

# Answer Key

## Chapter 1: Real Numbers

### 1.1 Exercises

#### Concept Check

1. cubed
3. base, exponent
5. 1
7. False; Nine squared equals 81.
9. False;  $7^0$  is 1.

#### 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.  $2^2 \cdot 7 \cdot 11$
59. 79 is prime.
61.  $17^2$       63.  $5^3$
65.  $2^4 \cdot 5^2$     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. No. Here it shows that we are only dividing the old trading cards by 6 friends versus both the old and new trading cards by 6 friends.
- b. 522;  $\frac{15 \cdot 10 \cdot 20 + 132}{6}$
111. a. No. The formula shows that we are using  $\frac{126}{4}$  yards of fabric to make only skirts, not full dresses. Adding 2 yards of silk after will only be enough for 1 bodice.
- b. 20;  $\frac{126}{4+2}$
113. a. Every 70 days
- b. 14, 10, and 7 times, respectively
115. a. 360 pieces
- b. 15 boxes, 10 boxes, and 8 boxes, respectively
117. a. 660 minutes
- b. 11 hours

#### Writing & Thinking

119. If addition is within parentheses (or other grouping symbols), addition would be performed first.
121. 53, 59, 61, 67, 71; answers will vary.
123. a. To be prime, a number has to have exactly two different factors. The number 1 only has one unique factor, itself.
- b. A composite number has more than two different factors. The number 1 only has one unique factor, itself.

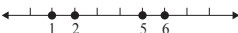




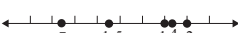

25.  $-7, -2, -\frac{5}{3}, -1.4, 0, \frac{3}{5}, 4, 5.9, 8$
27.  $<$       29.  $>$
31.  $<$       33.  $=$
35.  $>$       37.  $<$
39.  $=$       41.  $>$
43. True
45. False;  $-9 < -8.5$
47. True
49. True
51. False;  $-|-3| > -|4|$
53.  $x = -5, 5$
55.  $x = -2, 2$
57. No solution
59.  $x = -23, 23$

### 1.2 Exercises

#### Concept Check


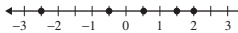
1. integers    3. irrational
5. graph      7. True
9. True

#### Practice

1. 3      3. 0
5. -2
7. 
9. 
11. 
13. 
15. 
17. 
19. 
21. 4, 8
23. -7, -2, 0, 4, 8

61. Sometimes. Examples will vary.
63. Always. Examples will vary.

#### Applications

65. -4500 meters
67. +8844 meters
69. a.  $|x| \leq 3$
- b. 
71. a. 
- 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  $-y = -(-2) = 2$ .

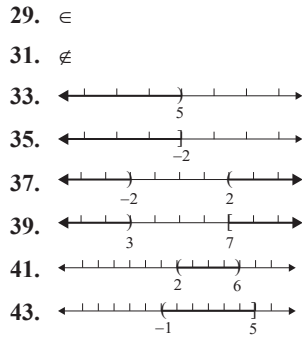
1.3 Exercises

Concept Check

- set
- empty set
- Set-builder notation
- False; The three ways to write sets are word descriptions, set-builder notation, and roster notation.
- True

Practice

- Transitive property
- Transitive property
- Trichotomy property
- $A$  is the set of the first five even positive integers.
- $C$  is the empty set.
- $E$  is the set of integers that are greater than two.
- $G = \{-12, -10, -8, -6, -4, -2\}$
- $I = \{0, 3, 6, 9, 12, 15, 18\}$
- $K = \{1, 3, 5, 7, 9, 11\}$
- $M = \begin{cases} x | 5 < x < 9 \text{ and} \\ x \text{ is even} \end{cases}$
- $O = \{x | x > 16\}$
- $S = \{x | x = 0\}$
- $U$  is the set of integers greater than 2 and less than 8.
  - $U = \{3, 4, 5, 6, 7\}$
  - $U = \begin{cases} x | 3 \leq x \leq 7 \text{ and} \\ x \text{ is an integer} \end{cases}$
- $W$  is the set of the first four whole numbers divisible by ten.
  - $W = \{0, 10, 20, 30\}$
  - $W = \begin{cases} x | 0 \leq x \leq 30 \\ \text{and } x \text{ is divisible} \\ \text{by } 10 \end{cases}$



1.4 Exercises

Concept Check

- positive
- perimeter
- area
- False; The sum of a positive and negative number can be positive, negative, or zero.
- True

Practice

- 35
- 11
- $\frac{7}{13}$
- 3
- 4
- 12
- $-\frac{7}{13}$
- $-\frac{3}{10}$
- 0.6
- 1
- 0
- 5
- 3
- $-\frac{23}{16}$
- $-\frac{1}{30}$
- 100
- 51
- 10
- $-\frac{15}{64}$
- $-\frac{1}{28}$
- 31.3326
- 3
- 4
- 4
- 4.1
- 11.08

Applications

- 45 cm
- 108 ft
- 31 m
- 25 square yards
- 63 square meters
- 216 square yards
- \$2101.61

- 2016 points
- 2820 ft
- 250 yards
- 648 square feet
- 10,080 square feet

1.5 Exercises

Concept Check

- grouping symbols
- left, right
- 1
- True
- True

Practice

- a. 36 b. 16
- 25
- 10
- 45
- 137
- 152
- 189
- 143
- 36
- 10
- $\frac{11}{30}$
- $\frac{1}{24}$
- $\frac{31}{24}$
- $\frac{10}{3}$
- $\frac{41}{32}$
- $\frac{3}{5}$
- 5.7
- 3.5
- 24
- 5
- 1
- $-\frac{13}{64}$
- 42.45
- 67.77
- 15.41

Applications

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

1.6 Exercises

Concept Check

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

Practice

- $3 + 7$
- $4 \cdot 19$
- $30 + 48$
- $(2 \cdot 3) \cdot x$
- $(3 + x) + 7$
- 0
- $x + 7$
- $2x - 24$
- 0
- Commutative property of addition
- Multiplicative identity
- Associative property of addition
- Commutative property of multiplication
- Commutative property of multiplication
- Multiplicative inverse
- Additive inverse
- Multiplicative identity
- Zero-factor law
- Associative property of addition
- $6(11) = 66$  and  $6 \cdot 3 + 6 \cdot 8 = 66$
- $10(-7) = -70$  and  $10 \cdot 2 - 10 \cdot 9 = -70$

43. Commutative property of multiplication;  
 $6 \cdot 4 = 4 \cdot 6 = 24$
44. 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  $\$85.04 - (\$28.79 + \$50.0 + \$12.16)$   
 b.  $-\$5.91$   
 c.  $-\$5.91 + \$5.91 = 0$   
 d. The additive inverse property

## Chapter 2: Solving 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.

15.  $x = -\frac{8}{15}$   
 17.  $x = -5$     19.  $n = 3$   
 21.  $y = 6$     23.  $x = 3$   
 25.  $n = 0$     27.  $y = 0$   
 29.  $z = -1$     31.  $y = \frac{1}{5}$   
 33.  $x = -3$     35.  $x = -4$   
 37.  $x = -21$     39.  $y = 0$   
 41.  $y = 1$     43.  $x = -\frac{3}{2}$   
 45.  $x = \frac{1}{4}$     47.  $x = \frac{3}{17}$   
 49.  $x = -\frac{1}{4}$     51.  $x = \frac{8}{5}$   
 53.  $x = \frac{2}{3}$     55.  $x = 6$   
 57.  $x = -11$     59.  $x = \frac{1}{2}$   
 61.  $x = -5$     63.  $n = -1.5$   
 65.  $x = 0$     67. Conditional

### 2.2 Exercises

#### Concept Check

1. identity  
 3. conditional  
 5. real,  $\mathbb{R}$   
 7. True

#### Practice

1.  $x = 5$         3.  $x = \frac{11}{20}$   
 5.  $x = 9$         7.  $y = 10$   
 9.  $y = 2.1$     11.  $x = -3$   
 13.  $x = -0.12$

#### Applications

81. 20 guests  
 83. 0.34 hours  
 85. 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.

87. 1800 square feet

89. 240 sundaes

Writing & Thinking

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

2.3 Exercises

Concept Check

- standard
- distance
- False; Equations involving absolute value can have more than one solution.
- True

Practice

- $x = -8, 8$
- No solution
- $x = -5, -1$
- $x = -\frac{4}{3}, \frac{5}{3}$
- $n = -2, \frac{2}{3}$
- No solution
- $x = 2$
- $x = -\frac{3}{2}, 2$
- $x = -\frac{1}{5}, 1$
- $x = -\frac{1}{3}, 3$
- $x = -22, 26$
- $x = -8, 4$
- $x = -6, 0$
- $x = -\frac{1}{3}, 3$
- $x = 1$
- $x = -\frac{5}{2}, \frac{3}{4}$
- $x = -\frac{20}{7}, \frac{4}{5}$
- $x = -20, \frac{40}{9}$

2.4 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  $b = \frac{2A}{h} - c$

61.  $x = \frac{8R + 36}{3}$  or  $x = \frac{8R}{3} + 12$

63.  $y = -x - 12$

65.  $C = nt + 9$

67.  $C = 325n + 5400$

69. a.  $I = Prt$

b.  $P = \$8000; I = \$600; t = 0.5$

c.  $r$  d.  $r = 15\%$

71. 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

2.5 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;  $4s = 20$
- $x - 5 = 13 - x; 9$
- $36 = 2x + 4; 16$
- $7x = 2x + 35; 7$
- $3x + 14 = 6 - x; -2$
- $\frac{2x}{5} = x + 6; -10$
- $4(x - 5) = x + 4; 8$
- $\frac{2x + 5}{11} = 4 - x; 3$

19.  $2x + 3x = 4(x + 3); 12$

21.  $n + (n + 2) = 60; 29, 31$

23.  $n + (n + 1) + (n + 2) = 69; 22, 23, 24$

25.  $n + (n + 1) + (n + 2) + (n + 3) = 74; 17, 18, 19, 20$

27.  $171 - n = (n + 1) + (n + 2); 56, 57, 58$

29.  $208 - 3n = (n + 1) + (n + 2) + (n + 3) - 50; 42, 43, 44, 45$

31.  $n + 2(n + 2) = 4(n + 4) - 54; 42, 44, 46$

33.  $(n + 2) + (n + 4) - n = 66; 60, 62, 64$

35.  $2n + 3(n + 2) = 2(n + 4) + 7; 3, 5, 7$

Applications

- a. The unknown value is the number of postcards purchased.  
b.  $p = 9$   
c. Brooke purchased 9 postcards.
- 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.
- $(c - 58.96) + c = 96.94$ ; Flash drive: \$18.99; Printer: \$77.95
- $7x = 91,399; 13,057$
- $x + x + (x + 3) + (x + 3 + 5) = 19; 2$  magazines
- $50 - 2x = 10.50; \$19.75$
- $800 + 50(x - 2) = 1450; 15$  hours
- $19.99 + 0.65x = 127.24; 165$  miles
- $n + 4n - 4 + 2n + 7 = 59; 8$  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;  $n = 3$

### 2.6 Exercises

#### Concept Check

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

#### Applications

- Original price
  - $x$ ;  $0.20x$     c. \$119.95
- 2 liters    b.  $0.25x$
  - $x + 20$
  - $0.20(x + 20) = 2 + 0.25x$
  - 40 liters
- $x$  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.
  - 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.
- 1.68 mph
- 8.75 hours

- 3 hours
- 50 mph; 300 miles
- 7 hours
- 36 mph; 60 mph
- Day: 56 mph;  
Night: 69 mph
- 4.5 miles

23. a.

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

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

- \$7400 at 5.5%;  
\$2600 at 6%
- \$7000 at 6%; \$9000 at 8%
- \$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 |   | $0.04(3600 - P)$ |

- $0.08P + 0.04(3600 - P) = 198$
  - $P = \$1350$
  - High-risk fund: \$1350;  
Low-risk fund: \$2250
  - Answer will vary.
- \$6720 at 5.5%;  
\$5280 at 7%
  - \$600 at 2.5%; \$800 at 4%
  - \$11,000 at 4%;  
\$9500 at 5%
  - \$40.50
  - \$113.75
  - \$1140
    - $x - 0.05x$  or  $0.95x$
    - $x - 0.05x - 2850 = 1140$  or  $0.95x - 2850 = 1140$
    - \$4200

e. Robin's Refurbished Wrecks should sell the used car for \$4200.

- 94
- 4 phone calls
- \$20
- Not possible
  - 192
- 3.2 inches
  - 7.1 inches
  - 6.9 inches
- 80.4 million
  - 26 million
  - 75 million

#### Writing & Thinking

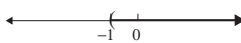
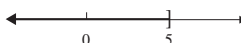
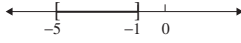
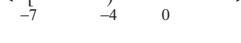
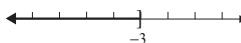
- If each equal side is 9 cm long, that would make the perimeter more than 18 cm; Correct answer: 6 cm
- He would not be able to paddle faster than the current, so he would not be able to return upriver at all; Correct answer:  $\frac{2}{3}$  mph

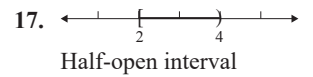
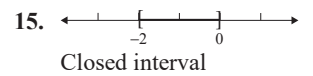
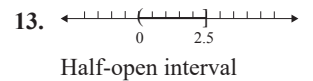
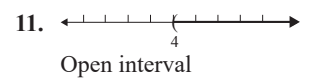
### 2.7 Exercises

#### Concept Check

- interval    3. closed
- addition    7. True
- False; Only one value in the solution set needs to be checked.

#### Practice

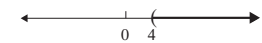
- $(-1, \infty)$   

- $(-\infty, 5]$   

- $[-5, -1]$   

- $[-7, -4)$   

-   
Half-open interval

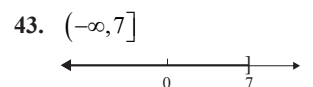
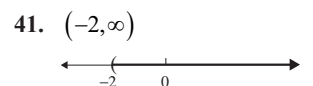
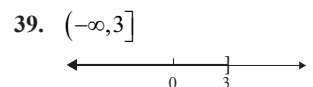
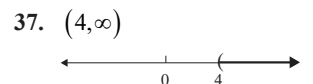
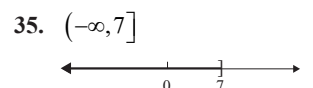
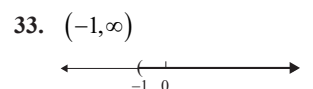
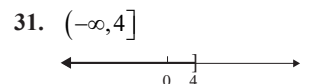


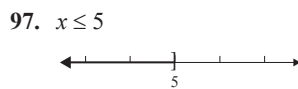
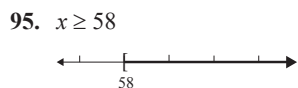
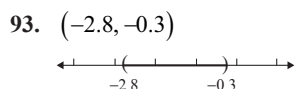
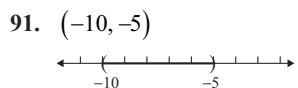
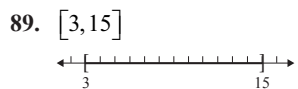
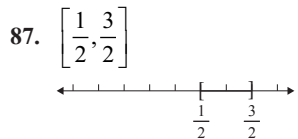
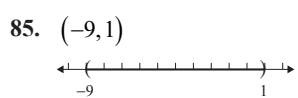
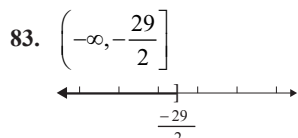
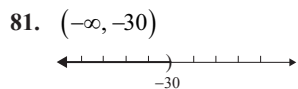
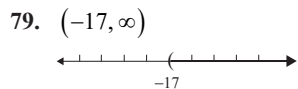
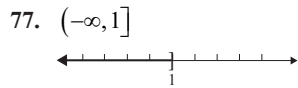
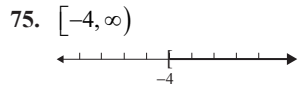
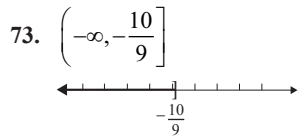
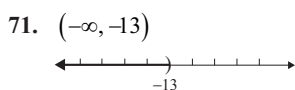
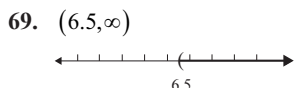
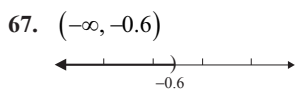
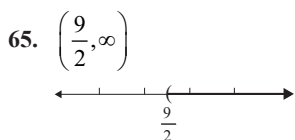
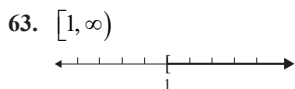
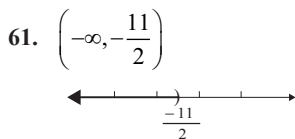
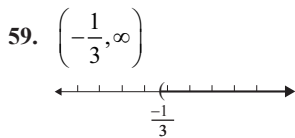
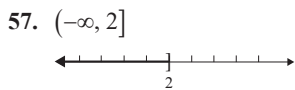
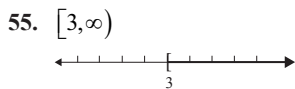
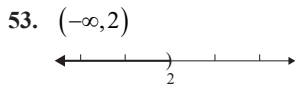
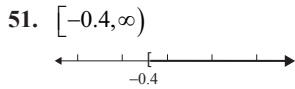
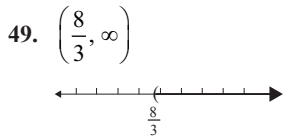
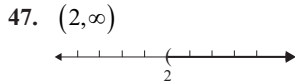
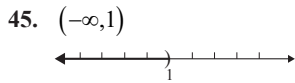
- $x \leq -2$
  - $(-\infty, -2]$   
Half-open interval

- $x \geq -4$
  - $[-4, \infty)$   
Half-open interval

- $-3 < x < 1$
  - $(-3, 1)$  Open interval
- $-2 \leq x \leq 2$
  - $[-2, 2]$  Closed interval

- $x < 3$
  - $(-\infty, 3)$  Open interval
- $(4, \infty)$   






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

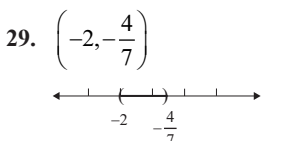
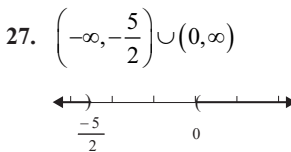
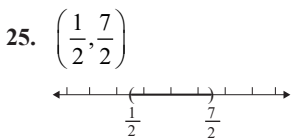
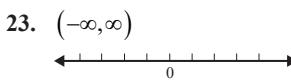
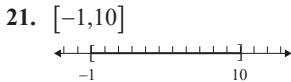
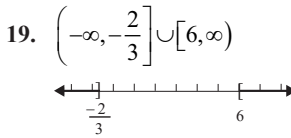
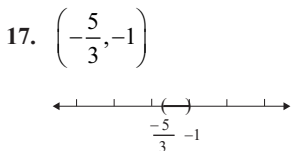
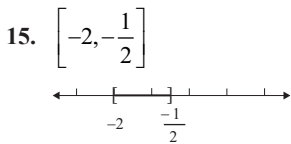
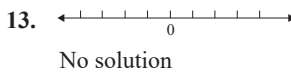
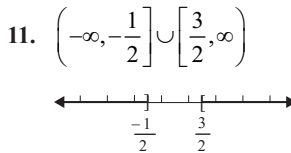
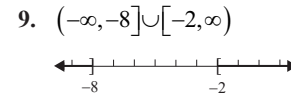
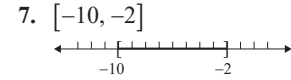
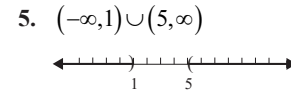
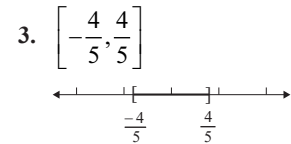
b. If you solve the inequality you get  $c \leq 15.2$ , but you can't buy 0.2 ink cartridges, so  $c \leq 15$ .

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.

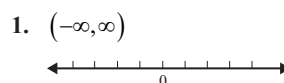


2.8 Exercises

Concept Check

- standard 3. or
- False; Only one statement/inequality must be true.
- False; Must be greater than 2

Practice



Writing & Thinking

31. a.



b.  $|x| \leq 10$

c.  $[-10, 10]$   
Closed interval

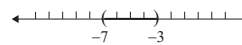
33. a.



b.  $|x - 8| > 6$

c.  $(-\infty, 2) \cup (14, \infty)$

35. a.



b.  $|x + 5| < 2$

c.  $(-7, -3)$ ,  
Open interval

## Chapter 3: Linear Equations and Functions

### 3.1 Exercises

Concept Check

1. quadrants
3. III      5. origin
7. True      9. True

Practice

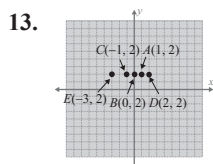
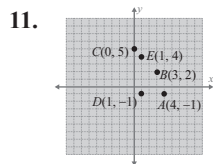
1.  $\left\{ \begin{array}{l} A(-5, 1), B(-3, 3), \\ C(-1, 1), D(1, 2), \\ E(2, -2) \end{array} \right\}$

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

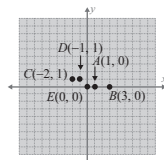
5.  $\left\{ \begin{array}{l} A(-4, 4), B(-3, -4), \\ C(0, -4), D(0, 3), \\ E(4, 1) \end{array} \right\}$

7.  $\left\{ \begin{array}{l} A(-3, -5), B(-1, 4), \\ C(0, -1), D(3, 1), \\ E(6, 0) \end{array} \right\}$

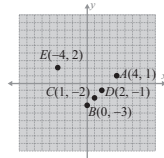
9.  $\left\{ \begin{array}{l} A(-5, 0), B(-2, 2), \\ C(-1, -4), D(0, 6), \\ E(2, 0) \end{array} \right\}$



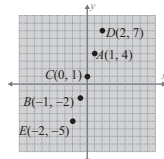
15.



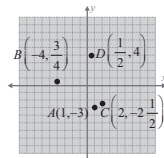
17.



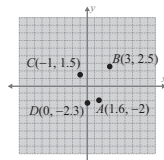
19.



21.



23.



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

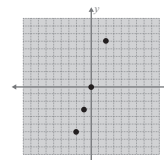
27.  $(0, 3), (2, 2), (6, 0), (-2, 4)$

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

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

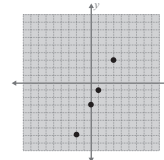
33.  $\left(0, \frac{-7}{4}\right), (1, -1), \left(\frac{7}{3}, 0\right), \left(3, \frac{1}{2}\right)$

35.



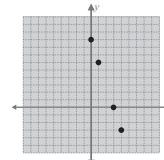
$(0, 0), (-1, -3), (-2, -6), (2, 6)$

37.



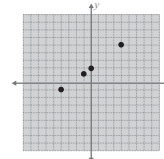
$(0, -3), (1, -1), (-2, -7), (3, 3)$

39.



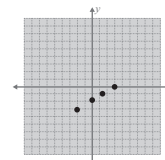
$(0, 9), (3, 0), (1, 6), (4, -3)$

41.



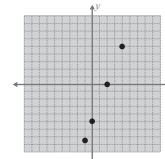
$(0, 2), (4, 5), (-4, -1), \left(-1, \frac{5}{4}\right)$

43.



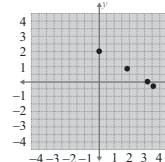
$\left(0, -\frac{9}{5}\right), (3, 0), (-2, -3), \left(\frac{4}{3}, -1\right)$

45.



$(0, -5), (2, 0), \left(-1, -\frac{15}{2}\right), (4, 5)$

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  $(4, 3).$

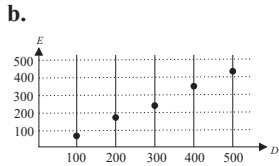
61. For example,  $(-4, -4), (0, -3),$  and  $(4, -2).$

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

Applications

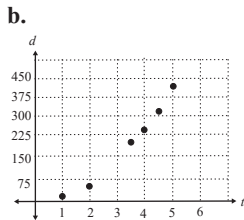
65. a.

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

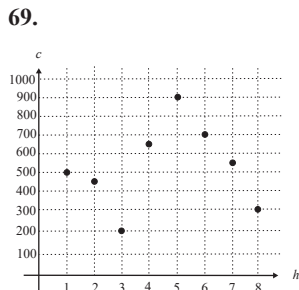


67. a.

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

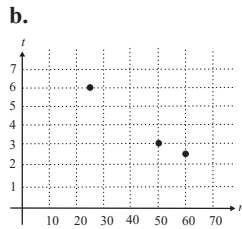


- c. The time  $t$  is squared in the equation.



71. a.

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



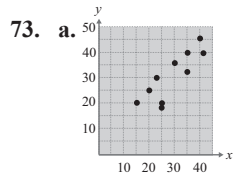
- c. The time decreases as the rate increases.

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.

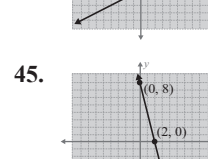
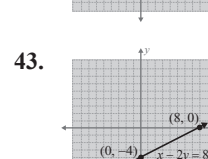
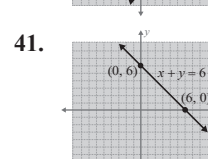
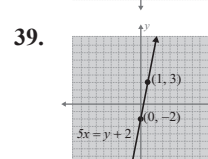
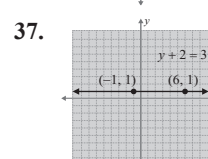
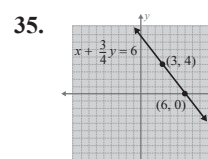
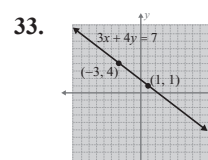
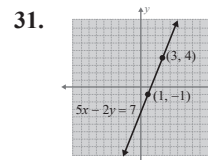
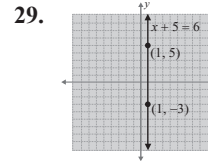
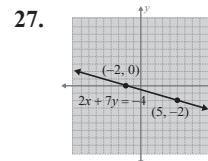
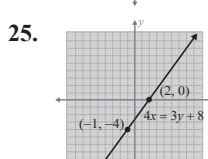
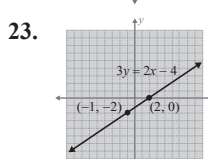
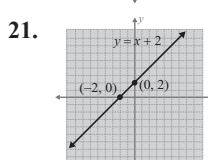
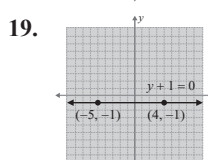
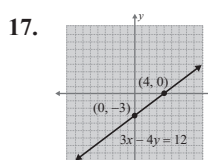
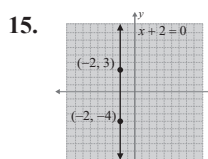
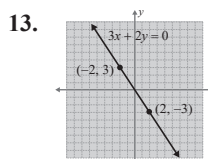
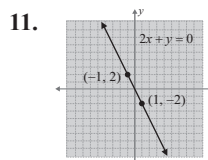
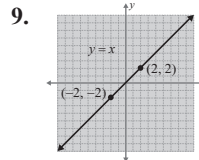
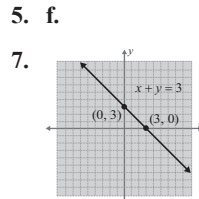
3.2 Exercises

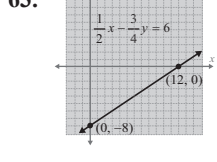
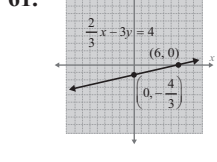
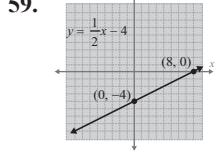
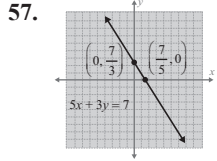
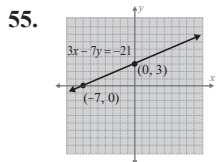
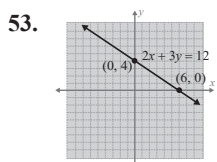
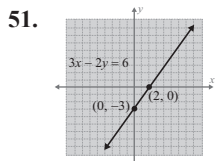
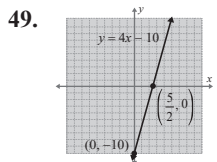
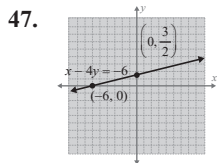
Concept Check

1.  $y$       3. infinite  
 5. line      7. True  
 9. False; Horizontal lines have  $y$ -intercepts.

Practice

1. a.      3. d.



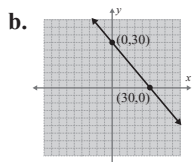


Applications

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:  $(0, 30)$

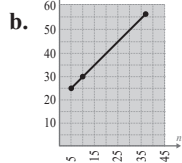


- c. Answers will vary.  
Negative number of cookies; Total amount of cookies is over 30 dozen.

- 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.

3.3 Exercises

Concept Check

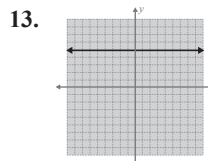
1. run                      3. positive  
5. 0                        7. True  
9. True

Practice

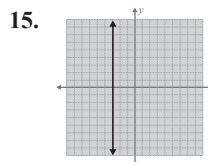
1.  $m = 5$                 3.  $m = -\frac{1}{7}$

5.  $m = 0$                 7.  $m = \frac{1}{2}$

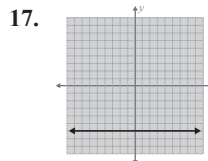
9.  $m = 2$                 11.  $m = \frac{1}{5}$



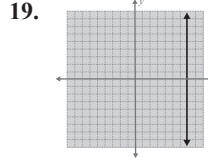
Horizontal line;  $m = 0$



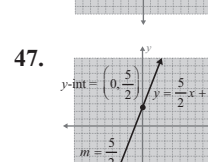
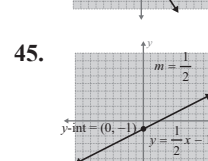
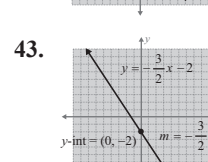
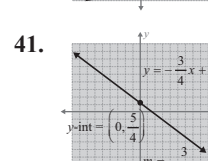
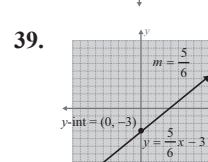
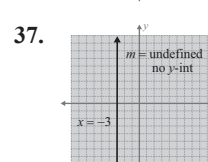
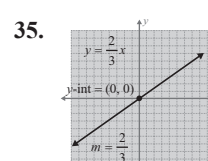
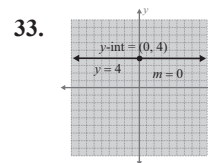
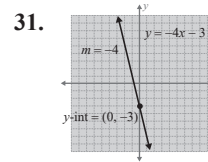
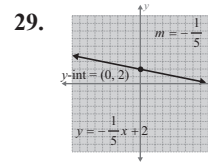
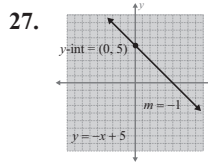
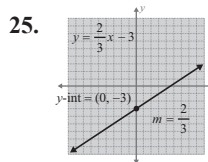
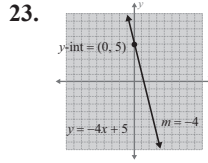
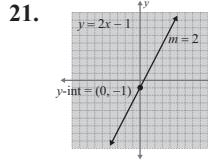
Vertical line;  
 $m$  is undefined



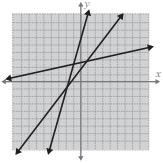
Horizontal line;  $m = 0$



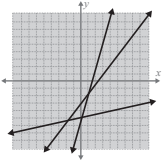
Vertical line;  
 $m$  is undefined



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

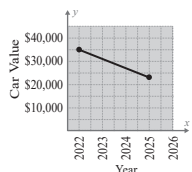
75. Yes

Applications

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

81. 54 mph

83. \$4000/year

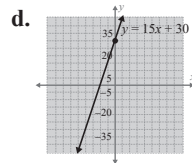


85. -5.66

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

b.  $(0, 30)$

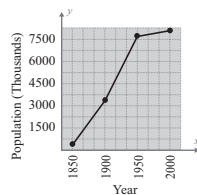
c.  $y = 15x + 30$



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

f. \$90

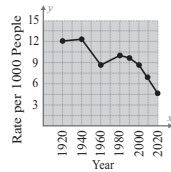
89. a. and b.



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.

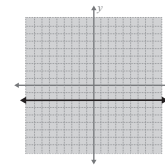


c. -0.18, 0.075, -0.02, -0.13, -0.17, -0.17

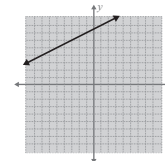
d. # of marriages decreased 0.18 marriages/1000 people from '40-'60, increased 0.075 marriages/1000 people from '60-'80, decreased 0.02 marriages/1000 people from '80-'90, decreased 0.13 marriages/1000 people from '90-'00, decreased

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

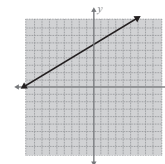
9.  $y = -2$



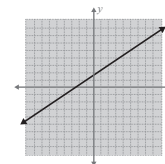
11.  $x - 2y = -15$



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



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

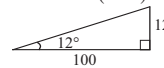


Writing & Thinking

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.



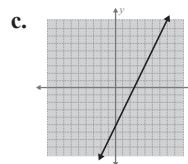
3.4 Exercises

Concept Check

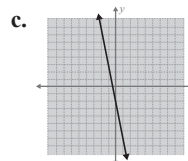
- 1. negative reciprocals
- 3. same
- 5. slope
- 7. True
- 9. True

Practice

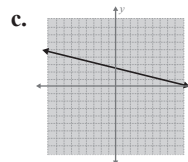
1. a.  $m = 2$  b.  $(3, 1)$



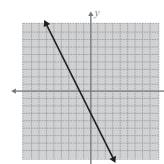
3. a.  $m = -5$  b.  $(0, -2)$



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



7.  $2x + y = -3$



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.  $3x - 4y = -14$

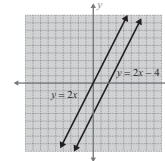
33.  $7x + 3y = -5$

35.  $y = 6$

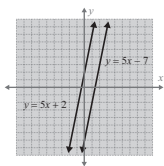
37.  $y = 7$

39.  $y = 7$

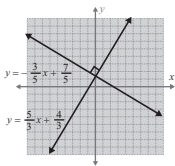
41.  $y = 2x$



43.  $y = 5x + 2$

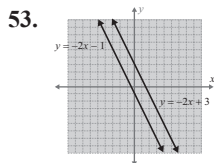
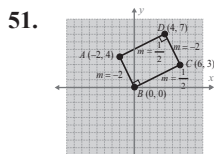


45.  $y = -\frac{3}{5}x + \frac{7}{5}$

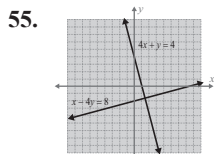


47.  $y = -\frac{1}{3}x$

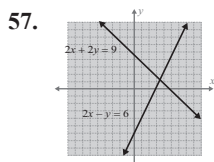
49.  $y = -\frac{1}{2}x - 2$



Parallel



Perpendicular

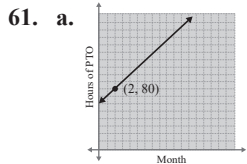


Neither

Applications

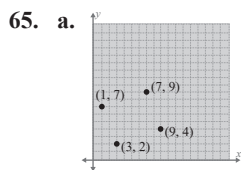
59. a.  $P = 100t - 5000$

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

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

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

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

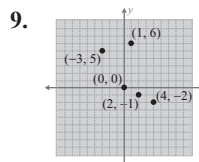
Not a function

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

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

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

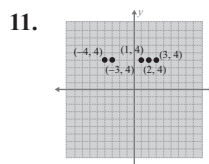
Not a function



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

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

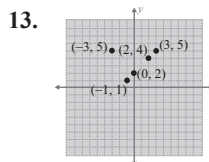
Function



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

$R = \{4\}$ ;

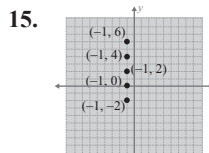
Function



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

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

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  $x \neq 3$

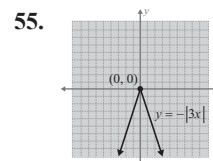
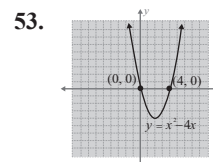
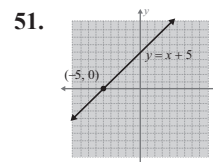
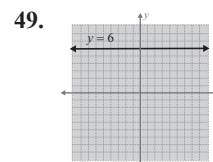
39. a. -4 b. -16 c. -10

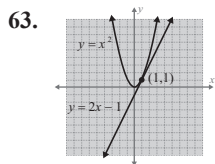
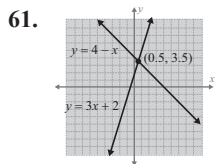
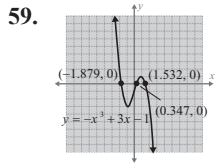
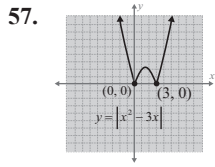
41. a. 0 b. 12 c. 56

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

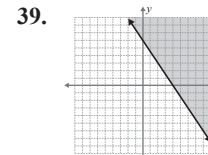
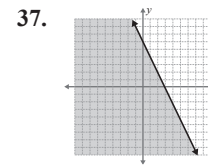
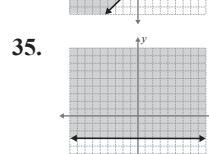
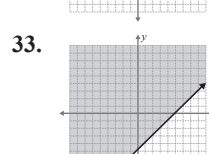
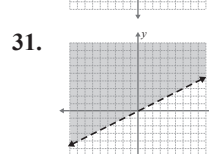
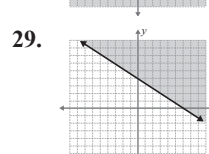
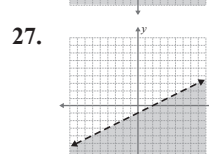
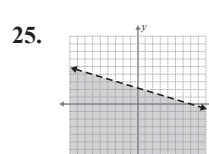
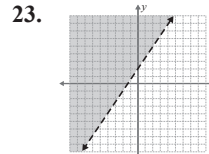
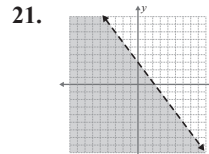
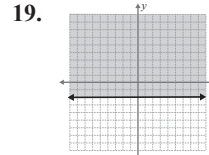
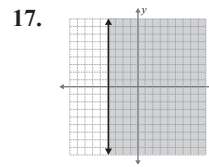
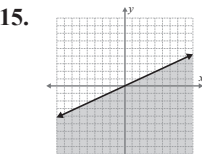
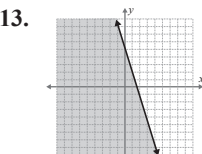
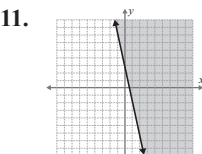
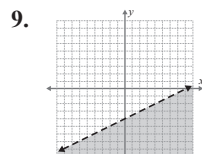
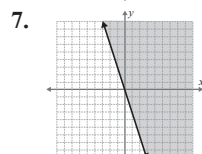
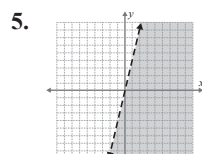
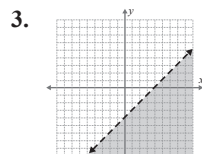
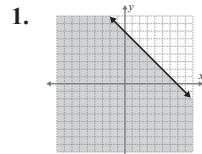
71. a.  $(0, 250)$ , represents Ariella's base weekly salary  
 b. 0.15; Represents the commission rate  
 c.  $y = 0.15x + 250$   
 d.  $f(x) = 0.15x + 250$   
 e. Domain is all real numbers; Range is all real numbers  
 f. Answers will vary. Some students may say sales cannot be negative, some will allow negative sales due to returns.  
 g. \$1000

3.6 Exercises

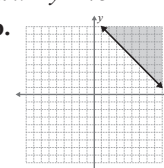
Concept Check

1. test      3. open  
 5. closed    7. True  
 9. False; The boundary line is solid if the inequality uses  $\leq$  or  $\geq$ .

Practice



Applications

41. a.  $x + y \geq 75$   
 b.   
 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 4: Systems of Linear Equations

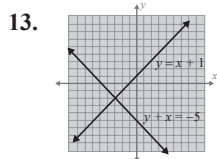
## 4.1 Exercises

### Concept Check

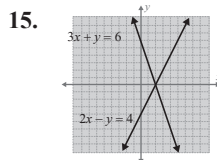
- simultaneous
- same
- one
- False; The solution must be checked in all equations.
- True

### Practice

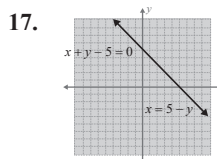
- c
- a, c
- (0, 2)
- (4, 2)
- $m_1 = -2, b_1 = 3,$   
 $m_2 = -2, b_2 = \frac{5}{2}$
- $m_1 = \frac{1}{2}, b_1 = 3,$   
 $m_2 = \frac{1}{2}, b_2 = -\frac{1}{2}$



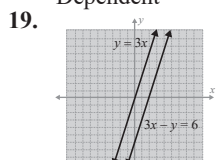
$(-3, -2)$ ; Consistent; Independent



$(2, 0)$ ; Consistent; Independent

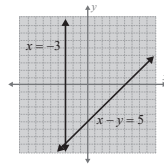


$(x, -x + 5)$ ; Consistent; Dependent

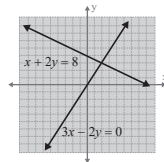


No solution; Inconsistent; Independent

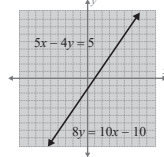
21.  $(-3, -8)$



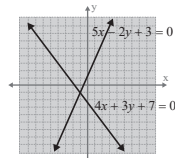
23.  $(2, 3)$



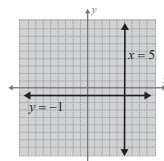
25.  $(x, \frac{5}{4}x - \frac{5}{4})$



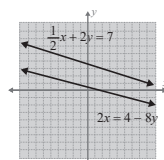
27.  $(-1, -1)$



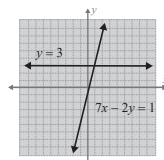
29.  $(5, -1)$



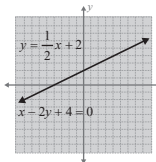
31. No solution



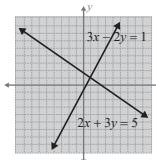
33.  $(1, 3)$



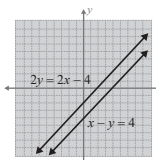
35.  $(x, \frac{1}{2}x + 2)$



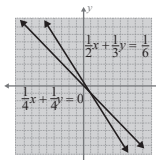
37.  $(1, 1)$



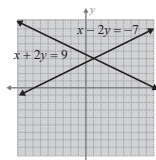
39. No solution



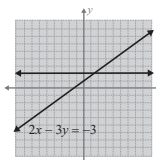
41.  $(1, -1)$



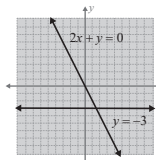
43.  $(1, 4)$



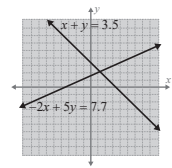
45.  $(1.5, 2)$



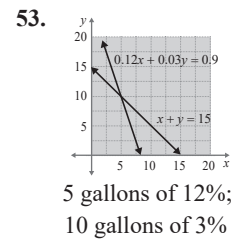
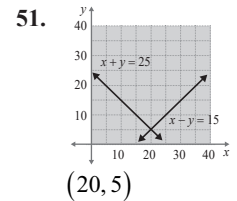
47.  $(1.5, -3)$



49.  $(1.4, 2.1)$



### Applications



5 gallons of 12%;

10 gallons of 3%

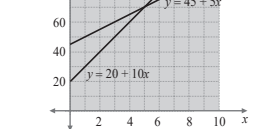
55. 134 hours

57. a. Fit4life:

$$y = 20 + 10x;$$

Workout Nation:

$$y = 45 + 5x$$



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.

### 4.2 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.

### 4.3 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. ( $1, -\frac{3}{2}$ )
5. No solution
7. (x, 3 - x) 9. (-2, -3)
11. (7, 5) 13. (1, -5)
15. ( $x, \frac{1}{2}x - 2$ )
17. ( $\frac{22}{7}, -\frac{2}{7}$ )
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. ( $2, \frac{10}{9}$ )
39. No solution
41. ( $-\frac{45}{7}, \frac{92}{7}$ )
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.

### 4.4 Exercises

Practice

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

Applications

7. 80°, 100°
9. 55°, 55°, 70°
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 × 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.

### 4.5 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.

### 4.6 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.  $(3, 5, 8)$

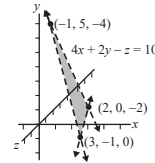
c. Each bouquet will have  
3 lilies, 5 roses, and  
8 daisies.

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



### 4.7 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.

### 4.8 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

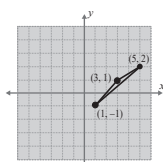
21. 20      23.  $x = 7$

25. -1      27. -2

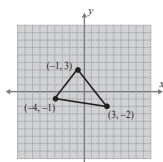
29.  $x = 2$       31.  $x + 2y = 7$

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.

4.9 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.

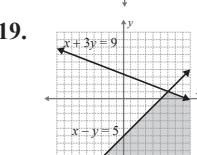
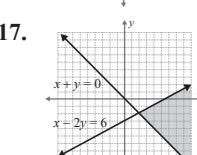
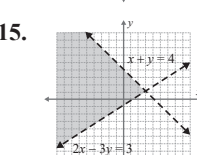
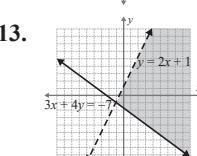
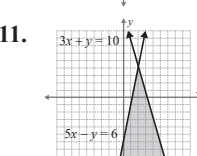
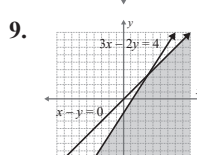
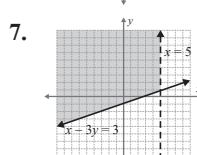
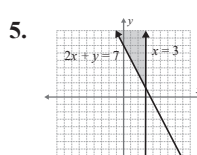
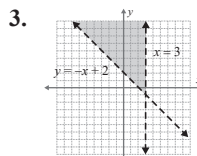
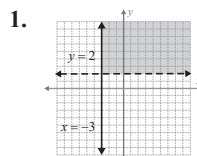
4.10 Exercises

Concept Check

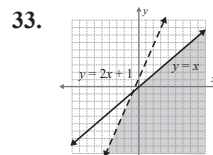
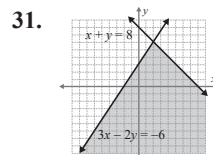
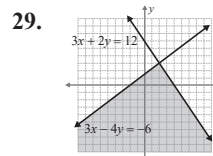
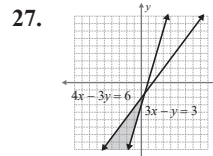
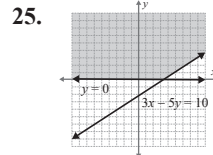
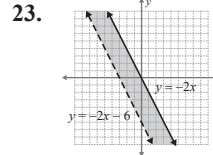
- 1. test-point    3. closed
- 5. three
- 7. False; When boundary lines are parallel, the solution is either the strip between the boundary lines, a half-plane, or there is no solution.

9. True

Practice

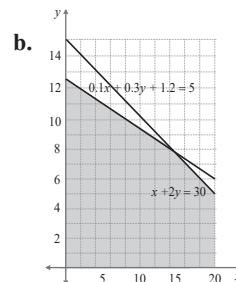


21. No solution



Applications

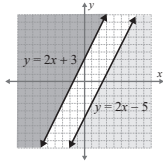
35. a.  $\begin{cases} 0.1x + 0.3y + 1.2 < 5 \\ x + 2y < 30 \end{cases}$



- 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 5: Exponents and Polynomials

### 5.1 Exercises

Concept Check

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

Practice

1. 27
3. 512
5.  $\frac{1}{3}$
7.  $\frac{1}{25}$
9. 16
11. 24
13. -500
15.  $\frac{3}{8}$
17.  $-\frac{3}{25}$
19.  $x^5$
21.  $y^2$
23.  $\frac{1}{x^3}$
25.  $\frac{2}{x}$
27.  $-\frac{8}{y^2}$
29.  $\frac{5x^6}{y^4}$
31. 4
33. 49
35.  $\frac{1}{10}$
37.  $\frac{1}{8}$
39.  $x^2$
41.  $x^2$
43.  $x^4$
45.  $\frac{1}{x^4}$
47.  $x^6$
49.  $x^2$
51.  $y^2$
53.  $3x^3$
55.  $x^4$
57.  $36x^3$
59.  $-14x^5$
61.  $-12x^6$
63.  $4y$

65.  $3y^2$
67.  $-2y^2$
69.  $\frac{1}{x^2}$
71. 1000
73. 1
75.  $-18x^5y^7$
77.  $-\frac{2y^2}{x}$
79.  $12a^3b^9c$
81.  $-4a^{10}b^3c$
83.  $\frac{5}{x}$
85. 1
87. 0.3906
89. 8875.147264

Applications

91. 2<sup>8</sup> GB
93.  $10^{-24}$  cm<sup>3</sup>
95. 1 delivery
97. 3<sup>9</sup> square yards
99. a.  $(2x)^3$   
b. Product rule for exponents  
c.  $8x^3$  d. 64 cm<sup>3</sup>
101. a.  $\frac{2^{38}}{230} = 28$  gigabytes  
b. 256 gigabytes  
c. Quotient rule

### 5.2 Exercises

Concept Check

1. exponent(s)
3. multiply, keep
5. coefficient
7. True
9. True

Practice

1. -81
3. -16

5. 1,000,000
7.  $a^6$
9.  $\frac{1}{x^{10}}$
11.  $\frac{1}{256}$
13.  $9y^2$
15.  $16x^2y^2$
17.  $\frac{1}{x^6y^6}$
19.  $36x^6$
21.  $-108x^6$
23.  $\frac{5x^2}{y}$
25.  $-\frac{2y^6}{27x^{15}}$
27.  $\frac{a^4}{b^4}$
29.  $\frac{4}{9}$
31.  $\frac{x^6}{y^6}$
33.  $\frac{27x^3}{y^3}$
35. 1
37.  $4x^4y^4$
39.  $\frac{y^2}{x^2}$
41.  $\frac{1}{3xy^2}$
43.  $-\frac{x^3y^6}{27}$
45.  $m^2n^4$
47.  $-\frac{y^2}{49x^2}$
49.  $\frac{25x^6}{y^2}$
51.  $\frac{x^6}{y^6}$
53.  $\frac{36y^{14}}{x^4}$
55.  $\frac{49y^4}{x^6}$
57.  $\frac{24y^5}{x^7}$
59.  $\frac{4x^3}{3}$

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.  $\frac{(8.4 \times 10^{-3})(3 \times 10^{-3})}{(2.1 \times 10^{-1})(6 \times 10)}$ ;  
 $2 \times 10^{-6}$

### 5.3 Exercises

Concept Check

1. 1, 10

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.  $\frac{(1.4 \times 10^{-2})(9.22 \times 10^2)}{(3.5 \times 10^3)(2.0 \times 10^6)}$   
 $1.844 \times 10^{-9}$
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.  $3 \times 10^8$     51.  $8.5 \times 10^7$   
 53.  $3 \times 10^{22}$     55.  $1.6051 \times 10^{15}$   
 57.  $1 \times 10^2$     59.  $1.02 \times 10^{22}$

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  $5.210^5$

5.4 Exercises

Concept Check

- descending
- leading
- binomial
- False; Degree of 0
- True

Practice

- Monomial
- Binomial
- Trinomial
- Not a polynomial

- Binomial
- $4y$ ; First-degree monomial; Leading coefficient 4
- $x^3 + 3x^2 - 2x$ ; Third-degree trinomial; Leading coefficient 1
- $-2x^2$ ; Second-degree monomial; Leading coefficient -2
- 0; Monomial of no degree; Leading coefficient 0
- $6a^5 - 7a^3 - a^2$ ; Fifth-degree trinomial; Leading coefficient 6
- $2y^3 + 4y$ ; Third-degree binomial; Leading coefficient 2
- 4; Monomial of degree 0; Leading coefficient 4
- $2x^3 + 3x^2 - x + 1$ ; Third-degree polynomial; Leading coefficient 2
- $4x^4 - x^2 + 4x - 10$ ; Fourth-degree polynomial; Leading coefficient 4
- $9x^3 + 4x^2 + 8x$ ; Third-degree trinomial; Leading coefficient 9
- 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.  $10a + 25$

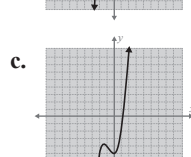
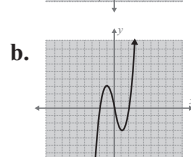
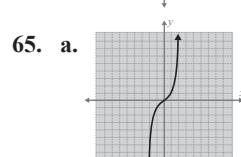
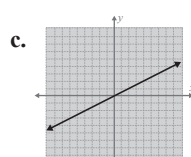
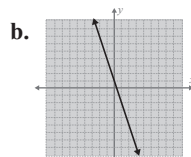
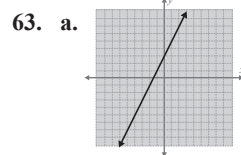
Applications

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.



9. False; They are like terms because they have the same variable raised to the same exponent.

Practice

- $3x^2 + 7x + 2$
- $2x^2 + 11x - 7$
- $3x^2$
- $x^2 - 5x + 17$
- $-x^2 + 2x - 7$
- $2x^3 + 4x^2 - 3x - 7$
- $-x^2 + 7x - 3$

- $-x^3 + 2x^2 + 3x - 4$
- $4x^3 + 7$
- $2x^3 + 11x^2 - 4x - 3$
- $x^2 + x + 6$
- $-3x^2 - 6x - 2$
- $3x^2 - 4x - 8$
- $-x^4 - 2x^3 - 16$
- $-4x^4 - 7x^3 - 11x^2 + 5x + 13$

- $-4x^2 + 6x + 1$
- $3x^4 - 7x^3 + 3x^2 - 5x + 9$
- $6x^2 - 7x + 18$
- $8x^4 + 6x^2 + 15$
- $2x^3 + 4x^2 + 3x - 10$
- $4x - 13$
- $-7x + 9$

- $2x + 17$
- $3x^3 + 13x^2 + 9$
- $8x^2 - x - 2$
- $3x - 19$

- $x^2 - 2x + 13$
- $7x - 3$
- $4x^2 + 3x + 5$
- $7x - 18$
- $x^2 + 11x - 8$
- $7x^3 - x^2 - 7$

Applications

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

5.5 Exercises

Concept Check

- sign
- like
- variables
- False; All terms are subtracted.

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.

5.6 Exercises

Concept Check

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

Practice

- $-6x^5 - 15x^3$
- $4x^7 - 12x^6 + 4x^5$
- $-y^5 + 8y - 2$
- $-4x^8 + 8x^7 - 12x^4$
- $25x^5 - 5x^4 + 10x^3$
- $a^7 + 2a^6 - 5a^3 + a^2$
- $x^2 + x - 12$
- $a^2 - 2a - 48$
- $x^2 - 3x + 2$
- $3t^2 - 3t - 60$
- $x^3 + 11x^2 + 24x$
- $2x^2 - 7x - 4$
- $6x^2 + 17x - 3$
- $4x^2 - 9$
- $16x^2 + 8x + 1$
- $y^3 + 2y^2 + y + 12$
- $3x^2 - 8x - 35$
- $5x^3 + 6x^2 - 22x - 9$
- $2x^4 + 7x^3 + 5x^2 + x - 15$
- $3x^2 + 2x - 8$
- $2x^2 + 3x - 5$
- $7x^2 - 13x - 2$
- $6x^2 - 13x - 8$
- $4x^2 + 12x + 9$
- $x^3 + 3x^2 - 4x - 12$

- $4x^2 - 49$
- $x^3 + 1$
- $49a^2 - 28a + 4$
- $x^3 + 8x^2 + 15x$
- $6x^3 - 2x^2 - 4x$
- $2x^3 + x^2 - 5x - 3$
- $x^3 + 6x^2 + 11x + 6$
- $a^4 - a^2 + 2a - 1$
- $t^4 + 6t^3 + 13t^2 + 12t + 4$
- $6x^2 - x - 2$
- $9a^2 - 25$
- $-10x^2 + 39x - 14$
- $x^3 + 5x^2 + 8x + 4$
- $2y^2 - 61$
- $3a^2 - 17a + 11$
- $-3x - 21$
- $a^2 + 9a - 1$

Applications

- $6x^2 + 15x$  square inches
- $R(x) = -8x^2 + 70x + 1500$
- 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

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

5.7 Exercises

Concept Check

- difference
- trinomial
- False; The product will be a binomial.
- True

Practice

- $x^2 - 14x + 49$ ;  
 Perfect square trinomial
- $x^2 + 8x + 16$ ;  
 Perfect square trinomial

- $x^2 - 9$ ;  
 Difference of two squares
- $x^2 - 81$ ;  
 Difference of two squares
- $2x^2 + x - 3$
- $9x^2 - 24x + 16$ ;  
 Perfect square trinomial
- $25x^2 - 4$ ;  
 Difference of two squares
- $9x^2 - 12x + 4$ ;  
 Perfect square trinomial
- $x^2 - 16x + 64$ ;  
 Perfect square trinomial
- $16x^2 - 25$ ;  
 Difference of two squares
- $25x^2 - 81$ ;  
 Difference of two squares
- $x^2 - 8x + 16$ ;  
 Perfect square trinomial
- $4x^2 - 49$ ;  
 Difference of two squares
- $10x^4 - 11x^2 - 6$
- $49x^2 + 14x + 1$ ;  
 Perfect square trinomial
- $x^2 + 10x + 25$
- $x^4 - 1$
- $x^4 + 6x^2 + 9$
- $x^6 - 4x^3 + 4$
- $9x^2 - 4$
- $16x^2 - 9$
- $25x^2 + 30x + 9$
- $36x^2 - 60x + 25$
- $x^2 - 1.96$
- $x^2 - 5x + 6.25$
- $x^2 - 4.6225$
- $x^2 + 2.48x + 1.5376$
- $2.0164x^2 + 27.264x + 92.16$
- $129.96x^2 - 12.25$
- $93.24x^2 + 142.46x - 104.04$

Applications

- a.  $A(x) = 900 - 4x^2$   
 b.  $P(x) = 4(30 - 2x) + 8x = 120$

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

5.8 Exercises

Concept Check

- rational
- numerator, simplify
- 0
- False; Descending order
- True

Practice

- $y^2 - 2y + 3$
- $2x^2 - 3x + 1$
- $10x^3 - 11x^2 + x$
- $-4x^2 + 7x - \frac{5}{2}$
- $y^3 - \frac{7}{2}y^2 - \frac{15}{2}y + 4$
- $x - 6 + \frac{4}{x + 4}$
- $3x - 4 - \frac{7}{2x - 1}$
- $3x + 4 + \frac{1}{7x - 1}$
- $x - 9$
- $x^2 - x - \frac{3}{x - 8}$
- $4x^2 - 6x + 9 - \frac{17}{x + 2}$
- $x^2 + 7x + 55 + \frac{388}{x - 7}$

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  $x$ .

5.9 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.  $41^\circ\text{F}$

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 6: Factoring Polynomials

6.1 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.

6.2 Exercises

Concept Check

- constant, middle
- positive
- different
- False; One factor is negative, one is positive.
- True

Practice

- $\{1, 15\}, \{-1, -15\}, \{3, 5\}, \{-3, -5\}$
- $\{1, 20\}, \{-1, -20\}, \{4, 5\}, \{-4, -5\}, \{2, 10\}, \{-2, -10\}$
- $\{1, -6\}, \{6, -1\}, \{2, -3\}, \{3, -2\}$
- $\{1, 16\}, \{-1, -16\}, \{4, 4\}, \{-4, -4\}, \{8, 2\}, \{-8, -2\}$
- $\{1, -10\}, \{10, -1\}, \{5, -2\}, \{2, -5\}$
- 4, 3    13. -7, 2
- 8, -1    17. -6, -6
- 5, -4    21.  $x+1$
- $p-10$     25.  $a+b$

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.

6.3 Exercises

Concept Check

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

Practice

- $(x+2)(x+3)$
- $(2x-5)(x+1)$
- $(6x+5)(x+1)$
- $-(x-2)(x-1)$
- $(x-5)(x+2)$
- $-(x-14)(x+1)$
- Not factorable
- $-x(2x+1)(x-1)$
- $(t-1)(4t+1)$
- $(5a-6)(a+1)$
- $(7x-2)(x+1)$
- $(2x-3)(4x+1)$
- $(3x+4)(3x-5)$
- $2(2x-5)(3x-2)$
- $(3x-1)(x-2)$
- $(3x-1)(3x-1)$
- $(3y+2)(2y+1)$
- $(x-1)(x-45)$
- Not factorable
- $2b(4a-3)(a-2)$
- Not factorable
- $(4x-1)(4x-1)$
- $(8x-3)(8x-3)$
- $2(3x-5)(x+2)$
- $5(2x+3)(x+2)$
- $-2(9x^2-36x+4)$
- $-15(3y+4)(y-2)$
- $3(2x-5)(2x-5)$
- $3x(2x-1)(x+2)$
- $3x(2x-9)(2x-9)$
- $9xy^3(x^2+x+1)$
- $4xy(3y-4)(4y-3)$

65.  $7y^2(y-4)(3y-2)$

Writing & Thinking

- This is not an error, but the trinomial is not completely factored. The completely factored form of this trinomial is  $2(x+2)(x+3)$ .
- $x(5-2x)(25-2x)$ ; The height is  $x$ , the width is  $(5-2x)$ , and the length is  $(25-2x)$ .

6.4 Exercises

Concept Check

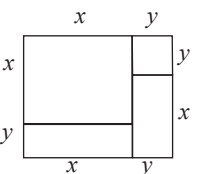
- binomial    3.  $2ax, -2ax$
- $(x+a)(x^2-ax+a^2)$
- True
- False; The sum of two squares is not factorable.

Practice

- $(x-5)(x+5)$
- $(9-y)(9+y)$
- $2(x-8)(x+8)$
- $4(x-2)(x+2)(x^2+4)$
- Not factorable
- $(y-8)^2$
- $-4(x-5)(x+5)$
- $(3x-5)(3x+5)$
- $(y-5)^2$
- $(2x-1)^2$
- $(5x+3)^2$
- $(4x-5)^2$
- $4x(x-4)(x+4)$
- $2xy(x+8)^2$
- $(y+3)^2$
- $(x-10)^2$
- $(x^2+5y)^2$
- $(x-5)(x^2+5x+25)$
- $(y+6)(y^2-6y+36)$
- $(x+3y)(x^2-3xy+9y^2)$
- 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.  $3xy(2x+3y)(4x^2-6xy+9y^2)$   
 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.  $\frac{\quad}{x+4}x-4$

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).

6.5 Exercises

Concept Check

- trial-and-error,  $ac$
- original
- monomial
- True

Practice

- $(m+6)(m+1)$
- $(x+9)(x+2)$
- $(x-10)(x+10)$
- $(m-3)(m+2)$
- Not factorable
- $(8a-1)(8a+1)$
- $(x+5)^2$
- $(x+12)(x-3)$
- $3(a+6)(a-2)$
- $-5(x-6)(x-8)$
- Not factorable
- $x(x-6)(x+2)$
- $-2a(a+8)(a-7)$
- $4x(2x-5)(2x+5)$
- $-(x-5)(3x-2)$
- $(2x-1)(3x-4)$
- $(4m+3)(3m-2)$
- $2(2x-1)(x-3)$
- $(4x-7)(2x+5)$
- $(5x+6)(4x-9)$
- $-(5x-7)(3x+2)$
- $-(2a-3)(4a-5)$
- $(4y+5)(5y-4)$

- $(6x-1)(3x-2)$
- $-6(5x-4)(5x+4)$
- $3(4n^2-20n-25)$
- $a(21a^2-13a-2)$
- $3x(3x-2)(4x+5)$
- $2x(2x-1)(4x-11)$
- $5(24m^2+2m+15)$
- $(y-4)(x+3)$
- $(x+2y)(x-6)$
- $-(x^2-5)(x-8)$
- $(x+5)(x^2-5x+25)$
- $x^4(y-1)(y^2+y+1)$
- $(2a^2+3b^2)(4a^4-6a^2b^2+9b^4)$
- $(x^2y-5)(x^4y^2+5x^2y+25)$
- $(x-3)(x+3)(x+7)$
- $(3x+y+6)(3x-y-6)$
- $(y+10+7x)(y+10-7x)$

6.6 Exercises

Concept Check

- zero
- factor
- substituting
- True
- True

Practice

- $x=2, 3$
- $x=-2, \frac{9}{2}$
- $x=-3$
- $x=0, 2$
- $x=-1, 4$
- $x=-3, 4$
- $x=-3, 0$
- $x=2, 4$
- $x=-4, 3$
- $x=-\frac{1}{2}, 3$
- $x=-\frac{2}{3}, 2$

- $x=-\frac{1}{2}, 4$
  - $x=-2, \frac{4}{3}$
  - $x=\frac{3}{2}$
  - $x=0, \frac{8}{5}$
  - $x=-2, 2$
  - $x=1$
  - $x=2$
  - $x=-3, 3$
  - $x=-5, 10$
  - $x=-6, -2$
  - $x=\frac{1}{2}$
  - $x=0, 2, 4$
  - $x=-\frac{2}{3}, -\frac{1}{2}, 0$
  - $x=-10, 10$
  - $x=-5, 5$
  - $x=-4$
  - $x=3$
  - $x=-1, 3$
  - $x=-8, -2$
  - $x=-5, 2$
  - $x=-5, 7$
  - $x=-6, 2$
  - $x=-1, \frac{2}{3}$
  - $x=-\frac{3}{2}, 4$
  - $y^2-y-6=0$
  - $2x^2+11x+5=0$
  - $8x^2-10x+3=0$
  - $x^3-x^2-6x=0$
  - $y^3-4y^2-3y+18=0$
- Applications
- a. 640 ft; 384 ft  
 b. 144 ft; 400 ft  
 c. 7 seconds;  
 $0 = -16(t+7)(t-7)$
  - 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.

6.7 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  $6$  in. and length is  $12$  in.
29.  $w(4w) = 64$ ;  $w = 4$ , so width is  $4$  ft and length is  $16$  ft.
31.  $l(l-4) = 45$ ;  $l = 9$ , so width is  $5$  ft and length is  $9$  ft.
33.  $\frac{1}{2}b(b-4) = 16$ ;  $b = 8$ , so base is  $8$  ft and height is  $4$  ft.
35.  $\frac{1}{2}(h+6)h = 20$ ;  $h = 4$ , so the base is  $10$  in.
37.  $w(16-w) = 48$ ;  $w = 4, 12$ , so the rectangle is  $4$  in. by  $12$  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  $3$  cm by  $10$  cm.
47.  $w = 10, 15$ , so width is  $10$  ft and length is  $30$  ft or width is  $15$  ft and length is  $20$  ft.
49.  $h^2 + (h-34)^2 = (h+2)^2$ ;  $h = 48$ , so the height of the pole is  $48$  ft.
51.  $x^2 + (x-49)^2 = (x+1)^2$ ;  $x = 60$ , so height is  $60$  ft.
53.  $l^2 + (l-28)^2 = (l+8)^2$ ;  $l = 60$ , so the length of the mat is  $60$  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  $5$  feet from the ground ( $12$  feet from the top) and attached to the stake which is  $12$  feet from the pole. Or the wire is attached to the pole  $12$  feet from the ground ( $5$  feet from the top) and attached to the stake which is  $5$  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.

6.8 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 7: Rational Expressions and Rational Equations

### 7.1 Exercises

#### Concept Check

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

#### Practice

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

#### Applications

- $p(x) = \frac{15x+200}{x}$
  - \$35
  - $x \neq 0$
  - 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
  - \$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.

### 7.2 Exercises

#### Concept Check

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

#### Practice

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

$$19. \frac{x+2y}{(x-3y)(x-2y)}$$

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

$$23. \frac{1}{x+1} \quad 25. \frac{x+2}{x-2}$$

$$27. \frac{1}{3xy^6} \quad 29. \frac{6y^7}{x^4}$$

$$31. \frac{x}{12} \quad 33. \frac{6x+18}{x^2}$$

$$35. \frac{6}{5x} \quad 37. \frac{3x+1}{x+1}$$

$$39. \frac{x-2}{2x-1} \quad 41. -\frac{x+4}{x(2x-1)}$$

$$43. \frac{x+1}{x-1}$$

$$45. \frac{6x^3 - x^2 + 1}{x^2(4x-3)(x-1)}$$

$$47. \frac{x^2 + 4x + 4}{x^2(2x-5)}$$

$$49. \frac{x^2 - 6x + 5}{(x-7)(x-2)(x+7)}$$

$$51. \frac{x^2 - 3x}{(x-1)^2}$$

$$53. \frac{x^2 + 5x}{2x+1}$$

$$55. 1$$

#### Applications

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

### 7.3 Exercises

#### Concept Check

- smallest
- prime factorization
- equivalent
- True

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

#### Practice

- 150
- 432
- 600
- 60
- $\frac{11}{17}$
- $\frac{3}{2}$
- $\frac{6}{5}$
- $\frac{23}{30}$
- $\frac{28}{27}$
- $7(x+5)(x-5)$
- $30(y-4)$
- $(x+3)(x-3)(x-3)$
- $-(y-3)$
- $-2(x+12)(x-12)$
- $(x+4)(x-3)(x+5)$
- $(x-2)(y+3)(x+7)$
- $2(x+6)(x-6)(x+3)$
- $6(x-5)(y+6)(y+1)$
- $(x+2)(x-2)(x^2+4)$
- 28
- $33(x-3)$
- $-3x^2$
- $2(y+3)(y-1) = 2y^2 + 4y - 6$
- $(x+1)(x+3) = x^2 + 4x + 3$

### 7.4 Exercises

#### Concept Check

- numerator, denominator
- most
- equivalent
- True
- True

#### Practice

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

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

7.5 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.  $\frac{x^4+x^3+3x^2+2x+1}{x^3+x^2+2x+1}$

7.6 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.  $R_{\text{total}} = \frac{R_1R_2}{R_1+R_2}$

47.  $P = \frac{A}{1+r}$

49.  $LK = 15, JB = 5$

51.  $AC = 2, ST = 12$

53.  $ST = 8, TU = 12, QR = 24$

55.  $AP = \frac{9}{2}$  in.;  $PC = \frac{15}{2}$  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.  $x = \frac{8}{7}$

7.7 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

7.8 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.  $9 \times 10^{-11}$  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 8: Roots, Radicals, and Complex Numbers

8.1 Exercises

Concept Check

1. 2 3. square root  
5. radical, radicand  
7. False; If the original number is negative, the principal square root will not be the same as the original number.  
9. 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.

### 8.2 Exercises

#### Concept Check

1. factor    3. 2  
 5.  $\sqrt{a}\sqrt{b}$     7. True  
 9. False; If  $x$  is a real number, then  $\sqrt{x^2} = |x|$ .

#### Practice

1.  $2\sqrt{3}$     3.  $12\sqrt{2}$   
 5.  $-6\sqrt{2}$     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.

### 8.3 Exercises

#### Concept Check

1. radical, index  
 3.  $a^{\frac{1}{2}}$     5.  $\sqrt[3]{a}$   
 7. True    9. True

#### Practice

1.  $\sqrt[3]{8}$     3.  $-\sqrt[6]{x}$   
 5.  $\sqrt[5]{4z^2}$     7.  $13^{\frac{1}{7}}$   
 9.  $(-9)^{\frac{1}{3}}$     11. 3  
 13.  $\frac{1}{10}$     15. -512  
 17. -4  
 19. Not a real number  
 21.  $\frac{3}{7}$     23. 16  
 25.  $-\frac{1}{6}$     27.  $\frac{5}{2}$   
 29.  $\frac{1}{4}$     31.  $\frac{3}{8}$   
 33.  $-\frac{1}{1000}$     35. 64  
 37. 8.5499  
 39. 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.  $\frac{1}{a^{\frac{9}{8}}}$   
 67.  $a^{\frac{1}{4}}$     69.  $\frac{a^2}{b^{\frac{6}{5}}}$   
 71.  $8x^{\frac{3}{2}}y$     73.  $\frac{x^{\frac{3}{2}}}{16y^{\frac{5}{2}}}$

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.
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.  $xy^2\sqrt[3]{2}(-2x^2y^2-2x^3y+3)$   
 51.  $3\sqrt{2}-8$   
 53. 18    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.

### 8.4 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.  $13\sqrt[3]{x}-2\sqrt[3]{y}$

#### Applications

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

8.5 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.  $\frac{-3\sqrt{7}}{7}$
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.  $\frac{-6(5 + 3\sqrt{2})}{7}$
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%

8.6 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

8.7 Exercises

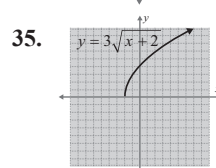
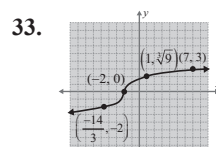
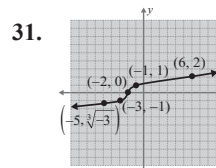
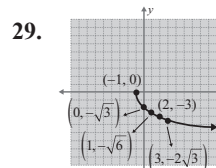
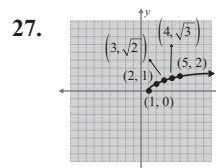
Concept Check

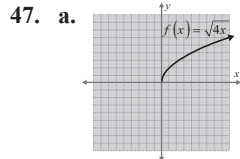
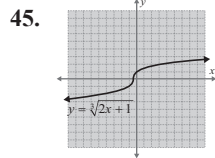
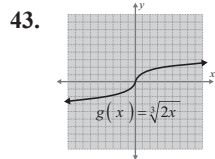
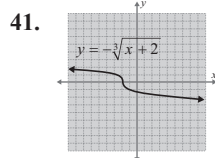
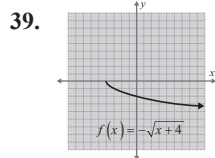
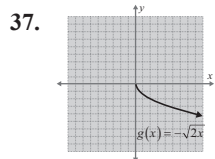
1. ordered
3. first coordinates
5. vertical, function
7. True
9. True

Practice

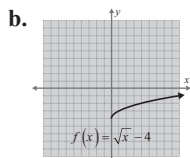
1. a.  $\sqrt{5} \approx 2.2361$
- b. 3
- c.  $5\sqrt{2} \approx 7.0711$
- d. 2
3. a. 3
- b. -1
- c. -2
- d.  $2\sqrt[3]{3} \approx 2.8845$

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

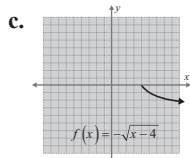




$D = [0, \infty)$ ; The graph of  $\sqrt{x}$  is stretched vertically.



$D = [0, \infty)$ ; 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.

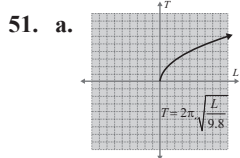
49. A negative sign reflects the graph across the  $x$ -axis.

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  $x = 3$ .

8.8 Exercises

Concept Check

- 1. polynomials
- 3. real, imaginary
- 5.  $i\sqrt{a}$
- 7. True
- 9. False;  $a = c, b = d$

Practice

- 1. Real part: 4, imaginary part:  $-3$

3. Real part:  $-11$ , imaginary part:  $\sqrt{2}$

5. Real part:  $\frac{3}{8}$ , imaginary part: 0

7. Real part:  $\frac{4}{5}$ , imaginary part:  $\frac{7}{5}$

9. Real part:  $\frac{2}{3}$ , imaginary part:  $\sqrt{17}$

11.  $7i$  13.  $-8i$

15.  $7\sqrt{3}$  17.  $10i\sqrt{6}$

19.  $-12i\sqrt{3}$  21.  $11\sqrt{2}$

23.  $10i\sqrt{10}$  25.  $x = 6, y = -3$

27.  $x = -2, y = \sqrt{5}$

29.  $x = \sqrt{2} - 3, y = 1$

31.  $x = 1, y = 4$

33.  $x = 2, y = -6$

35.  $x = 3, y = 10$

37.  $x = -\frac{4}{3}, y = -3$

39.  $6 + 2i$  41.  $1 + 7i$

43.  $6 - 6i$  45.  $14i$

47.  $(3 + \sqrt{5}) - 6i$

49.  $5 + (\sqrt{6} + 1)i$

51.  $\sqrt{3} - 5$

53.  $-2 - 5i$  55.  $11 - 16i$

57. 2 59.  $3 + 4i$

Writing & Thinking

61. a. Yes b. No

8.9 Exercises

Concept Check

- 1. FOIL
- 3.  $i, -1, -i, 1$
- 5.  $a^2 + b^2$
- 7. False;  $i, -i, 1$  and  $-1$
- 9. False; The product is  $-1$ .

Practice

- 1.  $16 + 24i$  3.  $-7\sqrt{2} + 7i$
- 5.  $3 + 12i$  7.  $1 - i\sqrt{3}$

9.  $3 + 2i\sqrt{3}$

11.  $2 + 8i$  13.  $-7 - 11i$

15.  $13 + 0i$  17.  $34 + 13i$

19.  $-24 + 70i$

21.  $5 - i\sqrt{3}$

23.  $23 - 10i\sqrt{2}$

25.  $21 + 0i$

27.  $(2 + \sqrt{10}) + (2\sqrt{2} - \sqrt{5})i$

29.  $(9 - \sqrt{30}) + (3\sqrt{5} + 3\sqrt{6})i$

31.  $0 + 3i$  33.  $0 - \frac{5}{4}i$

35.  $-\frac{1}{4} + \frac{1}{2}i$

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

39.  $\frac{24}{25} + \frac{18}{25}i$

41.  $-\frac{1}{13} + \frac{5}{13}i$

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

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

47.  $\frac{4 + \sqrt{3}}{4} + \left(\frac{4\sqrt{3} - 1}{4}\right)i$

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

51.  $0 + i$  53.  $-1 + 0i$

55.  $0 + i$  57.  $1 + 0i$

59.  $0 - i$  61.  $x^2 + 9$

63.  $x^2 + 2$

65.  $5y^2 + 4$

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

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

Writing & Thinking

71. Given a complex number  $(a + bi)$ :  $(a + bi)(a - bi) = a^2 - abi + abi - b^2i^2 = a^2 + b^2$  which is the sum of squares of real numbers. Thus, the product must be a positive real number.

73.  $a^2 + b^2 = 1$

## Chapter 9: Quadratic Equations and Quadratic Functions

### 9.1 Exercises

#### Concept Check

- hypotenuse, squares
- nonnegative
- True
- False; The square of a real number cannot be negative.

#### Practice

- $x = 0, 11$     3.  $x = -12, -3$
- $x = 1, -\frac{5}{3}$
- $x = -1, 3$
- $x = \frac{3}{4}, 1$
- $x = \pm 11$     13.  $x = \pm 6$
- $x = \pm\sqrt{35}$
- $x = \pm 5i$
- $x = \pm\sqrt{62}$
- $x = \pm 3\sqrt{5}$
- $x = \pm 3\sqrt{2}$
- $x = \pm \frac{2}{3}$
- $x = -1, 3$
- $x = -2 \pm 5i$
- $x = 3 \pm 2i$
- $x = -\frac{3}{2}, -\frac{1}{2}$
- $x = \frac{7}{4}, \frac{9}{4}$
- $x = -2 \pm i\sqrt{7}$
- $x = \frac{2 \pm 3\sqrt{7}}{5}$
- $x = \frac{-4 \pm 3\sqrt{3}}{3}$
- $x = 7 \pm 2\sqrt{3}$
- $x = 5 \pm i\sqrt{10}$
- $x = \pm 2i\sqrt{6}$
- $c = 15$     51.  $b = 6\sqrt{3}$
- $b = 1$     55.  $x = \pm 25.44$
- $x = \pm 5.25$
- $x = \pm 1.70$

- $x = \pm 4.13$
- 4.2361, -0.2361
- 2.3229, -0.3229

#### Applications

- The length of the leg is 4 feet and the hypotenuse is 8 feet.
- $3\sqrt{2}$  cm
- a.  $35^2 = x^2 + 34^2 \rightarrow 8.3$  ft  
b. No,  $\frac{1}{4}$  of 34 is 8.5, so the distance is too short by 0.2 feet.
- 125 yards
- a. 640 ft; 384 ft  
b. 144 ft; 400 ft  
c. 7 seconds;  
 $0 = -16(t+7)(t-7)$
- 3.2 miles

### 9.2 Exercises

#### Concept Check

- trinomial
- 1
- square
- False; It's also possible for there to be one solution.
- True

#### Practice

- $x^2 - 12x + 36 = (x-6)^2$
- $x^2 + 6x + 9 = (x+3)^2$
- $x^2 - 5x + \frac{25}{4} = \left(x - \frac{5}{2}\right)^2$
- $y^2 + y + \frac{1}{4} = \left(y + \frac{1}{2}\right)^2$
- $x^2 + \frac{1}{3}x + \frac{1}{36} = \left(x + \frac{1}{6}\right)^2$
- $2x^2 + 4x + 2 = 2(x+1)^2$
- $x = -5, 1$
- $y = -1 \pm \sqrt{6}$
- $x = 5 \pm \sqrt{22}$
- $x = -5, 9$
- $x = -5, 8$
- $x = -\frac{4}{3}, 1$
- $x = 3 \pm i$
- $x = 1, 11$
- $y = 5 \pm \sqrt{21}$
- $z = \frac{-3 \pm \sqrt{29}}{2}$
- $x = \frac{-1 \pm i\sqrt{7}}{2}$  or  $-\frac{1}{2} \pm \frac{\sqrt{7}}{2}i$
- $x = \frac{-5 \pm \sqrt{17}}{2}$
- $x = \frac{5 \pm \sqrt{10}}{3}$
- $x = -1 \pm i\sqrt{5}$
- $x = \frac{1 \pm i\sqrt{11}}{4}$  or  $\frac{1}{4} \pm \frac{\sqrt{11}}{4}i$
- $y = \frac{-3 \pm i\sqrt{11}}{2}$  or  $-\frac{3}{2} \pm \frac{\sqrt{11}}{2}i$
- $y = -\frac{4}{3}, 1$
- $x = 2 \pm \sqrt{2}$
- $x^2 - 7 = 0$
- $x^2 - 2x - 2 = 0$
- $y^2 + 4y - 16 = 0$
- $x^2 + 16 = 0$
- $y^2 + 6 = 0$
- $x^2 - 4x + 5 = 0$
- $x^2 - 2x + 3 = 0$
- $x^2 + 10x + 49 = 0$

#### Applications

- a.  $p = 0, 90$   
b. No income revenue is made if the price is set to \$0 or \$90 per frame.

#### Writing & Thinking

- See Example 2.

### 9.3 Exercises

#### Concept Check

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

#### Practice

- 68; Two real solutions
- 0; One real solution
- 44; Two nonreal solutions
- 4; Two real solutions
- 19,600; Two real solutions
- 11; Two nonreal solutions
- $x = -2 \pm 2\sqrt{2}$
- $x = -\frac{2}{3}$
- $x = 1 \pm i\sqrt{6}$
- $x = -3, \frac{1}{2}$
- $x = \frac{-3 \pm \sqrt{5}}{4}$
- $x = \frac{-3 \pm i\sqrt{3}}{4}$  or  $-\frac{3}{4} \pm \frac{\sqrt{3}}{4}i$
- $x = \frac{-3 \pm \sqrt{29}}{2}$
- $x = -3, -1$
- $x = \pm 2i\sqrt{2}$
- $x = \frac{5 \pm \sqrt{17}}{2}$
- $x = -\frac{1}{4}$
- $x = \pm \frac{2\sqrt{3}}{3}$
- $x = \frac{2}{3}$

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  $(x-2)(x+2)(x-3)(x+3)$

9.4 Exercises

Concept Check

- read, think, translate
- diagram
- True

Applications

- $w(2w-5) = 63$ ;  $w = 7$ , the rectangle is 7 m by 9 m
- $x + (x+9)^2 = 147$ ;  $x = 3$ , the numbers are 3 and 12
- $(w+12)(w+22) = 1344$ ;  $w = 20$ , the pool is 20 ft by 30 ft
- $(x+5)^2 = 4x^2$ ;  $x = 5$ , the side of the original square is 5 m
- $w^2 + (w+4)^2 = 400$ ;  $w = 12$ , the rectangle is 12 m by 16 m
- $x(x+16) = 960$ ;  $x = 24$ , there are 40 seats
- 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.  $(600 + 20x)(0.5 - 0.01x) = 315$ ;  $x = 5, 1$   
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.

9.5 Exercises

Concept Check

- middle, one-half
- first
- True
- True

Practice

- $x = \pm 2, \pm 3$
- $x = \pm 2, \pm \sqrt{5}$
- $y = \pm \sqrt{7}, \pm 2i$
- $y = \pm \sqrt{5}, \pm i\sqrt{5}$
- $x = 4, \frac{25}{4}$

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

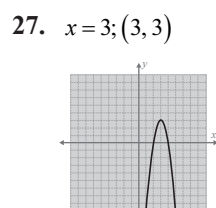
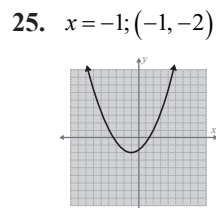
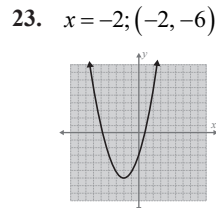
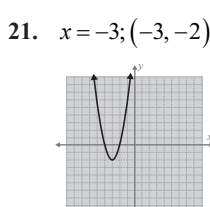
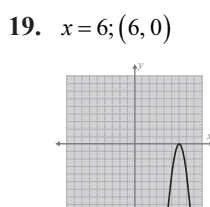
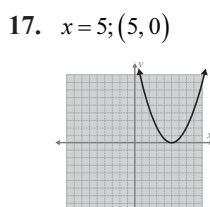
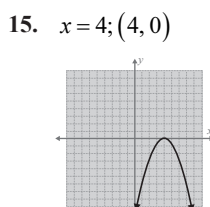
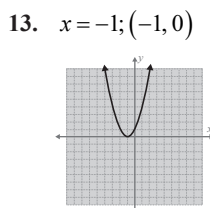
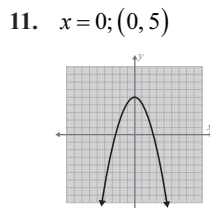
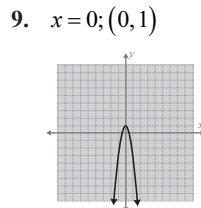
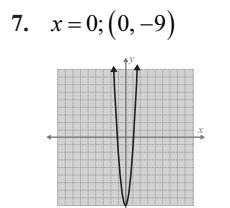
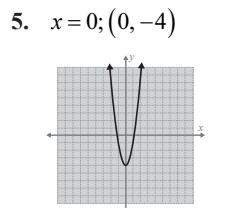
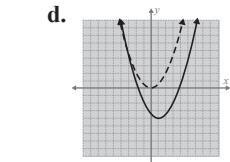
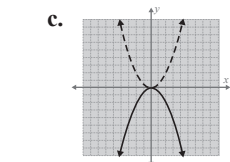
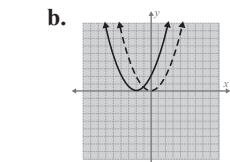
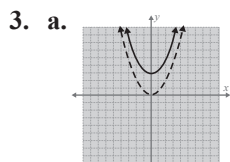
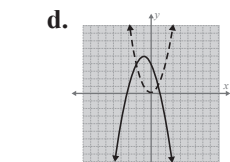
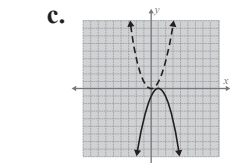
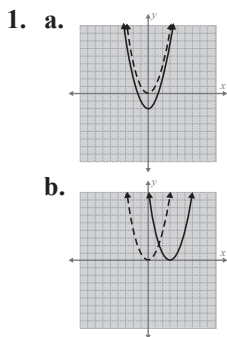
- 57. a.  $l^2 - l - 1 = 0,$   
 $l = \frac{1 + \sqrt{5}}{2}$  which is the golden ratio
- b. 97.08 feet
- c. Rectangle B is "golden."

9.6 Exercises

Concept Check

- 1. parabola 3.  $\geq$
- 5. range
- 7. False; It is a horizontal shift (or horizontal translation).

Practice



Writing & Thinking

- 29. The parabola is narrower for larger values of  $a$  because the value of  $y$  increases faster for increasing values of  $x$ .

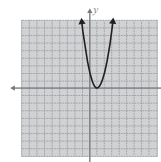
9.7 Exercises

Concept Check

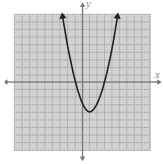
- 1. vertex 3.  $x$ -axis
- 5. downward, highest, maximum
- 7. False; The line of symmetry is at  $x = -\frac{b}{2a}$ .
- 9. True

Practice

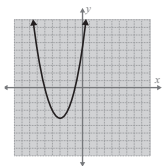
- 1.  $y = 2(x - 1)^2; x = 1;$   
 Vertex:  $(1, 0);$   
 $x$ -int:  $(1, 0);$   
 $y$ -int:  $(0, 2)$



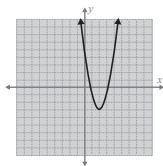
3.  $y = (x - 1)^2 - 4$ ;  $x = 1$ ;  
Vertex:  $(1, -4)$ ;  
 $x$ -int:  $(-1, 0), (3, 0)$ ;  
 $y$ -int:  $(0, -3)$



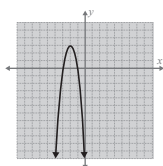
5.  $y = (x + 3)^2 - 4$ ;  $x = -3$ ;  
Vertex:  $(-3, -4)$ ;  
 $x$ -int:  $(-5, 0), (-1, 0)$ ;  
 $y$ -int:  $(0, 5)$



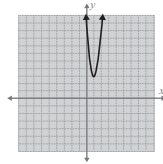
7.  $y = 2(x - 2)^2 - 3$ ;  $x = 2$ ;  
Vertex:  $(2, -3)$ ;  
 $x$ -int:  $(\frac{4 + \sqrt{6}}{2}, 0)$ ,  
 $(\frac{4 - \sqrt{6}}{2}, 0)$ ;  
 $y$ -int:  $(0, 5)$



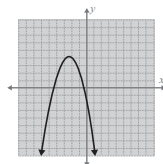
9.  $y = -3(x + 2)^2 + 3$ ;  
 $x = -2$ ; Vertex:  $(-2, 3)$ ;  
 $x$ -int:  $(-1, 0), (-3, 0)$ ;  
 $y$ -int:  $(0, -9)$



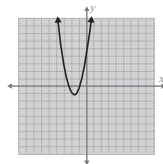
11.  $y = 5(x - 1)^2 + 3$ ;  
 $x = 1$ ; Vertex:  $(1, 3)$ ;  
 $x$ -int: None;  $y$ -int:  $(0, 8)$



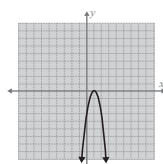
13.  $y = -(x + \frac{5}{2})^2 + \frac{17}{4}$ ;  
 $x = -\frac{5}{2}$ ;  
Vertex:  $(-\frac{5}{2}, \frac{17}{4})$ ;  
 $x$ -int:  $(\frac{-5 + \sqrt{17}}{2}, 0)$ ,  
 $(\frac{-5 - \sqrt{17}}{2}, 0)$ ;  
 $y$ -int:  $(0, -2)$



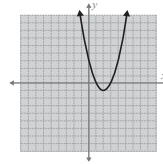
15.  $y = 2(x + \frac{7}{4})^2 - \frac{9}{8}$ ;  
 $x = -\frac{7}{4}$ ;  
Vertex:  $(-\frac{7}{4}, -\frac{9}{8})$ ;  
 $x$ -int:  $(-\frac{5}{2}, 0), (-1, 0)$ ;  
 $y$ -int:  $(0, 5)$



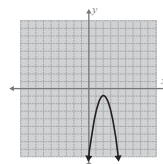
17.  $x = 1$ ; Vertex:  $(1, 0)$ ;  
 $x$ -int:  $(1, 0)$ ;  $y$ -int:  $(0, -3)$



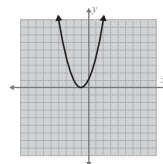
19.  $x = 2$ ; Vertex:  $(2, -1)$ ;  
 $x$ -int:  $(3, 0), (1, 0)$ ;  
 $y$ -int:  $(0, 3)$



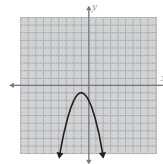
21.  $x = 2$ ; Vertex:  $(2, -1)$ ;  
 $x$ -int: None;  $y$ -int:  $(0, -9)$



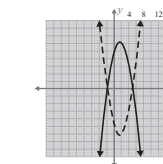
23.  $x = -1$ ; Vertex:  $(-1, 0)$ ;  
 $x$ -int:  $(-1, 0)$ ;  $y$ -int:  $(0, 1)$



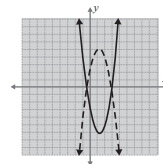
25.  $x = -1$ ; Vertex:  $(-1, -1)$ ;  
 $x$ -int: None;  $y$ -int:  $(0, -2)$



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.

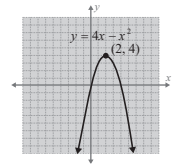


31. Zeros:  $x \approx -0.7321, 2.7321$

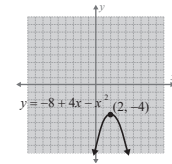
33. Zeros:  $x \approx -1.1583, 2.1583$

35. No real zeros

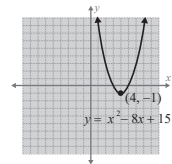
37.



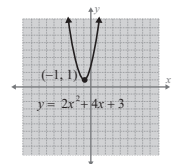
39.



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.

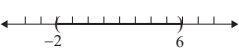


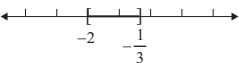
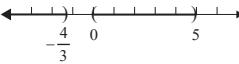
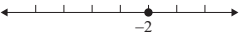
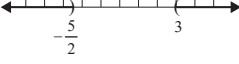
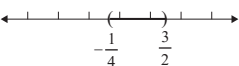
9.8 Exercises

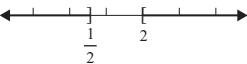
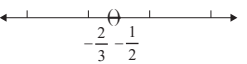

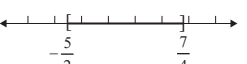
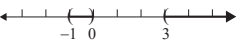
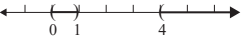
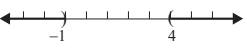
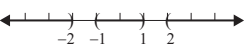
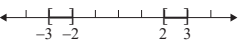

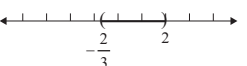
Concept Check


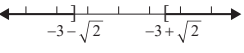
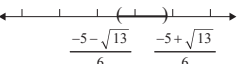

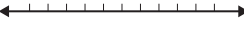
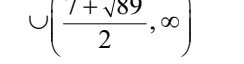
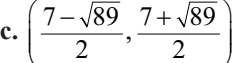
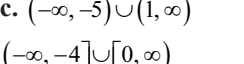
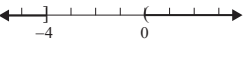
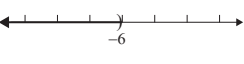
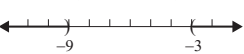

1. graphs 3. endpoints

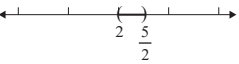
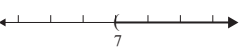
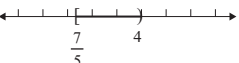

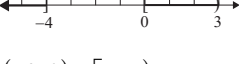
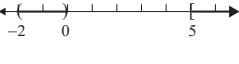
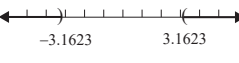
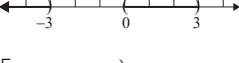
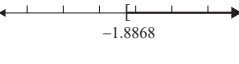
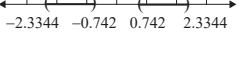
5. bracket, parenthesis  
 7. False; The goal is to get 0 on one side of the inequality and factor the other side.  
 9. False; The solution consists of all intervals where the test points satisfy the original inequality.

Practice

1.  $(-2, 6)$   

3.  $(-\infty, \frac{2}{3}) \cup (5, \infty)$   

5.  $(-\infty, -7] \cup [\frac{5}{2}, \infty)$   

7.  $[-2, -\frac{1}{3}]$   

9.  $(-\infty, -\frac{4}{3}) \cup (0, 5)$   

11.  $\{-2\}$   

13.  $(-\infty, -\frac{5}{2}) \cup (3, \infty)$   

15.  $(-\frac{1}{4}, \frac{3}{2})$   


17.  $(-\infty, \frac{1}{2}] \cup [2, \infty)$   

19.  $(-\frac{2}{3}, -\frac{1}{2})$   

21.  $(-\infty, \frac{5}{2}) \cup (\frac{5}{2}, \infty)$   

23.  $[-\frac{5}{2}, \frac{7}{4}]$   

25.  $(-1, 0) \cup (3, \infty)$   

27.  $(0, 1) \cup (4, \infty)$   

29.  $(-\infty, -1) \cup (4, \infty)$   

31.  $(-\infty, -2) \cup (-1, 1) \cup (2, \infty)$   

33.  $[-3, -2] \cup [2, 3]$   

35.  $(-\infty, -4] \cup [2, \infty)$   

37.  $(-\frac{2}{3}, 2)$   


39.  $(-\infty, -1 - \sqrt{5}) \cup (-1 + \sqrt{5}, \infty)$   

41.  $(-\infty, -3 - \sqrt{2}) \cup [-3 + \sqrt{2}, \infty)$   

43.  $(\frac{-5 - \sqrt{13}}{6}, \frac{-5 + \sqrt{13}}{6})$   

45.  $(-\infty, -\frac{1}{2}] \cup [0, 4]$   

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

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

55.  $(-\infty, -4] \cup [0, \infty)$   

57.  $(-\infty, -6)$   

59.  $(-\infty, -9) \cup (-3, \infty)$   


61.  $(2, \frac{5}{2})$   

63.  $(7, \infty)$   

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

67.  $(-9, -\frac{4}{3})$   

69.  $(-\infty, -4] \cup [0, 3)$   

71.  $(-2, 0) \cup [5, \infty)$   

73.  $(-\infty, -3.1623) \cup (3.1623, \infty)$   

75.  $\emptyset$
77.  $(-\infty, -3) \cup (0, 3)$   

79.  $[-1.8868, \infty)$   

81.  $(-2.3344, -0.7420) \cup (0.7420, 2.3344)$   


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 10: Exponential and Logarithmic Functions

## 10.1 Exercises

### Concept Check

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

### Practice

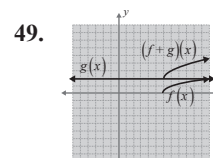
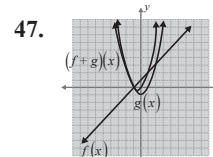
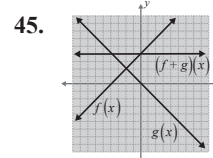
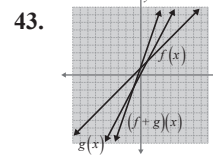
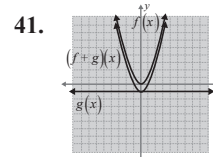
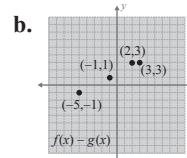
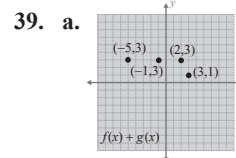
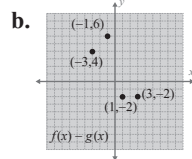
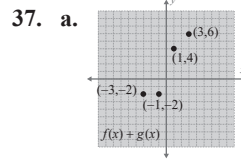
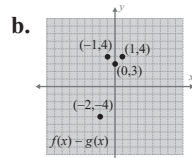
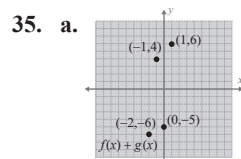
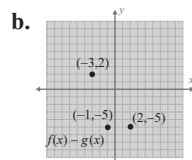
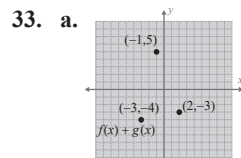
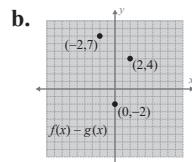
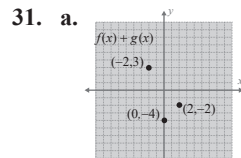
1. a.  $2x - 3$   
b. 7  
c.  $x^2 - 3x - 10$   
d.  $\frac{x+2}{x-5}, x \neq 5$
3. a.  $x^2 + 3x - 4$   
b.  $x^2 - 3x + 4$   
c.  $3x^3 - 4x^2$   
d.  $\frac{x^2}{3x-4}, x \neq \frac{4}{3}$
5. a.  $x^2 + x - 12$   
b.  $x^2 - x - 6$   
c.  $x^3 - 3x^2 - 9x + 27$   
d.  $x + 3, x \neq 3$
7. a.  $3x^2 + x + 2$   
b.  $x^2 + x - 2$   
c.  $2x^4 + x^3 + 4x^2 + 2x$   
d.  $\frac{2x^2 + x}{x^2 + 2}$
9. a.  $2x^2 + 2$   
b.  $8x$   
c.  $x^4 - 14x^2 + 1$   
d.  $\frac{x^2 + 4x + 1}{x^2 - 4x + 1}, x \neq 2 \pm \sqrt{3}$
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.  $-3x\sqrt{x-3}; D = [3, \infty)$

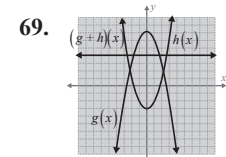
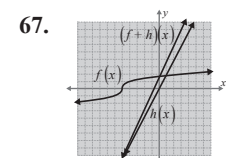
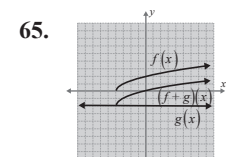
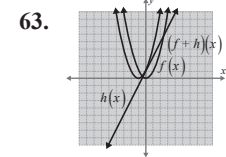
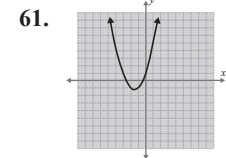
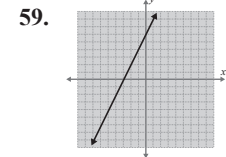
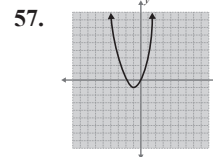
29.  $\sqrt[3]{x+3} + \sqrt{5+x};$   
 $D = [-5, \infty)$



51. 4

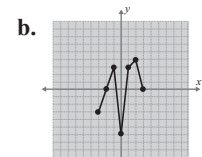
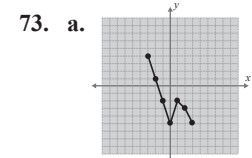
53. -12

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  $g(-2) = 0$ .

10.2 Exercises

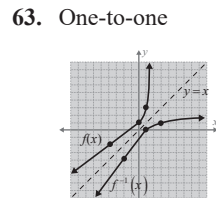
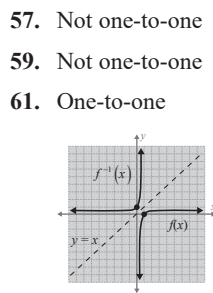
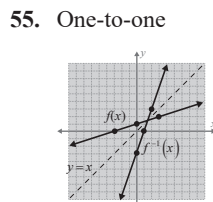
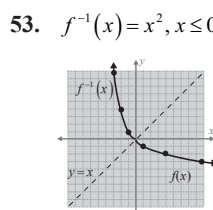
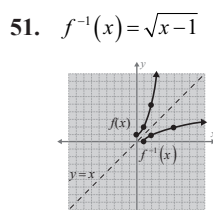
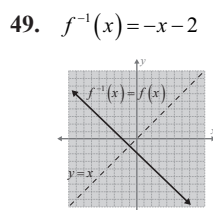
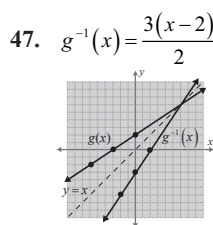
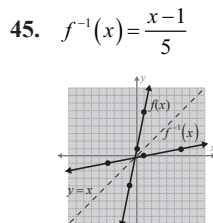
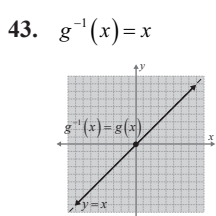
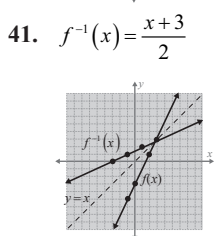
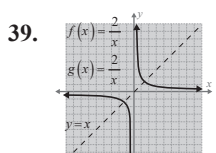
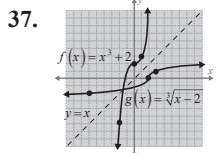
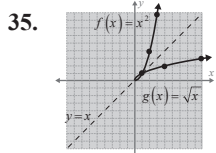
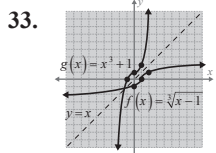
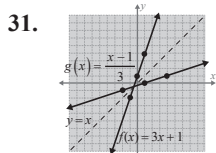
Concept Check

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

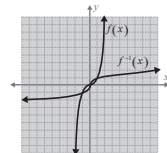
Practice

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

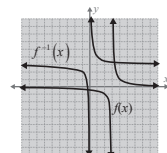
27. a. 21    b. 2  
c. No;  $f(g(x)) \neq x$  and  $g(f(x)) \neq x$
29. a. -9    b. does not exist  
c.  $f(4) = \frac{1}{9}$  and  $\frac{1}{9}$  is in the domain of  $g$ , so  $g(f(4))$  is defined. However,  $g(2) = -\frac{1}{2}$  and  $-\frac{1}{2}$  is not in the domain of  $f$ , so  $f(g(2))$  is not defined.



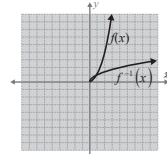
65. One-to-one
67. Not one-to-one
69. One-to-one
71. One-to-one
73. One-to-one
75. Not one-to-one
77.  $f^{-1}(x) = \sqrt[3]{x}$



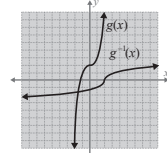
79.  $f^{-1}(x) = \frac{1}{x} + 3$



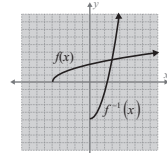
81.  $f^{-1}(x) = \sqrt{x}$



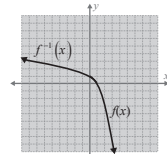
83.  $g^{-1}(x) = \sqrt[3]{x-2}$



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



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



Writing & Thinking

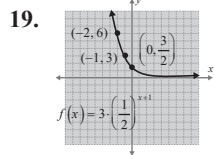
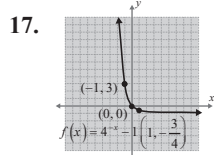
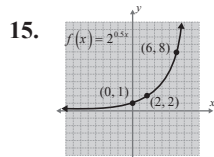
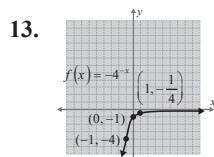
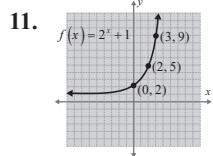
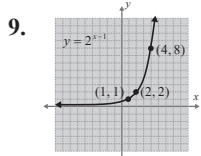
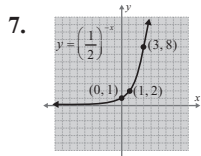
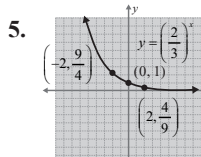
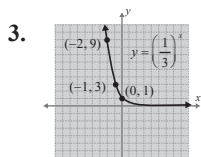
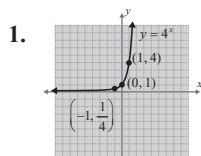
89. The domain of  $f(g(x))$  can only include values of  $x$  in the domain of  $g$ , while  $g(f(x))$  can only include values of  $x$  in the domain of  $f$ . For example,  $f(x) = \sqrt{x}$ ,  $g(x) = -x$ . Answers will vary.

10.3 Exercises

Concept Check

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

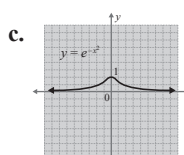
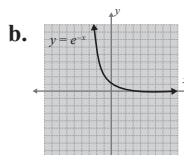
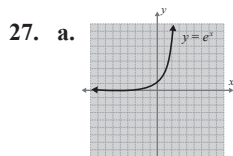
Practice



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.

10.4 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.  $\log_x 1 = 0$

7.  $\log_{10} 100 = 2$

9.  $\log_{10} 23 = k$

11.  $\log_{\frac{4}{3}} \frac{4}{9} = 2$

13.  $3^2 = 9$

15.  $9^{\frac{1}{2}} = 3$

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.  $x = \frac{1}{6}$

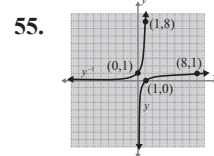
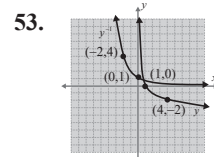
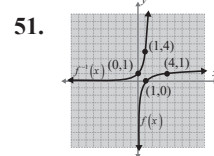
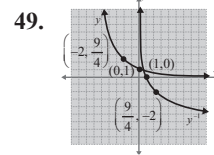
39.  $x = 2$

41.  $x = 32$

43.  $x = 3.7$

45.  $x = 2$

47.



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  $y = x$ .

10.5 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.

10.6 Exercises

Concept Check

- 1. 10      3. negative
- 5.  $\ln x$
- 7. False; When the base is omitted, it is understood to be 10.

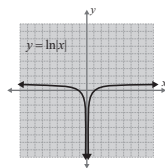
- 9. False; Both common logarithms and natural logarithms have inverses.

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.  $D = (-\infty, 0) \cup (0, \infty)$



10.7 Exercises

Concept Check

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

- 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.

10.8 Exercises

Concept Check

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

Applications

- 1. \$4027.51
- 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.  $10^6 I_0$

# Chapter 11: Conic Sections

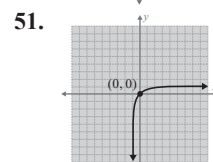
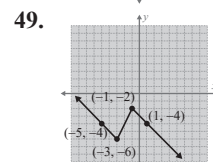
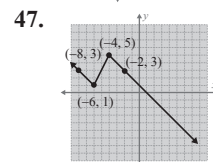
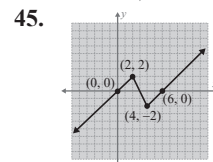
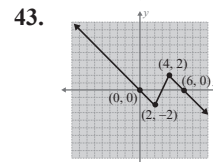
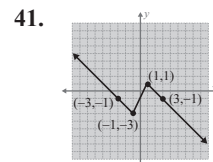
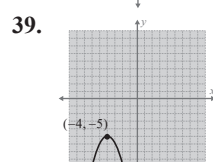
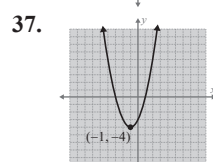
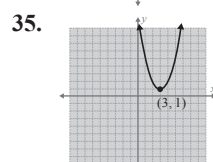
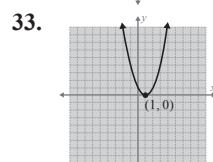
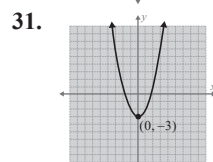
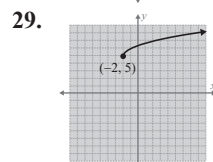
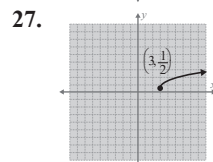
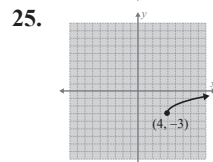
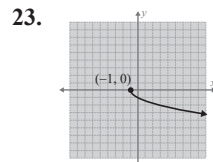
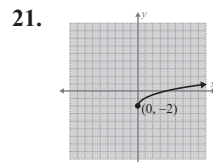
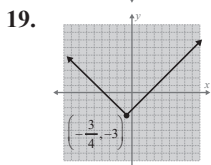
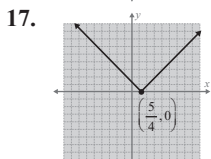
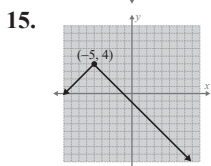
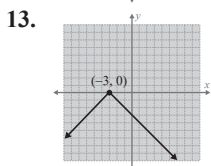
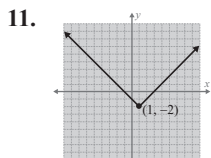
## 11.1 Exercises

### Concept Check

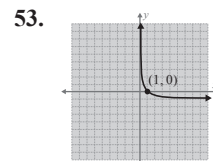
- slope, two
- horizontal
- shape, direction
- False; Translation does not change the shape of the graph of a function.

### Practice

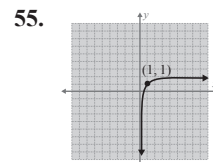
- a. 0   b.  $a^2 - 6a + 5$   
c.  $x^2 + 2xh + h^2 - 4$   
d.  $2x + h$
- a. 0   b.  $2a^2 - 11a + 14$   
c.  $2x^2 + 4xh - 3x + 2h^2 - 3h$   
d.  $4x + 2h - 3$
- 1
- 2
- The results are the coefficients of  $x$ .



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



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



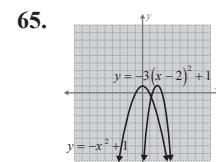
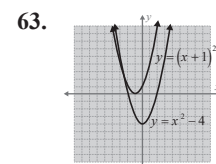
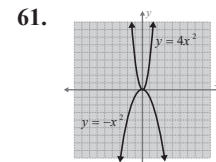
$D = (0, \infty); R = (-\infty, \infty)$

### 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.



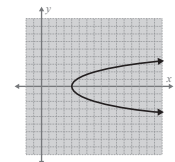
## 11.2 Exercises

### Concept Check

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

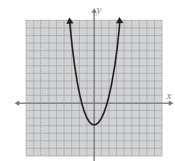
### Practice

- a. (4, 0)   b. None  
c.  $y = 0$

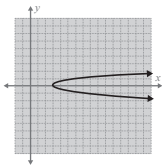


- a. (0, -3)   b. (0, -3)

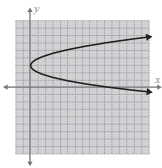
c.  $x = 0$



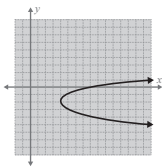
5. a. (3, 0) b. None  
c.  $y = 0$



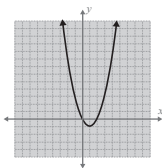
7. a. (0, 3) b. (0, 3)  
c.  $y = 3$



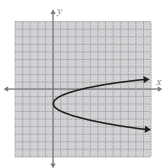
9. a. (4, -2) b. None  
c.  $y = -2$



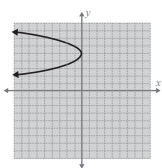
11. a. (1, -1) b. (0, 0)  
c.  $x = 1$



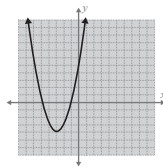
13. a. (0, -2) b. (0, -2)  
c.  $y = -2$



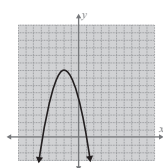
15. a. (0, 5) b. (0, 5)  
c.  $y = 5$



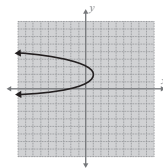
17. a. (-3, -4) b. (0, 5)  
c.  $x = -3$



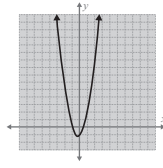
19. a. (-2, 9) b. (0, 5)  
c.  $x = -2$



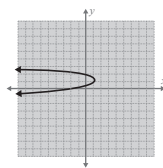
21. a. (1, 2) b. (0, 1), (0, 3)  
c.  $y = 2$



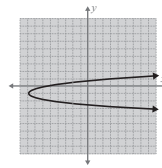
23. a.  $(-\frac{1}{4}, -\frac{9}{8})$  b. (0, -1)  
c.  $x = -\frac{1}{4}$



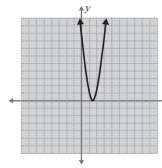
25. a.  $(\frac{9}{8}, \frac{5}{4})$  b.  $(0, \frac{1}{2}), (0, 2)$   
c.  $y = \frac{5}{4}$



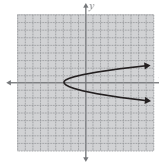
27. a. (-8, -1) b.  $(0, -1 + \frac{2\sqrt{6}}{3}), (0, -1 - \frac{2\sqrt{6}}{3})$   
c.  $y = -1$



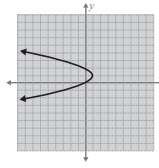
29. a.  $(\frac{3}{2}, 0)$  b. (0, 9)  
c.  $x = \frac{3}{2}$



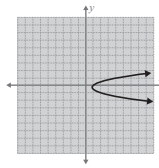
31. (0, 1.225), (0, -1.225)



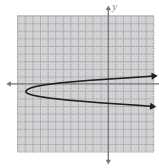
33. (0, 2), (0, 0)



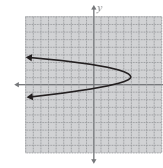
35. No y-intercept



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  $x = y^2$ .

11.3 Exercises

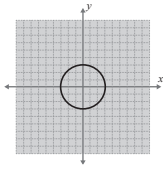
Concept Check

- $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- averaging
- twice
- True
- True

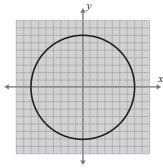
Practice

- 5; (4, 5.5)
- 13; (3, 4.5)
- $\sqrt{29}$ ; (2, 4.5)
- 3; (5.5, -3)
- $\sqrt{13}$ ; (6, -3.5)
- 17; (-3, -4.5)
- $x^2 + y^2 = 16$
- $x^2 + y^2 = 3$
- $x^2 + y^2 = 11$
- $x^2 + y^2 = \frac{4}{9}$
- $x^2 + (y - 2)^2 = 4$
- $(x - 4)^2 + y^2 = 1$
- $(x + 2)^2 + y^2 = 8$
- $(x - 3)^2 + (y - 1)^2 = 36$
- $(x - 3)^2 + (y - 5)^2 = 12$
- $(x - 7)^2 + (y - 4)^2 = 10$

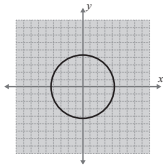
33.  $x^2 + y^2 = 9$   
Center:  $(0,0)$ ;  $r = 3$



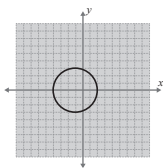
35.  $x^2 + y^2 = 49$   
Center:  $(0,0)$ ;  $r = 7$



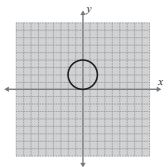
37.  $x^2 + y^2 = 18$   
Center:  $(0,0)$ ;  $r = 3\sqrt{2}$



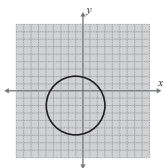
39.  $(x+1)^2 + y^2 = 9$   
Center:  $(-1,0)$ ;  $r = 3$



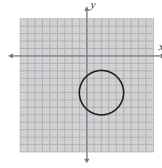
41.  $x^2 + (y-2)^2 = 4$   
Center:  $(0,2)$ ;  $r = 2$



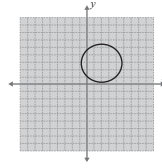
43.  $(x+1)^2 + (y+2)^2 = 16$   
Center:  $(-1,-2)$ ;  $r = 4$



45.  $(x-2)^2 + (y+5)^2 = 9$   
Center:  $(2,-5)$ ;  $r = 3$



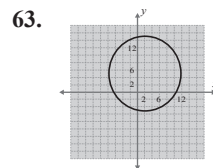
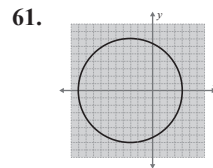
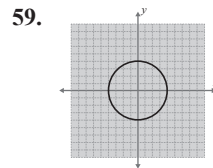
47.  $(x-2)^2 + (y-3)^2 = 8$   
Center:  $(2,3)$ ;  $r = 2\sqrt{2}$



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.  $10 + 4\sqrt{5}$



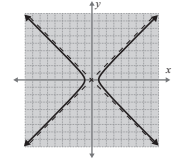
Applications

65. 10 blocks  
67.  $\sqrt{20} = 2\sqrt{5}$  hundred yards

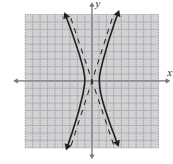
Writing & Thinking

69. a.  $d = \sqrt{x^2 + (y-p)^2}$   
b.  $d = |y+p|$   
c.  $y+p = \sqrt{x^2 + (y-p)^2}$   
 $(y+p)^2 = x^2 + (y-p)^2$   
 $y^2 + 2py + p^2 = x^2 + y^2 - 2py + p^2$   
 $x^2 = 4py$

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

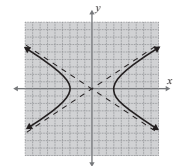


9.  $\frac{x^2}{1} - \frac{y^2}{9} = 1$



71. a.  $d = \sqrt{(x-p)^2 + y^2}$   
b.  $d = |x+p|$   
c.  $x+p = \sqrt{(x-p)^2 + y^2}$   
 $(x+p)^2 = (x-p)^2 + y^2$   
 $x^2 + 2px + p^2 = x^2 - 2px + p^2 + y^2$   
 $y^2 = 4px$

11.  $\frac{x^2}{9} - \frac{y^2}{4} = 1$

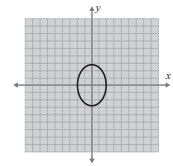


11.4 Exercises

Concept Check

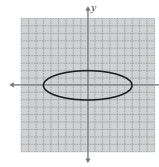
1. oval      3. focus  
5. minor      7. True  
9. False; The midway point between the foci is the center.

13.  $\frac{x^2}{4} + \frac{y^2}{8} = 1$

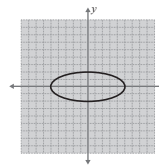


Practice

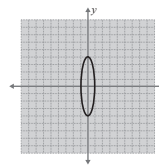
1.  $\frac{x^2}{36} + \frac{y^2}{4} = 1$



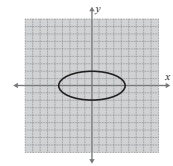
3.  $\frac{x^2}{25} + \frac{y^2}{4} = 1$



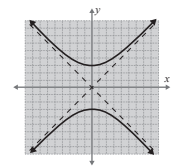
5.  $\frac{x^2}{1} + \frac{y^2}{16} = 1$



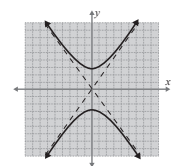
15.  $\frac{x^2}{20} + \frac{y^2}{4} = 1$



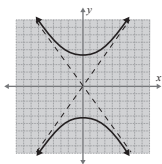
17.  $\frac{y^2}{9} - \frac{x^2}{9} = 1$



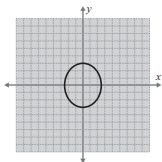
19.  $\frac{y^2}{8} - \frac{x^2}{4} = 1$



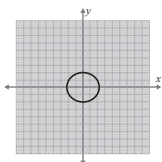
21.  $\frac{y^2}{18} - \frac{x^2}{9} = 1$



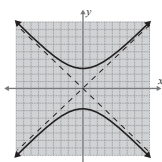
23.  $\frac{x^2}{6} + \frac{y^2}{9} = 1$



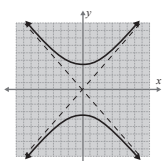
25.  $\frac{x^2}{5} + \frac{y^2}{4} = 1$



27.  $\frac{y^2}{8} - \frac{x^2}{9} = 1$



29.  $\frac{y^2}{12} - \frac{x^2}{9} = 1$

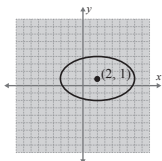


31. c

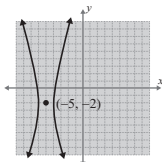
33. d

35. b

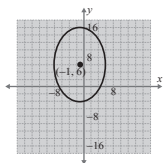
37.



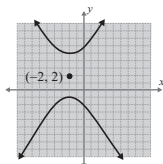
39.



41.



43.



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  $a^2 = b^2 + c^2$ .

11.5 Exercises

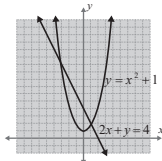
Concept Check

1. second
3. substitution, addition
5. both

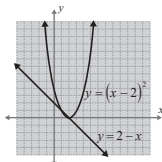
7. True
9. False; There are many situations where the curves do not intersect.

Practice

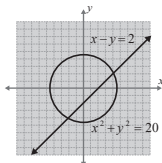
1.  $(-3, 10), (1, 2)$



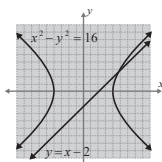
3.  $(1, 1), (2, 0)$



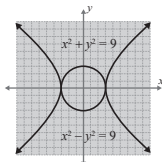
5.  $(-2, -4), (4, 2)$



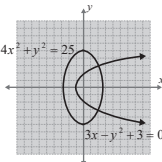
7.  $(5, 3)$



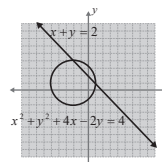
9.  $(-3, 0), (3, 0)$



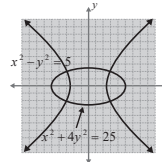
11.  $(2, 3), (2, -3)$



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.  $(4, 4), (-2, -2)$

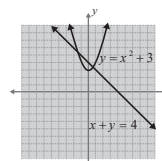
23.  $(-\frac{3}{2}, -1), (\frac{1}{2}, \frac{1}{2})$

25.  $(-3, \sqrt{11}), (-3, -\sqrt{11}), (3, \sqrt{11}), (3, -\sqrt{11})$

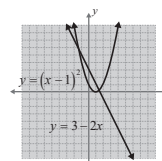
27.  $(5, -3), (-5, 1)$

29.  $(0, 3), (2, 3)$

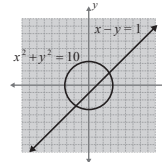
31.  $(-1.62, 5.62), (0.62, 3.38)$



33.  $(1.41, 0.17), (-1.41, 5.83)$



35.  $(2.68, 1.68), (-1.68, -2.68)$



## Chapter 12: Sequences, Series, and the Binomial Theorem

### 12.1 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
- $\{3n-1\}$     21.  $\{n^2\}$
- $\left\{\frac{1}{2^n}\right\}$     25.  $\{6n\}$
- $\left\{(-1)^{n+1}(2n-1)\right\}$
- 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

- \$28,000 when  $n = 1$ ;  
\$19,600 when  $n = 2$ ;  
\$13,720 when  $n = 3$ ; It will be worth \$13,720 after 3 years.

- 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.
- 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

- $a_1 = 3, a_2 = 1, \text{ and } a_3 = 4,$  so  $a_1 > a_2,$  but  $a_2 < a_3$  making the sequence neither increasing nor decreasing.
- a. 1, 1, 2, 3, 5, 8, 13, 21  
b. If we call the sequence of differences  $D_n,$  where  $n > 2,$  then  $D_n = F_n - 2.$

### 12.2 Exercises

#### Concept Check

- infinite
- index
- False; The lower limit of summation may be an integer other than 1.

#### Practice

- $S_1 = 2,$   
 $S_2 = 2 + 5 = 7,$   
 $S_3 = 2 + 5 + 8 = 15,$   
 $S_4 = 2 + 5 + 8 + 11 = 26$
- $S_1 = \frac{1}{2},$   
 $S_2 = \frac{1}{2} + \frac{2}{3} = \frac{7}{6},$   
 $S_3 = \frac{1}{2} + \frac{2}{3} + \frac{3}{4} = \frac{23}{12},$   
 $S_4 = \frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{4}{5} = \frac{163}{60}$

- $S_1 = 1,$   
 $S_2 = 1 + (-4) = -3,$   
 $S_3 = 1 + (-4) + 9 = 6,$   
 $S_4 = 1 + (-4) + 9 + (-16) = -10$

$$7. S_1 = \frac{1}{2}, S_2 = \frac{1}{2} + \frac{1}{4} = \frac{3}{4},$$

$$S_3 = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} = \frac{7}{8},$$

$$S_4 = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} = \frac{15}{16}$$

$$9. S_1 = 1, S_2 = 1 + 0 = 1,$$

$$S_3 = 1 + 0 + (-3) = -2,$$

$$S_4 = 1 + 0 + (-3) + (-8) = -10$$

$$11. 2 + 4 + 6 + 8 + 10 = 30$$

$$13. 5 + 6 + 7 + 8 + 9 = 35$$

$$15. \frac{1}{2} + \frac{1}{3} + \frac{1}{4} = \frac{13}{12}$$

$$17. 2 + 4 + 8 = 14$$

$$19. 16 + 25 + 36 + 49 + 64 = 190$$

$$21. 3 + 1 + (-1) + (-3) = 0$$

$$23. 6 + (-12) + 20 + (-30) = -16$$

$$25. \frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{4}{5} + \frac{5}{6} = \frac{71}{20}$$

$$27. \sum_{k=1}^5 (2k-1)$$

$$29. \sum_{k=1}^5 (-1)^k$$

$$31. \sum_{k=4}^7 k^2$$

$$33. \sum_{k=2}^6 (-1)^k \left(\frac{1}{k^3}\right)$$

$$35. \sum_{k=4}^{15} \frac{k}{k+1}$$

$$37. 39 \quad 39. 57$$

$$41. 48 \quad 43. 295$$

$$45. -1 \quad 47. 55$$

#### Writing & Thinking

$$49. \sum_{k=1}^{15} (-2k) + \sum_{k=1}^5 3k$$

### 12.3 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

$$21. \left\{\frac{2n+1}{3}\right\}$$

$$23. \{9-2n\}$$

$$25. \left\{\frac{17+3n}{2}\right\}$$

$$27. \{63-5n\}$$

$$29. \left\{\frac{81+3n}{2}\right\}$$

$$31. 232 \quad 33. 44$$

$$35. 7 \quad 37. 19$$

$$39. 154 \quad 41. 235$$

$$43. 126 \quad 45. 231$$

47.  $\frac{143}{3}$       49. 60  
 51. 171      53. -100

Applications

55. 9 days  
 57. 1625 cm  
 59. 134 seats; 1540 seats

Writing & Thinking

61. 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.

12.4 Exercises

Concept Check

1. same      3.  $a_n = a_1 r^{n-1}$   
 5. infinite  
 7. False; Find the ratio of consecutive terms and determine if the ratios are constant.

Practice

1. Not a geometric sequence  
 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.  $\{3(2)^{n-1}\}$

23.  $\left\{ \frac{1}{3} \left( -\frac{1}{2} \right)^{n-1} \right\}$

25.  $\{(\sqrt{2})^{n-1}\}$

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.  $\pi$

12.5 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.  $1,140,480x^8$

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. numerator  
 3. multiply  
 5. product  
 7. False; Multiply by the reciprocal of the number

Practice

1.  $\frac{4}{3}$       3. 3  
 5.  $\frac{1}{2}$   
 7. No reciprocal

9.  $\frac{7}{12}$       11.  $\frac{1}{10}$

13.  $\frac{15}{8}$       15.  $\frac{7}{4}$

17.  $\frac{1}{6}$       19.  $\frac{1}{6}$

21.  $\frac{9}{4}$       23.  $\frac{4}{5}$

25. 56      27.  $\frac{35}{6}$

29.  $\frac{3}{28}$       31.  $\frac{3}{8}$

33.  $\frac{2}{5}$       35.  $\frac{1}{3}$

37.  $\frac{8}{25}$       39.  $\frac{9}{10}$

41.  $\frac{5}{16}$       43.  $\frac{9}{7}$

45.  $\frac{1}{5}$       47.  $\frac{5}{16}$

49.  $\frac{25}{54}$

Applications

51.  $\frac{1}{12}$       53. 5 ft

55. a. 35 women  
 b. 21 women  
 c. Yes  
 d. Pass by 3 votes

57. a. More  
 b. Less  
 c. 200 passengers

59. a. More  
 b. Less  
 c. 8000 steel rods per week

61.  $\frac{5}{8}$  inch

63. a.  $\frac{5}{18}$   
 b. \$6000

65.  $\frac{23}{45}$  of the assignment

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

Writing & Thinking

69. No. If a fraction is less than 1 then its product with another number will be less than that other number. So, if the other number is less than 1, the product will be less than 1. Answers will vary.

71. 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.

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.