.88; \$5.63  
 33. \$61.25  
 35. a. \$161 b. \$5474  
 37. \$52  
 39. a. \$6.93 b. \$122.38  
 41. 1.5%  
 43. a. \$250 b. 20%  
 c. \$216  
 45. \$11,700  
 47. \$875  
 49. \$28,000  
 51. \$770  
 53. \$2520  
 55. \$112,700  
 57. \$10,000  
 59. 5.9%  
 61. 2.484%  
 63. 214,926 people  
 65. a. \$200.00 b. 11.11%  
 67. 38%  
 69. a. \$7 b.  $33\frac{1}{3}\%$   
 c. 25%  
 71. a. \$180 b. 40%  
 c.  $28\frac{4}{7}\%$  or 28.6%

73. a. \$500 b. 25%  
c. 20%
75. a. \$1075 b. \$258  
c. 24% d. 30%
77. \$1.89
79. \$1.39; \$1.75
81. \$8.64
83. \$31.80
85. a. \$3.60 b. \$22.50
87. \$111.60

Writing & Thinking

89. Sales tax and tips are percentages of some item or service. The percent is the rate, while the cost of the item being purchased is the base. The amount is then the sales tax itself, which is being compared to the base. A sales tax might be

8%, as in “what is 8% of the cost of the item purchased?”

91. For both types of percent of profit, the profit (the difference between selling price and cost) must be determined first. The profit is then used as a numerator. In profit based on cost, the denominator is the

cost. In profit based on selling price, the selling price is the denominator. The fraction is then divided and the result is a percent of profit, either based on cost or selling price.

## Chapter 3: Formulas and Linear Inequalities

### 3.1 Exercises

Concept Check

- mathematically
- time
- substitute
- False; Case matters in formulas.
- True

Applications

- \$192
- \$10,000
- a. \$183.75  
b. \$3683.75
- 2 seconds
- 4 milliliters
- \$1030
- 14 rafters
- 336 in. or 28 ft
- \$1030
- 230 calculators
- \$5 million
- \$2400
- 7 hours
- 1.625 mph
- $b = P - a - c$
- $m = \frac{F}{a}$

- $w = \frac{A}{l}$
- $n = \frac{R}{p}$
- $P = A - I$
- $m = 2A - n$
- $t = \frac{I}{Pr}$
- $b = \frac{P-a}{2}$
- $\beta = 180^\circ - \alpha - \gamma$
- $h = \frac{V}{lw}$
- $b = \frac{2A}{h}$
- $h = \frac{V}{\pi r^2}$
- $g = \frac{mv^2}{2K}$
- $y = \frac{6-2x}{3}$
- $x = \frac{11-2y}{5}$
- $b = \frac{2A-hc}{h}$  or  $b = \frac{2A}{h} - c$
- $x = \frac{8R+36}{3}$  or  $x = \frac{8R}{3} + 12$
- $y = -x - 12$

- $C = nt + 9$
- $C = 325n + 5400$
- a.  $I = Prt$   
b.  $P = \$8000; I = \$600; t = 0.5$   
c.  $r$  d.  $r = 15\%$
- a.  $A = \frac{1}{2}bh$  b.  $b = 3h$   
c.  $A = \frac{1}{2}(3h)h = \frac{3}{2}h^2$   
d.  $h^2 = \frac{2}{3}A$   
e. Take the square root of both sides  
f. 10 g. 30 feet

Writing & Thinking

73. a. 1 b. -1 c. 1.5  
d. -12

### 3.2 Exercises

Concept Check

- polygon
- square
- True
- True
- True

Practice

- 44 cm
- 48.1 yd

- 40 cm
- 45 cm
- 34 cm
- 200 yd
- 36 cm
- 35 ft
- 25.12 m
- 35.98 in.
- 21.42 m
- 81 ft<sup>2</sup>
- 67.24 cm<sup>2</sup>
- 48 in.<sup>2</sup>
- 162 yd<sup>2</sup>
- 25 yd<sup>2</sup>
- 48 cm<sup>2</sup>
- 160 in.<sup>2</sup>
- 75.3914 m<sup>2</sup>
- 26.13 cm<sup>2</sup>
- 11.14 m<sup>2</sup>
- 70 in.<sup>3</sup>
- 381.51 cm<sup>3</sup>
- 12.56 mm<sup>3</sup>
- 60 in.<sup>3</sup>
- 14.13 ft<sup>3</sup>
- 401.92 m<sup>3</sup>
- 376.8 ft<sup>3</sup>
- 2289.06 cm<sup>3</sup>
- 224 cm<sup>3</sup>

Applications

- 61. a. 4605 ft  
b. 15.7 minutes
- 63. 135 square feet
- 65. a. 2350 square feet  
b. 11.75 pounds
- 67. 7100.6 in.<sup>3</sup>
- 69. 96 mL

Writing & Thinking

71. The area of the interior triangle is equal to half of the area of the rectangle no matter where the point is chosen.

3.3 Exercises

Concept Check

- 1. rate, time
- 3. 12%
- 5. one
- 7. False; The value of  $r$  should be written as a decimal number.
- 9. True

Applications

- 1. a. Original price  
b.  $x$ ;  $0.20x$  c. \$119.95
- 3. a. 2 liters b.  $0.25x$   
c.  $x + 20$   
d.  $0.20(x + 20) = 2 + 0.25x$   
e. 40 liters
- 5. a.  $x$  is the number of quarters in Brian's pocket;  $0.10(2q) + 0.25q = 2.70$ ;  $q = 6$ , so Brian has 6 quarters and 12 dimes.  
b. Check against the language of the problem: 12 is twice as much as 6, and 6 quarters (\$1.50)

and 12 dimes (\$1.20) add up to \$2.70.

- 7. 1.68 mph
- 9. 8.75 hours
- 11. 3 hours
- 13. 50 mph; 300 miles
- 15. 7 hours
- 17. 36 mph; 60 mph
- 19. Day: 56 mph; Night: 69 mph
- 21. 4.5 miles

23. a.

	Rate (mph)	Time (min)	=	Distance (miles)
Tortoise	10	$t$		$10t$
Achilles	25	$t - 2$		$25(t - 2)$

- b.  $10t = 25(t - 2)$
- c.  $3\frac{1}{3}$  hours
- d.  $1\frac{1}{3}$  hours
- e. Yes

- 25. \$7400 at 5.5%; \$2600 at 6%
- 27. \$7000 at 6%; \$9000 at 8%
- 29. \$5500 at 8%; \$6500 at 10%

31. a.

	Principal (\$)	Rate	=	Interest (\$)
High-Risk Fund	$P$	0.08		$0.08P$
Low-Risk Fund	$3600 - P$	0.04		$0.04(3600 - P)$

- b.  $0.08P + 0.04(3600 - P) = 198$
- c.  $P = \$1350$
- d. High-risk fund: \$1350; Low-risk fund: \$2250
- e. Answer will vary.

- 33. \$6720 at 5.5%; \$5280 at 7%
- 35. \$600 at 2.5%; \$800 at 4%

- 37. \$11,000 at 4%; \$9500 at 5%
- 39. \$40.50
- 41. \$113.75
- 43. a. \$1140  
b.  $x - 0.05x$  or  $0.95x$   
c.  $x - 0.05x - 2850 = 1140$  or  $0.95x - 2850 = 1140$   
d. \$4200  
e. Robin's Refurbished Wrecks should sell the used car for \$4200.

- 45. 94
- 47. 4 phone calls
- 49. \$20
- 51. a. Not possible  
b. 192
- 53. a. 3.2 inches  
b. 7.1 inches  
c. 6.9 inches
- 55. a. 80.4 million  
b. 26 million  
c. 75 million

Writing & Thinking

- 57. If each equal side is 9 cm long, that would make the perimeter more than 18 cm; Correct answer: 6 cm
- 59. He would not be able to paddle faster than the current, so he would not be able to return upriver at all; Correct answer:  $\frac{2}{3}$  mph

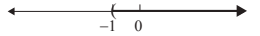

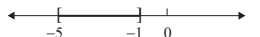
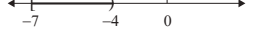
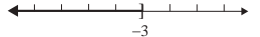
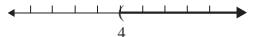
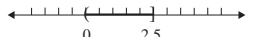
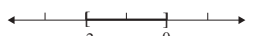
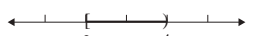
3.4 Exercises

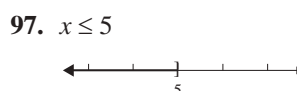
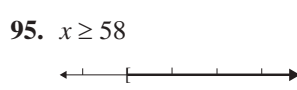
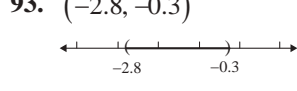
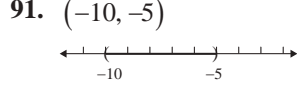
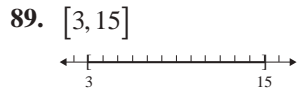
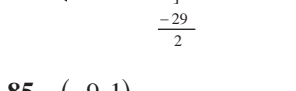
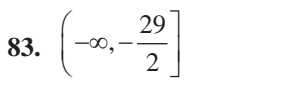
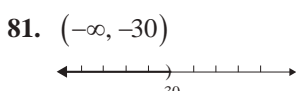
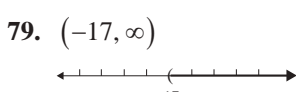
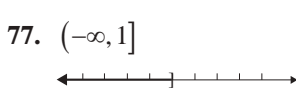
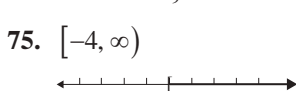
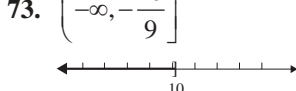
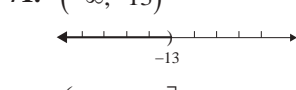
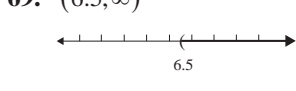
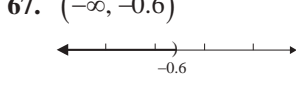
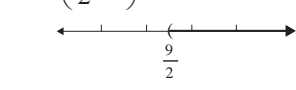
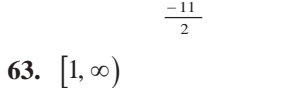
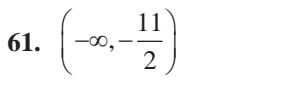
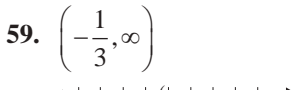
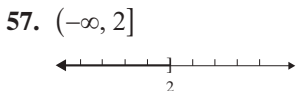
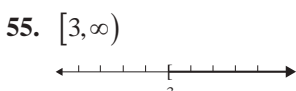
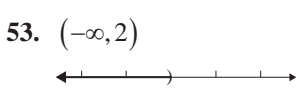
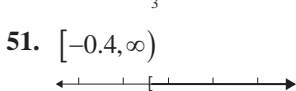
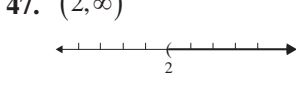
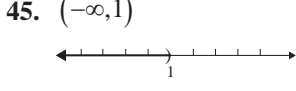
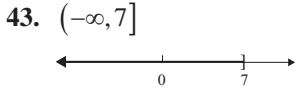
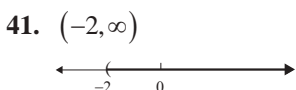
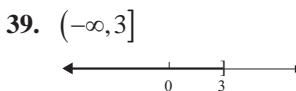
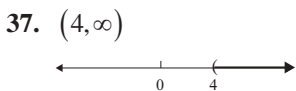
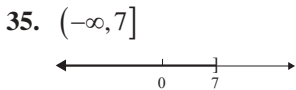
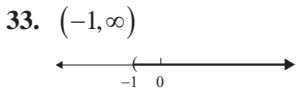
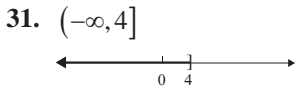
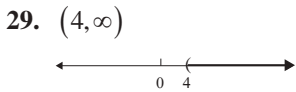
Concept Check

- 1. interval
- 3. closed
- 5. addition

- 7. True
- 9. False; Only one value in the solution set needs to be checked.

Practice

- 1.  $(-1, \infty)$   

- 3.  $(-\infty, 5]$   

- 5.  $[-5, -1]$   

- 7.  $[-7, -4)$   

- 9.   
Half-open interval
- 11.   
Open interval
- 13.   
Half-open interval
- 15.   
Closed interval
- 17.   
Half-open interval
- 19. a.  $x \leq -2$   
b.  $(-\infty, -2]$   
Half-open interval
- 21. a.  $x \geq -4$   
b.  $[-4, \infty)$   
Half-open interval
- 23. a.  $-3 < x < 1$   
b.  $(-3, 1)$   
Open interval
- 25. a.  $-2 \leq x \leq 2$   
b.  $[-2, 2]$   
Closed interval
- 27. a.  $x < 3$   
b.  $(-\infty, 3)$   
Open interval



Applications

99. a. The student would need a score higher than 102 points, which is not possible. Thus he cannot earn an A in the course.

b. The student must score at least 192 points to earn an A in the course.

101. He must sell at least 10 cars.

103. a.  $15 - x$   
 b.  $8x + 5(15 - x)$   
 c. 8 large arrangements

105.  $100 - 5(x - 3) \geq 70$ ;  
 9 unexcused absences

107. 22,500 tickets

109. 8 times

111. a.  $150 + 60 + 12.50c \leq 400$

b. If you solve the inequality you get  $c \leq 15.2$ , but you can't buy 0.2 ink cartridges, so  $c \leq 15$ .

c. Jeph can buy at most 15 ink cartridges.

113. a.  $\frac{92 + 74 + 80 + 72 + E}{5} \geq 80$

b.  $E \geq 82$

c. Andrew needs to earn at least an 82 on the fifth exam.

3.5 Exercises

Concept Check

1. standard
3. distance
5. False; Equations involving absolute value can have more than one solution.
7. True

Practice

1.  $x = -8, 8$
3. No solution
5.  $x = -5, -1$
7.  $x = -\frac{4}{3}, \frac{5}{3}$
9.  $n = -2, \frac{2}{3}$
11. No solution
13.  $x = 2$
15.  $x = -\frac{3}{2}, 2$
17.  $x = -\frac{1}{5}, 1$
19.  $x = -\frac{1}{3}, 3$
21.  $x = -22, 26$
23.  $x = -8, 4$
25.  $x = -6, 0$
27.  $x = -\frac{1}{3}, 3$
29.  $x = 1$
31.  $x = -\frac{5}{2}, \frac{3}{4}$
33.  $x = -\frac{20}{7}, \frac{4}{5}$
35.  $x = -20, \frac{40}{9}$

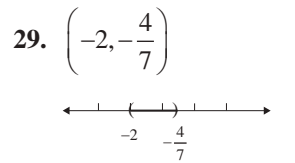
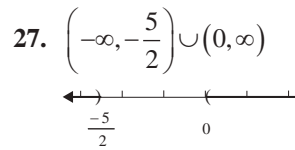
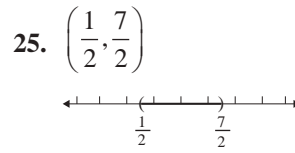
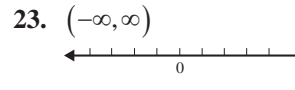
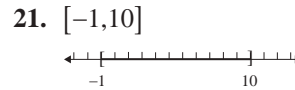
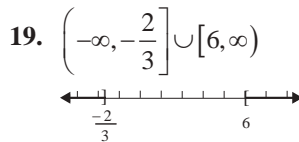
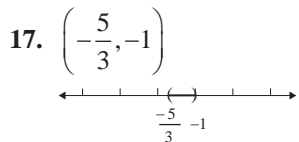
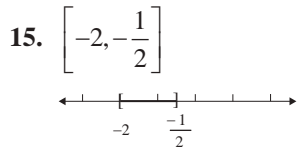
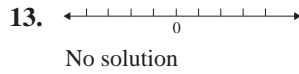
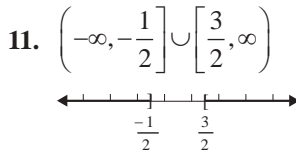
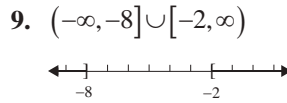
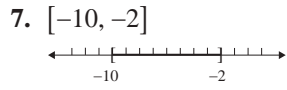
### 3.6 Exercises

#### Concept Check

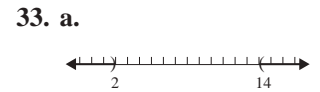
- standard
- or
- False; Only one statement/inequality must be true.
- False; Must be greater than 2

#### Practice

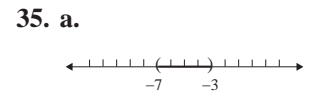
- $(-\infty, \infty)$
- $\left[-\frac{4}{5}, \frac{4}{5}\right]$
- $(-\infty, 1) \cup (5, \infty)$



- $|x| \leq 10$
- $[-10, 10]$ , Closed interval

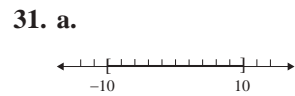


- $|x-8| > 6$
- $(-\infty, 2) \cup (14, \infty)$



- $|x+5| < 2$
- $(-7, -3)$ , Open interval

#### Writing & Thinking



## Chapter 4: Linear Equations and Functions

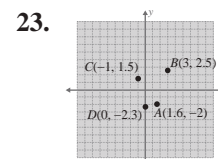
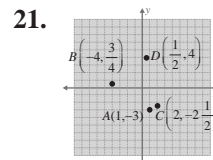
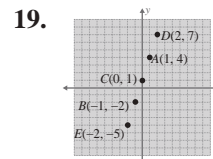
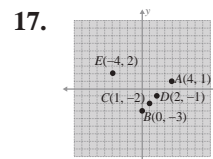
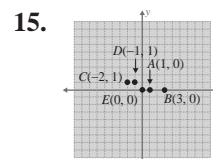
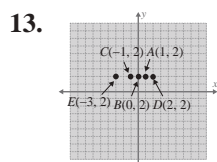
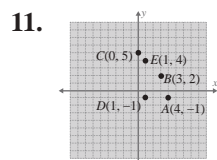
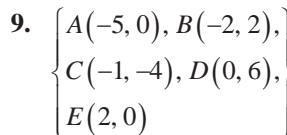
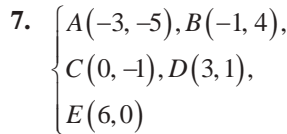
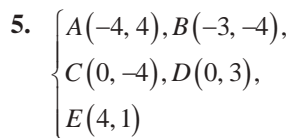
### 4.1 Exercises

#### Concept Check

- quadrants
- III
- origin
- True
- True

#### Practice

- $\left\{ \begin{array}{l} A(-5, 1), B(-3, 3), \\ C(-1, 1), D(1, 2), \\ E(2, -2) \end{array} \right\}$
- $\left\{ \begin{array}{l} A(-3, -2), \\ B(-1, -3), C(-1, 3), \\ D(0, 0), E(2, 1) \end{array} \right\}$



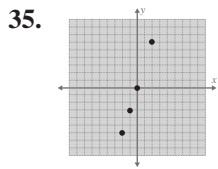
25.  $(0, -4), (2, -2), (4, 0), (1, -3)$

27.  $(0, 3), (2, 2), (6, 0), (-2, 4)$

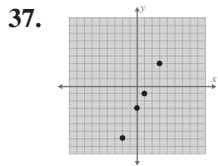
29.  $(0, -8), (1, -4), (2, 0), (3, 4)$

31.  $(0, 2), \left(-1, \frac{8}{3}\right), (3, 0), (6, -2)$

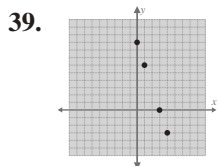
33.  $\left(0, \frac{-7}{4}\right), (1, -1), \left(\frac{7}{3}, 0\right), \left(3, \frac{1}{2}\right)$



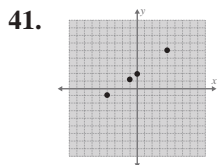
35.  $(0, 0), (-1, -3), (-2, -6), (2, 6)$



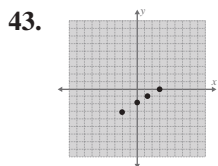
37.  $(0, -3), (1, -1), (-2, -7), (3, 3)$



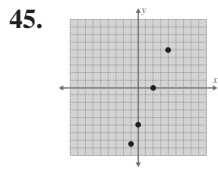
39.  $(0, 9), (3, 0), (1, 6), (4, -3)$



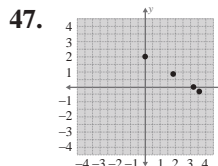
41.  $(0, 2), (4, 5), (-4, -1), (-1, \frac{5}{4})$



43.  $(0, -\frac{9}{5}), (3, 0), (-2, -3), (\frac{4}{3}, -1)$



45.  $(0, -5), (2, 0), (-1, -\frac{15}{2}), (4, 5)$



47.  $(0, 2), (3.2, 0), (1.92, 0.8), (3.52, -0.2)$

49. b, c, d

51. a, d

53. a, c, d

55. For example,  $(-3, -3), (0, 1),$  and  $(3, 5)$ .

57. For example,  $(-3, -1), (0, 0),$  and  $(3, 1)$ .

59. For example,  $(-2, 3), (0, 3),$  and  $(4, 3)$ .

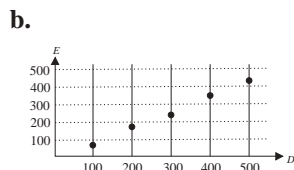
61. For example,  $(-4, -4), (0, -3),$  and  $(4, -2)$ .

63. For example,  $(-3, -3), (-2, 0),$  and  $(-1, 3)$ .

Applications

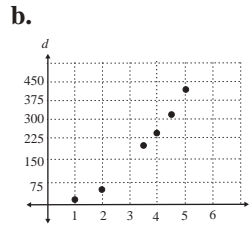
65. a.

D	E
100	85
200	170
300	255
400	340
500	425

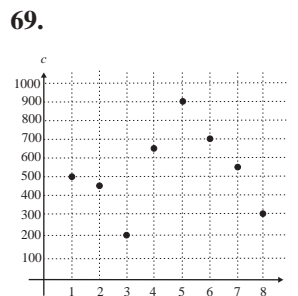


67. a.

t	d
1	16
2	64
3.5	196
4	256
4.5	324
5	400

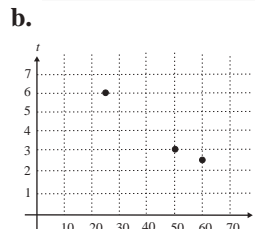


c. The time  $t$  is squared in the equation.



71. a.

r (mph)	t (hours)
25	6
50	3
60	2.5



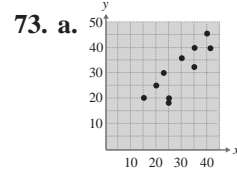
c. The time decreases as the rate increases.

d.

r (mph)	t (hours)
30	5
60	2.5
150	1
300	0.5
1500	0.1

e. Answers will vary. Rate increases as the time decreases.

Writing & Thinking



b. Yes, the more push-ups a person can do it appears the more sit-ups he/she can do.

c. 24 sit-ups, 33 sit-ups, 36 sit-ups, 45 sit-ups. Answers will vary.

75. Answers will vary. Not all scatter plots can be used to predict information related to the two variables graphed because not all variables are related.

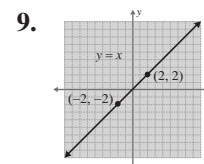
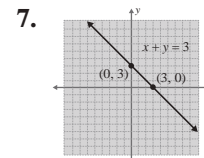
4.2 Exercises

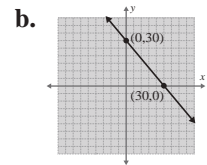
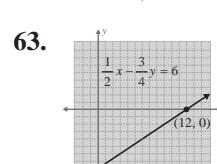
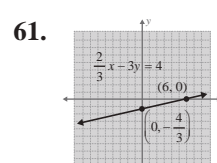
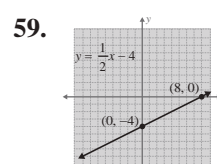
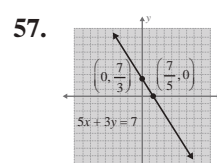
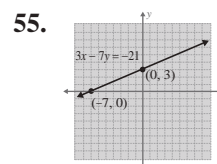
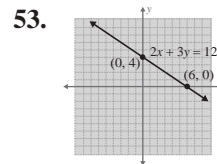
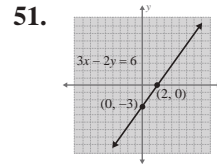
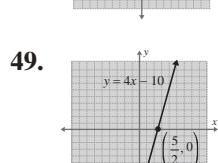
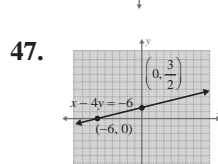
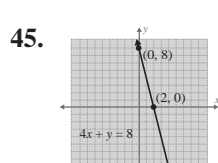
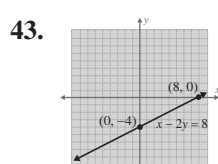
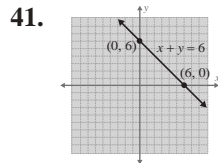
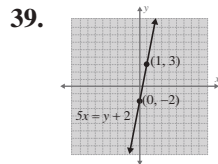
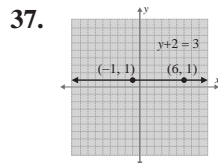
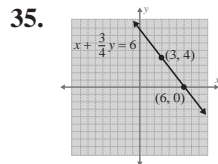
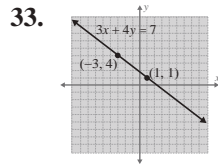
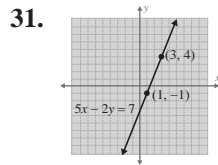
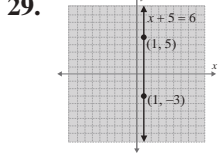
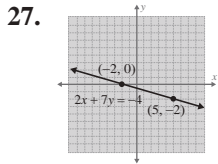
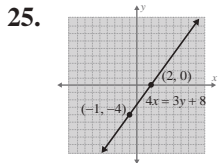
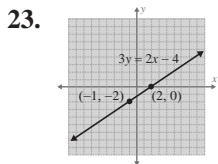
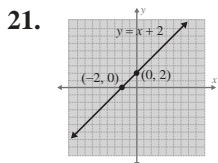
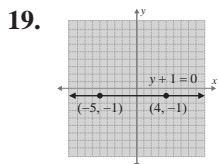
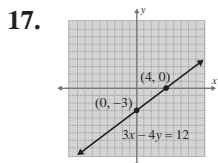
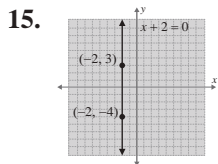
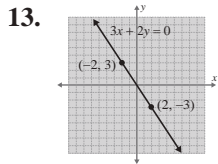
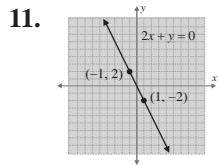
Concept Check

- y
- infinite
- line
- True
- False; Horizontal lines have y-intercepts.

Practice

1. a. 3. d.  
5. f.



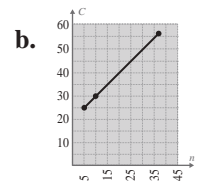


c. Answers will vary. Negative number of cookies; Total amount of cookies is over 30 dozen.

d. 14 dozen chocolate chip cookies

69. a.

$n$	5	10	37
$C$	25	30	57



c. Answers will vary. Negative number of songs; Negative cost.

d. \$57

Writing & Thinking

71. Substitute the  $x$  and  $y$  values into the equation. Then evaluate both sides to see if the equation is true.

4.3 Exercises

Concept Check

- 1. run
- 3. positive
- 5. 0
- 7. True
- 9. True

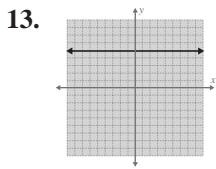
Practice

- 1.  $m = 5$
- 3.  $m = -\frac{1}{7}$
- 5.  $m = 0$
- 7.  $m = \frac{1}{2}$
- 9.  $m = 2$
- 11.  $m = \frac{1}{5}$

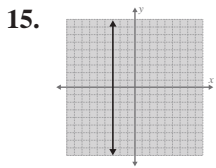
Applications

65. The  $x$ -intercept is  $(12, 0)$  meaning that after 12 days, there will be 0 mg of potassium remaining in the bottle of sports drink. The  $y$ -intercept is  $(0, 360)$  meaning that the original amount of potassium in the sports drink is 360 mg.

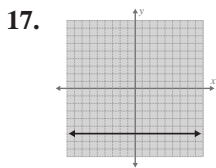
67. a.  $C$ -intercept:  $(30, 0)$   
 $P$ -intercept:  $(0, 30)$



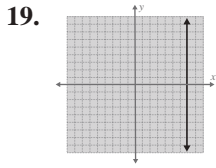
Horizontal line;  $m = 0$



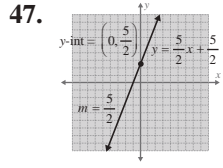
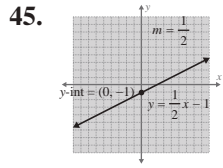
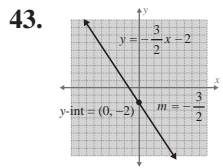
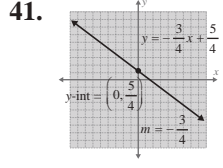
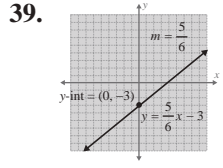
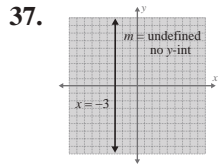
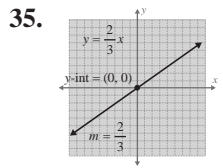
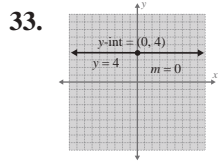
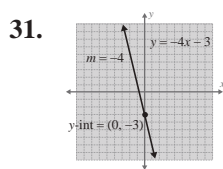
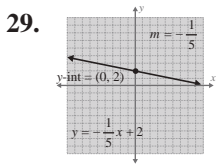
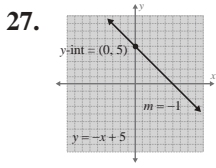
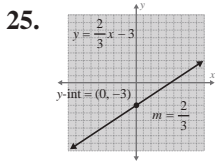
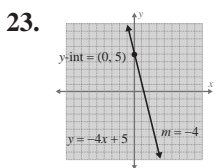
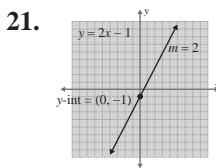
Vertical line;  $m$  is undefined



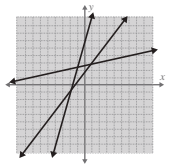
Horizontal line;  $m = 0$



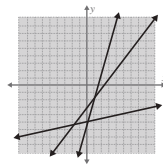
Vertical line;  $m$  is undefined



49. Answers will vary.



51. Answers will vary.



53.  $y = -\frac{1}{2}x + 3$

55.  $y = \frac{2}{5}x - 3$

57.  $y = 4x - 5$

59.  $y = x - 4$

61.  $y = -\frac{5}{6}x - 3$

63. a.  $m = -\frac{1}{6}$  b.  $(0, \frac{5}{2})$

c.  $y = -\frac{1}{6}x + \frac{5}{2}$

65. a.  $m = 0$  b.  $(0, -6)$

c.  $y = -6$

67. a.  $m = \frac{1}{2}$  b.  $(0, -3)$

c.  $y = \frac{1}{2}x - 3$

69. a.  $m = -\frac{1}{3}$  b.  $(0, 2)$

c.  $y = -\frac{1}{3}x + 2$

71. Yes 73. No

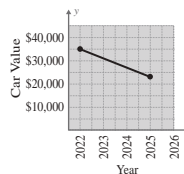
75. Yes

Applications

77.  $\frac{3}{4}$  79.  $\frac{11}{10}$

81. 54 mph

83. \$4000/year

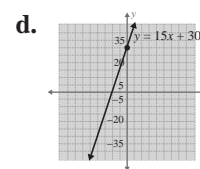


85. -5.66

87. a. Slope is \$15; Units are dollars and paintings

b.  $(0, 30)$

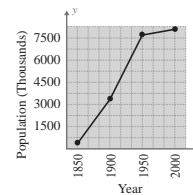
c.  $y = 15x + 30$



d. Answers will vary.  $x$  cannot be negative since you can't sell a negative number of paintings.

f. \$90

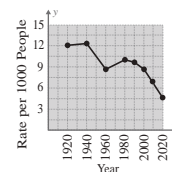
89. a. and b.



c. 58,433.1; 89,095.1; 2326.42

d. The population of New York increased by 58,433 people/year from 1850–1900; 89,095 ppy from 1900–1950; and 2326 ppy from 1950–2000.

91. a. and b.



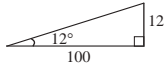
c. -0.18, 0.075, -0.02, -0.13, -0.17, -0.17

d. # of marriages decreased 0.18 marriages/1000 people from '40–'60, increased 0.075 marriages/1000 people from '60–'80, decreased 0.02 marriages/1000 people from '80–'90, decreased 0.13 marriages/1000 people from '90–'00,

decreased 0.17 marriages/1000 people from '00-'10, and decreased 0.17 marriages/1000 people per year from '10-'20.

Writing & Thinking

- 93. a. The  $x$ -axis  
b. The  $y$ -axis
- 95. A grade of 12% means that the slope of the road is 0.12. For every 100 feet of horizontal distance (run) there is a vertical distance (rise) of 12 feet.



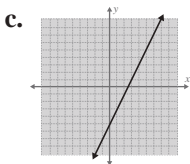
4.4 Exercises

Concept Check

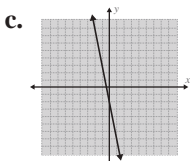
- 1. negative reciprocals
- 3. same      5. slope
- 7. True      9. True

Practice

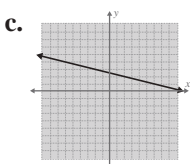
- 1. a.  $m = 2$     b.  $(3,1)$



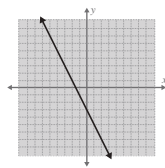
- 3. a.  $m = -5$     b.  $(0,-2)$



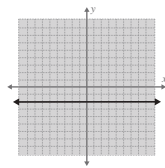
- 5. a.  $m = -\frac{1}{4}$     b.  $(-2,3)$



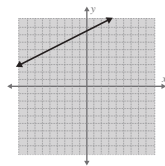
7.  $2x + y = -3$



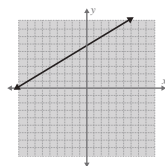
9.  $y = -2$



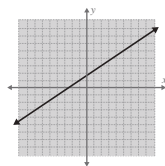
11.  $x - 2y = -15$



13.  $3x - 5y = -29$



15.  $2x - 3y = -5$



17.  $y = \frac{1}{2}x + \frac{9}{2}$

19.  $y = -\frac{1}{7}x + \frac{2}{7}$

21.  $y = -\frac{5}{4}x + 2$

23.  $y = -5$

25.  $y = -x + 4$

27.  $x - y = 1$

29.  $3x + y = 2$

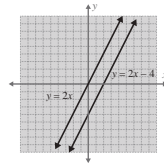
31.  $3x - 4y = -14$

33.  $7x + 3y = -5$

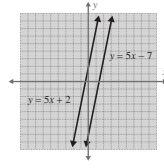
35.  $y = 6$       37.  $y = 7$

39.  $y = 7$

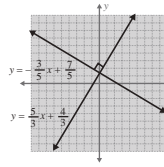
41.  $y = 2x$



43.  $y = 5x + 2$

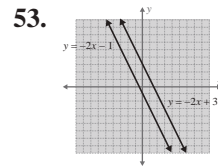
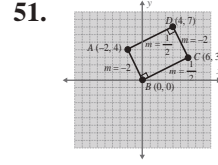


45.  $y = -\frac{3}{5}x + \frac{7}{5}$

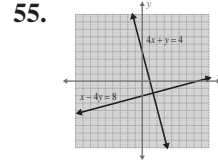


47.  $y = -\frac{1}{3}x$

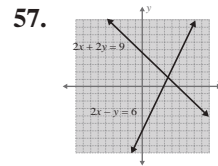
49.  $y = -\frac{1}{2}x - 2$



Parallel



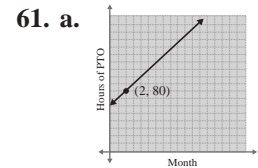
Perpendicular



Neither

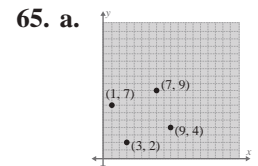
Applications

- 59. a.  $P = 100t - 5000$   
b. 50 tickets



b.  $y - 80 = 10(x - 2)$

- 63. a.  $f = 5 + 2m$     b. \$35



b. Top:  $m = \frac{1}{3}$ ;

Bottom:  $m = \frac{1}{3}$ ;

Left:  $m = -\frac{5}{2}$

Right:  $m = -\frac{5}{2}$

- c. Top is parallel with bottom, left is parallel with right.

d. No

e. Parallelogram

4.5 Exercises

Concept Check

- 1. function
- 3. domain
- 5. domain
- 7. True
- 9. True

Practice

1.  $\left\{ (-4, 0), (-1, 4), (1, 2), (2, 5), (6, -3) \right\}$ ;

$D = \{-4, -1, 1, 2, 6\}$ ;

$R = \{-3, 0, 2, 4, 5\}$ ;

Function

3.  $\left\{(-5, -4), (-4, -2), (-2, -2), (1, -2), (2, 1)\right\}$ ;

$D = \{-5, -4, -2, 1, 2\}$ ;

$R = \{-4, -2, 1\}$ ;

Function

5.  $\left\{(-4, -3), (-4, 1), (-1, -1), (-1, 3), (3, -4)\right\}$ ;

$D = \{-4, -1, 3\}$ ;

$R = \{-4, -3, -1, 1, 3\}$ ;

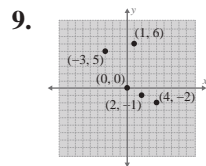
Not a function

7.  $\left\{(-5, -5), (-5, 3), (0, 5), (1, -2), (1, 2)\right\}$ ;

$D = \{-5, 0, 1\}$ ;

$R = \{-5, -2, 2, 3, 5\}$ ;

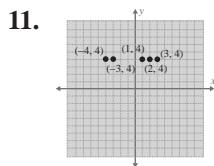
Not a function



$D = \{-3, 0, 1, 2, 4\}$ ;

$R = \{-2, -1, 0, 5, 6\}$ ;

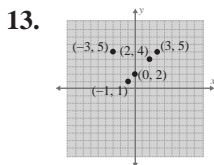
Function



$D = \{-4, -3, 1, 2, 3\}$ ;

$R = \{4\}$ ;

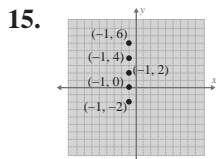
Function



$D = \{-3, -1, 0, 2, 3\}$ ;

$R = \{1, 2, 4, 5\}$ ;

Function



$D = \{-1\}$ ;

$R = \{-2, 0, 2, 4, 6\}$ ;

Not a function

17. Function;

$D = (-\infty, \infty)$ ;

$R = [0, \infty)$

19. Function;

$D = (-\infty, \infty)$ ;

$R = (-\infty, \infty)$

21. Not a function;

$D = (-\infty, \infty)$ ;

$R = (-\infty, \infty)$

23. Not a function;

$D = (-\infty, \infty)$ ;

$R = (-\infty, \infty)$

25. Function;

$D = [-5, 5]$ ;

$R = [-2, 2]$

27. Not a function;

$D = \{-3\}$ ;

$R = (-\infty, \infty)$

29.  $\left\{(-9, -26), \left(-\frac{1}{3}, 0\right), (0, 1), \left(\frac{4}{3}, 5\right), (2, 7)\right\}$

31.  $\left\{(-2, -11), (-1, -2), (0, 1), (1, -2), (2, -11)\right\}$

33.  $D = (-\infty, \infty)$

35.  $D = (-\infty, 0) \cup (0, \infty)$   
or  $x \neq 0$

37.  $D = (-\infty, 3) \cup (3, \infty)$   
or  $x \neq 3$

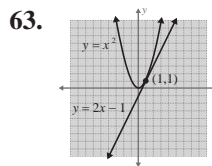
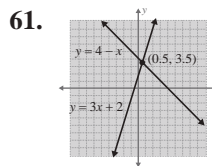
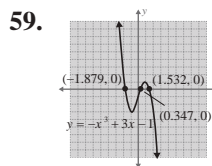
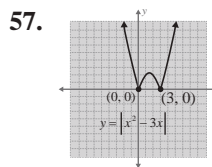
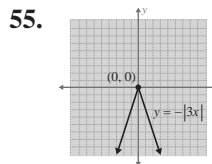
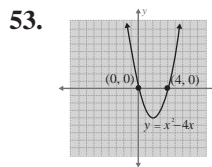
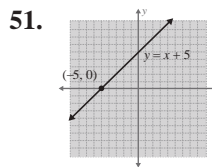
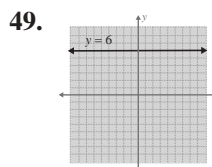
39. a. -4 b. -16 c. -10

41. a. 0 b. 12 c. 56

43. a. -3 b. 0 c. 3

45.  $f(1) = 3$

47.  $f(4) = 0$



65. y-intercept =  $(0, -5)$   
(should be  $(0, 5)$ )

67. y-intercept =  $(0, -8)$   
(should be  $(0, -2)$ )

69. Slope =  $-3$  (should be the reciprocal,  $-\frac{1}{3}$ ) and y-intercept =  $(0, 2)$  (should be  $(0, 0)$ )

Applications

71. a.  $(0, 250)$ , represents Ariella's base weekly salary

b. 0.15; Represents the commission rate

c.  $y = 0.15x + 250$

d.  $f(x) = 0.15x + 250$

e. Domain is all real numbers; Range is all real numbers

f. Answers will vary. Some students may say sales cannot be negative, some will allow negative sales due to returns.

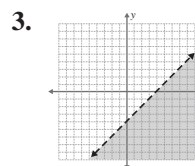
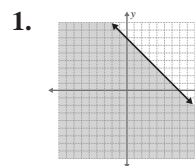
g. \$1000

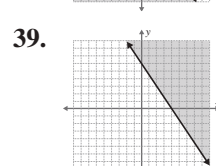
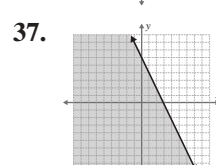
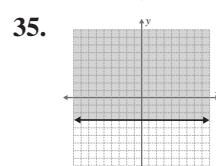
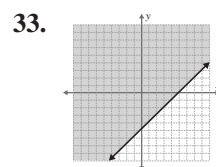
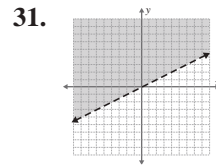
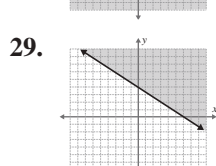
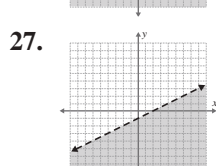
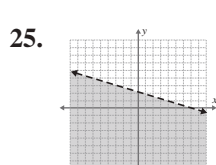
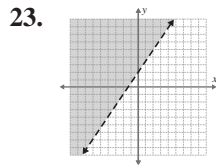
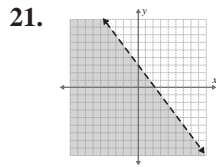
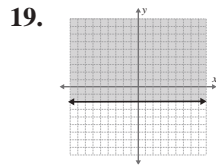
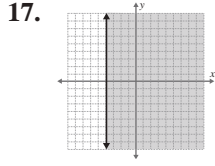
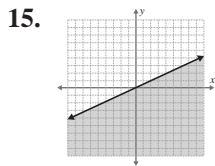
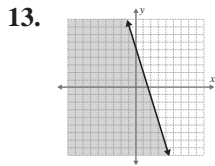
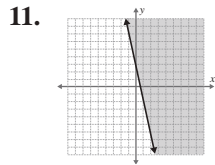
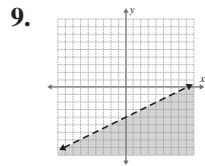
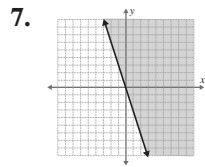
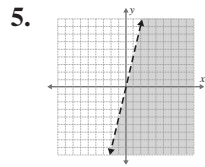
4.6 Exercises

Concept Check

- test
- open
- closed
- True
- False; The boundary line is solid if the inequality uses  $\leq$  or  $\geq$ .

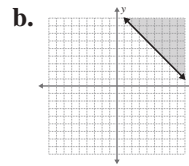
Practice





Applications

41. a.  $x + y \geq 75$



c. No;  $67 < 75$

d. Answers will vary; Any points with  $x$  or  $y < 0$  or  $> 50$ .

43. a.

Domain, $d$	Range, $m$
1	$\frac{23}{10}$
2	$\frac{13}{5}$
3	$\frac{29}{10}$
4	$\frac{16}{5}$
5	$\frac{7}{2}$
6	$\frac{19}{5}$
7	$\frac{41}{10}$

b. 6.2

Writing & Thinking

45. A closed half-plane includes points on the line and is symbolized by a solid boundary line. An open half-plane does not include points on the line and is symbolized by a dashed boundary line.

## Chapter 5: Systems of Linear Equations

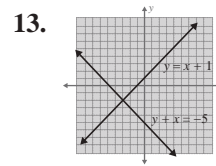
### 5.1 Exercises

Concept Check

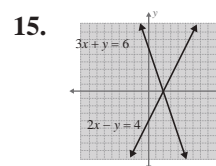
- simultaneous
- same
- one
- False; The solution must be checked in all equations.
- True

Practice

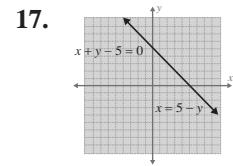
- c
- a, c
- (0, 2)
- (4, 2)
- $m_1 = -2, b_1 = 3,$   
 $m_2 = -2, b_2 = \frac{5}{2}$
- $m_1 = \frac{1}{2}, b_1 = 3,$   
 $m_2 = \frac{1}{2}, b_2 = -\frac{1}{2}$



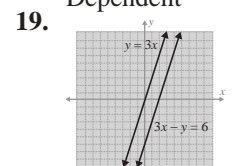
(-3, -2); Consistent; Independent



(2, 0); Consistent; Independent

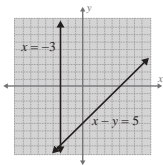


(x, -x + 5); Consistent; Dependent

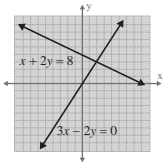


No solution; Inconsistent; Independent

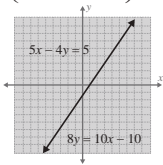
21.  $(-3, -8)$



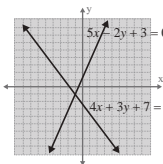
23.  $(2, 3)$



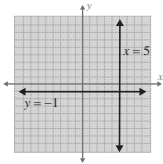
25.  $(x, \frac{5}{4}x - \frac{5}{4})$



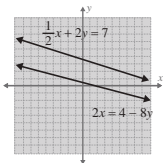
27.  $(-1, -1)$



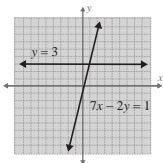
29.  $(5, -1)$



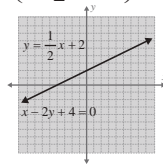
31. No solution



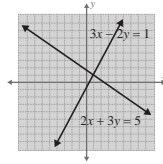
33.  $(1, 3)$



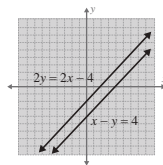
35.  $(x, \frac{1}{2}x + 2)$



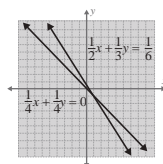
37.  $(1, 1)$



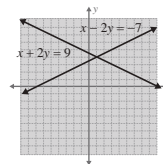
39. No solution



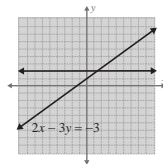
41.  $(1, -1)$



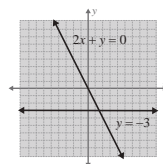
43.  $(1, 4)$



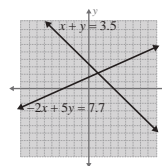
45.  $(1.5, 2)$



47.  $(1.5, -3)$

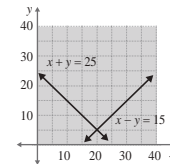


49.  $(1.4, 2.1)$



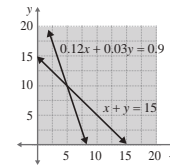
Applications

51.



$(20, 5)$

53.



5 gallons of 12%;  
10 gallons of 3%

55. 134 hours

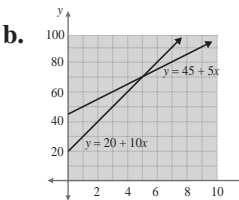
57. a. Fit4life:

$y = 20 + 10x$ ;

Workout Nation:

$y = 45 + 5x$

b.



c.  $(5, 70)$

d. The gym

memberships will  
cost the same amount  
per month if 5 classes  
are taken.

e. Workout Nation

Writing & Thinking

59. The solution to a  
consistent system of  
linear equations is a  
single point, which is  
easily written as an  
ordered pair.

5.2 Exercises

Concept Check

1. variables
3. no
5. back substitution
7. True
9. True

Practice

1.  $(2, 4)$
3.  $(x, 3x - 7)$
5.  $(-6, -2)$
7.  $(4, 1)$
9. No solution
11.  $(3, 2)$
13.  $(4, -5)$
15.  $(3, -2)$
17.  $(2, \frac{5}{2})$

19.  $(\frac{1}{2}, -4)$

21.  $(\frac{7}{2}, -\frac{1}{2})$

23.  $(x, 2 - 3x)$

25.  $(-2, 1)$

27.  $(-\frac{4}{5}, -\frac{7}{5})$

29.  $(\frac{11}{7}, \frac{8}{7})$

31.  $(x, \frac{1}{6}x + \frac{10}{3})$

33.  $(3, 3)$

35.  $(10, 20)$

37. No solution

39.  $(x, -\frac{3}{2}x + 12)$

41.  $(2, \frac{5}{3})$

Applications

43.  $(20, 5)$
45. 5 gallons of 12%;  
10 gallons of 3%
47. 3 months

49. a.  $\begin{cases} c = 45 + 0.15t \\ c = 55 + 0.10t \end{cases}$   
 b.  $t = 200, c = 75$   
 c. The gifts will both cost \$75 when the engraved message contains 200 letters.  
 d. More than 200 letters

Writing & Thinking

51. Answers will vary.

5.3 Exercises

Concept Check

1. eliminate
3. standard
5. combining
7. False; The solution always needs to be checked in both original equations.
9. False; Both methods give exact solutions.

Practice

1. (4, 3)
3.  $\left(1, -\frac{3}{2}\right)$
5. No solution
7.  $(x, 3 - x)$
9.  $(-2, -3)$
11. (7, 5)
13. (1, -5)
15.  $\left(x, \frac{1}{2}x - 2\right)$
17.  $\left(\frac{22}{7}, -\frac{2}{7}\right)$
19. (2, -2)
21.  $(x, 2x - 4)$
23. (2, -1)
25. (5, -6)
27. (3, -1)
29. (2, 4)

31. (-6, 2)
33. No solution
35. (20, 10)
37.  $\left(2, \frac{10}{9}\right)$
39. No solution
41.  $\left(-\frac{45}{7}, \frac{92}{7}\right)$
43.  $y = 5x - 7; m = 5, b = -7$
45.  $y = -3; m = 0, b = -3$
47.  $y = \frac{1}{2}x + \frac{3}{2}; m = \frac{1}{2}, b = \frac{3}{2}$

Applications

49.  $y = 25x + 50$
51. \$4000 at 10%; \$6000 at 6%
53. 40 liters of 30% solution ( $x$ ), 60 liters of 40% solution ( $y$ )
55. a.  $\begin{cases} y = 3500 + 1.5x \\ y = 1000 + 2x \end{cases}$   
 b.  $x = 5000, y = 11,000$   
 c. The cards will earn the same amount of rewards points if you spend \$5000.  
 d. City

Writing & Thinking

57. Answers will vary.

5.4 Exercises

Practice

1. 23, 33
3. 15, 21
5. 37, 50

Applications

7.  $80^\circ, 100^\circ$
9.  $55^\circ, 55^\circ, 70^\circ$

11. The rate of the boat is 10 mph and the rate of the current is 2 mph.
13. Bolt's speed was 10.32 meters per second and the wind speed was 0.12 meters per second.
15. He traveled  $1\frac{1}{2}$  hours at 52 mph and 2 hours at 56 mph.
17. Marcos traveled at 40 mph and Cana traveled at 51 mph.
19. Steve traveled at 28 mph and Tim traveled at 7 mph.
21. The westbound train was traveling 45 mph and the eastbound train was traveling 40 mph.
23. He jogged 12 miles.
25. 20 nickels and 10 dimes
27. 52 nickels and 130 pennies
29. 800 adults and 2700 children attended.
31.  $l = 14$  meters;  $w = 8$  meters
33. 100 yards  $\times$  45 yards
35.  $l = 33$  meters;  $w = 17$  meters
37. Priscilla was 21 years old and Elvis was 32 years old.
39. She bought 10 paperbacks and 5 hardbacks.
41. 5000 general admission and 7500 reserved tickets were sold.
43. 22 at \$625 and 25 at \$550
45. 30 dozen (360 balls)
47. The store sold 22 of the \$95 jackets and 18 of the \$120 jackets.
49. One Big Mac costs \$4.11 and one order of medium French fries costs \$1.84.
51. They will produce 7 of Model X and 10 of Model Y.
53. a.  $\begin{cases} 5c + 10a = 1400 \\ c + a = 200 \end{cases}$   
 b.  $c = 120, a = 80$   
 c. 120 children and 80 adults visited the petting zoo on Tuesday.

Writing & Thinking

55. The number is 49.

5.5 Exercises

Concept Check

1. payment, interest
3. paid or earned
5. time
7. False; When interest is calculated on an annual basis,  $t = 1$ .
9. True

Applications

1. \$5500 at 6%; \$3500 at 10%
3. \$7400 at 5.5%; \$2600 at 6%
5. \$450
7. \$3500 in each or \$7000 total
9. \$20,000 at 24%; \$11,000 at 18%
11. \$800 at 5%; \$2100 at 7%
13. \$8500 at 9%; \$3500 at 11%
15. \$87,000 in bonds; \$37,000 in certificates
17. 20 pounds of 20%; 30 pounds of 70%

- 19. 20 ounces of 30%;  
30 ounces of 20%
- 21. 450 pounds of 35%;  
1350 pounds of 15%
- 23. 20 pounds of 40%;  
30 pounds of 15%
- 25. 10 g of pure acid;  
20 g of the 40% solution
- 27. 10 oz of salt;  
50 oz of the 4% solution
- 29. 2 lb of 72%; 4 lb of 42%
- 31. 7.11 ounces of 0.5% solution;  
0.89 ounces of the 5% solution

33. a. 
$$\begin{cases} x + y = 5000 \\ 0.04x + 0.09y = 350 \end{cases}$$

Account	Principal	Interest Rate	=	Interest
Account A	$x$	0.04		$0.04x$
Account B	$y$	0.09		$0.09y$
Totals	\$5000	N/A		\$350

- b.  $x = 2000, y = 3000$
- c. Sanjay should invest \$2000 in Account A and \$3000 in Account B to earn \$350 in interest.
- d. Yes; Invest more in Account B.
- 35. a.  $5x + 7.50y = 6.50;$   
 $x + y = 1$
- b.  $x = 0.4, y = 0.6$
- c. The manager should mix 0.4 pounds of cashews with 0.6 pounds of almonds to create a mixture which will cost \$6.50 for a one-pound bag.

**5.6 Exercises**

**Concept Check**

1.  $Ax + By + Cz = D$

- 3. infinite
- 5. octants
- 7. False; Choose 2 equations, eliminate 1 variable.
- 9. True

**Practice**

- 1.  $(1, 0, 1)$
- 3.  $(1, 2, -1)$
- 5. Infinite number of solutions
- 7.  $(4, 1, 1)$
- 9.  $(1, 2, -1)$
- 11.  $(-2, 3, 1)$
- 13. No solution
- 15.  $(3, -1, 2)$
- 17.  $(2, 1, -3)$
- 19.  $(\frac{1}{2}, \frac{1}{3}, -1)$

**Applications**

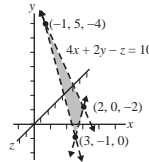
- 21. a. 
$$\begin{cases} x + y + z = 16 \\ 10x + 6y + 4z = 92 \\ x + y = z \end{cases}$$
- b.  $(3, 5, 8)$
- c. Each bouquet will have 3 lilies, 5 roses, and 8 daisies.
- 23. 34, 6, 27
- 25. 18 ones, 16 fives, 12 tens
- 27. 19 cm, 24 cm, 30 cm
- 29. Bananas: \$0.60/lb;  
Apples: \$1.60/lb;  
Grapes: \$3.60/lb
- 31. Savings: \$30,000;  
Bonds: \$55,000;  
Stocks: \$15,000
- 33. 3 liters of 10%,  
4.5 liters of 30%,  
1.5 liters of 40%

**Writing & Thinking**

- 35. No. Graphically, the three planes intersect

at one point (one solution), or in a line (infinitely many solutions) or, they do not have a common intersection (no solution).

37.  $A = 4, B = 2, C = -1$



**5.7 Exercises**

**Concept Check**

- 1. matrix, matrices
- 3. dimension
- 5. augmented
- 7. False; A matrix that has 3 rows and 5 columns is a  $3 \times 5$  matrix.
- 9. False; Interchanging two equations in a system of linear equations will not change the solution.

**Practice**

- 1.  $\begin{bmatrix} 2 & 2 \\ 5 & -1 \end{bmatrix}, \begin{bmatrix} 2 & 2 & | & 13 \\ 5 & -1 & | & 10 \end{bmatrix}$
- 3.  $\begin{bmatrix} 7 & -2 & 7 \\ -5 & 3 & 0 \\ 0 & 4 & 11 \end{bmatrix}, \begin{bmatrix} 7 & -2 & 7 & | & 2 \\ -5 & 3 & 0 & | & 2 \\ 0 & 4 & 11 & | & 8 \end{bmatrix}$
- 5.  $\begin{bmatrix} 3 & 1 & -1 & 2 \\ 1 & -1 & 2 & -1 \\ 0 & 2 & 5 & 1 \\ 1 & 3 & 0 & 3 \end{bmatrix}, \begin{bmatrix} 3 & 1 & -1 & 2 & | & 6 \\ 1 & -1 & 2 & -1 & | & -8 \\ 0 & 2 & 5 & 1 & | & 2 \\ 1 & 3 & 0 & 3 & | & 14 \end{bmatrix}$
- 7. 
$$\begin{cases} -3x + 5y = 1 \\ -x + 3y = 2 \end{cases}$$

9. 
$$\begin{cases} x + 3y + 4z = 1 \\ 2x - 3y - 2z = 0 \\ x + y = -4 \end{cases}$$

11. a.  $\begin{bmatrix} -1 & 7 \\ 1 & 4 \end{bmatrix}$   
b.  $\begin{bmatrix} 1 & 4 \\ 2 & -14 \end{bmatrix}$

13. a.  $\begin{bmatrix} 1 & 3 & 7 \\ 4 & -1 & 6 \\ -8 & -2 & 5 \end{bmatrix}$

b.  $\begin{bmatrix} 1 & 3 & 7 \\ -16 & 0 & -7 \\ 4 & -1 & 6 \end{bmatrix}$

- 15.  $(-1, 2)$
- 17.  $(-1, -1)$
- 19.  $(-1, -2, 3)$
- 21.  $(1, 0, 1)$
- 23.  $(2, 1, -1)$
- 25.  $(-2, 9, 1)$
- 27. No solution
- 29. Infinite number of solutions
- 31.  $(1, -3, 2)$
- 33.  $(0, -4)$
- 35.  $(2, 1, 7)$
- 37.  $(2, -3, 4)$
- 39.  $(\frac{13}{12}, \frac{5}{4}, \frac{8}{3})$

**Applications**

- 41. 52, 40, 77
- 43. Bacon: \$3.09/lb;  
Eggs: \$4.03/doz;  
Bread: \$1.40/loaf
- 45. a. 
$$\begin{cases} u + c = 12 \\ 2500u + 625c = 13,125 \end{cases}$$
- b. 
$$\begin{bmatrix} 1 & 1 & | & 12 \\ 2500 & 625 & | & 13,125 \end{bmatrix}$$
- c. University: 3,  
Community College: 9

Writing & Thinking

47. Solving the second equation for  $z$ , we can back substitute into the first equation, eliminating  $z$ . The result is the equation  $x + 5y = 6$ , which means the system has an infinite number of solutions.

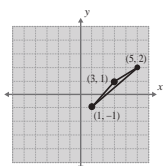
5.8 Exercises

Concept Check

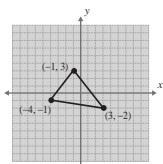
1. square
3. real-number
5. +1, -1
7. True

Practice

1. -22      3. 11
5. 3      7. 47
9.  $\begin{vmatrix} -5 & 9 \\ 0 & -7 \end{vmatrix}$
11.  $\begin{vmatrix} 3 & 9 \\ 2 & -7 \end{vmatrix}$
13. 36      15. -3
17. -4      19. -25
21. 20      23.  $x = 7$
25. -1      27. -2
29.  $x = 2$
31.  $x + 2y = 7$
33.  $5x + 2y = 12$
35.  $A = 1$



37.  $A = \frac{31}{2}$



39. -25

41. -33.28

Writing & Thinking

43. A straight line can be drawn through all three points.
45. 0; Answers may vary. If you expand by minors using a row of all zeros, each minor will be multiplied by zero resulting in a sum of zero.

5.9 Exercises

Concept Check

1. determinants
3. unique
5. True

Practice

1.  $x = 4, y = 3$
3.  $x = \frac{2}{3}, y = -\frac{1}{4}$
5. No solution
7.  $x = -\frac{1}{4}, y = \frac{3}{2}$
9.  $x = \frac{31}{17}, y = \frac{2}{17}$
11.  $x = \frac{39}{44}, y = \frac{41}{44}$
13.  $x = \frac{18}{7}, y = -\frac{3}{7}$
15.  $x = -\frac{7}{61}, y = \frac{266}{183}$
17.  $x = \frac{210}{41}, y = -\frac{40}{123}$
19.  $x = \frac{525}{124}, y = \frac{109}{93}$
21.  $x = -2, y = 1, z = 3$
23. No solution
25.  $x = 4, y = 2, z = 6$
27. Infinite solutions
29.  $x = -\frac{2}{3}, y = \frac{11}{3}, z = 2$

Applications

31.  $\begin{cases} x + y + z = 43 \\ 5 + 2x = y \\ x + y - 3 = z \end{cases}$   
6 feet, 17 feet, 20 feet
33.  $\begin{cases} x + y = 6,000,000 \\ 0.02x + 0.04y = 170,000 \end{cases}$   
\$3,500,000 in mutual funds, \$2,500,000 in stocks

Writing & Thinking

35. Answers will vary. If  $D \neq 0$ , then it's possible the solution can be found faster.

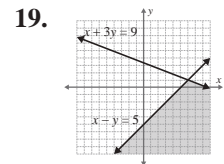
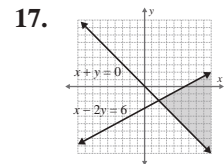
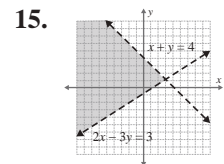
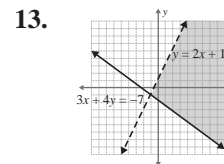
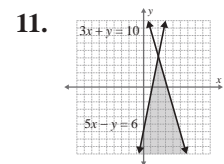
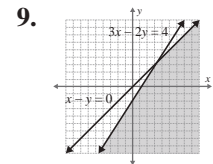
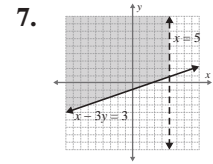
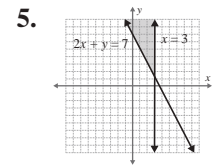
5.10 Exercises

Concept Check

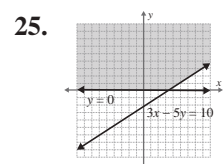
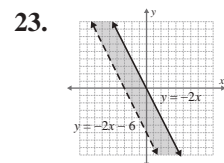
1. test-point
3. closed
5. three
7. False; When boundary lines are parallel, the solution is either the strip between the boundary lines, a half-plane, or there is no solution.
9. True

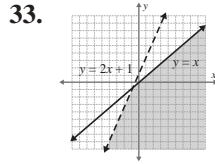
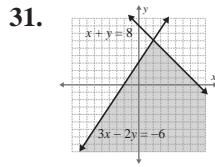
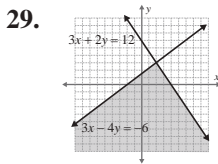
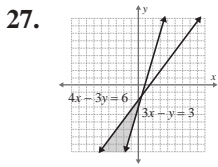
Practice

- 1.
- 3.



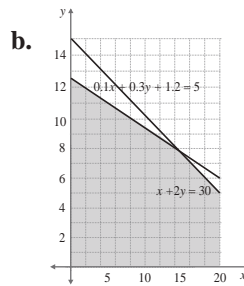
21. No solution





Applications

35. a. 
$$\begin{cases} 0.1x + 0.3y + 1.2 < 5 \\ x + 2y < 30 \end{cases}$$

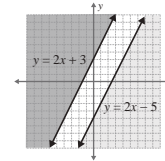


- c. Answers will vary.  
 d. Answers will vary.  
 For example, any negative values of  $x$  and  $y$  since

you cannot have a negative number of cookies.

Writing & Thinking

37. The solutions of the two inequalities do not overlap.



## Chapter 6: Exponents and Polynomials

### 6.1 Exercises

Concept Check

- subtract
- positive
- $a$
- False; If there is no exponent written, the exponent is assumed to be 1.
- True

Practice

- 27
- 512
- $\frac{1}{3}$
- $\frac{1}{25}$
- 16
- 24
- 500
- $\frac{3}{8}$
- $-\frac{3}{25}$
- $x^5$
- $y^2$
- $\frac{1}{x^3}$
- $\frac{2}{x}$
- $-\frac{8}{y^2}$
- $\frac{5x^6}{y^4}$
- 4
- 49
- $\frac{1}{10}$
- $\frac{1}{8}$
- $x^2$
- $x^2$
- $x^4$

- $\frac{1}{x^4}$
- $x^6$
- $x^2$
- $y^2$
- $3x^3$
- $x^4$
- $36x^3$
- $-14x^5$
- $-12x^6$
- $4y$
- $3y^2$
- $-2y^2$
- $\frac{1}{x^2}$
- 1000
- 1

- $-18x^5y^7$
- $-\frac{2y^2}{x}$
- $12a^3b^9c$
- $-4a^{10}b^3c$
- $\frac{5}{x}$
- 1
- 0.3906
- 8875.147264

Applications

- $2^8$  GB
- $10^{-24}$  cm<sup>3</sup>
- 1 delivery
- $3^9$  square yards
- a.  $(2x)^3$

- Product rule for exponents
- $8x^3$
- $64 \text{ cm}^3$
- $\frac{2^{38}}{230} = 28$  gigabytes
- 256 gigabytes
- Quotient rule

### 6.2 Exercises

Concept Check

- exponent(s)
- multiply, keep
- coefficient
- True
- True

Practice

- 81
- 16
- 1,000,000
- $a^6$
- $\frac{1}{x^{10}}$
- $\frac{1}{256}$
- $9y^2$
- $16x^2y^2$
- $\frac{1}{x^6y^6}$

- $36x^6$
- $-108x^6$
- $\frac{5x^2}{y}$
- $-\frac{2y^6}{27x^{15}}$
- $\frac{a^4}{b^4}$
- $\frac{4}{9}$
- $\frac{x^6}{y^6}$
- $\frac{27x^3}{y^3}$
- 1
- $4x^4y^4$
- $\frac{y^2}{x^2}$
- $\frac{1}{3xy^2}$
- $-\frac{x^3y^6}{27}$
- $m^2n^4$
- $-\frac{y^2}{49x^2}$
- $\frac{25x^6}{y^2}$
- $\frac{x^6}{y^6}$
- $\frac{36y^{14}}{x^4}$
- $\frac{49y^4}{x^6}$

- 57.  $\frac{24y^5}{x^7}$
- 59.  $\frac{4x^3}{3}$
- 61.  $\frac{16x^{13}}{243y^6}$
- 63.  $96x^2y^4z^4$
- 65. 19.4481
- 67. 208.5136x<sup>4</sup>
- 69. 22.7024

**6.3 Exercises**

Concept Check

- 1. 1, 10
- 3. decimal point
- 5. False; The decimal point should be moved 3 places to the left.
- 7. False; 4000 written in scientific notation is  $4.0 \times 10^3$ .

Practice

- 1.  $8.6 \times 10^4$
- 3.  $3.62 \times 10^{-2}$
- 5.  $1.83 \times 10^7$
- 7.  $2.368 \times 10^{-10}$
- 9.  $9 \times 10^{-7}$
- 11.  $3.28 \times 10^{-11}$
- 13. 0.042
- 15. 7,560,000
- 17. 0.00006132
- 19. 30,670,000,000
- 21. 7,205,000,000
- 23. 0.00000691
- 25.  $(3 \times 10^2)(1.5 \times 10^{-4}); 4.5 \times 10^{-2}$
- 27.  $(3 \times 10^{-4})(2.5 \times 10^{-6}); 7.5 \times 10^{-10}$

- 29.  $(2.34 \times 10^{10})(5.5 \times 10^9); 1.287 \times 10^{20}$
- 31.  $\frac{3.9 \times 10^3}{3 \times 10^{-3}}; 1.3 \times 10^6$
- 33.  $\frac{1.25 \times 10^2}{5 \times 10^4}; 2.5 \times 10^{-3}$
- 35.  $\frac{1.3 \times 10^{-12}}{2.6 \times 10^{-8}}; 5 \times 10^{-5}$
- 37.  $\frac{(8.4 \times 10^{-3})(3 \times 10^{-3})}{(2.1 \times 10^{-1})(6 \times 10)}; 2 \times 10^{-6}$

39. 
$$\frac{(5.4 \times 10^0)(3 \times 10^{-3})(5 \times 10)}{(1.5 \times 10)(2.7 \times 10^{-3})(2 \times 10^2)}; 1 \times 10^{-1}$$

41. 
$$\frac{(1.4 \times 10^{-2})(9.22 \times 10^2)}{(3.5 \times 10^3)(2.0 \times 10^6)};$$

43. 
$$\frac{(2.5 \times 10)(3.75 \times 10^{-5})}{(4 \times 10^{10})(7.5 \times 10^{-6})}; 3.125 \times 10^{-9}$$

45. 
$$\frac{(1.4 \times 10^{-7})(7 \times 10^{13})}{4 \times 10}; 2.45 \times 10^5$$

47. 
$$\frac{(1.95 \times 10^{-5})(2.65 \times 10^3)(7.56 \times 10^{10})}{(1.5 \times 10^7)(1.3 \times 10^{-13})}; 2.0034 \times 10^{15}$$

- 49. 3E8
- 51. 8.5E7
- 53. 3E22
- 55. 1.6051E15
- 57. 1E2
- 59. 1.02E22

Applications

- 61.  $1.67 \times 10^{-24}$  grams
- 63. 60,000,000,000,000 cells

- 65.  $5.98 \times 10^{27}$  grams
- 67.  $4.0678 \times 10^{16}$  m
- 69.  $6.5 \times 10^{-19}$  grams
- 71.  $2.592 \times 10^6$  seconds
- 73. No. Should be  $5.2 \times 10^5$

**6.4 Exercises**

Concept Check

- 1. descending
- 3. leading
- 5. binomial
- 7. False; Degree of 0
- 9. True

Practice

- 1. Monomial
- 3. Binomial
- 5. Trinomial
- 7. Not a polynomial
- 9. Binomial
- 11. 4y; First-degree monomial; Leading coefficient 4
- 13.  $x^3 + 3x^2 - 2x$ ; Third-degree trinomial; Leading coefficient 1
- 15.  $-2x^2$ ; Second-degree monomial; Leading coefficient -2
- 17. 0; Monomial of no degree; Leading coefficient 0
- 19.  $6a^5 - 7a^3 - a^2$ ; Fifth-degree trinomial; Leading coefficient 6
- 21.  $2y^3 + 4y$ ; Third-degree binomial; Leading coefficient 2
- 23. 4; Monomial of degree 0; Leading coefficient 4
- 25.  $2x^3 + 3x^2 - x + 1$ ; Third-degree polynomial; Leading coefficient 2

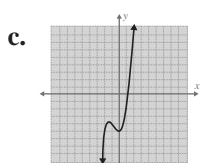
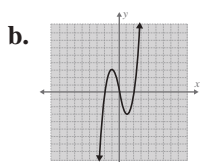
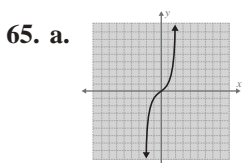
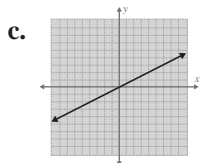
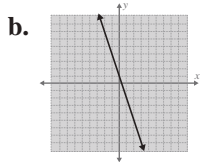
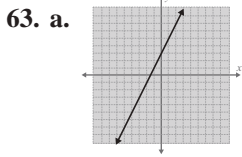
- 27.  $4x^4 - x^2 + 4x - 10$ ; Fourth-degree polynomial; Leading coefficient 4
- 29.  $9x^3 + 4x^2 + 8x$ ; Third-degree trinomial; Leading coefficient 9
- 31. a. -4 b. -16 c. -10
- 33. -16
- 35. -41
- 37. 4379
- 39. 13
- 41. -28
- 43.  $3a^4 + 5a^3 - 8a^2 - 9a$
- 45.  $3a + 11$
- 47.  $10a + 25$

Applications

- 49. a. First degree polynomial
- b. 5 feet per second
- c. 50 feet per second
- d. 95 feet per second
- 51. a. First degree polynomial
- b. 9 games
- c. 11 games
- d. 29 games
- 53. a. \$20,250 b. \$16,000
- 55. a. 12 feet b. 28 feet c. 72 feet d. No. Answers will vary.
- 57. \$45,950 in 2020; \$24,950 in 2026
- 59. 61 after 4 hours; 250,122 after 2 days (48 hours)

Writing & Thinking

- 61. He was correct. The expression is a sum/difference of monomials.



**6.5 Exercises**

**Concept Check**

1. sign
3. like
5. variables
7. False; All terms are subtracted.
9. False; They are like terms because they have the same variable raised to the same exponent.

**Practice**

1.  $3x^2 + 7x + 2$
3.  $2x^2 + 11x - 7$
5.  $3x^2$

7.  $x^2 - 5x + 17$
9.  $-x^2 + 2x - 7$
11.  $2x^3 + 4x^2 - 3x - 7$
13.  $-x^2 + 7x - 3$
15.  $-x^3 + 2x^2 + 3x - 4$
17.  $4x^3 + 7$
19.  $2x^3 + 11x^2 - 4x - 3$
21.  $x^2 + x + 6$
23.  $-3x^2 - 6x - 2$
25.  $3x^2 - 4x - 8$
27.  $-x^4 - 2x^3 - 16$
29.  $-4x^4 - 7x^3 - 11x^2 + 5x + 13$
31.  $-4x^2 + 6x + 1$
33.  $3x^4 - 7x^3 + 3x^2 - 5x + 9$

35.  $6x^2 - 7x + 18$
37.  $8x^4 + 6x^2 + 15$
39.  $2x^3 + 4x^2 + 3x - 10$
41.  $4x - 13$
43.  $-7x + 9$
45.  $2x + 17$
47.  $3x^3 + 13x^2 + 9$
49.  $8x^2 - x - 2$
51.  $3x - 19$
53.  $x^2 - 2x + 13$
55.  $7x - 3$
57.  $4x^2 + 3x + 5$
59.  $7x - 18$
61.  $x^2 + 11x - 8$
63.  $7x^3 - x^2 - 7$

**Applications**

65. a.  $3.50x^3 + 4x^2 - 30$  dollars
- b.  $6.50x^3 + 4x^2 - 20$  dollars
- c. \$460
67. a.  $27x - 40$  dollars
- b. \$284

**Writing & Thinking**

69. Add the opposite of each term in the polynomial being subtracted to the original polynomial and combine like terms.

**6.6 Exercises**

**Concept Check**

1. distributive
3. FOIL
5. like
7. False; The product of  $(a + b)$  and  $(c + d)$  is  $ac + ad + bc + bd$ .

**Practice**

1.  $-6x^5 - 15x^3$
3.  $4x^7 - 12x^6 + 4x^5$
5.  $-y^5 + 8y - 2$
7.  $-4x^8 + 8x^7 - 12x^4$
9.  $25x^5 - 5x^4 + 10x^3$
11.  $a^7 + 2a^6 - 5a^3 + a^2$
13.  $x^2 + x - 12$
15.  $a^2 - 2a - 48$
17.  $x^2 - 3x + 2$
19.  $3t^2 - 3t - 60$
21.  $x^3 + 11x^2 + 24x$
23.  $2x^2 - 7x - 4$
25.  $6x^2 + 17x - 3$
27.  $4x^2 - 9$
29.  $16x^2 + 8x + 1$
31.  $y^3 + 2y^2 + y + 12$
33.  $3x^2 - 8x - 35$
35.  $5x^3 + 6x^2 - 22x - 9$
37.  $2x^4 + 7x^3 + 5x^2 + x - 15$
39.  $3x^2 + 2x - 8$
41.  $2x^2 + 3x - 5$
43.  $7x^2 - 13x - 2$
45.  $6x^2 - 13x - 8$
47.  $4x^2 + 12x + 9$

49.  $x^3 + 3x^2 - 4x - 12$

51.  $4x^2 - 49$

53.  $x^3 + 1$

55.  $49a^2 - 28a + 4$

57.  $x^3 + 8x^2 + 15x$

59.  $6x^3 - 2x^2 - 4x$

61.  $2x^3 + x^2 - 5x - 3$

63.  $x^3 + 6x^2 + 11x + 6$

65.  $a^4 - a^2 + 2a - 1$

67.  $t^4 + 6t^3 + 13t^2 + 12t + 4$

69.  $6x^2 - x - 2$

71.  $9a^2 - 25$

73.  $-10x^2 + 39x - 14$

75.  $x^3 + 5x^2 + 8x + 4$

77.  $2y^2 - 61$

79.  $3a^2 - 17a + 11$

81.  $-3x - 21$

83.  $a^2 + 9a - 1$

**Applications**

85.  $6x^2 + 15x$  square inches

87.  $R(x) = -8x^2 + 70x + 1500$

89. a.  $A(x) = 280 - 4x^2$

b.  $14 - 2x$  and  $20 - 2x$

c.  $B(x) = 4x^2 - 68x + 280$

d.  $V(x) = 4x^3 - 68x^2 + 280x$

**Writing & Thinking**

91. a. Answers will vary.
- b. Answers will vary.

**6.7 Exercises**

**Concept Check**

1. difference
3. trinomial
5. False; The product will be a binomial.
7. True

Practice

1.  $x^2 - 14x + 49$ ;  
Perfect square trinomial
3.  $x^2 + 8x + 16$ ;  
Perfect square trinomial
5.  $x^2 - 9$ ;  
Difference of two squares
7.  $x^2 - 81$ ;  
Difference of two squares
9.  $2x^2 + x - 3$
11.  $9x^2 - 24x + 16$ ;  
Perfect square trinomial
13.  $25x^2 - 4$ ;  
Difference of two squares
15.  $9x^2 - 12x + 4$ ;  
Perfect square trinomial
17.  $x^2 - 16x + 64$ ;  
Perfect square trinomial
19.  $16x^2 - 25$ ;  
Difference of two squares
21.  $25x^2 - 81$ ;  
Difference of two squares
23.  $x^2 - 8x + 16$ ;  
Perfect square trinomial
25.  $4x^2 - 49$ ;  
Difference of two squares
27.  $10x^4 - 11x^2 - 6$
29.  $49x^2 + 14x + 1$ ;  
Perfect square trinomial
31.  $x^2 + 10x + 25$
33.  $x^4 - 1$
35.  $x^4 + 6x^2 + 9$
37.  $x^6 - 4x^3 + 4$
39.  $9x^2 - 4$
41.  $16x^2 - 9$
43.  $25x^2 + 30x + 9$
45.  $36x^2 - 60x + 25$
47.  $x^2 - 1.96$

49.  $x^2 - 5x + 6.25$
51.  $x^2 - 4.6225$
53.  $x^2 + 2.48x + 1.5376$
55.  $2.0164x^2 + 27.264x + 92.16$
57.  $129.96x^2 - 12.25$
59.  $93.24x^2 + 142.46x - 104.04$

Applications

61. a.  $A(x) = 900 - 4x^2$   
b.  $P(x) = 4(30 - 2x) + 8x = 120$
63. a.  $f(x) = 15x^6 - 30x^5 + 15x^4$   
b. 0.234375
65. a.  $A(x) = 150 - 4x^2$   
b.  $P(x) = 2(15 - 2x) + 2(10 - 2x) + 8x = 50$
- c.  $V(x) = (10 - 2x)(15 - 2x)x = 4x^3 - 50x^2 + 150x$
67. a.  $A(x) = 400 - 4x^2$   
b.  $20 - 2x$  and  $20 - 2x$   
c.  $B(x) = 400 - 80x + 4x^2$   
d.  $V(x) = 400x - 80x^2 + 4x^3$

6.8 Exercises

Concept Check

1. rational
3. numerator, simplify
5. 0
7. False; Descending order
9. True

Practice

1.  $y^2 - 2y + 3$
3.  $2x^2 - 3x + 1$
5.  $10x^3 - 11x^2 + x$

7.  $-4x^2 + 7x - \frac{5}{2}$
9.  $y^3 - \frac{7}{2}y^2 - \frac{15}{2}y + 4$
11.  $x - 6 + \frac{4}{x + 4}$
13.  $3x - 4 - \frac{7}{2x - 1}$
15.  $3x + 4 + \frac{1}{7x - 1}$

17.  $x - 9$
19.  $x^2 - x - \frac{3}{x - 8}$
21.  $4x^2 - 6x + 9 - \frac{17}{x + 2}$
23.  $x^2 + 7x + 55 + \frac{388}{x - 7}$
25.  $2x^2 - 9x + 18 - \frac{30}{x + 2}$
27.  $7x^2 + 2x + 1$
29.  $x^2 + 2x + 2 - \frac{12}{2x + 3}$
31.  $x^2 + 3x + 2 - \frac{2}{x - 4}$
33.  $2x^2 + x - 3 + \frac{18}{5x + 3}$
35.  $2x^2 - 8x + 25 - \frac{98}{x + 4}$
37.  $3x^2 + 2x - 5 - \frac{1}{3x - 2}$

39.  $3x^2 - 2x + 5$
41.  $x^3 + 2x + 5 + \frac{17}{x - 3}$
43.  $x^3 + 2x^2 + 6x + 9 + \frac{23}{x - 2}$
45.  $x^3 + \frac{1}{2}x^2 - \frac{3}{4}x - \frac{3}{8} + \frac{45}{16\left(x - \frac{1}{2}\right)}$
47.  $3x + 5 + \frac{x - 1}{x^2 + 2}$

49.  $x^2 + x - 4 + \frac{-8x + 17}{x^2 + 4}$
51.  $2x + 3 + \frac{6}{3x^2 - 2x - 1}$

53.  $3x^2 - 10x + 12 + \frac{-x - 14}{x^2 + x + 1}$
55.  $x^2 - 2x + 7 + \frac{-17x + 14}{x^2 + 2x - 3}$
57.  $x^2 + 3x + 9$
59.  $x^5 - x^4 + x^3 - x^2 + x - 1$
61.  $x^4 + x^3 + x^2 + x + 1 + \frac{2}{x - 1}$
63.  $x^4 - \frac{1}{2}x^3 - \frac{3}{4}x^2 + \frac{3}{8}x + \frac{13}{16} - \frac{13}{32\left(x + \frac{1}{2}\right)}$

Applications

65. a.  $x^2 - 4x - 5$  square inches  
b.  $x^2 - 3x - 10$  square inches

Writing & Thinking

67.  $3x^3 + 4x^2 + 8x + 12$ ; Multiply the divisor  $(3x - 2)$  by the quotient,  $x^2 + 2x + 4 + \frac{20}{3x - 2}$ , to get the original polynomial.

69. a. 19;  
 $2x^2 - 4x + 2 + \frac{19}{x - 2}$   
b.  $-5$ ;  
 $2x^2 - 10x + 20 - \frac{5}{x + 1}$   
c. 55;  
 $2x^2 + 10 + \frac{55}{x - 4}$   
Yes;  $R = P(a)$  when  $P(x)$  is divided by  $x - a$ .

6.9 Exercises

Concept Check

1. binomial

- 3. remainder
- 5. one
- 7. True
- 9. True

Practice

- 1. a.  $x - 9$   
b.  $c = 3; P(3) = 0$
- 3. a.  $x^2 - 4x + 33 - \frac{265}{x+8}$   
b.  $c = -8; P(-8) = -265$
- 5. a.  $4x^2 - 6x + 9 - \frac{17}{x+2}$   
b.  $c = -2; P(-2) = -17$
- 7. a.  $x^2 + 7x + 55 + \frac{388}{x-7}$   
b.  $c = 7; P(7) = 388$

- 9. a.  $2x^2 - 2x + 6 - \frac{27}{x+3}$   
b.  $c = -3; P(-3) = -27$
- 11. a.  $x^3 + 2x + 5 + \frac{17}{x-3}$   
b.  $c = 3; P(3) = 17$
- 13. a.  $x^3 + 2x^2 + 6x + 9 + \frac{23}{x-2}$   
b.  $c = 2; P(2) = 23$
- 15. a.  $x^3 + \frac{1}{2}x^2 - \frac{3}{4}x - \frac{3}{8} + \frac{45}{16\left(x - \frac{1}{2}\right)}$   
b.  $c = \frac{1}{2}; P\left(\frac{1}{2}\right) = \frac{45}{16}$

- 17. a.  $x^4 + x^3 + x^2 + x + 1$   
b.  $c = 1; P(1) = 0$
- 19. a.  $x^3 - \frac{14}{5}x^2 + \frac{56}{25}x - \frac{224}{125} + \frac{3396}{625\left(x + \frac{4}{5}\right)}$   
b.  $c = -\frac{4}{5}; P\left(-\frac{4}{5}\right) = \frac{3396}{625}$

Applications

- 21. 41 °F

Collaborative Learning

- 23. a. Answers will vary.  
 $x^2 - \frac{7}{2}x + \frac{13}{4} + \frac{73}{4(2x-1)}$   
 $2x^2 - 7x + \frac{13}{2} + \frac{73}{4\left(x - \frac{1}{2}\right)}$
- b.  $\frac{P(x)}{x - \frac{b}{a}} = \frac{aP(x)}{ax - b}$
- c. If a polynomial  $P(x)$  is divided by  $(ax - b)$ , then the remainder will be  $P\left(\frac{b}{a}\right)$ .  
Answers will vary.

## Chapter 7: Factoring Polynomials

### 7.1 Exercises

Concept Check

- 1. product, factors
- 3. greatest common factor, largest
- 5. negative / opposite
- 7. True
- 9. False; Binomials can be common factors.

Practice

- 1. 5      3. 8
- 5. 1      7.  $10x^3$
- 9.  $4a^2$     11.  $13ab$
- 13.  $15xy^2z^2$
- 15.  $x^4$     17.  $-4y$
- 19.  $3x^3$     21.  $2x^2y$
- 23.  $m + 9$     25.  $x - 6$
- 27.  $b + 1$
- 29.  $3y + 4x + 1$
- 31.  $11(x - 11)$
- 33.  $4y(4y^2 + 3)$

- 35.  $-3a(2x - 3y)$
- 37.  $5xy(2x - 5)$
- 39.  $-2yz(9yz - 1)$
- 41.  $8(y^2 - 4y + 1)$
- 43.  $x(2y^2 - 3y - 1)$
- 45.  $4m^2(2x^3 - 3y + z)$
- 47.  $-7x^2z^3(8x^2 + 14xz + 5z^2)$
- 49.  $x^4y^2(15 + 24x^2y^4 - 32x^3y)$
- 51.  $(y + 3)(7y^2 + 2)$
- 53.  $(x - 4)(3x + 1)$
- 55.  $(x - 2)(4x^3 - 1)$
- 57.  $(2y + 3)(10y - 7)$
- 59.  $(x - 2)(a - b)$
- 61.  $(b + c)(x + 1)$
- 63.  $(x^2 + 6)(x + 3)$
- 65. Not factorable
- 67.  $(3 - b)(x + y)$
- 69.  $(y - 4)(5x + z)$

- 71.  $(z^2 + 3)(a + 1)$
- 73.  $(6x + 1)(a + 2)$
- 75.  $(x + 1)(y + 1)$
- 77.  $(2y - 7z)(5x - y)$
- 79.  $(3x - 4u)(y - 2v)$
- 81. Not factorable
- 83.  $(2c - 3d)(3a + b)$

Applications

- 85. She can make 30 identical treat bags, each containing 5 pieces of candy A, 6 pieces of candy B, and 11 pieces of candy C.
- 87. a. 32 feet  
b.  $16x(3 - x)$   
c. 32 feet  
d. Yes. They are equivalent expressions.

### 7.2 Exercises

Concept Check

- 1. constant, middle
- 3. positive
- 5. different
- 7. False; One factor is negative, one is positive.
- 9. True

Practice

- 1.  $\{1, 15\}, \{-1, -15\}, \{3, 5\}, \{-3, -5\}$
- 3.  $\{1, 20\}, \{-1, -20\}, \{4, 5\}, \{-4, -5\}, \{2, 10\}, \{-2, -10\}$
- 5.  $\{1, -6\}, \{6, -1\}, \{2, -3\}, \{3, -2\}$
- 7.  $\{1, 16\}, \{-1, -16\}, \{4, 4\}, \{-4, -4\}, \{8, 2\}, \{-8, -2\}$
- 9.  $\{1, -10\}, \{10, -1\}, \{5, -2\}, \{2, -5\}$

- 11. 4, 3
- 13.  $-7, 2$
- 15. 8,  $-1$
- 17.  $-6, -6$
- 19.  $-5, -4$
- 21.  $x + 1$
- 23.  $p - 10$
- 25.  $a + 6$
- 27.  $(x - 4)(x + 3)$
- 29.  $(y + 6)(y - 5)$
- 31. Not factorable
- 33.  $(x - 4)(x - 4)$
- 35.  $(x + 4)(x + 3)$
- 37.  $(y - 1)(y - 2)$
- 39. Not factorable
- 41.  $(x + 8)(x - 9)$
- 43.  $(z - 6)(z - 9)$
- 45.  $x(x + 7)(x + 3)$
- 47.  $5(x - 4)(x + 3)$
- 49.  $10y(y - 3)(y + 2)$
- 51.  $4p^2(p + 1)(p + 8)$
- 53.  $2x^2(x - 9)(x + 2)$
- 55.  $2(x^2 - x - 36)$
- 57.  $2a^2(a - 10)(a + 6)$
- 59.  $3y^3(y - 8)(y + 1)$
- 61.  $x(x - 2)(x - 8)$
- 63.  $5(a^2 + 2a - 6)$
- 65.  $20a^2(a + 1)(a + 1)$

**Applications**

- 67. Base =  $x + 48$ ;  
Height =  $x$
- 69.  $x + 5$
- 71. a. 0 feet  
b.  $-16(t - 3)(t + 2)$   
c. 0 feet  
d. Yes. They are equivalent expressions.

**Writing & Thinking**

73. If the sign of the constant term is positive, the signs in the factors will both be positive or both be negative. If the sign of the constant term is negative, the sign in one factor will be positive and the sign in the other factor will be negative.

**7.3 Exercises**

**Concept Check**

- 1. factors
- 3. factorable
- 5. product, sum
- 7. False; The middle term should be the sum of the inner and outer products.
- 9. False; The first step is to multiply  $a$  and  $c$ .

**Practice**

- 1.  $(x + 2)(x + 3)$
- 3.  $(2x - 5)(x + 1)$
- 5.  $(6x + 5)(x + 1)$
- 7.  $-(x - 2)(x - 1)$
- 9.  $(x - 5)(x + 2)$
- 11.  $-(x - 14)(x + 1)$
- 13. Not factorable
- 15.  $-x(2x + 1)(x - 1)$
- 17.  $(t - 1)(4t + 1)$
- 19.  $(5a - 6)(a + 1)$
- 21.  $(7x - 2)(x + 1)$
- 23.  $(2x - 3)(4x + 1)$
- 25.  $(3x + 4)(3x - 5)$
- 27.  $2(2x - 5)(3x - 2)$
- 29.  $(3x - 1)(x - 2)$
- 31.  $(3x - 1)(3x - 1)$
- 33.  $(3y + 2)(2y + 1)$

- 35.  $(x - 1)(x - 45)$
- 37. Not factorable
- 39.  $2b(4a - 3)(a - 2)$
- 41. Not factorable
- 43.  $(4x - 1)(4x - 1)$
- 45.  $(8x - 3)(8x - 3)$
- 47.  $2(3x - 5)(x + 2)$
- 49.  $5(2x + 3)(x + 2)$
- 51.  $-2(9x^2 - 36x + 4)$
- 53.  $-15(3y + 4)(y - 2)$
- 55.  $3(2x - 5)(2x - 5)$
- 57.  $3x(2x - 1)(x + 2)$
- 59.  $3x(2x - 9)(2x - 9)$
- 61.  $9xy^3(x^2 + x + 1)$
- 63.  $4xy(3y - 4)(4y - 3)$
- 65.  $7y^2(y - 4)(3y - 2)$
- 7.  $4(x - 2)(x + 2)(x^2 + 4)$
- 9. Not factorable
- 11.  $(y - 8)^2$
- 13.  $-4(x - 5)(x + 5)$
- 15.  $(3x - 5)(3x + 5)$
- 17.  $(y - 5)^2$
- 19.  $(2x - 1)^2$
- 21.  $(5x + 3)^2$
- 23.  $(4x - 5)^2$
- 25.  $4x(x - 4)(x + 4)$
- 27.  $2xy(x + 8)^2$
- 29.  $(y + 3)^2$
- 31.  $(x - 10)^2$
- 33.  $(x^2 + 5y)^2$
- 35.  $(x - 5)(x^2 + 5x + 25)$

**Writing & Thinking**

- 67. This is not an error, but the trinomial is not completely factored. The completely factored form of this trinomial is  $2(x + 2)(x + 3)$ .
- 69.  $x(5 - 2x)(25 - 2x)$ ; The height is  $x$ , the width is  $(5 - 2x)$ , and the length is  $(25 - 2x)$ .
- 37.  $(y + 6)(y^2 - 6y + 36)$
- 39.  $(x + 3y)(x^2 - 3xy + 9y^2)$
- 41. Not factorable
- 43.  $4(x - 2)(x^2 + 2x + 4)$
- 45.  $2(3x - y)(9x^2 + 3xy + y^2)$
- 47.  $y(x + y)(x^2 - xy + y^2)$
- 49.  $x^2y^2(1 - y)(1 + y + y^2)$
- 51.  $3xy(2x + 3y)(4x^2 - 6xy + 9y^2)$

**7.4 Exercises**

**Concept Check**

- 1. binomial
- 3.  $2ax, -2ax$
- 5.  $(x + a)(x^2 - ax + a^2)$
- 7. True
- 9. False; The sum of two squares is not factorable.

**Practice**

- 1.  $(x - 5)(x + 5)$
- 3.  $(9 - y)(9 + y)$
- 5.  $2(x - 8)(x + 8)$
- 53.  $(x^2 - y^3)(x^4 + x^2y^3 + y^6)$
- 55.  $(3x + y^2)(9x^2 - 3xy^2 + y^4)$
- 57.  $(2x + y)(4x^2 - 2xy + y^2)$
- 59.  $8(y - 1)(y^2 + y + 1)$
- 61.  $(3x - y)(3x + y)$
- 63.  $(x - 2y)(x + 2y)(x^2 + 4y^2)$
- 65.  $(x - y - 9)(x - y + 9)$

67.  $(x - y - 6)(x - y + 6)$

69.  $(4x + 1 - y)(4x + 1 + y)$

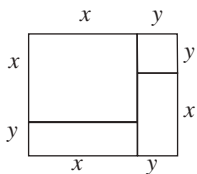
71. a.  $x^2 - 16$

b.  $\boxed{\phantom{0000}}x - 4$   
 $x + 4$

Writing & Thinking

73. a.  $xy + xy + x^2 + y^2$   
 $= x^2 + 2xy + y^2$   
 $= (x + y)^2$

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



75. For a 3-digit integer:  
 $abc$   
 $= 100a + 10b + c$   
 $= (99 + 1)a + (9 + 1)b + c$   
 $= 9(11a + b) + a + b + c$

So, if the sum  $(a + b + c)$  is divisible by 3 (or 9), then the number  $abc$  will be divisible by 3 (or 9).

For a 4-digit integer:  
 $abcd$   
 $= 1000a + 100b + 10c + d$   
 $= (999 + 1)a + (99 + 1)b + (9 + 1)c + d$   
 $= 9(111a + 11b + c) + a + b + c + d$

So, if the sum  $(a + b + c + d)$  is divisible by 3 (or 9), then the number  $abcd$  will be divisible by 3 (or 9).

7.5 Exercises

Concept Check

1. trial-and-error,  $ac$
3. original

5. monomial

7. True

Practice

1.  $(m + 6)(m + 1)$

3.  $(x + 9)(x + 2)$

5.  $(x - 10)(x + 10)$

7.  $(m - 3)(m + 2)$

9. Not factorable

11.  $(8a - 1)(8a + 1)$

13.  $(x + 5)^2$

15.  $(x + 12)(x - 3)$

17.  $3(a + 6)(a - 2)$

19.  $-5(x - 6)(x - 8)$

21. Not factorable

23.  $x(x - 6)(x + 2)$

25.  $-2a(a + 8)(a - 7)$

27.  $4x(2x - 5)(2x + 5)$

29.  $-(x - 5)(3x - 2)$

31.  $(2x - 1)(3x - 4)$

33.  $(4m + 3)(3m - 2)$

35.  $2(2x - 1)(x - 3)$

37.  $(4x - 7)(2x + 5)$

39.  $(5x + 6)(4x - 9)$

41.  $-(5x - 7)(3x + 2)$

43.  $-(2a - 3)(4a - 5)$

45.  $(4y + 5)(5y - 4)$

47.  $(6x - 1)(3x - 2)$

49.  $-6(5x - 4)(5x + 4)$

51.  $3(4n^2 - 20n - 25)$

53.  $a(21a^2 - 13a - 2)$

55.  $3x(3x - 2)(4x + 5)$

57.  $2x(2x - 1)(4x - 11)$

59.  $5(24m^2 + 2m + 15)$

61.  $(y - 4)(x + 3)$

63.  $(x + 2y)(x - 6)$

65.  $-(x^2 - 5)(x - 8)$

67.  $(x + 5)(x^2 - 5x + 25)$

69.  $x^4(y - 1)(y^2 + y + 1)$

71.  $(2a^2 + 3b^2)$

$(4a^4 - 6a^2b^2 + 9b^4)$

73.  $(x^2y - 5)$

$(x^4y^2 + 5x^2y + 25)$

75.  $(x - 3)(x + 3)(x + 7)$

77.  $(3x + y + 6)(3x - y - 6)$

79.  $(y + 10 + 7x)$

$(y + 10 - 7x)$

7.6 Exercises

Concept Check

1. zero
3. factor
5. substituting
7. True
9. True

Practice

1.  $x = 2, 3$

3.  $x = -2, \frac{9}{2}$

5.  $x = -3$

7.  $x = -5$

9.  $x = 0, 2$

11.  $x = -6$

13.  $x = -1, 4$

15.  $x = -3, 4$

17.  $x = -3, 0$

19.  $x = 2, 4$

21.  $x = -4, 3$

23.  $x = -\frac{1}{2}, 3$

25.  $x = -\frac{2}{3}, 2$

27.  $x = -\frac{1}{2}, 4$

29.  $x = -2, \frac{4}{3}$

31.  $x = \frac{3}{2}$

33.  $x = 0, \frac{8}{5}$

35.  $x = -2, 2$

37.  $x = 1$

39.  $x = 2$

41.  $x = -3, 3$

43.  $x = -5, 10$

45.  $x = -6, -2$

47.  $x = \frac{1}{2}$

49.  $x = 0, 2, 4$

51.  $x = -\frac{2}{3}, -\frac{1}{2}, 0$

53.  $x = -10, 10$

55.  $x = -5, 5$

57.  $x = -4$

59.  $x = 3$

61.  $x = -1, 3$

63.  $x = -8, -2$

65.  $x = -5, 2$

67.  $x = -5, 7$

69.  $x = -6, 2$

71.  $x = -1, \frac{2}{3}$

73.  $x = -\frac{3}{2}, 4$

75.  $y^2 - y - 6 = 0$

77.  $2x^2 + 11x + 5 = 0$

79.  $8x^2 - 10x + 3 = 0$

81.  $x^3 - x^2 - 6x = 0$

83.  $y^3 - 4y^2 - 3y + 18 = 0$

Applications

85. a. 640 ft; 384 ft

b. 144 ft; 400 ft

c. 7 seconds;  
 $0 = -16(t + 7)(t - 7)$

87. a. The ball will hit the ground.

b.  $0 = -16t^2 + 16t + 96$

c.  $t = -2, 3$

d. The ball will hit the ground after  $-2$  seconds and after 3 seconds.

- e. No, time cannot be negative.
- 89. a.  $\pi \text{ in.}^2$
- b.  $4\pi \text{ in.}^2$
- c.  $16\pi \text{ in.}^2$
- d.  $64\pi \text{ in.}^2$
- e. The area gets 4 times larger.

Writing & Thinking

- 91. This allows for use of the zero factor law, which says that for the product to equal zero one of the factors must equal zero. Answers will vary.

7.7 Exercises

Concept Check

- 1. variable, unknown
- 3. consecutive
- 5. 1
- 7. False; The sum of the squares of the lengths of the legs is equal to the hypotenuse squared.
- 9. False: Only with right triangles

Applications

- 1.  $x(x+8) = -16$ ;  
 $x = -4$ , so the numbers are  $-4$  and  $4$ .
- 3.  $x^2 = 7x$ ;  $x = 0, 7$
- 5.  $x^2 + 3x = 28$ ;  $x = 4$
- 7.  $x(x+3) = 40$   
 $x = -8, 5$ , so the numbers are  $-8$  and  $-5$  or  $5$  and  $8$ .
- 9.  $(x+5)^2 + x^2 = 53$ ;  
 $x = 2$ , so the numbers are  $2$  and  $7$ .
- 11.  $x+(x+4)^2 = 38$ ;  
 $x = 2$ , so the integers are  $2$  and  $6$ .

- 13.  $x(2x-5) = x+56$ ;  
 $x = -4$
- 15.  $x(x+1) = 72$ ;  $x = 8$ , so the integers are  $8$  and  $9$ .
- 17.  $x^2 + (x+1)^2 = 85$ ;  
 $x = 6$ , so the integers are  $6$  and  $7$ .
- 19.  $x(x+2) = 63$ ;  $x = -9, 7$ , so the integers are  $-9$  and  $-7$  or  $7$  and  $9$ .
- 21.  $4x+(x+1)^2 = 41$ ;  
 $x = 4$ , so the integers are  $4$  and  $5$ .
- 23.  $2x(x+1) = (x+1)(x+2)+88$ ;  
 $x = 10$ , so the integers are  $10, 11$ , and  $12$ .
- 25.  $6x(x+2) = (x+1)+(x+3)^2$ ;  
 $x = -2, 1$ , so the integers are  $-2, -1, 0$ , and  $1$  or  $1, 2, 3$ , and  $4$ .
- 27.  $w(2w) = 72$ ;  $w = 6$ , so width is  $6 \text{ in.}$  and length is  $12 \text{ in.}$
- 29.  $w(4w) = 64$ ;  $w = 4$ , so width is  $4 \text{ ft}$  and length is  $16 \text{ ft.}$
- 31.  $l(l-4) = 45$ ;  $l = 9$ , so width is  $5 \text{ ft}$  and length is  $9 \text{ ft.}$
- 33.  $\frac{1}{2}b(b-4) = 16$ ;  
 $b = 8$ , so base is  $8 \text{ ft}$  and height is  $4 \text{ ft.}$
- 35.  $\frac{1}{2}(h+6)h = 20$ ;  $h = 4$ , so the base is  $10 \text{ in.}$
- 37.  $w(16-w) = 48$ ;  $w = 4, 12$ , so the rectangle is  $4 \text{ in.}$  by  $12 \text{ in.}$
- 39.  $r(r+13) = 140$ ;  
 $r = 7$ , so there are  $7$  trees in each row.
- 41.  $r(r+7) = 144$ ;  $r = 9$ , so there are  $9$  rows.

- 43.  $n(n+1675) = 8400$ ;  
 $n = 5$ , so there are  $5$  floors.
- 45.  $(w+11)(w+4) = 98$ ;  
 $w = 3$ , so the rectangle was  $3 \text{ cm}$  by  $10 \text{ cm.}$
- 47.  $w = 10, 15$ , so width is  $10 \text{ ft}$  and length is  $30 \text{ ft}$  or width is  $15 \text{ ft}$  and length is  $20 \text{ ft.}$
- 49.  $h^2 + (h-34)^2 = (h+2)^2$ ;  
 $h = 48$ , so the height of the pole is  $48 \text{ ft.}$
- 51.  $x^2 + (x-49)^2 = (x+1)^2$ ;  
 $x = 60$ , so height is  $60 \text{ ft.}$
- 53.  $l^2 + (l-28)^2 = (l+8)^2$ ;  
 $l = 60$ , so the length of the mat is  $60 \text{ inches.}$
- 55. a. Figures will vary.
- b.  $(17-x)^2 + x^2 = 13^2$
- c.  $x = 12, x = 5$
- d. Yes
- e. The wire is attached to the pole  $5 \text{ feet}$  from the ground ( $12 \text{ feet}$  from the top) and attached to the stake which is  $12 \text{ feet}$  from the pole. Or the wire is attached to the pole  $12 \text{ feet}$  from the ground ( $5 \text{ feet}$  from the top) and attached to the stake which is  $5 \text{ feet}$  from the pole.
- f. Answers will vary.
- 57.  $\$1.50$  per pound
- 59.  $\$16$  or  $\$20$  per reel

Writing & Thinking

- 61.  $128 \text{ in.}^2$ ; We can use the Pythagorean Theorem to find the length and the width (by finding the diagonals of the interior square) instead.

7.8 Exercises

Concept Check

- 1. zeros
- 3. window
- 5. False, the zeros of a function are where  $y = 0$ .
- 7. True

Practice

- 1.  $x = \pm 2$
- 3.  $x \approx \pm 1.41$
- 5.  $x = -2, 6$
- 7.  $x \approx 2.46, -4.46$
- 9.  $x \approx 4.70, -1.70$
- 11. no solution
- 13.  $x \approx 1.91, -1.57$
- 15.  $x \approx -2.49, 0.66, 1.83$
- 17.  $x = 0, 1, 3$
- 19.  $x = -3, -1, 5$
- 21.  $x \approx 3.40$
- 23.  $x \approx -0.91, 1.71, 3.20$
- 25.  $x \approx -1.73, 0, 1.73$
- 27. no solution
- 29.  $x = -4, 3$
- 31.  $x = -5, 4.5$
- 33.  $x = 0.5$
- 35.  $x \approx -1.25, 0.83$
- 37.  $x \approx -0.06, 0.39$
- 39.  $x = -96, 76$
- 41.  $(-\infty, -6) \cup (6, \infty)$
- 43.  $[2, 4]$
- 45.  $(-\infty, 2] \cup [6, \infty)$
- 47.  $[-29, 25]$
- 49.  $(-3, 9)$
- 51.  $(-\infty, -16] \cup [4, \infty)$

Writing & Thinking

- 53. Answers may vary.  
 $[-1, 3] \cup [5, 9]$

## Chapter 8: Rational Expressions and Rational Equations

### 8.1 Exercises

#### Concept Check

- rational
- fundamental
- fractions
- True
- False; A rational expression cannot have a zero denominator.

#### Practice

- $\frac{3x}{4y}; x \neq 0, y \neq 0$
- $\frac{2x^3}{3y^3}; x \neq 0, y \neq 0$
- $\frac{1}{x-3}; x \neq 0, 3$
- $7; x \neq 2$
- $-\frac{3}{4}; x \neq 3$
- $\frac{2x}{y}; x \neq -\frac{2}{3}, y \neq 0$
- $\frac{x}{x-1}; x \neq -6, 1$
- $\frac{x-7}{x-3}; x \neq -3, 3$
- $\frac{x-3}{y-2}; y \neq -2, 2$
- $\frac{x+7}{y+5}; x \neq 2, y \neq -5$
- $\frac{2}{75}$       23. 9
- 0      27.  $\frac{-3}{32}$
- 1

#### Applications

- $p(x) = \frac{15x+200}{x}$
  - \$35    c.  $x \neq 0$
  - The variable cannot be negative because you cannot have a negative quantity of people. There would

also be a maximum number depending on the size of the room.

- \$11.62    b. \$6.29
  - \$5.33
  - The cost per calculator decreases as the number of calculators purchased increases.
  - $x \neq -20$
  - The value of  $x$  cannot be negative because you cannot buy a negative quantity of calculators
- $(2x - 5)$  feet

#### Writing & Thinking

- A rational expression is an algebraic expression that can be written in the form  $\frac{P}{Q}$  where  $P$  and  $Q$  are polynomials and  $Q \neq 0$ .
  - $\frac{x-1}{(x+2)(x-3)}$   
Answers will vary.
  - $\frac{1}{x+5}$   
Answers will vary.

### 8.2 Exercises

#### Concept Check

- factor
- numerator, denominator
- numerators, denominators
- True
- False; the restriction is 0.

#### Practice

- $\frac{ab}{6y}$
- $\frac{8x^2y^3}{15}$
- $\frac{x+3}{x}$
- $\frac{x-1}{x+1}$
- $-\frac{1}{x-8}$
- $\frac{x-2}{x}$
- $\frac{4x+20}{x(x+1)}$
- $\frac{x}{(x+3)(x-1)}$
- $-\frac{x+4}{x(x+1)}$
- $\frac{x+2y}{(x-3y)(x-2y)}$
- $\frac{x-1}{x(2x-1)}$
- $\frac{1}{x+1}$
- $\frac{x+2}{x-2}$
- $\frac{1}{3xy^6}$
- $\frac{6y^7}{x^4}$
- $\frac{x}{12}$
- $\frac{6x+18}{x^2}$
- $\frac{6}{5x}$
- $\frac{3x+1}{x+1}$
- $\frac{x-2}{2x-1}$
- $-\frac{x+4}{x(2x-1)}$

- $\frac{x+1}{x-1}$
- $\frac{6x^3 - x^2 + 1}{x^2(4x-3)(x-1)}$
- $\frac{x^2 + 4x + 4}{x^2(2x-5)}$
- $\frac{x^2 - 6x + 5}{(x-7)(x-2)(x+7)}$
- $\frac{x^2 - 3x}{(x-1)^2}$
- $\frac{x^2 + 5x}{2x+1}$
- 1

#### Applications

- $\frac{x^2 - 3x - 10}{x+3}$
  - $\frac{x^2 + 5x + 6}{x-5}$
  - $(x+2)^2 = x^2 + 4x + 4$

### 8.3 Exercises

#### Concept Check

- smallest
- prime factorization
- equivalent
- True
- False; You completely factor each polynomial, including prime factors for numerical terms.

#### Practice

- 150      3. 432
- 600      7. 60
- $\frac{11}{17}$       11.  $\frac{3}{2}$
- $\frac{6}{5}$       15.  $\frac{23}{30}$
- $\frac{28}{27}$
- $7(x+5)(x-5)$

- 21.  $30(y-4)$
- 23.  $(x+3)(x-3)(x-3)$
- 25.  $-(y-3)$
- 27.  $-2(x+12)(x-12)$
- 29.  $(x+4)(x-3)(x+5)$
- 31.  $(x-2)(y+3)(x+7)$
- 33.  $2(x+6)(x-6)(x+3)$
- 35.  $6(x-5)(y+6)(y+1)$
- 37.  $(x+2)(x-2)(x^2+4)$
- 39. 28
- 41.  $33(x-3)$
- 43.  $-3x^2$
- 45.  $2(y+3)(y-1)$   
 $= 2y^2 + 4y - 6$
- 47.  $(x+1)(x+3)$   
 $= x^2 + 4x + 3$

### 8.4 Exercises

#### Concept Check

- 1. numerator, denominator
- 3. most
- 5. equivalent
- 7. True
- 9. True

#### Practice

- 1. 3                      3. 2
- 5. 1                      7.  $\frac{2}{x-1}$
- 9.  $\frac{14}{7-x}$                 11. 4
- 13.  $\frac{x^2-x+1}{(x+4)(x-3)}$
- 15.  $\frac{x-2}{x+2}$
- 17.  $\frac{4x+5}{2(7x-2)}$
- 19.  $\frac{6x+15}{(x+3)(x-3)}$
- 21.  $\frac{x^2-2x+4}{(x+2)(x-1)}$

- 23.  $\frac{-x^2-3x-6}{(x+3)(3-x)}$
- 25.  $\frac{8x^2+13x-21}{6(x+3)(x-3)}$
- 27.  $\frac{3x^2-20x}{(x+6)(x-6)}$
- 29.  $\frac{-4x}{x-7}$
- 31.  $\frac{4x^2-x-12}{(x+7)(x-4)(x-1)}$
- 33.  $\frac{x-6}{(x-10)(x-8)}$
- 35.  $\frac{6x}{(x-1)(x-7)}$
- 37.  $\frac{4x-19}{(7x+4)(x-1)(x+2)}$
- 39.  $\frac{-7x-9}{(4x+3)(x-2)}$
- 41.  $\frac{4x^2-41x+3}{(x+4)(x-4)}$
- 43.  $\frac{x-4}{2(x-2)}$
- 45.  $\frac{x^2-4x-6}{(x+2)(x-2)(x-1)}$
- 47.  $\frac{3x^2+26x-3}{(x+7)(x-3)(x+1)}$
- 49.  $\frac{6x+2}{(x-1)(x+3)}$
- 51.  $\frac{2x^2+x-4}{(x-2)(y+1)(x+1)}$
- 53.  $\frac{2x+4xy-15y}{(x+3)(y+2)(x-5)}$
- 55.  $\frac{-2x+2}{2x-1}$
- 57.  $\frac{2x^2-x-5}{(x-3)(x+3)(x^2+1)}$
- 59.  $\frac{x^2+9x+6}{(3x+1)(x+3)(x-1)}$

#### Applications

- 61. a.  $\frac{7x^2+3}{x-2}$

- b.  $\frac{4x^2+5}{x+2}$
- c.  $\frac{22x^3+12x^2+16x-8}{(x+2)(x-2)}$
- 63.  $\frac{5x+6}{2x(x+3)}$
- 65. a.  $\frac{100}{x}$     b.  $\frac{100}{2x+15}$
- c.  $\frac{100x+1500}{x(2x+15)}$
- 67. a. \$5750
- b.  $C(x) = 5750 + 0.35x$
- c.  $A(x) = \frac{5750 + 0.35x}{x}$
- d. \$6.40 per cupcake
- e. \$1.99 per cupcake

### 8.5 Exercises

#### Concept Check

- 1. rational
- 3. LCM
- 5. complex algebraic
- 7. True
- 9. True

#### Practice

- 1.  $\frac{4}{5xy}$
- 3.  $\frac{8}{7x^2y}$
- 5.  $\frac{2x^2+6x}{2x-1}$
- 7.  $\frac{2x-1}{2+3x}$
- 9.  $\frac{7}{2(x+2)}$
- 11.  $\frac{x}{x-1}$
- 13.  $\frac{4x}{3(x+6)}$
- 15.  $\frac{7x}{x+2}$
- 17.  $\frac{2x+6}{3(x-2)}$

- 19.  $\frac{24y+9x}{2(9y-10x)}$
- 21.  $\frac{x}{x-1}$
- 23.  $\frac{xy}{x+y}$
- 25.  $\frac{1}{xy}$
- 27.  $\frac{y+x}{y-x}$
- 29.  $\frac{3-x}{x}$
- 31.  $\frac{x+1}{x+3}$
- 33.  $\frac{-1}{x(x+h)}$
- 35.  $\frac{-1}{x(x+h)}$
- 37.  $-(x-2y)(x-y)$
- 39.  $\frac{2x}{x^2+1}$
- 41.  $\frac{(x-3)(x^2-2x+4)}{(x-4)(x-2)(x+1)}$
- 43.  $\frac{-5}{x+1}$
- 45.  $\frac{29}{4(4x+5)}$
- 47.  $\frac{x^2-3x-6}{x(x-1)}$
- 49.  $\frac{x^2-4x-2}{(x-4)(x+4)}$

#### Applications

- 51. a.  $\frac{2r_1r_2}{r_1+r_2}$
- b. 44.2 miles per hour
- c. 1.8 hours

#### Writing & Thinking

- 53. a.  $\frac{8}{5}$
- b. 1
- c.  $\frac{x^4+x^3+3x^2+2x+1}{x^3+x^2+2x+1}$

**8.6 Exercises**

Concept Check

1. ratio
3. extraneous
5. variables
7. False; It is not a proportion.
9. True

Practice

1.  $x = 7$
3.  $x \neq 0, 2; x = 4$
5.  $x \neq -3, 4; x = -10$
7.  $x \neq 0; x = 18$
9.  $x \neq 6; x = -\frac{74}{9}$
11.  $x = \frac{1}{4}$
13.  $x = 6$
15.  $x = 4$
17.  $x \neq 0; x = \frac{10}{3}$
19.  $x \neq 0; x = -\frac{3}{4}$
21.  $x \neq 0; x = -\frac{3}{16}$
23.  $x \neq -9, -\frac{1}{4}, 0; x = -2, 1$
25.  $x \neq \frac{3}{2}, 0, 6; x = \frac{3}{5}, 9$
27.  $x \neq \frac{1}{2}, 4; x = -3$
29.  $x \neq -4, -1; x = 2$
31.  $x \neq -1, \frac{1}{4}; x = \frac{2}{3}$
33.  $x \neq 2, 3; x = \frac{13}{10}$
35.  $x \neq -\frac{2}{3}, 2; \text{no solution}$
37.  $x \neq -1, \frac{1}{3}, \frac{1}{2}; x = \frac{1}{5}$
39.  $r = \frac{S-a}{S}$
41.  $s = \frac{x-\bar{x}}{z}$

43.  $y = m(x - x_1) + y_1$
45.  $R_{\text{total}} = \frac{R_1 R_2}{R_1 + R_2}$
47.  $P = \frac{A}{1+r}$
49.  $LK = 15, JB = 5$
51.  $AC = 2, ST = 12$
53.  $ST = 8, TU = 12, QR = 24$
55.  $AP = \frac{9}{2} \text{ in.}; PC = \frac{15}{2} \text{ in.}$

Applications

57. 360 defective computers
59. 36,800 students
61. 34 miles
63. 6.8 cups
65. Width = 3 inches; Length = 7.5 inches
67. 4 hours
69. First group: 10 hours; Second group: 6 hours.
71. a.  $\frac{3x}{3} = \frac{16}{x}$   
b.  $x = -4, +4$   
c.  $x = -4$  does not make sense because length cannot be negative  
d. The side of the small triangle is 4 feet long and the base of the large triangle is 12 feet long.

Writing & Thinking

73. a.  $\frac{x^2 - 8x}{4(x-4)(x+4)}$   
b.  $x = 0, 8$
75. a.  $\frac{14x-16}{5x(x-4)}$  b.  $x = \frac{8}{7}$

**8.7 Exercises**

Concept Check

1. unit, time
3. check

5. diagram, chart
  7. True
- Applications

1. 72, 45
3. 9
5.  $\frac{6}{13}$
7. 36, 27
9. 7, 12
11. 37.5 miles
13.  $\frac{12}{5}$  or  $2\frac{2}{5}$  hours
15.  $\frac{9}{5}$  or  $1\frac{4}{5}$  hours
17. 6 hours
19. Charles: 8 mph; Chase: 6 mph
21. 63 mph
23. sailboat: 5 mph; cruise ship: 25 mph
25. 20 mph
27. 120 hours
29. John: 11 hours; Raul: 22 hours; Denny: 33 hours
31. 1 mph
33. a.  $\frac{1}{x} + \frac{1}{4x} = \frac{1}{4}$

Printer	Time of Work (in Hours)	Part of Work Done in 1 Hour
Newest	$x$	$\frac{1}{x}$
Old	$4x$	$\frac{1}{4x}$
Together	4	$\frac{1}{4}$

- b.  $x = 5$
- c. It would take the newest printer 5 hours to complete the job and the old printer 20 hours to complete the job.

Writing & Thinking

35. a. 5 and 7 b. 2 and 4

**8.8 Exercises**

Concept Check

1. decrease
3. increase
5. joint
7. False; Varies directly
9. True

Practice

1.  $\frac{7}{3}$
3. 2
5.  $-\frac{32}{9}$
7. 36
9. 120
11.  $\frac{56}{3}$
13. 40
15. 54
17.  $\frac{48}{5}$
19. 27

Applications

21. 400 feet
23. \$35.10
25. 4.71 feet
27. 6 m
29. 0.0073 cm
31. 16,000 lb
33.  $9 \times 10^{-11} \text{ N}$
35. \$59.70
37. a.  $SL = \frac{kwd}{l^2}$   
b. 200 c. 4320 pounds
39. 25,200 lb
41. 18,000 lb
43. 200 cm<sup>3</sup>
45. 330 bar
47. 5.2 ohms
49. 10 ohms
51.  $10\frac{2}{3}$  ft from the 120 lb weight or,  $1\frac{1}{3}$  ft from the 960 lb weight.
53. 216 kilograms

## Chapter 9: Roots, Radicals, and Complex Numbers

### 9.1 Exercises

#### Concept Check

- 2
- square root
- radical, radicand
- False; If the original number is negative, the principal square root will not be the same as the original number.
- False; The radicand is underneath the radical symbol.

#### Practice

- |                   |                   |
|-------------------|-------------------|
| 1. 3              | 3. 9              |
| 5. 17             | 7. 13             |
| 9. 1              | 11. 5             |
| 13. 6             | 15. $\frac{1}{2}$ |
| 17. $\frac{3}{4}$ | 19. 0.2           |
| 21. -10           | 23. -0.04         |
| 25. -3            | 27. -5            |
| 29. $\frac{3}{5}$ |                   |
31.  $\sqrt{64} < \sqrt{74} < \sqrt{81}$  and  $8 < \sqrt{74} < 9$  because  $64 < 74 < 81$  or  $(8.6023)^2 = 73.99956529$
33.  $\sqrt{25} < \sqrt{32} < \sqrt{36}$  and  $5 < \sqrt{32} < 6$  because  $25 < 32 < 36$  or  $(5.6569)^2 = 32.00051761$
35. >      37. <
39. =      41. =
43. Rational
45. Rational
47. Irrational
49. Not a real number
51. Rational
53. Irrational

55. 6.2450
57. 2.4960
59. 0.4472
61. 8.9443
63. -8.2462
65. 2.6207
67. 4.9324

#### Applications

69.  $5\sqrt{2}$  or 6.30 inches
71. a. 4 inches  
b. 12 tiles
73. 10 inches
75. 4.64 cm
77. a. 1.7 meters  
b. 1.6 meters  
c. 1.8 meters
79. a. 4.2 ft  
b. 10.2 ft  
c. 18 tiles

#### Writing & Thinking

81. There is no real number that results in a negative number when squared.

### 9.2 Exercises

#### Concept Check

- factor
- 2
- $\sqrt{a}\sqrt{b}$
- True
- False; If  $x$  is a real number, then  $\sqrt{x^2} = |x|$ .

#### Practice

- $2\sqrt{3}$
- $12\sqrt{2}$
- $-6\sqrt{2}$

7.  $-2\sqrt{14}$
9.  $-5\sqrt{5}$
11.  $\frac{1}{2}$
13.  $-\frac{\sqrt{11}}{8}$
15.  $\frac{2\sqrt{7}}{5}$

17.  $6x$
19.  $2x\sqrt{2x}$
21.  $2x^5y\sqrt{6x}$
23.  $5xy^3\sqrt{5x}$
25.  $-3xy\sqrt{2}$
27.  $2bc\sqrt{3ac}$
29.  $5x^2y^3z^4\sqrt{3}$
31.  $\frac{x^2\sqrt{5}}{3}$
33.  $\frac{4a^2\sqrt{2a}}{9b^8}$
35.  $\frac{10x^4\sqrt{2}}{17}$

37. 6
39.  $2\sqrt[3]{7}$
41. -1
43.  $-4\sqrt[3]{2}$
45.  $5x\sqrt[3]{x}$
47.  $-2x^2\sqrt[3]{x^2}$
49.  $2a^2b\sqrt[3]{9b}$
51.  $6x^2y\sqrt[3]{y^2}$
53.  $2xy^2z^3\sqrt[3]{3x^2y}$
55.  $\frac{\sqrt[3]{3}}{2}$
57.  $\frac{5\sqrt[3]{3}}{2}$
59.  $\frac{5y^4}{3x^2}$

#### Applications

61.  $\sqrt{6} \approx 2.45$  amperes

63. 120 volts
65. a. 10 cm  
b.  $2\sqrt{30}$  cm  
c.  $5\sqrt{6}$  cm

#### Writing & Thinking

67. A cube root has no restrictions as the cube root of a negative number is negative.

### 9.3 Exercises

#### Concept Check

- radical, index
- $a^{\frac{1}{2}}$
- $\sqrt[3]{a}$
- True
- True

#### Practice

- $\sqrt[3]{8}$
- $-\sqrt[6]{x}$
- $\sqrt[5]{4z^2}$
- $13^{\frac{1}{7}}$
- $(-9)^{\frac{1}{3}}$
- 3
- $\frac{1}{10}$
- 512
- 4
- Not a real number
- $\frac{3}{7}$
- 16
- $-\frac{1}{6}$
- $\frac{5}{2}$
- $\frac{1}{4}$
- $\frac{3}{8}$
- $-\frac{1}{1000}$
- 64
- 8.5499
- 10,000,000

41. 99.6055  
 43. 0.0922  
 45. 1.6083  
 47. 0.2236  
 49. 7.7460  
 51. 2.0408
53.  $8x$   
 55.  $\frac{1}{3a^2}$
57.  $8x^{\frac{5}{2}}$   
 59.  $5a^{\frac{13}{6}}$
61.  $x^{\frac{7}{12}}$   
 63.  $x^{\frac{1}{2}}$
65.  $\frac{1}{a^{\frac{8}{9}}}$   
 67.  $a^{\frac{1}{4}}$
69.  $\frac{a^2}{b^5}$   
 71.  $8x^{\frac{3}{2}}y$
73.  $\frac{x^{\frac{3}{2}}}{16y^{\frac{2}{5}}}$   
 75.  $\frac{x^2y^4}{z^4}$
77.  $\frac{y^{\frac{3}{2}}z^2}{x}$   
 79.  $\frac{8b^{\frac{9}{4}}}{a^3c^3}$
81.  $x^{\frac{1}{4}}y^{\frac{5}{4}}$   
 83.  $\frac{y^{\frac{2}{3}}}{50x^{\frac{4}{3}}}$
85.  $\frac{b^{\frac{5}{12}}}{a^{\frac{11}{12}}}$   
 87.  $\frac{3x^{\frac{1}{2}}}{20y^{\frac{2}{3}}}$
89.  $\sqrt[6]{x^5}$   
 91.  $\sqrt[12]{y^7}$
93.  $\sqrt[30]{x^{11}}$   
 95.  $\sqrt[6]{y}$
97.  $\sqrt[9]{x}$   
 99.  $\sqrt[3]{7a}$
101.  $\sqrt[24]{x}$   
 103.  $a^{20}b^5c^{10}$

Applications

105. 0.24 Earth years  
 107. 576 ft<sup>2</sup>  
 109. a. 20 feet per second  
       b. 35.78 feet per second  
 111. a. 50 kmph  
       b. 20 kmph

Writing & Thinking

113. a.  $n$  must be an integer greater than 1.

- b.  $n$  must be a number less than 0.  
 c.  $n$  must equal 0.  
 d.  $n$  must be a rational number that is not an integer.

9.4 Exercises

Concept Check

1. index  
 3. FOIL  
 5. True

Practice

1.  $8\sqrt{2}$     3.  $\sqrt{11}$   
 5.  $-3\sqrt{10}$     7.  $13\sqrt[3]{3}$   
 9.  $-\sqrt{11}$     11.  $3\sqrt{a}$   
 13.  $7\sqrt{x}$   
 15.  $4\sqrt{2} + 3\sqrt{3}$   
 17.  $8\sqrt{b} - 4\sqrt{a}$   
 19.  $13\sqrt[3]{x} - 2\sqrt[3]{y}$   
 21.  $5\sqrt{3}$   
 23. 0  
 25.  $17\sqrt[3]{2}$   
 27.  $2\sqrt{2} - 6\sqrt{3}$   
 29.  $6 + \sqrt{5}$   
 31.  $\sqrt{3} - 4\sqrt{2}$   
 33.  $5\sqrt[3]{2} - 8\sqrt[3]{3}$   
 35.  $4\sqrt{2x}$   
 37.  $2y\sqrt{2y}$   
 39.  $-4x\sqrt{3xy}$   
 41.  $15x\sqrt{x}$   
 43.  $-xy^2\sqrt{x}$   
 45.  $4x^5y^{10}\sqrt{3}$   
 47.  $-8x^8y^2$   
 49.  $xy^2\sqrt[3]{2}$   
        $(-2x^2y^2 - 2x^3y + 3)$

9.5 Exercises

Concept Check

1. denominator  
 3. rational  
 5. conjugate  
 7. True  
 9. False; You would need to multiply by  $\sqrt[3]{a^2}$ .

Practice

1.  $\frac{5\sqrt{2}}{2}$     3.  $\frac{-3\sqrt{7}}{7}$

55.  $-8\sqrt{3}$   
 57.  $12 + \sqrt{6}$   
 59.  $2y + \sqrt{xy}$   
 61.  $13 + 2\sqrt{2}$   
 63.  $3x - 9\sqrt{3x} + 8$   
 65.  $2 - 2\sqrt{7}$   
 67.  $13 + 4\sqrt{10}$   
 69.  $\sqrt{10} + \sqrt{15} - \sqrt{6} - 3$   
 71.  $x - 2\sqrt{6x} - 18$   
 73. 58  
 75.  $x + 10\sqrt{xy} + 25y$   
 77.  $x + 28 - 10\sqrt{x+3}$   
 79.  $2x + 19 - 8\sqrt{2x+3}$   
 81. 4.3397  
 83. 31.6  
 85. -57  
 87. -37.3569  
 89.  $\sqrt{16} + \sqrt{48} \neq \sqrt{16+48}$ , as radicals cannot be added by simply adding their radicands.
5.  $2\sqrt{3}$     7. 3  
 9. 3    11.  $\frac{1}{3}$   
 13.  $\frac{2\sqrt{3}}{3}$     15.  $\frac{3\sqrt{2}}{2}$   
 17.  $\frac{\sqrt{x}}{x}$     19.  $\frac{\sqrt{2xy}}{y}$   
 21.  $\frac{\sqrt{2y}}{y}$     23.  $\frac{3\sqrt{7}}{5}$   
 25.  $\frac{-\sqrt{2y}}{5}$     27.  $\frac{\sqrt[3]{30}}{3}$   
 29.  $-\frac{5\sqrt{x}}{x^2}$     31.  $\frac{2\sqrt{3x}}{3y}$   
 33.  $\frac{2\sqrt{b}}{b}$   
 35.  $\frac{\sqrt[3]{28xy^2}}{2y^2}$   
 37.  $\frac{x\sqrt[3]{3xy^2}}{3y}$   
 39.  $\frac{\sqrt[3]{22}}{2}$   
 41.  $\frac{\sqrt[3]{45ab^2}}{3b^2}$   
 43.  $\frac{a\sqrt[3]{2ab^2}}{2b}$   
 45.  $\sqrt{6} + 2$   
 47.  $\frac{-(\sqrt{5} + 3)}{4}$   
 49.  $\frac{-6(5 + 3\sqrt{2})}{7}$

Applications

91.  $5\sqrt{6} + \sqrt{170} \approx 25.29$  ft  
 93. a.  $7\sqrt{2t}$  dollars  
       b.  $\sqrt{2t}$  dollars  
 95. a.  $60\sqrt{6}\%$   
       b.  $6x^4\sqrt{2}\%$

9.5 Exercises

Concept Check

1. denominator  
 3. rational  
 5. conjugate  
 7. True  
 9. False; You would need to multiply by  $\sqrt[3]{a^2}$ .

Practice

1.  $\frac{5\sqrt{2}}{2}$     3.  $\frac{-3\sqrt{7}}{7}$

51.  $\frac{\sqrt{3}(\sqrt{2} - 5)}{23}$   
 53.  $\frac{-7(1 + 3\sqrt{5})}{44}$   
 55.  $\frac{-(\sqrt{3} + \sqrt{5})}{2}$   
 57.  $5(\sqrt{2} - \sqrt{3})$   
 59.  $\frac{4(\sqrt{x} - 1)}{x - 1}$   
 61.  $\frac{5(6 - \sqrt{y})}{36 - y}$

63.  $\frac{8(2\sqrt{x}-3)}{4x-9}$
65.  $\frac{2\sqrt{y}(\sqrt{5y}+\sqrt{3})}{5y-3}$
67.  $\frac{3(\sqrt{x}+\sqrt{y})}{x-y}$
69.  $\frac{x(\sqrt{x}-2\sqrt{y})}{x-4y}$
71.  $-(\sqrt{3}+1)(\sqrt{3}+2)$
73.  $\frac{-(\sqrt{5}-2)(\sqrt{5}-3)}{4}$
75.  $\frac{(\sqrt{x}+1)^2}{x-1}$
77.  $\frac{(\sqrt{x}+2)(\sqrt{3x}-y)}{3x-y^2}$

79. The numerator and denominator were not multiplied by the conjugate of the denominator. The conjugate is  $\sqrt{3}-y$ . Also, the multiplication is incorrect:  $(\sqrt{3}+y)(\sqrt{3}+y) \neq 3+y^2$ .

Applications

81.  $r = \frac{\sqrt{V\pi h}}{\pi h}$
83. a.  $\frac{5\sqrt{6}}{3}$  cm  
 b.  $\frac{2\sqrt{30}}{3}$  cm  
 c.  $\frac{5\sqrt{3}}{3}$  cm
85. a.  $r = \frac{\sqrt{AP}}{P} - 1$   
 b. 5%

9.6 Exercises

Concept Check

1. isolate

3. radicals  
 5. extraneous  
 7. True  
 9. True

Practice

1.  $x = 3$   
 3. No solution  
 5.  $x = -3$   
 7.  $x = 14$   
 9.  $x = 9$   
 11. No solution  
 13.  $x = 6$   
 15.  $x = -4, 1$   
 17.  $x = -5, \frac{5}{2}$   
 19.  $x = -2$   
 21.  $x = 2, 3$   
 23.  $x = 2, 5$   
 25.  $x = -5, 5$   
 27.  $x = 4$     29.  $x = 4$   
 31.  $x = 3$     33.  $x = 2$   
 35.  $x = 2$     37.  $x = 7$   
 39.  $x = 4$     41.  $x = 0$   
 43.  $x = 5$   
 45. No solution  
 47.  $x = 4$   
 49.  $x = -1, 3$   
 51.  $x = 5$     53.  $x = 2$   
 55.  $x = 1$     57.  $x = -4$   
 59.  $x = 12$

Applications

61. a. \$1814.06  
 b.  $r = \sqrt{\frac{A}{P}} - 1$
63. a. 1 sec  
 b. 3 ft
65. 28.63 m
67. a. 0.64 seconds  
 b. 1.01 seconds  
 c. 1.09 seconds

9.7 Exercises

Concept Check

1. ordered  
 3. first coordinates  
 5. vertical, function  
 7. True  
 9. True

Practice

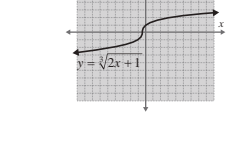
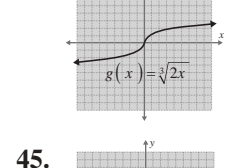
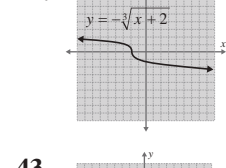
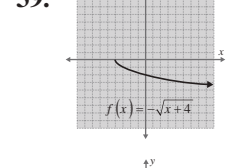
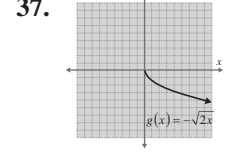
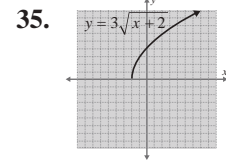
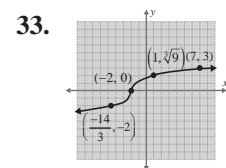
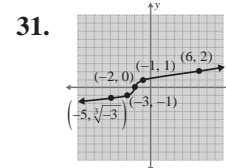
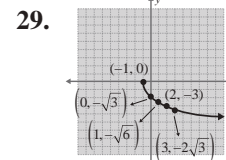
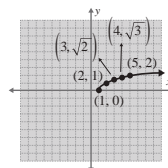
1. a.  $\sqrt{5} \approx 2.2361$   
 b. 3  
 c.  $5\sqrt{2} \approx 7.0711$   
 d. 2
3. a. 3  
 b. -1  
 c. -2  
 d.  $2\sqrt[3]{3} \approx 2.8845$

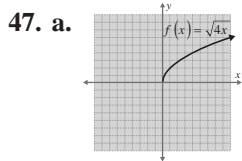
5.  $[-8, \infty)$   
 7.  $(-\infty, \frac{1}{2}]$   
 9.  $(-\infty, \infty)$   
 11.  $(-\infty, 2]$   
 13.  $(-\infty, \infty)$

15.  $D = [-2, \infty);$   
 $R = [0, \infty);$   
 zero =  $(-2, 0)$
17.  $D = [-1, \infty);$   
 $R = (-\infty, 1];$   
 zero =  $(0, 0)$

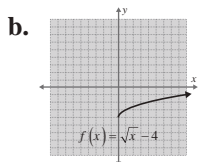
19.  $D = [0, \infty);$   
 $R = [3, \infty);$   
 zero = none

21. E    23. B  
 25. A  
 27.

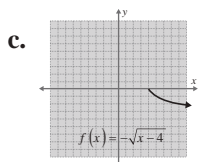




$D = [0, \infty)$ ; The graph of  $\sqrt{x}$  is stretched vertically.



$D = [0, \infty)$ ; The graph of  $\sqrt{x}$  is shifted down four units.



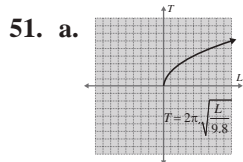
$D = [4, \infty)$ ; The graph of  $\sqrt{x}$  is shifted to the right four units, and then reflected across the  $x$ -axis.

49. A negative sign reflects the graph across the  $x$ -axis.

- a. Affects how quickly the graph goes to infinity.
- b. Causes the graph to move in a horizontal direction, and

c. Causes the graph to move in a vertical direction.

Applications



b.  $D = [0, \infty)$ ;  $R = [0, \infty)$   
Yes, this makes sense since both length and time cannot be negative

c. 7.77 seconds

Writing & Thinking

53. a.  $\frac{1}{\sqrt{3+h} + \sqrt{3}}$

b. Slope of the line connecting  $(3+h, f(3+h))$  and  $(3, f(3))$

c. A line just touching the curve at one point

d.  $\frac{1}{2\sqrt{3}}$ ; represents the slope of the line tangent to  $f(x)$  at  $x = 3$ .

9.8 Exercises

Concept Check

- 1. complex
- 3.  $a + bi$
- 5. conjugates
- 7. False; if  $a + bi = c + di$ , then  $a = c, b = d$

9. True.

Practice

- 1.  $7i$
- 3.  $-8i$
- 5.  $7\sqrt{3}$
- 7.  $10i\sqrt{6}$
- 9.  $-12i\sqrt{3}$
- 11. Real part: 4, imaginary part:  $-3$
- 13. Real part:  $-11$ , imaginary part:  $\sqrt{2}$
- 15. Real part:  $\frac{3}{8}$ , imaginary part: 0
- 17. Real part:  $\frac{4}{5}$ , imaginary part:  $\frac{7}{5}$
- 19. Real part:  $\frac{2}{3}$ , imaginary part:  $\sqrt{17}$

- 21.  $x = 6, y = -3$
- 23.  $x = \sqrt{2} - 3, y = 1$
- 25.  $x = 1, y = 4$
- 27.  $x = 2, y = -6$
- 29.  $x = 3, y = 10$
- 31.  $6 + 2i$
- 33.  $1 + 7i$
- 35.  $6 - 6i$
- 37.  $14i$
- 39.  $(3 + \sqrt{5}) - 6i$
- 41.  $5 + (\sqrt{6} + 1)i$
- 43.  $\sqrt{3} - 5$
- 45.  $-2 - 5i$
- 47.  $11 - 16i$

49. 2

51.  $16 + 24i$

53.  $2 + 8i$

55.  $-24 + 70i$

57.  $21 + 0i$

59.  $(9 - \sqrt{30}) + (3\sqrt{5} + 3\sqrt{6})i$

61.  $0 - \frac{5}{4}i$

63.  $-\frac{4}{5} + \frac{8}{5}i$

65.  $-\frac{1}{29} - \frac{12}{29}i$

67.  $-\frac{17}{26} - \frac{7}{26}i$

69.  $-\frac{1}{7} + \frac{4\sqrt{3}}{7}i$

71.  $0 + i$     73.  $-1 + 0i$

75.  $0 + i$     77.  $1 + 0i$

79.  $0 - i$

81.  $x^2 + 9$

83.  $x^2 + 2$

85.  $5y^2 + 4$

87.  $x^2 + 4x + 40$

89.  $y^2 - 6y + 13$

Writing & Thinking

91. a. Yes    b. No

93. The property  $\sqrt{a}\sqrt{b} = \sqrt{ab}$  is only true if  $a$  and  $b$  are positive. The actual value is  $-4$ , because  $\sqrt{-4} \cdot \sqrt{-4} = 2i \cdot 2i = 4i^2 = -4$ .

## Chapter 10: Quadratic Equations and Quadratic Functions

### 10.1 Exercises

Concept Check

1. 0, 0

3.  $x = \pm\sqrt{c}$

5. trinomial

7. True

9. True

Practice

1.  $x = 0, 11$

3.  $x = -12, -3$

5.  $x = 1, -\frac{5}{3}$

7.  $x = -1, 3$

- 9.  $x = \frac{3}{4}, 1$
- 11.  $x = \pm 11$
- 13.  $x = \pm 6$
- 15.  $x = \pm\sqrt{35}$
- 17.  $x = \pm 5i$
- 19.  $x = \pm\sqrt{62}$
- 21.  $x = \pm 3\sqrt{2}$
- 23.  $x = \pm \frac{2}{3}$
- 25.  $x = -1, 3$
- 27.  $x = 3 \pm 2i$
- 29.  $x = -\frac{3}{2}, -\frac{1}{2}$
- 31.  $x = -2 \pm i\sqrt{7}$
- 33.  $x = \frac{2 \pm 3\sqrt{7}}{5}$
- 35.  $x = \frac{-4 \pm 3\sqrt{3}}{3}$
- 37.  $x = 7 \pm 2\sqrt{3}$
- 39.  $x = 5 \pm i\sqrt{10}$
- 41.  $x^2 - 12x + 36 = (x-6)^2$
- 43.  $x^2 - 5x + \frac{25}{4} = \left(x - \frac{5}{2}\right)^2$
- 45.  $y^2 + y + \frac{1}{4} = \left(y + \frac{1}{2}\right)^2$
- 47.  $x^2 + \frac{1}{3}x + \frac{1}{36} = \left(x + \frac{1}{6}\right)^2$
- 49.  $2x^2 + 4x + 2 = 2(x+1)^2$
- 51.  $x = -5, 1$
- 53.  $y = -1 \pm \sqrt{6}$
- 55.  $x = 5 \pm \sqrt{22}$
- 57.  $x = -5, 9$
- 59.  $x = -\frac{4}{3}, 1$
- 61.  $x = 3 \pm i$
- 63.  $y = 5 \pm \sqrt{21}$
- 65.  $z = \frac{-3 \pm \sqrt{29}}{2}$

- 67.  $x = \frac{-1 \pm i\sqrt{7}}{2}$  or  $-\frac{1}{2} \pm \frac{\sqrt{7}}{2}i$
- 69.  $x = \frac{-5 \pm \sqrt{17}}{2}$
- 71.  $x = \frac{5 \pm \sqrt{10}}{3}$
- 73.  $x = -1 \pm i\sqrt{5}$
- 75.  $x = \frac{1 \pm i\sqrt{11}}{4}$  or  $\frac{1}{4} \pm \frac{\sqrt{11}}{4}i$
- 77.  $y = \frac{-3 \pm i\sqrt{11}}{2}$  or  $-\frac{3}{2} \pm \frac{\sqrt{11}}{2}i$
- 79.  $y = -\frac{4}{3}, 1$
- 81.  $x = 2 \pm \sqrt{2}$
- 83.  $x^2 - 7 = 0$
- 85.  $x^2 - 2x - 2 = 0$
- 87.  $y^2 + 4y - 16 = 0$
- 89.  $x^2 + 16 = 0$
- 91.  $y^2 + 6 = 0$
- 93.  $x^2 - 4x + 5 = 0$
- 95.  $x^2 - 2x + 3 = 0$
- 97.  $x^2 + 10x + 49 = 0$

**Applications**

- 99. 3 seconds
- 101. a.  $s(0) = 490$ ; This means that the ball is dropped from a height of 490 meters.
  - b. 470.4 meters
  - c. 10 seconds
- 103. a.  $p = 0, 90$ 
  - b. No income revenue is made if the price is set to \$0 or \$90 per frame.

**Writing & Thinking**

105. Answers will vary

**10.2 Exercises**

**Concept Check**

- 1.  $ax^2 + bx + c = 0$
- 3.  $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
- 5. completing
- 7. True
- 9. False; Two real solutions

**Practice**

- 1. 68; Two real solutions
- 3. 0; One real solution
- 5. -44; Two nonreal solutions
- 7. 4; Two real solutions
- 9. 19,600; Two real solutions
- 11. -11; Two nonreal solutions
- 13.  $x = -2 \pm 2\sqrt{2}$
- 15.  $x = -\frac{2}{3}$
- 17.  $x = 1 \pm i\sqrt{6}$
- 19.  $x = -3, \frac{1}{2}$
- 21.  $x = \frac{-3 \pm \sqrt{5}}{4}$
- 23.  $x = \frac{-3 \pm i\sqrt{3}}{4}$  or  $-\frac{3}{4} \pm \frac{\sqrt{3}}{4}i$
- 25.  $x = \frac{-3 \pm \sqrt{29}}{2}$
- 27.  $x = -3, -1$
- 29.  $x = \pm 2i\sqrt{2}$
- 31.  $x = \frac{5 \pm \sqrt{17}}{2}$
- 33.  $x = -\frac{1}{4}$

- 35.  $x = \pm \frac{2\sqrt{3}}{3}$
- 37.  $x = \frac{2}{3}$
- 39.  $x = \frac{-4 \pm i\sqrt{2}}{2}$  or  $-2 \pm \frac{\sqrt{2}}{2}i$
- 41.  $x = \frac{7 \pm i\sqrt{51}}{10}$  or  $\frac{7}{10} \pm \frac{\sqrt{51}}{10}i$
- 43.  $x = -2, \frac{5}{3}$
- 45.  $x = 3 \pm i\sqrt{2}$
- 47.  $x = -1, 0$
- 49.  $x = \frac{9 \pm \sqrt{65}}{2}, 0$
- 51.  $x = \frac{-3 \pm \sqrt{5}}{2}, 0$
- 53.  $x = \frac{1}{2}, -3$
- 55.  $x = -\frac{1}{3}, 3$
- 57.  $x = \frac{2 \pm \sqrt{3}}{3}$
- 59.  $x = \frac{1 \pm i\sqrt{3}}{6}$
- 61.  $x = \frac{2 \pm i\sqrt{2}}{2}$
- 63.  $x = \frac{-7 \pm \sqrt{17}}{4}$
- 65.  $c < 16$
- 67.  $c = \frac{81}{4}$
- 69.  $a > 3$
- 71.  $a > -\frac{1}{36}$
- 73.  $a = \frac{49}{48}$
- 75.  $c > \frac{4}{3}$
- 77.  $x \approx 2.5993, 60.4007$
- 79.  $x \approx -0.7862, 2.0110$
- 81.  $x \approx -4.1334, -0.5806$

83.  $x \approx -2.6933, 2.6933$

Applications

- 85. a. 3.35 seconds
- b. 4.15 seconds
- c. 0.80 seconds

Writing & Thinking

87.  $x^4 - 13x^2 + 36 = 0$ ;  
multiplied  
 $(x-2)(x+2)$   
 $(x-3)(x+3)$

10.3 Exercises

Concept Check

- 1. read, think, translate
- 3. diagram
- 5. True

Applications

- 1.  $w(2w-5) = 63$ ;  $w = 7$ , the rectangle is 7 m by 9 m
- 3.  $x + (x+9)^2 = 147$ ;  
 $x = 3$ , the numbers are 3 and 12
- 5.  $(w+12)(w+22) = 1344$ ;  
 $w = 20$ , the pool is 20 ft by 30 ft
- 7.  $(x+5)^2 = 4x^2$ ;  $x = 5$ , the side of the original square is 5 m
- 9.  $w^2 + (w+4)^2 = 400$ ;  
 $w = 12$ , the rectangle is 12 m by 16 m
- 11.  $x(x+16) = 960$ ;  
 $x = 24$ , there are 40 seats
- 13. a.  $x(29-x) = 198$   
b.  $x = 11$  or  $x = 18$   
c. Either length = 11 meters and width = 18 meters, or length = 18 meters and width = 11 meters.

15.  $(9+2x)(12+2x) - (9)(12) = 162$ ;  
 $x = 3$ , the frame is 3 in. thick

17.  $40I - 4I^2 = 100$ ;  
 $I = 5$ , It needs a current of 5 amperes

19.  $x(40-x) = 336$ ;  
 $x = 12, 28$ ; He must sell 12 signs

21. a. \$307.20  
b.  $(600+20x)(0.5-0.01x) = 315$ ;  
 $x = 5, 15$ ; He must charge 45 cents or 35 cents

23.  $(15-x)(700+70x) = 10,920$ ;  
 $x = 2$  or  $3$ , the rental rate is \$840 or \$910.

25.  $\frac{8}{x+2} + \frac{4}{x-2} = 2$ ;  
 $x = 6$ , the speed of the boat in still water is 6 mph

27.  $\frac{540}{x-9} - \frac{540}{x} = 2$ ; their average speed to San Francisco was 54 mph

29.  $\frac{120}{x} + 2 = \frac{120}{x-5}$ ;  
 $x = 20$ , there were initially 20 members

31.  $3w(w+6) = 336$ ;  
 $w = 8$ , the sheet metal was 14 in. by 20 in.

33.  $\frac{1}{x} + \frac{1}{x+8} = \frac{1}{3}$ ;  $x = 4$ , the mother would take 4 hours

35.  $\frac{1}{x} + \frac{1}{x+30} = \frac{1}{8}$ ;  
 $x = 10$ ; the smaller pipe would take 40 min

37. a.  $\frac{1}{x} + \frac{1}{x+6} = \frac{1}{4}$

Persons	Time of work (in Hours)	Part of work Done in 1 Hour
Jack	$x$	$\frac{1}{x}$
Diane	$x+6$	$\frac{1}{x+6}$
Together	4	$\frac{1}{4}$

- b.  $x = -4, 6$
- c. 6 hours; Time cannot be negative in this context.
- d. It would take Jack 6 hours to decorate the nursery and it would take Diane 12 hours to decorate the nursery.

- 39. a. 4 sec
- b. No, the projectile's maximum height is 256 ft.
- c. 3 seconds, 5 seconds
- d. 8 sec

41. 34.6 ft

Writing & Thinking

43.  $a$  cannot be equal to zero and  $b^2$  must be greater than or equal to  $4ac$  to produce a real solution. Also, all the solutions found may not apply to the problem at hand. You must check that each answer makes sense in the context of the problem.

10.4 Exercises

Concept Check

- 1. middle, one-half
- 3. first
- 5. True

7. True

Practice

- 1.  $x = \pm 2, \pm 3$
- 3.  $x = \pm 2, \pm \sqrt{5}$
- 5.  $y = \pm \sqrt{7}, \pm 2i$
- 7.  $y = \pm \sqrt{5}, \pm i\sqrt{5}$
- 9.  $x = 4, \frac{25}{4}$
- 11.  $x = 1, 4$
- 13.  $x = -8, \frac{1}{8}$
- 15.  $x = -27, -8, 0$
- 17.  $x = -17, -2$
- 19.  $x = -\frac{7}{2}, -3$
- 21.  $x = 0, 8$
- 23.  $x = -1, -\frac{1}{2}$
- 25.  $x = \pm \sqrt{1+i}, \pm \sqrt{1-i}$
- 27.  $x = \pm \sqrt{1+3i}, \pm \sqrt{1-3i}$
- 29.  $x = \pm \sqrt{2+i\sqrt{3}}, \pm \sqrt{2-i\sqrt{3}}$
- 31.  $x = \frac{1}{7}, \frac{1}{5}$
- 33.  $x = -\frac{1}{3}, \frac{3}{8}$
- 35.  $x = \frac{1}{25}$
- 37.  $x = \pm \frac{\sqrt{5}}{5}, \pm 1$
- 39.  $x = \pm \frac{\sqrt{6}}{2}, \pm \frac{1}{3}i$
- 41.  $x = -\frac{1}{4}$
- 43.  $x = -4, 1$
- 45.  $x = -\frac{1}{2}$
- 47.  $x = -7, -\frac{3}{2}$
- 49.  $x = \frac{26}{5}$
- 51.  $x = 0, \pm 2\sqrt{2}, \pm 2i\sqrt{2}$
- 53.  $x = 2, -1 \pm i\sqrt{3}$

55.  $x = -10, 0, 5 \pm 5i\sqrt{3}$

Writing & Thinking

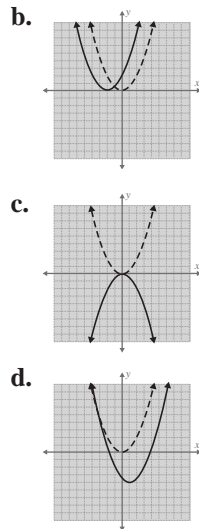
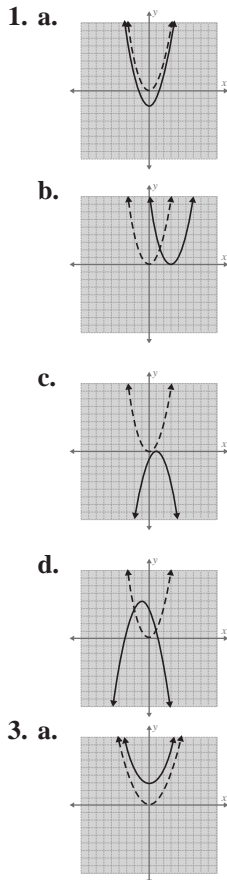
57. a.  $l^2 - l - 1 = 0$ ,  
 $l = \frac{1 + \sqrt{5}}{2}$  which is  
 the golden ratio  
 b. 97.08 feet  
 c. Rectangle B is  
 "golden."

10.5 Exercises

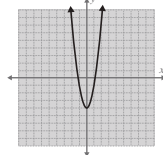
Concept Check

- parabola
- $\geq$
- range
- False; It is a horizontal shift (or horizontal translation).

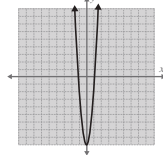
Practice



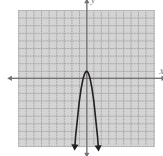
5.  $x = 0; (0, -4)$



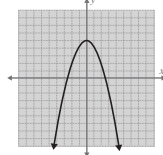
7.  $x = 0; (0, -9)$



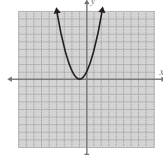
9.  $x = 0; (0, 1)$



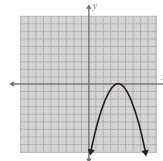
11.  $x = 0; (0, 5)$



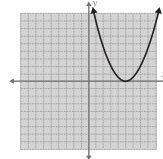
13.  $x = -1; (-1, 0)$



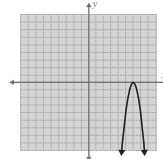
15.  $x = 4; (4, 0)$



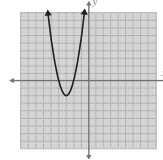
17.  $x = 5; (5, 0)$



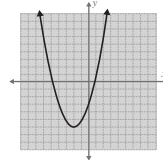
19.  $x = 6; (6, 0)$



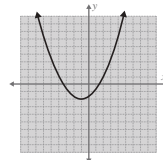
21.  $x = -3; (-3, -2)$



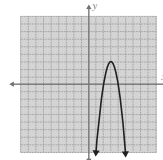
23.  $x = -2; (-2, -6)$



25.  $x = -1; (-1, -2)$



27.  $x = 3; (3, 3)$



Writing & Thinking

29. The parabola is narrower for larger values of  $a$  because the

value of  $y$  increases faster for increasing values of  $x$ .

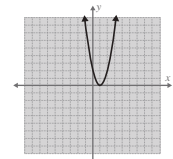
10.6 Exercises

Concept Check

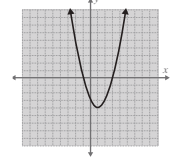
- vertex
- $x$ -axis
- downward, highest, maximum
- False; The line of symmetry is at  $x = -\frac{b}{2a}$ .
- True

Practice

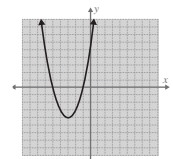
1.  $y = 2(x-1)^2; x = 1$ ;  
 Vertex:  $(1, 0)$ ;  
 $x$ -int:  $(1, 0)$ ;  
 $y$ -int:  $(0, 2)$



3.  $y = (x-1)^2 - 4; x = 1$ ;  
 Vertex:  $(1, -4)$ ;  
 $x$ -int:  $(-1, 0), (3, 0)$ ;  
 $y$ -int:  $(0, -3)$



5.  $y = (x+3)^2 - 4; x = -3$ ;  
 Vertex:  $(-3, -4)$ ;  
 $x$ -int:  $(-5, 0), (-1, 0)$ ;  
 $y$ -int:  $(0, 5)$



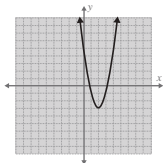
7.  $y = 2(x-2)^2 - 3; x = 2;$

Vertex:  $(2, -3);$

$x$ -int:  $\left(\frac{4+\sqrt{6}}{2}, 0\right),$

$\left(\frac{4-\sqrt{6}}{2}, 0\right);$

$y$ -int:  $(0, 5)$

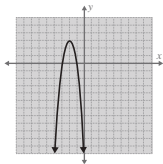


9.  $y = -3(x+2)^2 + 3;$

$x = -2;$  Vertex:  $(-2, 3);$

$x$ -int:  $(-1, 0), (-3, 0);$

$y$ -int:  $(0, -9)$

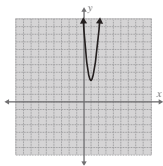


11.  $y = 5(x-1)^2 + 3;$

$x = 1;$  Vertex:  $(1, 3);$

$x$ -int: None;

$y$ -int:  $(0, 8)$



13.  $y = -\left(x + \frac{5}{2}\right)^2 + \frac{17}{4};$

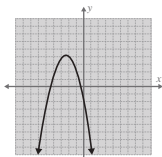
$x = -\frac{5}{2};$

Vertex:  $\left(-\frac{5}{2}, \frac{17}{4}\right);$

$x$ -int:  $\left(\frac{-5+\sqrt{17}}{2}, 0\right),$

$\left(\frac{-5-\sqrt{17}}{2}, 0\right);$

$y$ -int:  $(0, -2)$



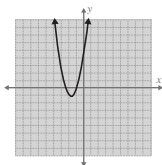
15.  $y = 2\left(x + \frac{7}{4}\right)^2 - \frac{9}{8};$

$x = -\frac{7}{4};$

Vertex:  $\left(-\frac{7}{4}, -\frac{9}{8}\right);$

$x$ -int:  $\left(-\frac{5}{2}, 0\right), (-1, 0);$

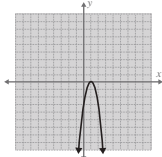
$y$ -int:  $(0, 5)$



17.  $x = 1;$  Vertex:  $(1, 0);$

$x$ -int:  $(1, 0);$

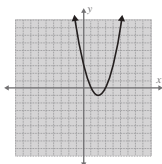
$y$ -int:  $(0, -3)$



19.  $x = 2;$  Vertex:  $(2, -1);$

$x$ -int:  $(3, 0), (1, 0);$

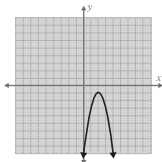
$y$ -int:  $(0, 3)$



21.  $x = 2;$  Vertex:  $(2, -1);$

$x$ -int: None;

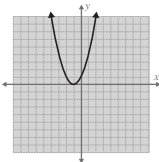
$y$ -int:  $(0, -9)$



23.  $x = -1;$  Vertex:  $(-1, 0);$

$x$ -int:  $(-1, 0);$

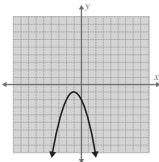
$y$ -int:  $(0, 1)$



25.  $x = -1;$  Vertex:  $(-1, -1);$

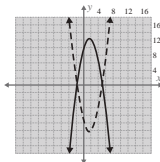
$x$ -int: None;

$y$ -int:  $(0, -2)$



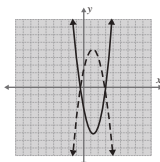
27. a. No b. Yes

c. One function is a reflection of the other across the  $x$ -axis.



29. a. No b. Yes

c. One function is a reflection of the other across the  $x$ -axis.

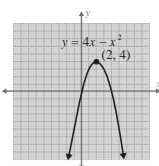


31. Zeros:  $x \approx -0.7321,$   
 $2.7321$

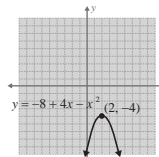
33. Zeros:  $x \approx -1.1583,$   
 $2.1583$

35. No real zeros

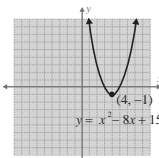
37.



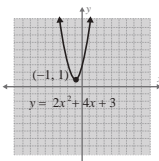
39.



41.



43.



### Applications

45. a. 3.5 s b. 196 ft

47. a. 5 s b. 420 ft

49. a. \$50 b. \$2500

51. \$20

53. a. Two sides are 150 yards and one side is 300 yards  
b. 45,000 yd<sup>2</sup>

### Writing & Thinking

55. a. Parabola

b.  $x = -\frac{b}{2a}$

c.  $x = -\frac{b}{2a}$

d. No. A graph can be entirely above or below the  $x$ -axis.

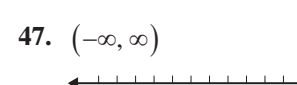
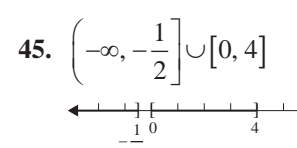
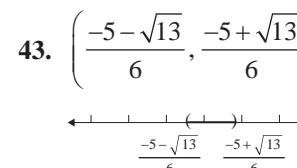
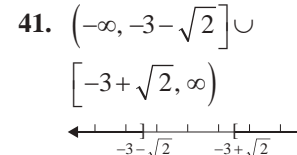
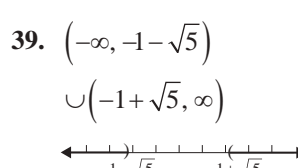
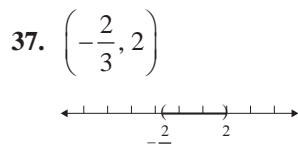
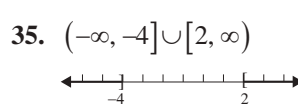
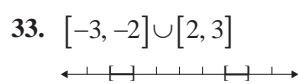
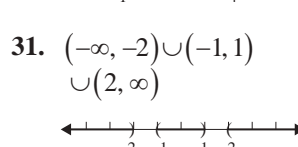
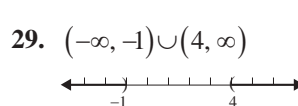
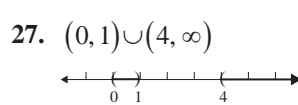
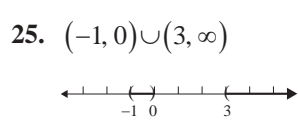
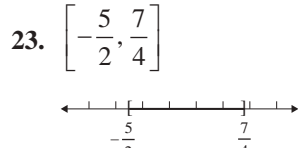
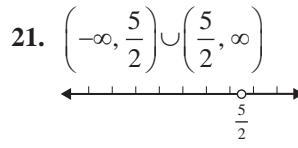
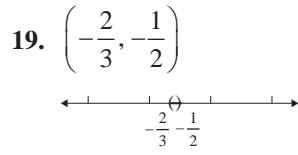
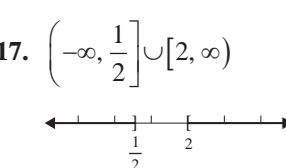
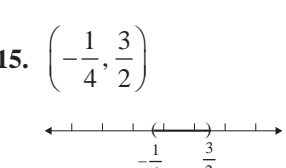
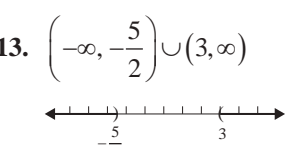
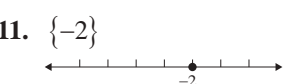
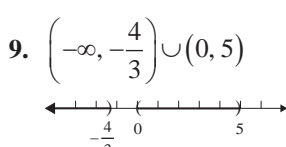
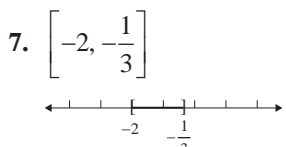
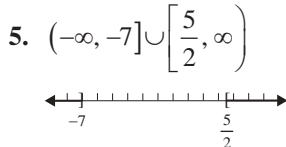
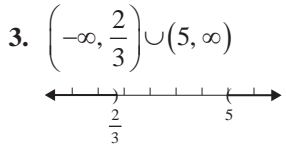
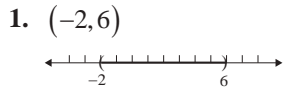
## 10.7 Exercises

### Concept Check

- graphs
- endpoints
- bracket, parenthesis
- False; The goal is to get 0 on one side of the inequality and factor the other side.

9. False; The solution consists of all intervals where the test points satisfy the original inequality.

Practice



49.  $\emptyset$

51. a.  $x = \frac{7 \pm \sqrt{89}}{2}$

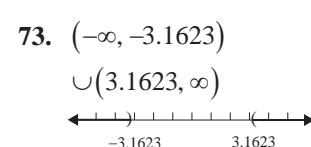
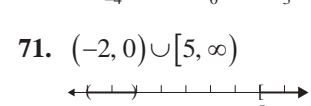
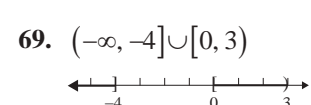
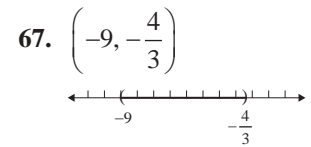
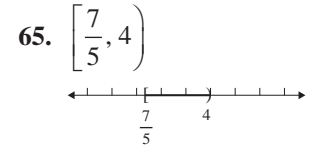
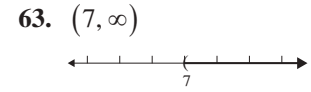
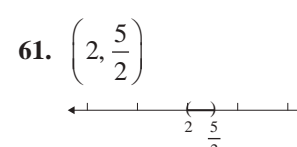
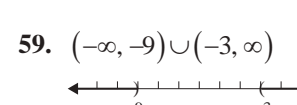
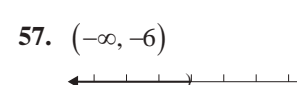
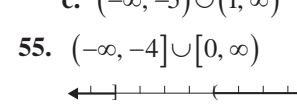
b.  $(-\infty, \frac{7-\sqrt{89}}{2}) \cup (\frac{7+\sqrt{89}}{2}, \infty)$

c.  $(\frac{7-\sqrt{89}}{2}, \frac{7+\sqrt{89}}{2})$

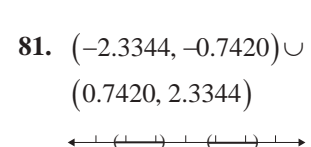
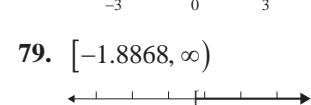
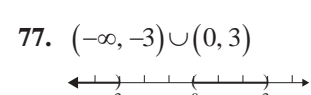
53. a.  $x = -5, 1$

b.  $(-5, 1)$

c.  $(-\infty, -5) \cup (1, \infty)$



75.  $\emptyset$



Applications

83.  $[3, 9]$

Writing & Thinking

85. a.  $(-4, 0) \cup (1, \infty)$

b.  $(-\infty, -4) \cup (0, 1)$

c. The function is undefined at  $x = 0$ .

# Chapter 11: Exponential and Logarithmic Functions

## 11.1 Exercises

### Concept Check

- composition, inverses
- domain
- y-values,  $x$
- True
- False; The operations are restricted to the portions of the domain that are in common.

### Practice

- $2x - 3$
  - 7
  - $x^2 - 3x - 10$
  - $\frac{x+2}{x-5}, x \neq 5$
- $x^2 + 3x - 4$
  - $x^2 - 3x + 4$
  - $3x^3 - 4x^2$
  - $\frac{x^2}{3x-4}, x \neq \frac{4}{3}$
- $x^2 + x - 12$
  - $x^2 - x - 6$
  - $x^3 - 3x^2 - 9x + 27$
  - $x + 3, x \neq 3$
- $3x^2 + x + 2$
  - $x^2 + x - 2$
  - $2x^4 + x^3 + 4x^2 + 2x$
  - $\frac{2x^2 + x}{x^2 + 2}$
- $2x^2 + 2$
  - $8x$
  - $x^4 - 14x^2 + 1$
  - $\frac{x^2 + 4x + 1}{x^2 - 4x + 1}, x \neq 2 \pm \sqrt{3}$

11. 9

13.  $-a^2 - a - 1$

15. 27

17.  $\frac{8}{5}$

19. -31

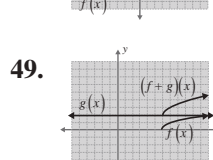
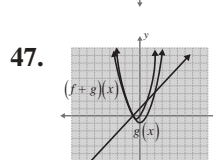
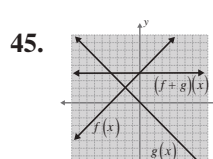
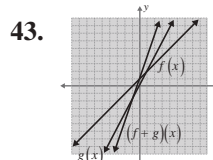
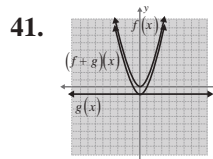
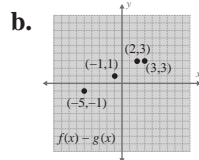
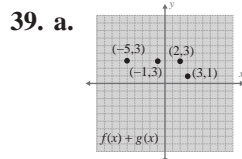
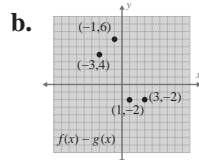
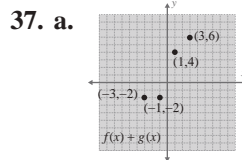
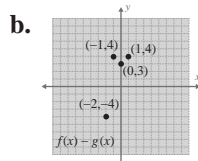
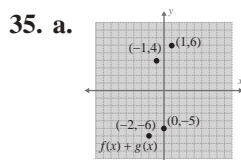
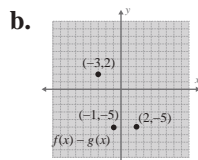
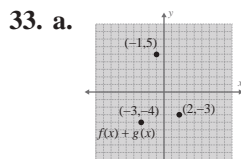
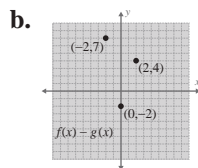
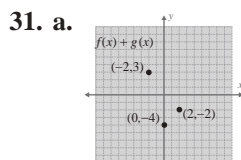
21.  $\sqrt{2x-6} + x + 4,$   
 $D = [3, \infty)$

23.  $3x^2 - 19x - 14;$   
 $D = (-\infty, \infty)$

25.  $\frac{x-5}{\sqrt{x+3}}; D = (-3, \infty)$

27.  $-3x\sqrt{x-3}; D = [3, \infty)$

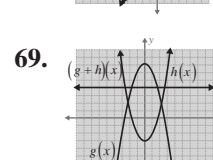
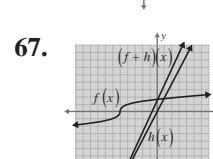
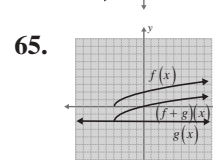
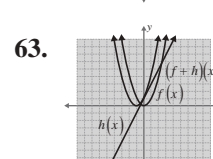
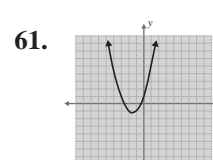
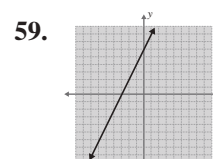
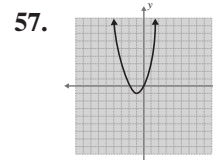
29.  $\sqrt[3]{x+3} + \sqrt{5+x};$   
 $D = [-5, \infty)$



51. 4

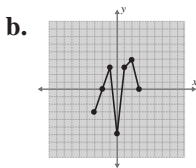
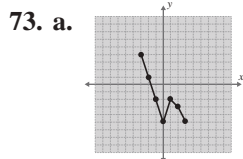
53. -12

55.  $-\frac{3}{7}$



### Writing & Thinking

71. In general, subtraction is not commutative. Answers will vary.



c.  $\frac{f}{g}$  is undefined for  $x = -2$  as  $g(-2) = 0$ .

### 11.2 Exercises

#### Concept Check

1. variable, variable
3.  $\neq$
5. one-to-one
7. False; The vertical line test determines whether a graph represents a function.
9. True

#### Practice

1. a.  $8r - 5$   
b.  $24a - 13$
3. a.  $5x^2 - 20x + 24$   
b.  $45n^4 + 4$
5. a.  $3n^2 - 6n - 9$   
b.  $48y^6 + 24y^3 - 9$
7.  $f(g(2)) = 14$   
 $g(f(2)) = \frac{15}{2}$
9.  $(f \circ g)(-5) = 49$   
 $(g \circ f)(-1) = 5$
11.  $f(g(x)) = \sqrt{x^2} = |x|$   
 $g(f(x)) = (\sqrt{x})^2 = x$
13.  $f(g(x)) = \sqrt{x-2}$   
 $g(f(x)) = \sqrt{x} - 2$

15.  $f(g(x)) = \frac{1}{x^2} - 1$   
 $g(f(x)) = \frac{1}{(x-1)^2}$

17.  $f(g(x)) = x^3 + 3x^2 + 4x + 3$   
 $g(f(x)) = x^3 + x + 2$

19.  $f(g(x)) = \frac{1}{|x|}$   
 $g(f(x)) = \frac{1}{x}$

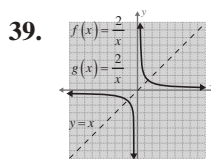
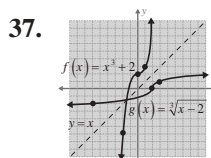
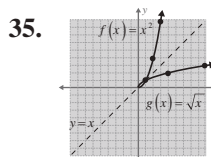
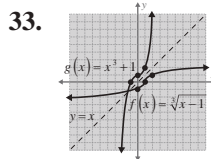
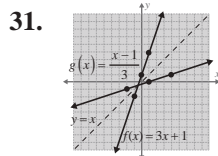
21.  $f(g(x)) = \frac{1}{x^2 + 7x - 8}$   
 $g(f(x)) = \left(\frac{1}{x}\right)^2 + 7\left(\frac{1}{x}\right) - 8$

23.  $f(g(x)) = (2x - 6)^{3n}$   
 $g(f(x)) = 2x^{3n} - 6$

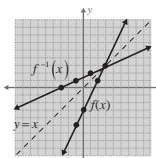
25.  $f(g(x)) = (x - 8)^{\frac{3}{2}}$   
 $g(f(x)) = \sqrt{x^3 - 8}$

27. a. 21  
b. 2  
c. No;  $f(g(x)) \neq x$  and  $g(f(x)) \neq x$

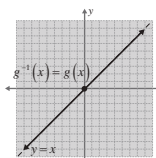
29. a. -9  
b. does not exist  
c.  $f(4) = \frac{1}{9}$  and  $\frac{1}{9}$  is in the domain of  $g$ , so  $g(f(4))$  is defined. However,  $g(2) = -\frac{1}{2}$  and  $-\frac{1}{2}$  is not in the domain of  $f$ , so  $f(g(2))$  is not defined.



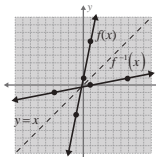
41.  $f^{-1}(x) = \frac{x+3}{2}$



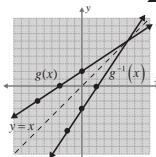
43.  $g^{-1}(x) = x$



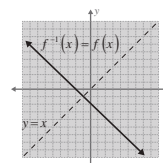
45.  $f^{-1}(x) = \frac{x-1}{5}$



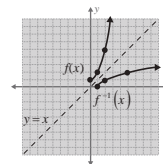
47.  $g^{-1}(x) = \frac{3(x-2)}{2}$



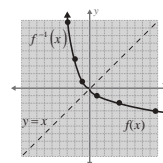
49.  $f^{-1}(x) = -x - 2$



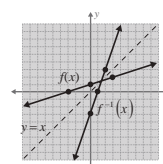
51.  $f^{-1}(x) = \sqrt{x-1}$



53.  $f^{-1}(x) = x^2, x \leq 0$



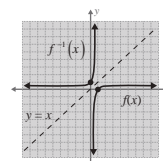
55. One-to-one



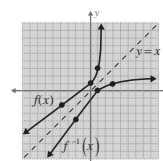
57. Not one-to-one

59. Not one-to-one

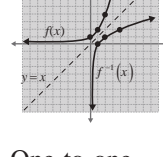
61. One-to-one



63. One-to-one



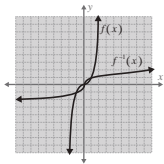
65. One-to-one



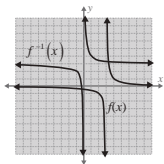
67. Not one-to-one

69. One-to-one

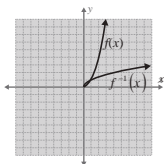
- 71. One-to-one
- 73. One-to-one
- 75. Not one-to-one
- 77.  $f^{-1}(x) = \sqrt[3]{x}$



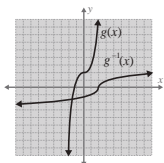
79.  $f^{-1}(x) = \frac{1}{x} + 3$



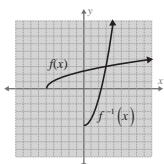
81.  $f^{-1}(x) = \sqrt{x}$



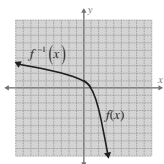
83.  $g^{-1}(x) = \sqrt[3]{x-2}$



85.  $f^{-1}(x) = x^2 - 5, x \geq 0$



87.  $f^{-1}(x) = \sqrt{1-x}$



Writing & Thinking

89. The domain of  $f(g(x))$  can only include values of  $x$  in the domain of  $g$ , while  $g(f(x))$  can only include values

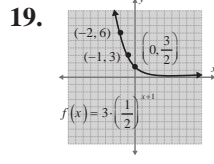
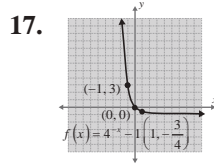
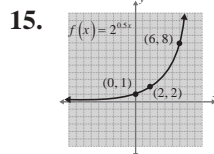
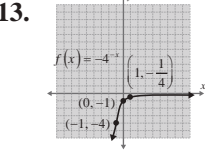
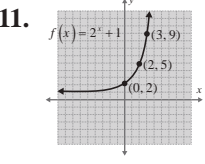
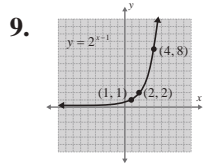
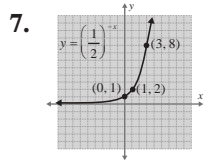
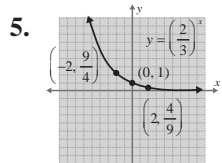
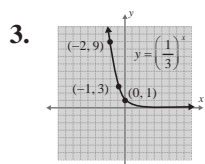
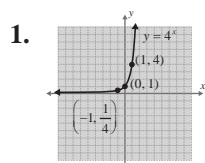
of  $x$  in the domain of  $f$ . For example,  $f(x) = \sqrt{x}, g(x) = -x$ . Answers will vary.

11.3 Exercises

Concept Check

- 1. constant, variable
- 3. 0, 1
- 5. compound
- 7. False;  $b > 0$  and  $b \neq 1$
- 9. True

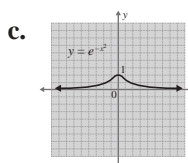
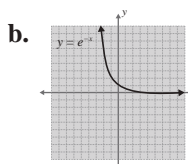
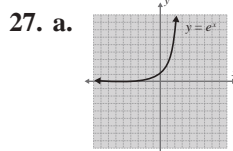
Practice



21. 48

23. 12.27

25. 4108.87



Applications

29. 20,000 bacteria

31. a. \$2621.59

b. \$2633.62

c. \$2639.86

d. \$2646.19

e. \$2646.26

33. \$3210.06

35. \$53.33

37. a. \$100,149.34

b. \$222,886.46

c. \$1,103,963.86

39. a. \$63,890.56

b. \$17,182.82

c. Answers will vary.

41. \$1228.25

43.  $y = 10,000 \cdot 2^t$

Writing & Thinking

45. The graphs are reflections of each other across the  $x$ -axis.

11.4 Exercises

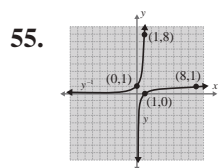
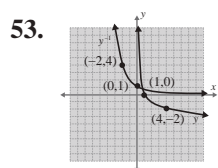
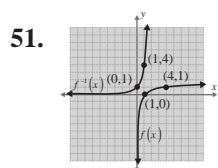
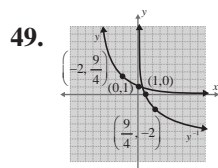
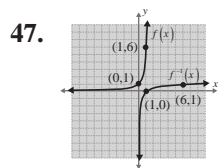
Concept Check

- 1.  $\log_b x$
- 3. logarithmic
- 5. reflecting
- 7. True
- 9. True

Practice

- 1.  $\log_7 49 = 2$
- 3.  $\log_5 \frac{1}{25} = -2$
- 5.  $\log_\pi 1 = 0$
- 7.  $\log_{10} 100 = 2$
- 9.  $\log_{10} 23 = k$
- 11.  $\log_{2/3} \frac{4}{9} = 2$
- 13.  $3^2 = 9$
- 15.  $9^{1/2} = 3$
- 17.  $7^{-1} = \frac{1}{7}$
- 19.  $10^{1.74} = N$
- 21.  $b^4 = 18$
- 23.  $n^x = y^2$
- 25. 4
- 27. 0
- 29. -3
- 31.  $x = 16$
- 33.  $x = 2$
- 35.  $x = -3$
- 37.  $x = \frac{1}{6}$
- 39.  $x = 2$

41.  $x = 32$   
 43.  $x = 3.7$   
 45.  $x = 2$



57. a.  $D = (-\infty, \infty)$   
 b.  $R = (0, \infty)$   
 c.  $y = 0$   
 d. Answers will vary.

Writing & Thinking

59. The two functions are symmetric about the line  $y = x$ .

11.5 Exercises

Concept Check

1. exponents, exponents  
 3. difference between  
 5. sum, difference  
 7. True  
 9. True

Practice

1. a. 2 b. 3  
 c. 5 d. 6  
 3. 5 5. -2  
 7.  $\frac{1}{2}$  9. 10  
 11.  $\sqrt{3}$   
 13.  $\log_b 5 + 4 \log_b x$   
 15.  $\log_b 2 - 3 \log_b x + \log_b y$   
 17.  $\log_6 2 + \log_6 x - 3 \log_6 y$   
 19.  $2 \log_b x - \log_b y - \log_b z$   
 21.  $-2 \log_5 x - 2 \log_5 y$   
 23.  $\frac{1}{3} \log_6 x + \frac{2}{3} \log_6 y$   
 25.  $\frac{1}{2} \log_3 x + \frac{1}{2} \log_3 y$   
 $-\frac{1}{2} \log_3 z$   
 27.  $\log_5 21 + 2 \log_5 x$   
 $+\frac{2}{3} \log_5 y$   
 29.  $-\frac{1}{2} \log_6 x - \frac{5}{2} \log_6 y$   
 31.  $-9 \log_b x - 6 \log_b y$   
 $+ 3 \log_b z$   
 33.  $\log_b \left( \frac{9x}{5} \right)$   
 35.  $\log_2 63x^2$   
 37.  $\log_b x^2 y$   
 39.  $\log_5 \left( \frac{y^3}{\sqrt{x}} \right)$   
 or  $\log_5 \left( \frac{y^3 \sqrt{x}}{x} \right)$   
 41.  $\log_5 \sqrt{\frac{x}{y}}$   
 43.  $\log_2 \left( \frac{xz}{y} \right)$   
 45.  $\log_b \left( \frac{xy^2}{\sqrt{z}} \right)$   
 or  $\log_b \left( \frac{xy^2 \sqrt{z}}{z} \right)$   
 47.  $\log_5 (2x^3 + x^2)$

49.  $\log_2 (x^2 + 2x - 3)$   
 51.  $\log_b (x+1)$   
 53.  $\log_{10} \left( \frac{1}{2x-3} \right)$

Writing & Thinking

55. Answers will vary.

11.6 Exercises

Concept Check

1. 10  
 3. negative  
 5.  $\ln x$   
 7. False; When the base is omitted, it is understood to be 10.  
 9. False; Both common logarithms and natural logarithms have inverses.

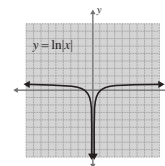
Practice

1.  $\log x = 1.5$   
 3.  $\log \frac{1}{1000} = -3$   
 5.  $\ln 27 = x$   
 7.  $\ln 1 = 0$   
 9.  $\log 3.2 = x$   
 11.  $10^0 = 1$   
 13.  $10^y = 5.4$   
 15.  $e^{1.54} = x$   
 17.  $e^1 = e$   
 19.  $e^a = x$   
 21. 2.2380  
 23. 1.9465  
 25. -1.2418  
 27. 3.6243  
 29. Error (undefined)  
 31. -5.3795  
 33. 204.1738  
 35. 0.0120  
 37. 0.9572  
 39. 175.9148

41. 0.0002  
 43. 1.0403

Writing & Thinking

45.  $\log x$  is a base 10 logarithm.  $\ln x$  is a base  $e$  logarithm.  
 47.  $D = (-\infty, 0) \cup (0, \infty)$



11.7 Exercises

Concept Check

1. logarithm  
 3. 1  
 5.  $\frac{1}{b^x}$   
 7. False; The change of base formula is

$$\log_b x = \frac{\log_a x}{\log_a b}$$

9. True

Practice

1.  $x = 11$   
 3.  $x = 9$   
 5.  $x = \frac{7}{2}$   
 7.  $x = \frac{6}{5}$   
 9.  $x = \frac{7}{2}$   
 11.  $x = -5$   
 13.  $x = -3$   
 15.  $x = -1, 4$   
 17.  $x = -1, \frac{3}{2}$   
 19.  $x = -2, 3$   
 21.  $x = -2$   
 23.  $x = -\frac{3}{2}, 0$   
 25.  $x = -1, 3$   
 27.  $x \approx 0.7154$

- 29.  $x \approx 7.5098$
- 31.  $x \approx -1.5947$
- 33.  $x \approx 0.2473$
- 35.  $x \approx -7.7003$
- 37.  $t \approx -1.5193$
- 39.  $x \approx 3.3219$
- 41.  $x \approx -1.4307$
- 43.  $x = 1$
- 45.  $x \approx -4.1610$
- 47.  $x \approx 1.2058$
- 49.  $x \approx 1.1292$
- 51.  $x \approx 0.9513$
- 53.  $x \approx 1.2520$
- 55.  $x \approx 25.1189$
- 57.  $x \approx 31.6228$
- 59.  $x = 0.0001$
- 61.  $x \approx 4.9530$
- 63.  $x \approx \pm 0.3329$
- 65.  $x = 3$
- 67.  $x = 100$
- 69.  $x = 6$
- 71.  $x = 20$
- 73.  $x \approx 3.1893$
- 75. No solution
- 77. No solution
- 79.  $x = 105$
- 81.  $x \approx 22.0855$
- 83.  $x = -10, 8$
- 85. 2.2619
- 87. 0.3223
- 89.  $-0.6279$
- 91. 2.4391
- 93.  $-1.2222$
- 95.  $x \approx 2.3219$
- 97.  $x \approx 1.5480$
- 99.  $x \approx 0.8390$

Writing & Thinking

101. Answers will vary.

$$x = \frac{1}{2}$$

103.  $7 \cdot 7^x = 7^{1+x}$  and  $49^x = 7^{2x}$ . Since  $1 + x \neq 2x$ , in general,  $7 \cdot 7^x \neq 49^x$ .  
Answers will vary.

3. 11.55 years

5.  $f \approx 0.30$

7. 1.73 hours

9. 10.99 days

11. 7.44 hours

13. 2350.02 years

15. 2.31 days

17. 39.65 minutes

19. 7.00 years

21. 5600 years

23. a. 13.86 years

b. 6.93 years

25. 100

27. 8.64 million

29. 2083, 2437, 2744

31. a. 117.95 dB

b.  $3.16 \times 10^8 I_0$

c.  $10^6 I_0$

11.8 Exercises

Concept Check

- 1. decomposition, centuries
- 3. Richter
- 5. False; The variable  $t$  is measured in days.

Applications

- 1. \$4027.51

Chapter 12: Conic Sections

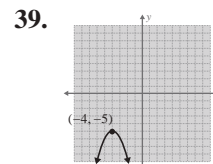
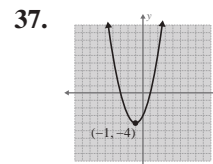
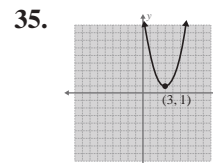
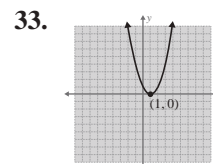
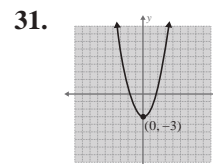
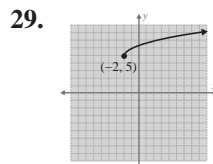
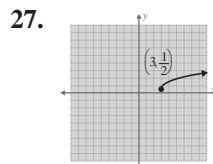
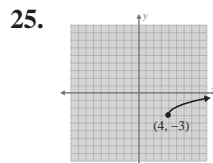
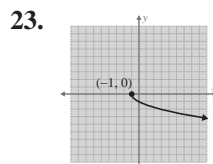
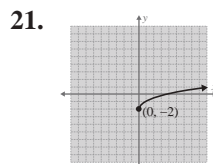
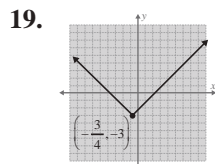
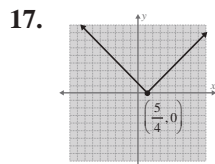
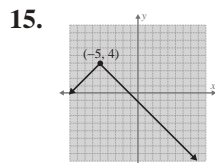
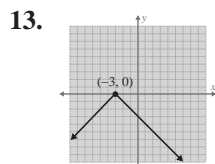
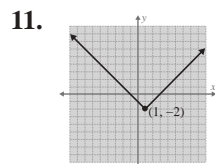
12.1 Exercises

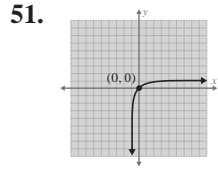
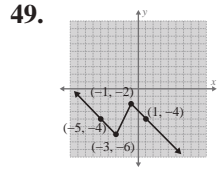
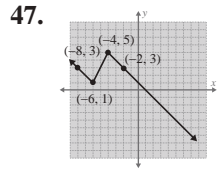
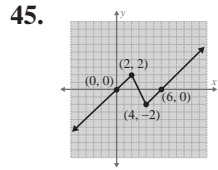
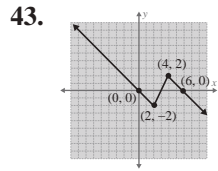
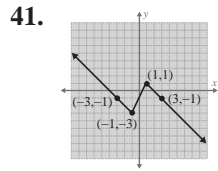
Concept Check

- 1. slope, two
- 3. horizontal
- 5. shape, direction
- 7. False; Translation does not change the shape of the graph of a function.

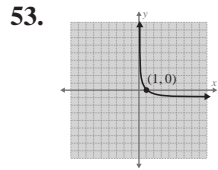
Practice

- 1. a. 0    b.  $a^2 - 6a + 5$   
c.  $x^2 + 2xh + h^2 - 4$   
d.  $2x + h$
- 3. a. 0    b.  $2a^2 - 11a + 14$   
c.  $2x^2 + 4xh - 3x + 2h^2 - 3h$   
d.  $4x + 2h - 3$
- 5. 1            7. -2
- 9. The results are the coefficients of  $x$ .

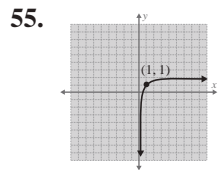




$D = (-1, \infty)$ ;  
 $R = (-\infty, \infty)$



$D = (0, \infty)$ ;  
 $R = (-\infty, \infty)$



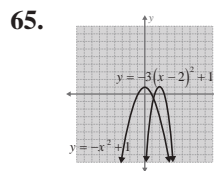
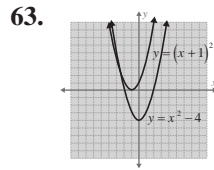
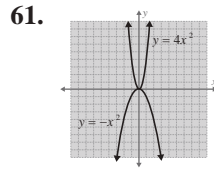
$D = (0, \infty)$ ;  
 $R = (-\infty, \infty)$

Applications

57.  $y = x^4 - 5x^2 + 2x + 10$

Writing & Thinking

59. The graph of the function  $y = f(x-h)+k$  is the graph of the function  $y = f(x)$  shifted  $h$  units to the right and  $k$  units up.



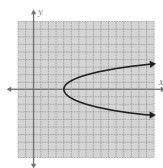
12.2 Exercises

Concept Check

- circle, ellipse, parabola, hyperbola
- vertical
- 0, y-intercepts
- True
- False;  $y = k$  is the line of symmetry for a horizontal parabola.

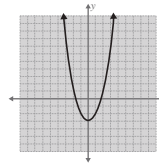
Practice

- a. (4, 0) b. None  
c.  $y = 0$



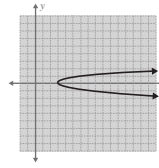
3. a. (0, -3) b. (0, -3)

c.  $x = 0$



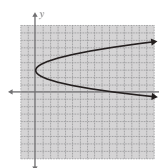
5. a. (3, 0) b. None

c.  $y = 0$



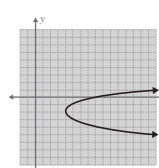
7. a. (0, 3) b. (0, 3)

c.  $y = 3$



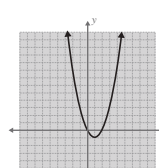
9. a. (4, -2) b. None

c.  $y = -2$



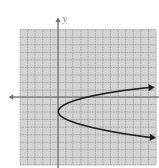
11. a. (1, -1) b. (0, 0)

c.  $x = 1$



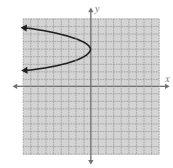
13. a. (0, -2) b. (0, -2)

c.  $y = -2$



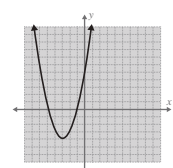
15. a. (0, 5) b. (0, 5)

c.  $y = 5$



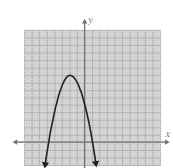
17. a. (-3, -4) b. (0, 5)

c.  $x = -3$



19. a. (-2, 9) b. (0, 5)

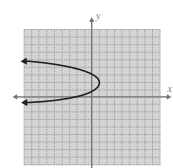
c.  $x = -2$



21. a. (1, 2)

- b. (0, 1), (0, 3)

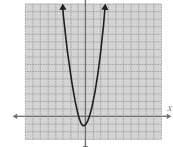
c.  $y = 2$



23. a.  $(-\frac{1}{4}, -\frac{9}{8})$

- b. (0, -1)

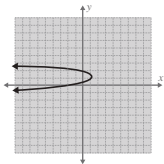
c.  $x = -\frac{1}{4}$



25. a.  $(\frac{9}{8}, \frac{5}{4})$

- b.  $(0, \frac{1}{2}), (0, 2)$

c.  $y = \frac{5}{4}$

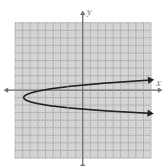


27. a.  $(-8, -1)$

b.  $\left(0, -1 + \frac{2\sqrt{6}}{3}\right)$

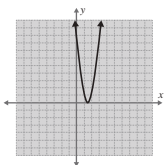
$\left(0, -1 - \frac{2\sqrt{6}}{3}\right)$

c.  $y = -1$

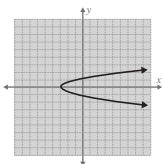


29. a.  $\left(\frac{3}{2}, 0\right)$  b.  $(0, 9)$

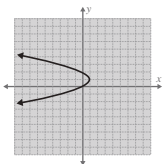
c.  $x = \frac{3}{2}$



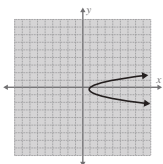
31.  $(0, 1.225), (0, -1.225)$



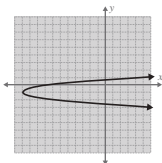
33.  $(0, 2), (0, 0)$



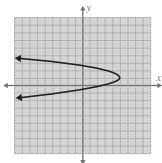
35. No y-intercept



37.  $(0, 0.658), (0, -2.658)$



39.  $(0, 2.581), (0, -0.581)$



41. b 43. c

Writing & Thinking

45. If  $|a| < 1$ , then the parabola will be wider than the graph of  $x = y^2$ . If  $|a| > 1$ , then the parabola will be narrower than the graph of  $x = y^2$ .

12.3 Exercises

Concept Check

1.  $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
3. averaging
5. twice
7. True
9. True

Practice

1. 5;  $(4, 5.5)$
3. 13;  $(3, 4.5)$
5.  $\sqrt{29}$ ;  $(2, 4.5)$
7. 3;  $(5.5, -3)$
9.  $\sqrt{13}$ ;  $(6, -3.5)$
11. 17;  $(-3, -4.5)$
13.  $x^2 + y^2 = 16$
15.  $x^2 + y^2 = 3$
17.  $x^2 + y^2 = 11$
19.  $x^2 + y^2 = \frac{4}{9}$
21.  $x^2 + (y - 2)^2 = 4$

23.  $(x - 4)^2 + y^2 = 1$

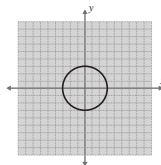
25.  $(x + 2)^2 + y^2 = 8$

27.  $(x - 3)^2 + (y - 1)^2 = 36$

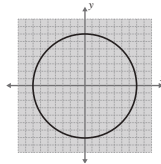
29.  $(x - 3)^2 + (y - 5)^2 = 12$

31.  $(x - 7)^2 + (y - 4)^2 = 10$

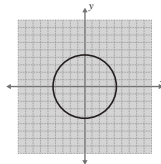
33.  $x^2 + y^2 = 9$   
Center:  $(0, 0)$ ;  $r = 3$



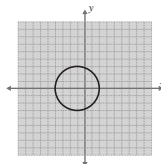
35.  $x^2 + y^2 = 49$   
Center:  $(0, 0)$ ;  $r = 7$



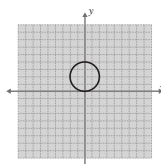
37.  $x^2 + y^2 = 18$   
Center:  $(0, 0)$ ;  $r = 3\sqrt{2}$



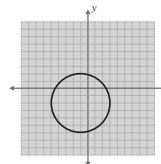
39.  $(x + 1)^2 + y^2 = 9$   
Center:  $(-1, 0)$ ;  $r = 3$



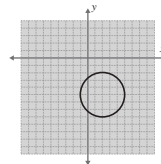
41.  $x^2 + (y - 2)^2 = 4$   
Center:  $(0, 2)$ ;  $r = 2$



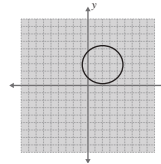
43.  $(x + 1)^2 + (y + 2)^2 = 16$   
Center:  $(-1, -2)$ ;  $r = 4$



45.  $(x - 2)^2 + (y + 5)^2 = 9$   
Center:  $(2, -5)$ ;  $r = 3$



47.  $(x - 2)^2 + (y - 3)^2 = 8$   
Center:  $(2, 3)$ ;  $r = 2\sqrt{2}$



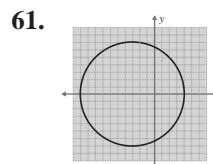
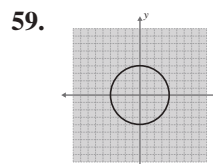
49.  $\overline{AB} = 3\sqrt{5}, \overline{AC} = \sqrt{65}, \overline{BC} = 2\sqrt{5}$   
 $(3\sqrt{5})^2 + (2\sqrt{5})^2 = (\sqrt{65})^2$ ;  
Right triangle

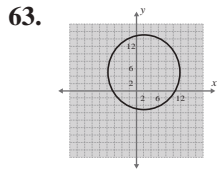
51.  $\overline{AB} = \overline{AC} = 4\sqrt{5}$

53.  $\overline{AB} = \overline{AC} = \overline{BC} = 4$

55.  $\overline{AC} = \overline{BD} = \sqrt{61}$

57.  $10 + 4\sqrt{5}$





Applications

65. 10 blocks  
 67.  $\sqrt{20} = 2\sqrt{5}$  hundred yards

Writing & Thinking

69. a.  $d = \sqrt{x^2 + (y-p)^2}$   
 b.  $d = |y+p|$   
 c.  $y+p = \sqrt{x^2 + (y-p)^2}$   
 $(y+p)^2 = x^2 + (y-p)^2$   
 $y^2 + 2py + p^2 = x^2 + y^2 - 2py + p^2$   
 $x^2 = 4py$

71. a.  $d = \sqrt{(x-p)^2 + y^2}$   
 b.  $d = |x+p|$   
 c.  $x+p = \sqrt{(x-p)^2 + y^2}$   
 $(x+p)^2 = (x-p)^2 + y^2$   
 $x^2 + 2px + p^2 = x^2 - 2px + p^2 + y^2$   
 $y^2 = 4px$

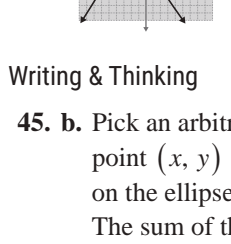
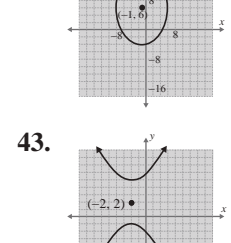
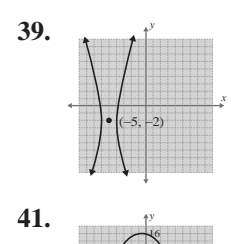
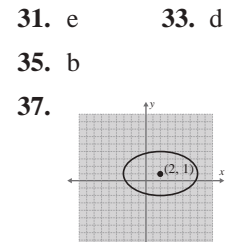
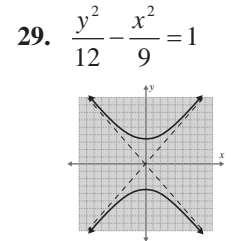
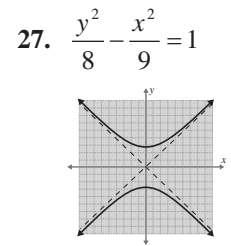
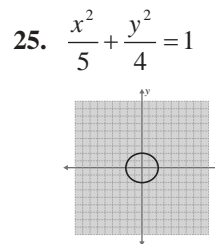
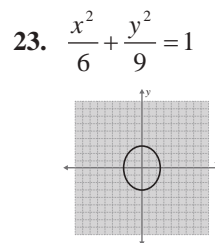
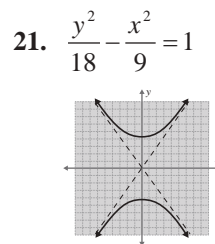
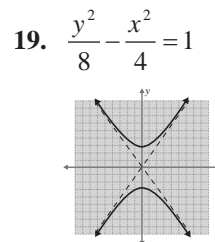
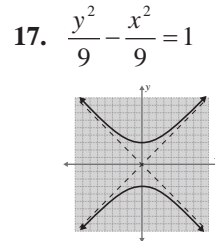
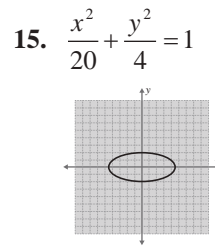
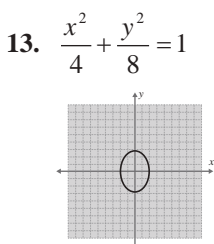
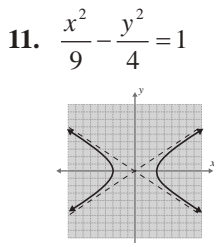
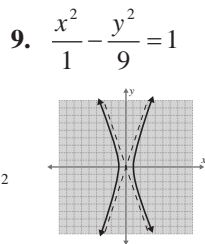
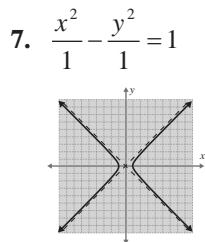
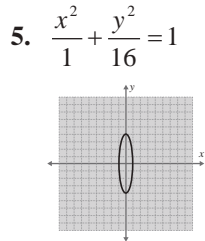
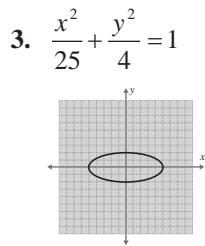
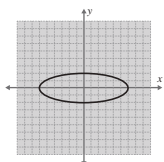
12.4 Exercises

Concept Check

- oval
- focus
- minor
- True
- False; The midway point between the foci is the center.

Practice

1.  $\frac{x^2}{36} + \frac{y^2}{4} = 1$



Writing & Thinking

45. b. Pick an arbitrary point  $(x, y)$  located on the ellipse. The sum of the distances from  $(x, y)$  to the points  $(-c, 0)$  and  $(c, 0)$  (the foci) will equal  $2a$ . Using the distance formula

we get the equation  
 $\sqrt{(x+c)^2 + (y-0)^2}$   
 $+ \sqrt{(x-c)^2 + (y-0)^2}$   
 $= 2a.$

Now to remove the radicals, simplify so that one side of the equation is a single radical and square both sides. Then repeat the previous step and simplify. This gives

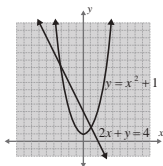
$$\frac{x^2}{a^2} + \frac{y^2}{a^2 - c^2} = 1.$$

- c. At the y-intercept  $(0, b)$  a right triangle is formed with hypotenuse  $a$  and sides  $b$  and  $c$ . The Pythagorean Theorem gives  $a^2 = b^2 + c^2$ .

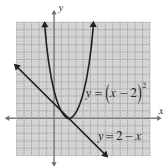
9. False; There are many situations where the curves do not intersect.

Practice

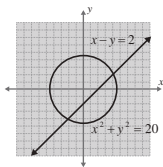
1.  $(-3, 10), (1, 2)$



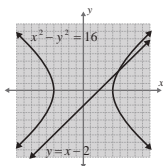
3.  $(1, 1), (2, 0)$



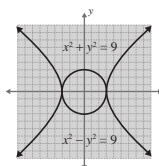
5.  $(-2, -4), (4, 2)$



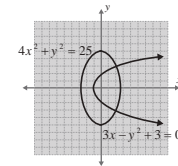
7.  $(5, 3)$



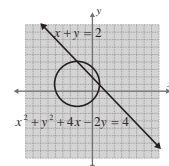
9.  $(-3, 0), (3, 0)$



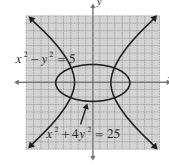
11.  $(2, 3), (2, -3)$



13.  $(-2, 4), (1, 1)$



15.  $(-3, -2), (3, 2), (-3, 2), (3, -2)$



17.  $(-3\sqrt{5}, 5), (-6, 4), (3\sqrt{5}, 5), (6, 4)$

19.  $(1, 3), (-1, 3)$

21.  $(4, 4), (-2, -2)$

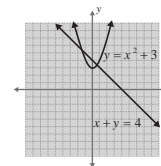
23.  $(-\frac{3}{2}, -1), (\frac{1}{2}, \frac{1}{2})$

25.  $(-3, \sqrt{11}), (-3, -\sqrt{11}), (3, \sqrt{11}), (3, -\sqrt{11})$

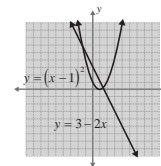
27.  $(5, -3), (-5, 1)$

29.  $(0, 3), (2, 3)$

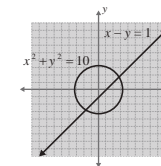
31.  $(-1.62, 5.62), (0.62, 3.38)$



33.  $(1.41, 0.17), (-1.41, 5.83)$



35.  $(2.68, 1.68), (-1.68, -2.68)$



12.5 Exercises

Concept Check

- second
- substitution, addition
- both
- True

13.1 Exercises

Concept Check

- numbers
- recursive
- decreasing
- True
- False; The terms in an alternating sequence alternate being positive and negative.

Practice

- 2, 5, 8, 11, 14
- $2, \frac{3}{2}, \frac{4}{3}, \frac{5}{4}, \frac{6}{5}$
- 2, 6, 12, 20, 30
- 2, 4, 8, 16, 32
- $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}$
- 2, 5, -10, 17, -26
- $-\frac{1}{2}, \frac{2}{3}, -\frac{3}{4}, \frac{4}{5}, -\frac{5}{6}$

- $1, \frac{1}{3}, \frac{1}{6}, \frac{1}{10}, \frac{1}{15}$
- 0, 1, 3, 6, 10
- $\{3n-1\}$
- $\{n^2\}$
- $\left\{\frac{1}{2^n}\right\}$
- $\{6n\}$
- $\{(-1)^{n+1}(2n-1)\}$

- Increasing;  
 $a_n = n + 4, a_{n+1} = n + 5;$   
 $n + 4 < n + 5, \text{ so } a_n < a_{n+1}$
- Neither
- Decreasing;  
 $a_n = \frac{1}{3^n}, a_{n+1} = \frac{1}{3 \cdot 3^n};$   
 $\frac{1}{3^n} > \frac{1}{3 \cdot 3^n}, \text{ so } a_n > a_{n+1}$
- Neither

Applications

37. \$28,000 when  $n = 1$ ;  
 \$19,600 when  $n = 2$ ;  
 \$13,720 when  $n = 3$ ; It  
 will be worth \$13,720  
 after 3 years.
39. 4 m when  $n = 1$ ; 1.6 m  
 when  $n = 2$ ; 0.64 m  
 when  $n = 3$ ; 0.256 m  
 when  $n = 4$ ; The ball  
 will bounce 0.256 m on  
 the 4<sup>th</sup> bounce.
41. 50 mg when  $n = 1$ ,  
 25 mg when  $n = 2$ ,  
 12.5 mg when  $n = 3$ ;  
 After 3 days, 12.5 mg  
 of medication will  
 remain in a person's  
 system.

Writing & Thinking

43.  $a_1 = 3, a_2 = 1$ , and  
 $a_3 = 4$ , so  $a_1 > a_2$ , but  
 $a_2 < a_3$  making the se-  
 quence neither increas-  
 ing nor decreasing.
45. a. 1, 1, 2, 3, 5, 8, 13, 21  
 b. If we call the se-  
 quence of differences  
 $D_n$ , where  $n > 2$ , then  
 $D_n = F_n - 2$

13.2 Exercises

Concept Check

- infinite
- index
- False; The lower limit  
of summation may be  
an integer other than 1.

Practice

- $S_1 = 2,$   
 $S_2 = 2 + 5 = 7,$   
 $S_3 = 2 + 5 + 8 = 15,$   
 $S_4 = 2 + 5 + 8 + 11 = 26$
- $S_1 = \frac{1}{2},$

$$S_2 = \frac{1}{2} + \frac{2}{3} = \frac{7}{6},$$

$$S_3 = \frac{1}{2} + \frac{2}{3} + \frac{3}{4} = \frac{23}{12},$$

$$S_4 = \frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{4}{5}$$

$$= \frac{163}{60}$$

- $S_1 = 1,$   
 $S_2 = 1 + (-4) = -3,$   
 $S_3 = 1 + (-4) + 9 = 6,$   
 $S_4 = 1 + (-4)$   
 $+ 9 + (-16) = -10$
- $S_1 = \frac{1}{2}, S_2 = \frac{1}{2} + \frac{1}{4} = \frac{3}{4},$   
 $S_3 = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} = \frac{7}{8},$   
 $S_4 = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} = \frac{15}{16}$

- $S_1 = 1, S_2 = 1 + 0 = 1,$   
 $S_3 = 1 + 0 + (-3) = -2,$   
 $S_4 = 1 + 0 + (-3) + (-8)$   
 $= -10$
- $2 + 4 + 6 + 8 + 10 = 30$
- $5 + 6 + 7 + 8 + 9 = 35$
- $\frac{1}{2} + \frac{1}{3} + \frac{1}{4} = \frac{13}{12}$
- $2 + 4 + 8 = 14$

- $16 + 25 + 36 + 49 + 64$   
 $= 190$
- $3 + 1 + (-1) + (-3) = 0$
- $6 + (-12) + 20$   
 $+ (-30) = -16$
- $\frac{1}{2} + \frac{2}{3} + \frac{3}{4}$   
 $+ \frac{4}{5} + \frac{5}{6} = \frac{71}{20}$
- $\sum_{k=1}^5 (2k - 1)$
- $\sum_{k=1}^5 (-1)^k$
- $\sum_{k=4}^7 k^2$
- $\sum_{k=2}^6 (-1)^k \left( \frac{1}{k^3} \right)$

- $\sum_{k=4}^{15} \frac{k}{k+1}$
- 39      39. 57
41. 48      43. 295
45. -1      47. 55

Writing & Thinking

49.  $\sum_{k=1}^{15} (-2k) + \sum_{k=1}^5 3k$

13.3 Exercises

Concept Check

- same
- $a_n = a_1 + (n - 1)d$
- True

Practice

- Arithmetic sequence  
 $d = 3; \{3n - 1\}$
- Arithmetic sequence  
 $d = -2; \{9 - 2n\}$
- Not an arithmetic  
 sequence
- Arithmetic sequence  
 $d = -4; \{10 - 4n\}$
- Arithmetic sequence  
 $d = \frac{1}{2}; \left\{ \frac{n-1}{2} \right\}$
- 1, 3, 5, 7, 9;  
 Arithmetic sequence

- $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6};$   
 Not an arithmetic  
 sequence
- $\frac{3}{2}, 3, \frac{9}{2}, 6, \frac{15}{2};$   
 Arithmetic sequence
- $\frac{20}{3}, \frac{19}{3}, 6, \frac{17}{3}, \frac{16}{3};$   
 Arithmetic sequence
- 1, 4, -7, 10, -13;  
 Not an arithmetic  
 sequence

- $\left\{ \frac{2n+1}{3} \right\}$
- $\{9 - 2n\}$
- $\left\{ \frac{17+3n}{2} \right\}$
- $\{63 - 5n\}$
- $\left\{ \frac{81+3n}{2} \right\}$
- 232      33. 44
- 7      37. 19
- 154      41. 235
- 126      45. 231
- $\frac{143}{3}$       49. 60
- 171      53. -100

Applications

- 9 days
- 1625 cm
- 134 seats; 1540 seats

Writing & Thinking

- An arithmetic sequence  
 has a constant difference  
 $d$ . If the terms alternated  
 between positive and  
 negative values, then  
 $d$  would also have  
 to alternate between  
 positive and negative  
 values. This is a  
 contradiction.

13.4 Exercises

Concept Check

- same
- $a_n = a_1 r^{n-1}$
- infinite
- False; Find the ratio of  
consecutive terms and  
determine if the ratios  
are constant.

Practice

- Not a geometric se-  
 quence

3. Geometric sequence  
 $r = -\frac{1}{2}; \left\{ 3\left(-\frac{1}{2}\right)^{n-1} \right\}$
5. Geometric sequence  
 $r = \frac{3}{8}; \left\{ \frac{32}{27}\left(\frac{3}{8}\right)^{n-1} \right\}$
7. Not a geometric sequence
9. Geometric sequence  
 $r = -\frac{1}{4}; \left\{ 48\left(-\frac{1}{4}\right)^{n-1} \right\}$
11. 9, -27, 81, -243;  
 Geometric sequence
13.  $\frac{2}{3}, \frac{4}{3}, 2, \frac{8}{3}$ ; Not a  
 geometric sequence
15.  $-\frac{8}{5}, \frac{32}{25}, -\frac{128}{125}, \frac{512}{625}$ ;  
 Geometric sequence
17.  $3\sqrt{2}, 6, 6\sqrt{2}, 12$ ;  
 Geometric sequence
19. 0.3, -0.09, 0.027,  
 -0.0081; Geometric  
 sequence
21.  $\left\{ 3(2)^{n-1} \right\}$
23.  $\left\{ \frac{1}{3}\left(-\frac{1}{2}\right)^{n-1} \right\}$
25.  $\left\{ (\sqrt{2})^{n-1} \right\}$
27.  $\left\{ \frac{1}{3}(3)^{n-1} \right\}$
29.  $\left\{ -5\left(-\frac{3}{4}\right)^{n-1} \right\}$
31.  $\frac{1}{4}$       33.  $\frac{32}{9}$
35.  $\frac{1}{4}$  or  $-\frac{1}{4}$
37.  $n = 4$       39. 363
41.  $\frac{1023}{64}$       43.  $-\frac{333}{64}$
45.  $\frac{422}{243}$       47.  $\frac{75}{128}$
49. 4      51.  $-\frac{1}{3}$
53.  $\frac{4}{9}$       55.  $\frac{4}{11}$

Applications

57. \$27,859.63  
 59. 14.76 liters  
 61. \$12,841.18  
 63. 7.59 meters

Writing & Thinking

65.  $\pi$

13.5 Exercises

Concept Check

1.  $n, 1$   
 3. Pascal's  
 5. expansion  
 7. True

Practice

1. 56      3.  $\frac{1}{15}$   
 5. 4      7.  $(n-1)!$   
 9.  $(k+3)(k+2)(k+1)$   
 11. 20      13. 35  
 15. 1  
 17.  $x^7 + 7x^6y + 21x^5y^2 + 35x^4y^3$   
 19.  $x^9 + 9x^8 + 36x^7 + 84x^6$   
 21.  $x^5 + 15x^4 + 90x^3 + 270x^2$   
 23.  $x^6 + 12x^5y + 60x^4y^2 + 160x^3y^3$   
 25.  $2187x^7 - 5103x^6y + 5103x^5y^2 - 2835x^4y^3$   
 27.  $x^{18} - 36x^{16}y + 576x^{14}y^2 - 5376x^{12}y^3$

29.  $x^6 + 6x^5y + 15x^4y^2 + 20x^3y^3 + 15x^2y^4 + 6xy^5 + y^6$
31.  $x^7 - 7x^6 + 21x^5 - 35x^4 + 35x^3 - 21x^2 + 7x - 1$
33.  $243x^5 + 405x^4y + 270x^3y^2 + 90x^2y^3 + 15xy^4 + y^5$
35.  $x^4 + 8x^3y + 24x^2y^2 + 32xy^3 + 16y^4$
37.  $81x^4 - 216x^3y + 216x^2y^2 - 96xy^3 + 16y^4$
39.  $x^8 + 8x^6y + 24x^4y^2 + 32x^2y^3 + 16y^4$
41.  $3360x^6y^4$
43. 1,140,480 $x^8$
45.  $-27,500x^6y^{18}$
47. 1.062  
 49. 0.808  
 51. 64.363  
 53. 0.851

Writing & Thinking

55.  $(x+2)^4$

Appendix

A.1 Exercises

Concept Check

1. place value  
 3. and  
 5. zeros  
 7. 100  
 9. True  
 11. True

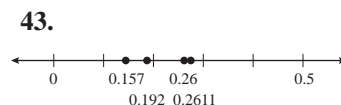
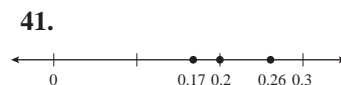
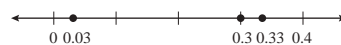
Practice

1. 6.5  
 3. 18.76  
 5. 56.03

7. 37.498  
 9. 87.003  
 11. Nine tenths  
 13. Twenty and seven tenths  
 15. One and fifty-three hundredths  
 17. Nineteen and one hundred two thousandths  
 19. Eight hundred and nine thousandths  
 21. 0.3      23. 17.9  
 25. 0.23      27. 6.028

29. 0.4502      31. 0.27

33. 0.163  
 35. 24.295  
 37. 0.01  
 39.



41.  
 43.  
 45. 1.4      47. 5.76  
 49. 1.64      51. 25.89  
 53. 147.385  
 55. 19.464  
 57. 0.04  
 59. 0.01096  
 61. 5      63. 2.03  
 65. 3%      67. 300%  
 69. 108%      71. 0.06  
 73. 0.032      75. 1.2  
 77. 3%      79. 50%  
 81. 12.5%      83.  $\frac{1}{20}$

85.  $\frac{1}{4}$       87.  $\frac{1}{8}$

Applications

- 89. One hundred fourteen and eight tenths
- 91. Nine hundred fourteen thousandths; One and nine hundredths; Thirty-nine and thirty-seven hundredths; Three and thirty-seven hundredths
- 93. a. \$94.85    b. \$5.15
- 95. \$936,945
- 97. \$239.56
- 99. 4%

Writing & Thinking

- 101. Answers will vary.
- 103. Moving left to right, compare digits with the same place value. When one compared digit is larger, the corresponding number is larger.

A.2 Exercises

Concept Check

- 1. branch out
- 3. arrangement
- 5.  $n!$
- 7. False; There are  $m \cdot n$  ways for the two events to occur in the given order.
- 9. False; Each ordering of a set of elements is called a permutation.

Practice

- 1. 27      3. 45
- 5. 450    7. 2520
- 9. 2      11. 362,880
- 13. 720    15. 30
- 17. 14     19. 990
- 21. 3024

Applications

- 23. a. 720  
b. 1000
- 25. a. 360  
b. 1296
- 27. a. 6720  
b. 32,768
- 29. a. 30,240  
b. 100,000
- 31. 90
- 33. 3360
- 35. 3024
- 37. 30,240
- 39. 20,160

41.  $\frac{6!}{2!} = 360$  ways

43.  $\frac{7!}{2!2!3!} = 210$  numbers

45.  $\frac{16!}{7!5!3!1!} = 5,765,760$  arrangements

47.  $\frac{14!}{5!4!3!2!} = 2,522,520$  ways

Writing & Thinking

- 49. The notation  ${}_n P_r$  is for the number of permutations of  $n$  elements taken  $r$  at a time. That is, we take  $r$  elements from a set of  $n$  elements. So, when  $n < r$ , we do not have enough elements in the set. Thus, we cannot calculate  ${}_n P_r$ .
- 51. We can find the number of possible lists in each group by using the permutation formula. Then, since every list from the first group can be paired with every list from the second group, we multiply

the obtained numbers (that is, use the fundamental counting principle).

A.3 Exercises

Concept Check

- 1. permutation, permutation
- 3.  $r!$
- 5. permutation
- 7. False; The number of combinations of  $n$  elements taken  $r$  at a time is smaller than the number of permutations of  $n$  elements taken  $r$  at a time.

9. True

Practice

- 1. Combination
- 3. Permutation
- 5. Permutation
- 7. Permutation
- 9. Combination
- 11. 15      13. 45
- 15. 15      17. 17

Applications

- 19. 36
- 21. 120
- 23. 455
- 25. 4845
- 27. 230,300
- 29. 1,184,040
- 31. a. 210;  
b. 5040
- 33. a. 14,950;  
b. 358,800
- 35. 1620
- 37. 980
- 39. 360,360
- 41. 9,338,000
- 43. 408,282,336

45. 69,300

Writing & Thinking

- 47. You should find the number of combinations of three elements from the first group and the number of permutations of three elements from the second group, and then use the fundamental counting principle to multiply the results. Alternatively, you can find permutations in the first group and combinations in the second, and then multiply.

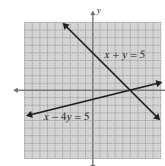
A.4 Exercises

Concept Check

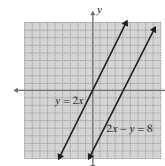
- 1. system
- 3. inconsistent
- 5. independent
- 7. False; graphs that are parallel indicate no solutions.
- 9. True

Practice

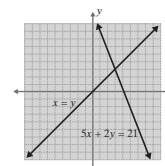
1. (5, 0)



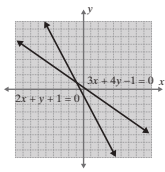
3. No solution



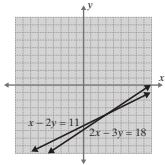
5. (3, 3)



7.  $(-1, 1)$



9.  $(3, -4)$



- 11.  $(2, 1)$ , consistent
- 13.  $(-1, -3)$ , consistent
- 15. No solution, inconsistent
- 17. Infinite number of solutions:  $(x, 8 - 3x)$ , dependent
- 19.  $(1, 6)$ , consistent
- 21.  $(\frac{3}{2}, 1)$ , consistent
- 23.  $(3, -\frac{3}{4})$ , consistent
- 25. No solution, inconsistent
- 27.  $(\frac{1}{2}, \frac{1}{4})$ , consistent
- 29.  $(5, 2)$ , consistent
- 31. Infinite number of solutions:  $(x, 6x - 15)$ , dependent

- 33.  $(7, 5)$ , consistent
- 35.  $(4, 7)$ , consistent

**Applications**

- 37. 40 liters of 12%, 50 liters of 30%
- 39. 240 gal of 5%, 120 gal of 2%
- 41. \$87,000 in bonds, \$37,000 in certificates
- 43. 325 at \$3.50/share, 175 at \$6.00/share
- 45. 40 lb at \$3.90/lb, 30 lb at \$2.50/lb
- 47. 16 lb at \$5.50/lb, 4 lb at \$7.20/lb
- 49. \$5.50 for paperback, \$9.00 for hardback
- 51. 205 legislators voted in favor of the bill
- 53. Commercial jet: 300 mph, Private jet: 125 mph
- 55. 78 chairs using Method I, 44 chairs using Method II
- 57. Sue: 12 years old; Pat: 22 years old

**Writing & Thinking**

- 59. The solution to a consistent system of linear equations is a single

point, which is easily written as an ordered pair.

**A.5 Exercises**

**Concept Check**

- 1. set
- 3. empty set
- 5. Set-builder notation
- 7. False; the three ways to write sets are word descriptions, set-builder notation, and roster notation.
- 9. True

**Practice**

- 1. Transitive property
- 3. Transitive property
- 5. Trichotomy property
- 7.  $A$  is the set of the first five even positive integers.
- 9.  $C$  is the empty set.
- 11.  $E$  is the set of integers that are greater than two.

- 13.  $G = \{-12, -10, -8, -6, -4, -2\}$
- 15.  $I = \{0, 3, 6, 9, 12, 15, 18\}$
- 17.  $K = \{1, 3, 5, 7, 9, 11\}$

19.  $M = \left\{ \begin{array}{l} x \mid 5 < x < 9 \text{ and} \\ x \text{ is even} \end{array} \right\}$

21.  $O = \{x \mid x > 16\}$

23.  $S = \{x \mid x = 0\}$

25. a.  $U$  is the set of integers greater than 2 and less than 8.

b.  $U = \{3, 4, 5, 6, 7\}$

c.  $U = \left\{ \begin{array}{l} x \mid 3 \leq x \leq 7 \text{ and} \\ x \text{ is an integer} \end{array} \right\}$

27. a.  $W$  is the set of the first four whole numbers divisible by ten.

b.  $W = \{0, 10, 20, 30\}$

c.  $W = \left\{ \begin{array}{l} x \mid 0 \leq x \leq 30 \\ \text{and } x \text{ is divisible} \\ \text{by } 10 \end{array} \right\}$

29.  $\in$       31.  $\notin$

