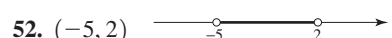
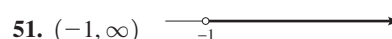
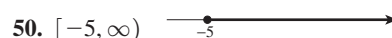
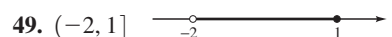
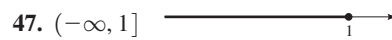
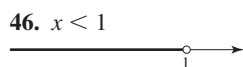
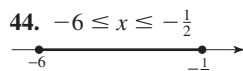
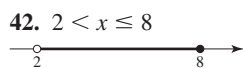
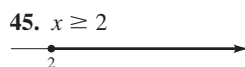
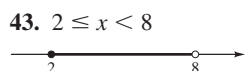
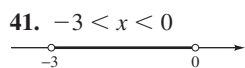


Answers to Exercises and Chapter Tests

Chapter 1

Section 1.1 ■ page 10

1. (a) 50 (b) 0, -10, 50 (c) 0, -10, 50, $\frac{27}{7}$, 0.538 , $1.2\bar{3}$, $-\frac{1}{3}$ (d) $\sqrt{7}$, $\sqrt[3]{2}$ 2. (a) 11, $\sqrt{16}$ (b) -11, 11, $\sqrt{16}$
 (c) 1.001, $0.3\bar{3}$, -11, 11, $\frac{13}{15}$, $\sqrt{16}$, 3.14, $\frac{15}{3}$ (d) $-\pi$
 3. Commutative Property for addition
 4. Commutative Property for multiplication
 5. Associative Property for addition
 6. Distributive Property
 7. Distributive Property
 8. Distributive Property
 9. Commutative Property for multiplication
 10. Distributive Property 11. $3 + x$ 12. $(7 \cdot 3)x$
 13. $4A + 4B$ 14. $5(x + y)$ 15. $3x + 3y$ 16. $8a - 8b$
 17. $8m$ 18. $-8y$ 19. $-5x + 10y$
 20. $3ab + 3ac - 6ad$ 21. (a) $\frac{17}{30}$ (b) $\frac{9}{20}$ 22. (a) $\frac{1}{15}$ (b) $\frac{35}{24}$
 23. (a) 3 (b) $\frac{25}{72}$ 24. (a) $\frac{13}{20}$ (b) $\frac{5}{36}$
 25. (a) $\frac{8}{3}$ (b) 6 26. (a) $\frac{15}{2}$ (b) 3 27. (a) $<$ (b) $>$
 (c) $=$ 28. (a) $<$ (b) $>$ (c) $=$ 29. (a) False (b) True
 30. (a) True (b) False 31. (a) False (b) True
 32. (a) False (b) True 33. (a) $x > 0$ (b) $t < 4$
 (c) $a \geq \pi$ (d) $-5 < x < \frac{1}{3}$ (e) $|p - 3| \leq 5$
 34. (a) $y < 0$ (b) $z > 1$ (c) $b \leq 8$ (d) $0 < w \leq 17$
 (e) $|y - \pi| \geq 2$ 35. (a) {1, 2, 3, 4, 5, 6, 7, 8}
 (b) {2, 4, 6} 36. (a) {2, 4, 6, 7, 8, 9, 10} (b) {8}
 37. (a) {1, 2, 3, 4, 5, 6, 7, 8, 9, 10} (b) {7}
 38. (a) {1, 2, 3, 4, 5, 6, 7, 8, 9, 10} (b) \emptyset
 39. (a) $\{x | x \leq 5\}$ (b) $\{x | -1 < x < 4\}$
 40. (a) $\{x | -1 < x \leq 5\}$ (b) $\{x | -2 \leq x < 4\}$



61. (a) 100 (b) 73 62. (a) $5 - \sqrt{5}$ (b) $10 - \pi$
 63. (a) 2 (b) -1 64. (a) 10 (b) -1 65. (a) 12
 (b) 5 66. (a) $\frac{1}{4}$ (b) 1 67. 5 68. 4 69. (a) 15 (b) 24
 (c) $\frac{67}{40}$ 70. (a) $\frac{18}{35}$ (b) 19 (c) 0.8 71. (a) $\frac{7}{9}$ (b) $\frac{13}{45}$
 (c) $\frac{19}{33}$ 72. (a) $\frac{518}{99}$ (b) $\frac{62}{45}$ (c) $\frac{1057}{495}$
 73. Distributive Property
 74. $T_O - T_G$: -9, -3, 0, 5, 8, 1, -1
 $|T_O - T_G|$: 9, 3, 0, 5, 8, 1, 1
 $T_O - T_G$ gives more information because it tells us which city had the higher (or lower) temperature.
 75. (a) Yes, no (b) 6 ft

Section 1.2 ■ page 21

1. $5^{-1/2}$ 2. $7^{2/3}$ 3. $\sqrt[3]{4^2}$ 4. $\frac{1}{\sqrt{11^3}}$ 5. $5^{3/5}$ 6. $\frac{1}{\sqrt{8}}$
 7. $\sqrt[3]{a^2}$ 8. $x^{-5/2}$ 9. (a) -9 (b) 9 (c) 1 10. (a) $\frac{1}{5}$
 (b) 1000 (c) 27 11. (a) 4 (b) $\frac{1}{81}$ (c) 16 12. (a) $\frac{27}{8}$
 (b) $\frac{1}{4}$ (c) $\frac{1}{100}$ 13. (a) 4 (b) 2 (c) $\frac{1}{2}$ 14. (a) 8 (b) -4
 (c) -2 15. (a) $\frac{2}{3}$ (b) $-\frac{1}{4}$ (c) $-\frac{1}{2}$ 16. (a) 14 (b) 4
 (c) 6 17. (a) $\frac{3}{2}$ (b) 4 (c) -4 18. (a) $\frac{1}{2}$ (b) $\frac{9}{4}$ (c) $\frac{512}{125}$

A2 Answers to Exercises and Chapter Tests

19. 5 20. 3 21. 14 22. $\frac{1}{144}$ 23. $7\sqrt{2}$ 24. $9\sqrt{3}$
 25. $3\sqrt[5]{3}$ 26. $\sqrt[3]{3}$ 27. a^4 28. $12y^7$ 29. $6x^7y^5$
 30. $216y^3$ 31. $16x^{10}$ 32. $\frac{a^2}{b}$ 33. $4/b^2$ 34. $8s^9t^3$
 35. $64r^7s$ 36. $\frac{8}{9}v^7$ 37. $648y^7$ 38. $\frac{12}{x^2}$ 39. $\frac{x^3}{y}$ 40. $\frac{d^7}{c^6}$
 41. $\frac{y^2z^9}{x^5}$ 42. $\frac{x^3y^{15}}{z^3}$ 43. $\frac{s^3}{q^7r^6}$ 44. $\frac{3c^7}{4a^3}$ 45. $|x|$ 46. x^2
 47. $2x^2$ 48. xy^2 49. $|ab^3|$ 50. $a^2\sqrt[3]{b^2}$ 51. $2|x|$
 52. $|x|\sqrt{|yz|}$ 53. $x^{13/15}$ 54. x 55. $\frac{-1}{9a^{5/4}}$ 56. $-10a^{9/4}$
 57. $16b^{9/10}$ 58. $\frac{1}{4x^4}$ 59. $\frac{1}{c^{2/3}d}$ 60. $8x^9y^{12}$ 61. $y^{1/2}$
 62. $\frac{1}{a^{3/10}}$ 63. $\frac{32x^{12}}{y^{16/15}}$ 64. $\frac{x^3}{y^{9/5}z^6}$ 65. $\frac{x^{15}}{y^{15/2}}$ 66. $\frac{16x^{4/3}}{y^2z^{2/3}}$
 67. $\frac{4a^2}{3b^{1/3}}$ 68. $\frac{y^{8/3}}{z^2}$ 69. $\frac{3t^{25/6}}{s^{1/2}}$ 70. $\frac{a^{9/2}x}{b^{10}y^{19/3}}$
 71. (a) 6.93×10^7 (b) 7.2×10^{12} (c) 2.8536×10^{-5}
 (d) 1.213×10^{-4} 72. (a) 1.2954×10^8 (b) 7.259×10^9
 (c) 1.4×10^{-9} (d) 7.029×10^{-4} 73. (a) 319,000
 (b) 272,100,000 (c) 0.00000002670 (d) 0.00000009999
 74. (a) 710,000,000,000,000 (b) 6,000,000,000,000
 (c) 0.00855 (d) 0.000000006257 75. (a) 5.9×10^{12} mi
 (b) 4×10^{-13} cm (c) 3.3×10^{19} molecules
 76. (a) 9.3×10^7 mi (b) 5.3×10^{-23} g (c) 5.97×10^{24} kg
 77. 1.3×10^{-20} 78. 9.14×10^{43} 79. 1.429×10^{19}
 80. 6.3×10^{38} 81. 7.4×10^{-14} 82. 3.19×10^{-106}
 83. (a) $\frac{\sqrt{10}}{10}$ (b) $\frac{\sqrt{2x}}{x}$ (c) $\frac{\sqrt{3x}}{3}$
 84. (a) $\frac{\sqrt{15}}{6}$ (b) $\frac{\sqrt{6x}}{6}$ (c) $\frac{\sqrt{2yz}}{2z}$
 85. (a) $\frac{2\sqrt[3]{x^2}}{x}$ (b) $\frac{\sqrt[4]{y}}{y}$ (c) $\frac{xy^{3/5}}{y}$
 86. (a) $\frac{\sqrt[4]{a^3}}{a}$ (b) $\frac{a\sqrt[3]{b}}{b}$ (c) $\frac{c^{4/7}}{c}$
 87. (a) Negative (b) Positive (c) Negative (d) Negative
 (e) Positive (f) Negative 89. 2.5×10^{13} mi 90. $8\frac{1}{3}$ min
 91. 1.3×10^{21} L 92. \$25,530 93. 4.03×10^{27} molecules
 94. 41.3 mi 95. (a) 28 mi/h (b) 167 ft 96. 1.5×10^{11} m
 97. (a) 17.707 ft/s (b) 1328.0 ft³/s

Section 1.3 ■ page 31

1. Trinomial; $x^2, -3x, 7; 2$ 2. Binomial; $2x^5, 4x^2; 5$
 3. Monomial; $-8; 0$ 4. Monomial; $\frac{1}{2}x^7; 7$ 5. Four terms;
 $-x^4, x^3, -x^2, x; 4$ 6. Binomial; $\sqrt{2}x, -\sqrt{3}; 1$ 7. $7x + 5$
 8. $-3 - x$ 9. $5x^2 - 2x - 4$ 10. $x^2 + 4x + 6$
 11. $x^3 + 3x^2 - 6x + 11$ 12. $7x + 5$ 13. $9x + 103$
 14. $x^2 - 6x + 17$ 15. $-t^4 + t^3 - t^2 - 10t + 5$
 16. $-3t^2 + 21t - 22$ 17. $x^{3/2} - x$ 18. $x^2 - x$

19. $21t^2 - 29t + 10$ 20. $12x^2 + 25x - 7$
 21. $3x^2 + 5xy - 2y^2$ 22. $8x^2 + 14xy - 15y^2$
 23. $1 - 4y + 4y^2$ 24. $9x^2 + 24x + 16$
 25. $4x^4 + 12x^2y^2 + 9y^4$ 26. $c^2 + 2 + \frac{1}{c^2}$
 27. $2x^3 - 7x^2 + 7x - 5$ 28. $2x^3 - 5x^2 - x + 1$
 29. $x^4 - a^4$ 30. $x - y$ 31. $a - 1/b^2$ 32. h^2
 33. $1 + 3a^3 + 3a^6 + a^9$ 34. $1 - 6y + 12y^2 - 8y^3$
 35. $2x^4 + x^3 - x^2 + 3x - 2$
 36. $3x^5 + 7x^4 - x^3 - 3x^2 - 4x + 2$ 37. $1 - x^{2/3} + x^{4/3} - x^2$
 38. $1 - 2b^2 + b^4$ 39. $3x^4y^4 + 7x^3y^5 - 6x^2y^3 - 14xy^4$
 40. $x^6y + x^5y^2 + x^4y^3 - x^2y^5 - xy^6 - y^7$
 41. $x^2 - y^2 - 2yz - z^2$ 42. $x^4 - y^2 + 2yz - z^2$
 43. $2x(-x^2 + 8)$ 44. $2x^2(x^2 + 2x - 7)$
 45. $(y - 6)(y + 9)$ 46. $(z + 2)(z - 3)$
 47. $xy(2x - 6y + 3)$ 48. $7xy^2(-x^3 + 2y + 3y^2)$
 49. $(x - 1)(x + 3)$ 50. $(x - 1)(x - 5)$
 51. $(2x - 5)(4x + 3)$ 52. $(y + 3)(6y - 7)$
 53. $(3x + 4)(3x + 8)$ 54. $(2a + 2b - 1)(a + b + 3)$
 55. $(3a - 4)(3a + 4)$ 56. $(x + 1)(x + 5)$
 57. $(3x + y)(9x^2 - 3xy + y^2)$
 58. $(2s - 5t^2)(4s^2 + 10st^2 + 25t^4)$ 59. $(x + 6)^2$
 60. $(4z - 3)^2$ 61. $(x + 4)(x^2 + 1)$
 62. $(3x - 1)(x^2 + 2)$
 63. $(2x + 1)(x^2 - 3)$ 64. $(3x + 1)(1 - 3x^2)$
 65. $(x + 1)(x^2 + 1)$ 66. $(x + 1)(x^4 + 1)$
 67. $x^{1/2}(x + 1)(x - 1)$ 68. $x^{-3/2}(x + 1)^2$
 69. $(x^2 + 3)(x^2 + 1)^{-1/2}$ 70. $x^{1/3}(x - 2)^{-1/3}(-3x - 4)$
 71. $6x(2x^2 + 3)$ 72. $ab(5 - 8c)$ 73. $(x - 4)(x + 2)$
 74. $(y - 3)(y - 5)$ 75. $(2x + 3)(x + 1)$
 76. $9(x - 5)(x + 1)$ 77. $(3x + 2)(2x - 3)$
 78. $(r - 3s)^2$ 79. $(5s - t)^2$
 80. $(x + 6)(x - 6)$ 81. $(2x - 5)(2x + 5)$
 82. $(7 + 2y)(7 - 2y)$ 83. $4ab$ 84. $\frac{4}{x}$
 85. $(x + 3)(x - 3)(x + 1)(x - 1)$
 86. $(a - 1)(a + 1)(b - 2)(b + 2)$
 87. $(2x + 5)(4x^2 - 10x + 25)$
 88. $(x^2 + 4)(x^4 - 4x^2 + 16)$
 89. $(x^2 - 2y)(x^4 + 2x^2y + 4y^2)$
 90. $(3a - b^2)(9a^2 + 3ab^2 + b^4)$ 91. $x(x + 1)^2$
 92. $3x(x - 3)(x + 3)$ 93. $(y + 2)(y - 2)(y - 3)$
 94. $(x + 3)(x - 1)(x + 1)$ 95. $(2x^2 + 1)(x + 2)$
 96. $(x^2 - 2)(3x + 5)$ 97. $3(x - 1)(x + 2)$
 98. $y^4(y + 2)^3(y + 1)^2$
 99. $(a + 2)(a - 2)(a + 1)(a - 1)$
 100. $(a - 1)(a + 3)(a + 1)^2$
 101. $2(x^2 + 4)^4(x - 2)^3(7x^2 - 10x + 8)$
 102. $(2x - 1)^2(x + 3)^{-1/2}(7x + \frac{35}{2})$
 103. $(x^2 + 3)^{-4/3}(\frac{1}{3}x^2 + 3)$ 104. $2x^{-1/2}(3x + 4)^{-1/2}$
 105. (d) $(a + b + c)(a + b - c)(a - b + c)(b - a + c)$

Section 1.4 ■ page 41

1. \mathbb{R} 2. \mathbb{R} 3. $x \neq 4$ 4. $t \neq -2$ 5. $x \geq -3$ 6. $x > 1$
 7. $\frac{x+2}{2(x-1)}$ 8. $\frac{x+1}{3(x+2)}$ 9. $\frac{1}{x+2}$ 10. $\frac{x-2}{x-1}$
 11. $\frac{x+2}{x+1}$ 12. $\frac{x-4}{x+2}$ 13. $\frac{y}{y-1}$ 14. $\frac{(y-6)(y+3)}{(2y+3)(y+1)}$
 15. $\frac{x(2x+3)}{2x-3}$ 16. $\frac{-(x+1)}{x^2+x+1}$ 17. $\frac{1}{4(x-2)}$ 18. $\frac{x-5}{x-4}$
 19. $\frac{x+3}{3-x}$ 20. $\frac{1-x}{x+1}$ 21. $\frac{1}{t^2+9}$ 22. x 23. $\frac{x+4}{x+1}$
 24. $\frac{2x+y}{x-2y}$ 25. $\frac{(2x+1)(2x-1)}{(x+5)^2}$ 26. 1 27. $x^2(x+1)$
 28. $\frac{x-2}{x+1}$ 29. $\frac{x}{yz}$ 30. $\frac{xz}{y}$ 31. $\frac{3(x+2)}{x+3}$ 32. $\frac{x-5}{x+4}$
 33. $\frac{3x+7}{(x-3)(x+5)}$ 34. $\frac{2x}{(x+1)(x-1)}$
 35. $\frac{1}{(x+1)(x+2)}$ 36. $\frac{x^2+3x+12}{(x-4)(x+6)}$ 37. $\frac{3x+2}{(x+1)^2}$
 38. $\frac{2(5x-9)}{(2x-3)^2}$ 39. $\frac{u^2+3u+1}{u+1}$ 40. $\frac{2b^2-3ab+4a^2}{a^2b^2}$
 41. $\frac{2x+1}{x^2(x+1)}$ 42. $\frac{x^2+x+1}{x^3}$ 43. $\frac{2x+7}{(x+3)(x+4)}$
 44. $\frac{2(x+1)}{(x-2)(x+2)}$ 45. $\frac{x-2}{(x+3)(x-3)}$
 46. $\frac{x^2-6x-4}{(x-1)(x+2)(x-4)}$ 47. $\frac{5x-6}{x(x-1)}$
 48. $\frac{-2x-1}{(x-3)(x+2)}$ 49. $\frac{-5}{(x+1)(x+2)(x-3)}$
 50. $\frac{x^2+x+4}{(x-1)(x+1)^2}$ 51. $-xy$ 52. $\frac{x^3}{x^2+y^2}$ 53. $\frac{c}{c-2}$
 54. $\frac{3+2x}{2+x}$ 55. $\frac{3x+7}{x^2+2x-1}$ 56. -1 57. $\frac{y-x}{xy}$
 58. $\frac{(x+y)^2}{xy}$ 59. 1 60. $\frac{a^{m+n}}{b^{m+n}}$ 61. $\frac{-1}{a(a+h)}$
 62. $\frac{-(3x^2+3xh+h^2)}{(x+h)^3x^3}$ 63. $\frac{-3}{(2+x)(2+x+h)}$
 64. $3x^2+3xh+h^2-7$ 65. $\frac{1}{\sqrt{1-x^2}}$ 66. $\left|x^3+\frac{1}{4x^3}\right|$
 67. $\frac{(x+2)^2(x-13)}{(x-3)^3}$ 68. $\frac{2x(6-x)}{(x+6)^5}$ 69. $\frac{x+2}{(x+1)^{3/2}}$
 70. $\frac{1}{(1-x^2)^{3/2}}$ 71. $\frac{2x+3}{(x+1)^{4/3}}$ 72. $\frac{7-\frac{3}{2}x}{(7-3x)^{3/2}}$
 73. $2+\sqrt{3}$ 74. $\frac{3+\sqrt{5}}{2}$ 75. $\frac{2(\sqrt{7}-\sqrt{2})}{5}$
 76. $\frac{\sqrt{x}-1}{x-1}$ 77. $\frac{y\sqrt{3}-y\sqrt{y}}{3-y}$ 78. $2(\sqrt{x}+\sqrt{y})$

79. $\frac{-4}{3(1+\sqrt{5})}$ 80. $\frac{-1}{\sqrt{3}-\sqrt{5}}$ 81. $\frac{r-2}{5(\sqrt{r}-\sqrt{2})}$
 82. $\frac{-1}{\sqrt{x}\sqrt{x+h}(\sqrt{x}+\sqrt{x+h})}$ 83. $\frac{1}{\sqrt{x^2+1}+x}$
 84. $\frac{1}{\sqrt{x+1}+\sqrt{x}}$ 85. True 86. False 87. False
 88. False 89. False 90. False 91. True 92. True
 93. (a) $\frac{R_1R_2}{R_1+R_2}$ (b) $\frac{20}{3} \approx 6.7$ ohms 94. \$56.10, \$31.20, \$16.50, \$12.00, \$10.50, \$12.00, \$16.50

Section 1.5 ■ page 55

1. (a) No (b) Yes 2. (a) Yes (b) No 3. (a) Yes (b) No 4. (a) Yes (b) No 5. 12 6. $\frac{7}{5}$ 7. 18 8. 6
 9. -3 10. $\frac{5}{2}$ 11. 12 12. -70 13. $-\frac{3}{4}$ 14. $\frac{21}{11}$ 15. 30
 16. $\frac{1}{17}$ 17. $-\frac{1}{3}$ 18. $\frac{13}{6}$ 19. $\frac{13}{3}$ 20. $\frac{11}{2}$ 21. -2 22. $-\frac{1}{2}$
 23. $R = \frac{PV}{nT}$ 24. $m = \frac{Fr^2}{GM}$ 25. $R_1 = \frac{RR_2}{R_2 - R}$
 26. $w = \frac{P-2l}{2}$ 27. $x = \frac{2d-b}{a-2c}$
 28. $x = \frac{-6+a-2b+6c}{6}$ 29. $x = \frac{1-a}{a^2-a-1}$
 30. $a = \frac{1}{2}(b^2+b)$ 31. $r = \pm \sqrt{\frac{3V}{\pi h}}$
 32. $r = \pm \sqrt{\frac{GMm}{F}}$ 33. $b = \pm \sqrt{c^2 - a^2}$
 34. $i = -100 \pm 100\sqrt{A/P}$ 35. $t = \frac{-v_0 \pm \sqrt{v_0^2 + 2gh}}{g}$
 36. $n = \frac{-1 \pm \sqrt{1+8S}}{2}$ 37. $-4, 3$ 38. $-4, 1$
 39. 3, 4 40. $-6, -2$ 41. $-\frac{3}{2}, \frac{5}{2}$ 42. $-3, -\frac{1}{2}$ 43. $-2, \frac{1}{3}$
 44. $-\frac{3}{2}, \frac{7}{3}$ 45. $-1 \pm \sqrt{6}$ 46. $2 \pm \sqrt{2}$
 47. $-\frac{7}{2}, \frac{1}{2}$ 48. $\frac{1}{4}, \frac{1}{2}$ 49. $-2 \pm \frac{\sqrt{14}}{2}$ 50. $1 \pm \frac{2\sqrt{3}}{3}$
 51. $0, \frac{1}{4}$ 52. $\frac{3 \pm \sqrt{15}}{2}$ 53. $-3, 5$ 54. $-20, -10$
 55. $\frac{-3 \pm \sqrt{5}}{2}$ 56. $3 \pm 2\sqrt{2}$ 57. $-\frac{3}{2}, 1$ 58. $-\frac{4}{3}, -1$
 59. $\frac{1 \pm \sqrt{5}}{4}$ 60. $\frac{3}{4}$ 61. $-\frac{9}{2}, \frac{1}{2}$ 62. No real solution
 63. $\frac{-5 \pm \sqrt{13}}{2}$ 64. $\frac{\sqrt{5} \pm 1}{2}$ 65. $-\frac{\sqrt{6}}{2}, \frac{\sqrt{6}}{6}$
 66. No real solution 67. $-\frac{7}{5}$ 68. No real solution
 69. 2 70. No real solution 71. 1 72. 2
 73. No real solution 74. 2 75. $-\frac{7}{5}, 2$ 76. $-\frac{3}{2}, 5$
 77. $-50, 100$ 78. No real solution 79. -4 80. $-4, -\frac{7}{3}$
 81. 4 82. 4 83. 3 84. 21 85. $\pm 2\sqrt{2}, \pm \sqrt{5}$

A4 Answers to Exercises and Chapter Tests

86. $-2, -1, 1, 2$ 87. No real solution 88. $-1, \sqrt[3]{3}$
 89. $\pm 3\sqrt{3}, \pm 2\sqrt{2}$ 90. 256 91. $-1, 0, 3$ 92. 2
 93. 27, 729 94. 4, 9 95. $-\frac{3}{2}, \frac{3}{2}$ 96. $-2, -\frac{4}{3}$
 97. 3.99, 4.01 98. No real solution 99. 4.24 s
 100. (a) 1.732 s (b) 2.449 s 101. (a) After 1 s and $1\frac{1}{2}$ s
 (b) Never (c) 25 ft (d) After $1\frac{1}{4}$ s (e) After $2\frac{1}{2}$ s
 102. 80 ft/s 103. (a) 0.00055, 12.018 m (b) 234.375 kg/m³
 104. 12 cm 105. (a) After 17 yr, on Jan. 1, 2019
 (b) After 18.612 yr, on Aug. 12, 2020 106. 89 days
 107. 50 108. 215,000 mi 109. 132.6 ft

Section 1.6 ■ page 68

1. $3n + 3$ 2. $3n$ 3. $\frac{160 + s}{3}$ 4. $\frac{24 + q}{4}$ 5. $0.025x$
 6. $795n$ 7. $A = 3w^2$ 8. $4w + 10$ 9. $d = \frac{3}{4}s$ 10. $\frac{d}{55}$
 11. $\frac{25}{x + 3}$ 12. $131p + 140$ 13. 51, 52, 53
 14. 101, 103, 105, 107 15. 19 and 36
 16. $-26, -24$ or $24, 26$ 17. \$9000 at $4\frac{1}{2}\%$ and \$3000 at 4%
 18. \$2000 19. 7.5% 20. 6% 21. \$7400 22. \$32,500
 23. \$45,000 24. 8 h 25. Plumber, 70 h; assistant, 35 h
 26. 714 27. 40 years old 28. 12 29. 9 pennies, 9 nickels,
 9 dimes 30. 5 quarters, 10 dimes, 15 nickels 31. 6.4 ft from
 the fulcrum 32. 1200 lb 33. (a) 9 cm (b) 5 in.
 34. (a) $4\sqrt{3} \approx 8.94$ in. (b) 48 cm 35. 45 ft 36. 240 ft
 37. 120 ft by 120 ft 38. 66 ft by 330 ft 39. 25 ft by 35 ft
 40. 12 ft 41. 60 ft by 40 ft 42. 120 ft by 126 ft
 43. 120 ft 44. 35 yd 45. 4 in. 46. 30 ft; 120 ft by 180 ft
 47. 18 ft 48. 32 ft 4 in. 49. 5 m 50. 95 ft 51. 4
 52. 200 mL 53. 18 g 54. 2.4 L 55. 0.6 L
 56. 3.06 gal 57. 35% 58. 48 lb of \$3.00/lb tea, 32 lb of
 \$2.75/lb tea 59. 37 min 20 s 60. 120 min 61. 3 h
 62. 40.5 h for Jim's hose, 32.4 h for Bob's hose
 63. Irene 3 h, Henry $4\frac{1}{2}$ h 64. 3 h 65. 4 h
 66. 15 mi/h; 30 mi/h 67. 500 mi/h 68. 55 mi/h
 69. 50 mi/h (or 240 mi/h) 70. 50 mi/h 71. 6 km/h
 72. 9 mi/h 73. 2 ft by 6 ft by 15 ft 74. 4.63 mm 75. 13 in.
 by 13 in. 76. 4 cm 77. 2.88 ft 78. 49 ft, 168 ft, and 175 ft
 79. 16 mi; no 80. 440 ft or 720 ft 81. 7.52 ft 82. 27.4 in.
 83. 18 ft 84. 169.1 in., 190.9 in. 85. 4.55 ft

Section 1.7 ■ page 84

1. $\{\sqrt{2}, 2, 4\}$ 2. $\{1, \sqrt{2}, 2, 4\}$ 3. $\{4\}$ 4. $\{\sqrt{2}, 2, 4\}$
 5. $\{-2, -1, 2, 4\}$ 6. $\{-1, 0, \frac{1}{2}, 1\}$
 7. $(4, \infty)$ 8. $(-\infty, -2)$
 9. $(-\infty, 2]$ 10. $[7, \infty)$

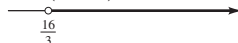
11. $(-\infty, -\frac{1}{2})$



13. $[1, \infty)$



15. $(\frac{16}{3}, \infty)$



17. $(-\infty, -18)$



19. $(-\infty, -1]$



21. $[-3, -1)$



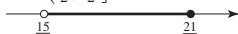
23. $(2, 6)$



25. $[\frac{9}{2}, 5)$



27. $(\frac{15}{2}, \frac{21}{2}]$



29. $(-2, 3)$



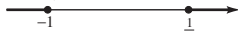
31. $(-\infty, -\frac{7}{2}] \cup [0, \infty)$



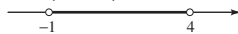
33. $[-3, 6]$



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



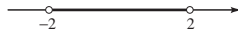
37. $(-1, 4)$



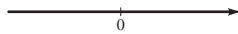
39. $(-\infty, -3) \cup (6, \infty)$



41. $(-2, 2)$



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



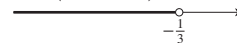
12. $(-\infty, \frac{5}{2})$



14. $(-\infty, -1]$



16. $(-\infty, -\frac{1}{3})$



18. $(-\infty, \frac{1}{3})$



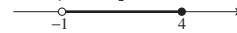
20. $(-\infty, 11]$



22. $[3, 6]$



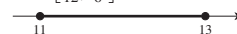
24. $(-1, 4]$



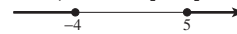
26. $[-\frac{10}{3}, -\frac{13}{6}]$



28. $[\frac{11}{12}, \frac{13}{6}]$



30. $(-\infty, -4] \cup [5, \infty)$



32. $(-\infty, 0] \cup [\frac{2}{3}, \infty)$



34. $(-\infty, -3) \cup (-2, \infty)$



36. $(-1, 2)$



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



40. $(-\infty, -3) \cup (1, \infty)$

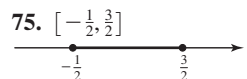
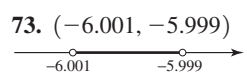
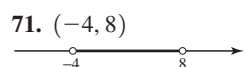
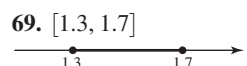
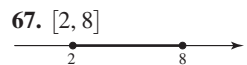
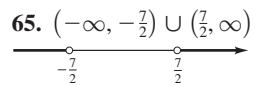
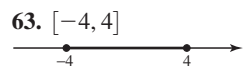
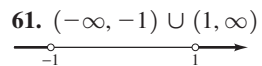
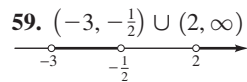
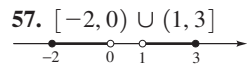
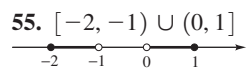
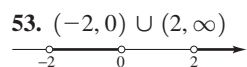
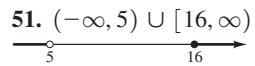
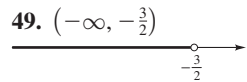
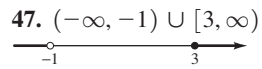
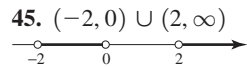


42. $(-\infty, -3] \cup [3, \infty)$



44. $(-\infty, -2] \cup [1, 3]$

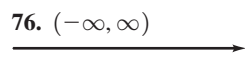
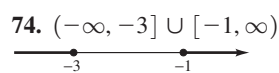
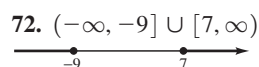
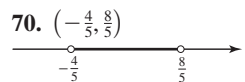
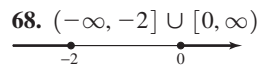
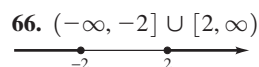
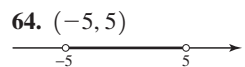
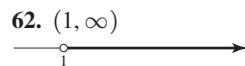
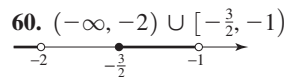
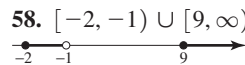
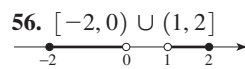
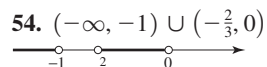
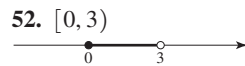
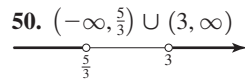
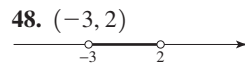
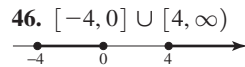




77. $|x| < 3$ 78. $|x| > 2$ 79. $|x - 7| \geq 5$

80. $|x - 2| \leq 4$ 81. $|x| \leq 2$ 82. $|x| \geq 1$ 83. $|x| > 3$

84. $|x| < 4$ 85. $|x - 1| \leq 3$ 86. $|x + 2| > 1$



87. $-\frac{4}{3} \leq x \leq \frac{4}{3}$ 88. $x \leq \frac{2}{3}$ or $x \geq 1$ 89. $x < -2$ or $x > 7$

90. $-2 < x \leq 1$ 91. (a) $x \geq \frac{c}{a} + \frac{c}{b}$

(b) $\frac{a-c}{b} \leq x < \frac{2a-c}{b}$

93. $68 \leq F \leq 86$ 94. $10 \leq C \leq 35$ 95. More than 200 mi

96. Less than 286 min 97. Between 12,000 mi and 14,000 mi

98. Between 40 and 50 mi/h 99. Distances between 20,000 km and 100,000 km 100. Distances greater than 30 m

101. Between 0 and 60 mi/h 102. Between 400 and 4400 units

103. (a) $T = 20 - \frac{h}{100}$ (b) From 20°C down to -30°C

104. (a) $-\frac{1}{3}P + \frac{560}{3}$ (b) From \$215 to \$290

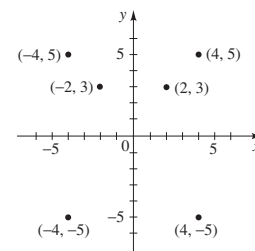
105. 24 106. Between 20 and 40 ft

107. (a) $|x - 0.020| \leq 0.003$ (b) $0.017 \leq x \leq 0.023$

108. Between 62.4 and 74.0 in.

Section 1.8 ■ page 97

1.

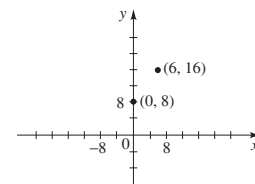


2. $A(5, 1), B(1, 2), C(-2, 6), D(-6, 2), E(-4, -1), F(-2, 0),$

$G(-1, -3), H(2, -2)$ 3. (a) $\sqrt{13}$ (b) $(\frac{3}{2}, 1)$ 4. (a) 5

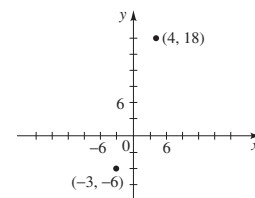
(b) $(0, \frac{1}{2})$ 5. (a) 10 (b) $(1, 0)$ 6. (a) $2\sqrt{10}$ (b) $(1, -2)$

7. (a)

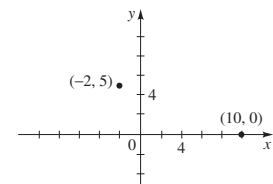


(b) 10 (c) $(3, 12)$

9. (a)

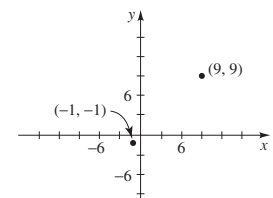


(b) 25 (c) $(\frac{1}{2}, 6)$



(b) 13 (c) $(4, \frac{5}{2})$

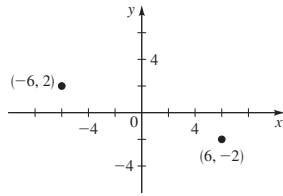
10. (a)



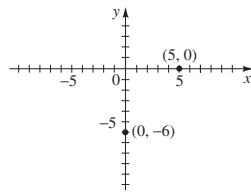
(b) $10\sqrt{2}$ (c) $(4, 4)$

A6 Answers to Exercises and Chapter Tests

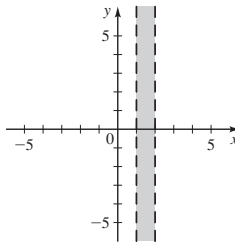
11. (a)



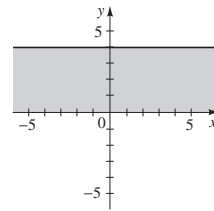
12. (a)



21.

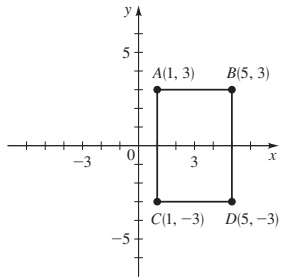


22.



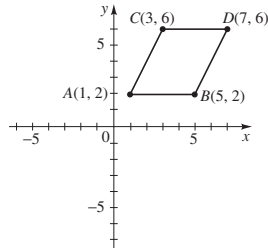
(b) $4\sqrt{10}$ **(c)** $(0, 0)$

13. 24

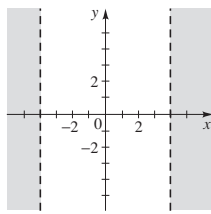


(b) $\sqrt{61}$ **(c)** $(\frac{5}{2}, -3)$

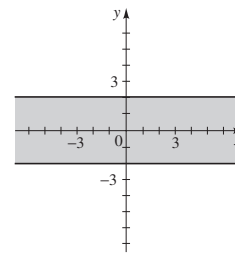
14. 16



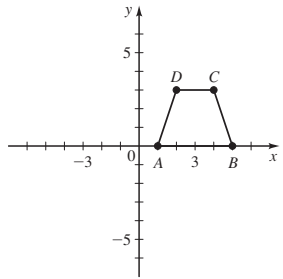
23.



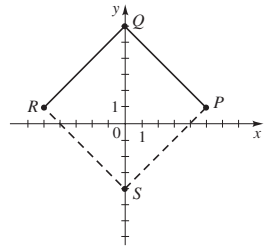
24.



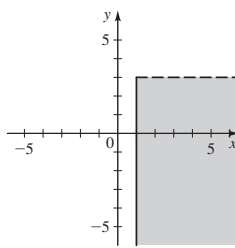
15. Trapezoid, area = 9



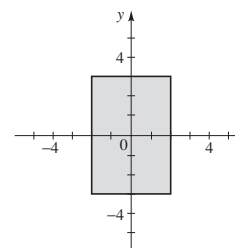
16. 50



25.



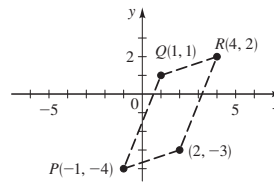
26.



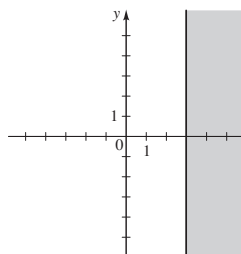
27. $A(6, 7)$ **28.** $C(-6, 3)$ **29.** $Q(-1, 3)$ **32.** 9

33. (b) 10 **37.** $(0, -4)$ **38.** $\sqrt{37}, \frac{\sqrt{109}}{2}, \frac{\sqrt{145}}{2}$

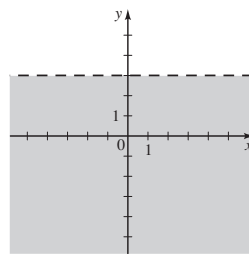
39. (2, -3)



17.

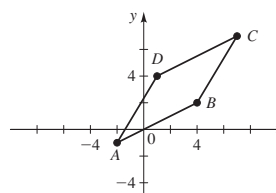


18.



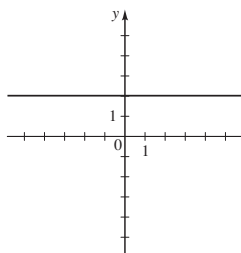
40. (10, 13)

41. (a)

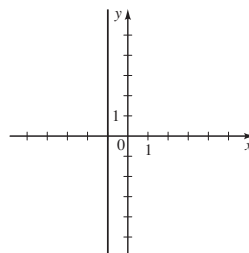


(b) $(\frac{5}{2}, 3), (\frac{5}{2}, 3)$

19.



20.



43. No, yes, yes **44.** No, yes, yes **45.** Yes, no, yes

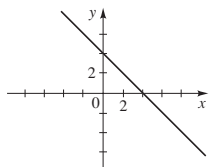
46. Yes, yes, yes **47.** x -intercepts 0, 4; y -intercept 0

48. x -intercepts -3, 3; y -intercepts -2, 2

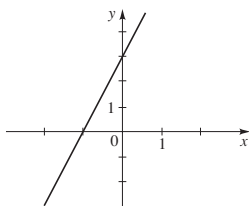
49. x -intercepts -2, 2; y -intercepts -4, 4

50. x -intercepts -8, 8; y -intercept 4

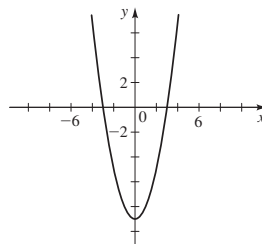
51. x -intercept 4,
 y -intercept 4,
 no symmetry



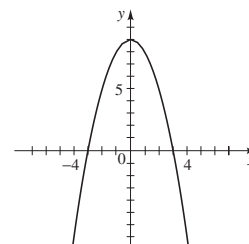
52. x -intercept -1 ,
 y -intercept 3,
 no symmetry



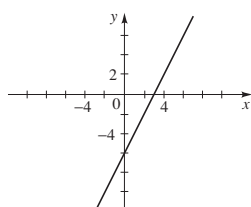
59. x -intercepts ± 3 ,
 y -intercept -9 ,
 symmetry about y -axis



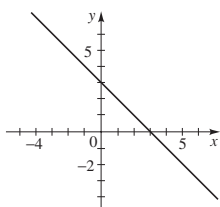
60. x -intercepts $-3, 3$,
 y -intercept 9,
 symmetry about y -axis



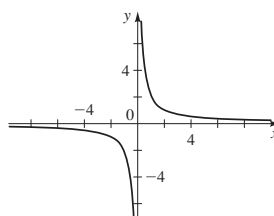
53. x -intercept 3,
 y -intercept -6 ,
 no symmetry



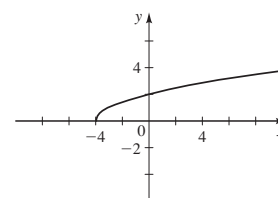
54. x -intercept 3,
 y -intercept 3,
 no symmetry



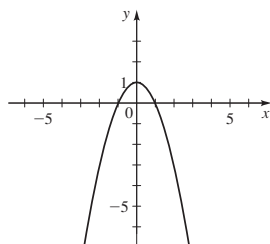
61. No intercepts,
 symmetry about origin



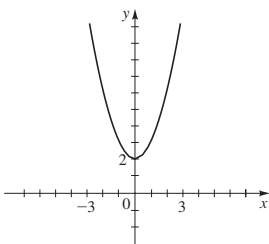
62. x -intercept -4 ,
 y -intercept 2,
 no symmetry



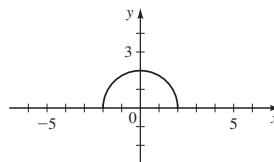
55. x -intercepts ± 1 ,
 y -intercept 1,
 symmetry about y -axis



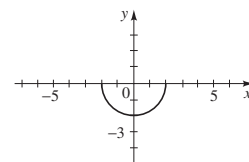
56. No x -intercepts,
 y -intercept 2,
 symmetry about y -axis



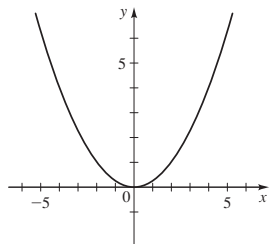
63. x -intercepts ± 2 ,
 y -intercept 2,
 symmetry about y -axis



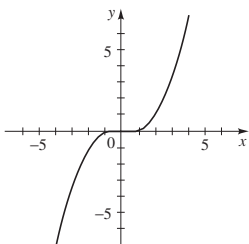
64. x -intercepts $-2, 2$,
 y -intercept -2 ,
 symmetry about y -axis



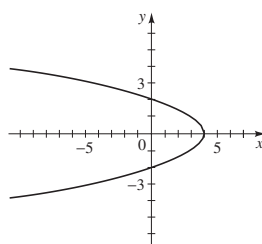
57. x -intercept 0,
 y -intercept 0,
 symmetry about y -axis



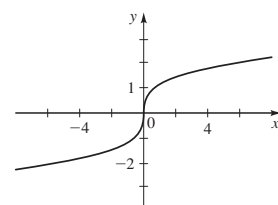
58. x -intercept 0,
 y -intercept 0,
 symmetry about origin



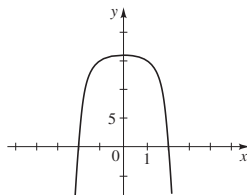
65. x -intercept 4,
 y -intercepts $-2, 2$,
 symmetry about x -axis



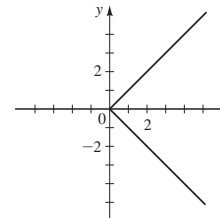
66. x -intercept 0,
 y -intercept 0,
 symmetry about origin



67. x -intercepts ± 2 ,
 y -intercept 16,
 symmetry about y -axis

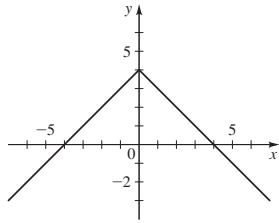


68. x -intercept 0,
 y -intercept 0,
 symmetry about x -axis

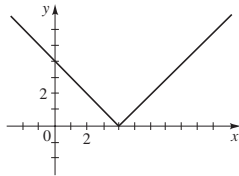


A8 Answers to Exercises and Chapter Tests

69. x -intercepts ± 4 ,
 y -intercept 4,
 symmetry about y -axis



70. x -intercept 4,
 y -intercept 4,
 no symmetry

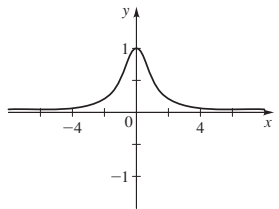


71. Symmetry about y -axis

73. Symmetry about origin

75. Symmetry about origin

77.

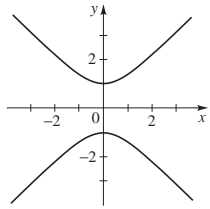


72. Symmetry about x -axis

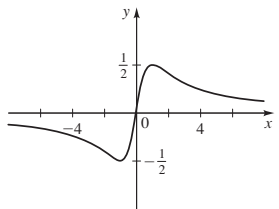
74. Symmetry about x -axis,
 y -axis, and origin

76. Symmetry about y -axis

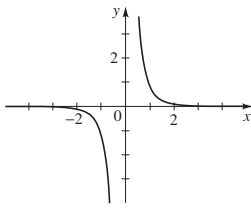
78.



79.



80.



81. $(x - 2)^2 + (y + 1)^2 = 9$

83. $x^2 + y^2 = 65$

85. $(x - 7)^2 + (y + 3)^2 = 9$

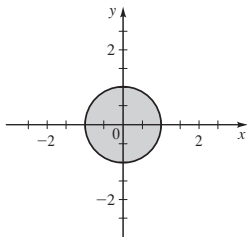
87. $(x + 2)^2 + (y - 2)^2 = 4$

89. $(2, -5), 4$

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

93. $(\frac{3}{4}, 0), \frac{3}{4}$

95.



82. $(x + 1)^2 + (y + 4)^2 = 64$

84. $(x - 2)^2 + (y - 5)^2 = 25$

86. $(x - 5)^2 + (y - 5)^2 = 25$

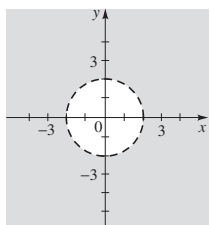
88. $(x + 1)^2 + (y - 1)^2 = 10$

90. $(0, -3), \sqrt{7}$

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

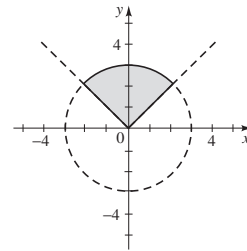
94. $(-1, \frac{1}{6}), \sqrt{37}/6$

96.



97. 12π

98. $\frac{9\pi}{4}$

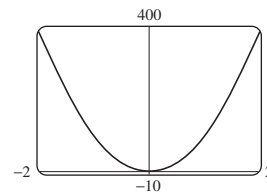


99. (a) 5 (b) 31; 25 (c) Points P and Q must either be on the same street or the same avenue. **100.** (a) 15th Street and 12th Avenue (b) 17 blocks **101.** (a) 2 Mm, 8 Mm (b) $-1.33, 7.33; 2.40$ Mm, 7.60 Mm

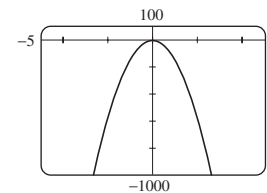
Section 1.9 ■ page 109

1. (c) **2.** (c) **3.** (c) **4.** (d) **5.** (c) **6.** (d)

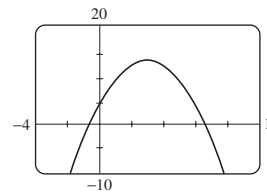
7.



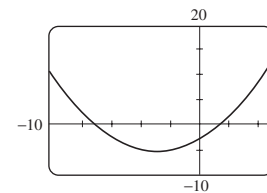
8.



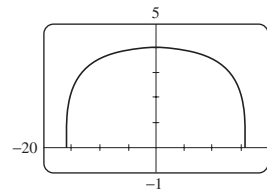
9.



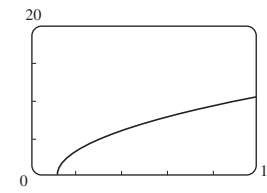
10.



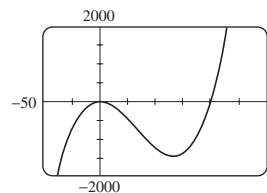
11.



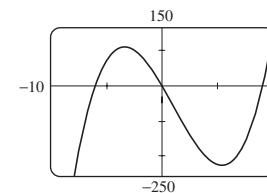
12.



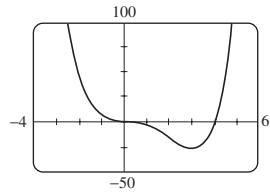
13.



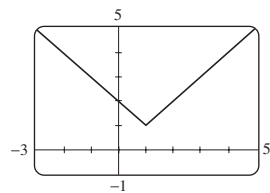
14.



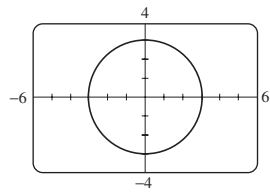
15.



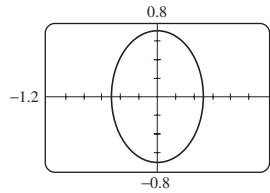
17.



19.

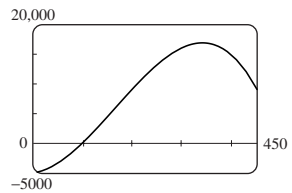


21.



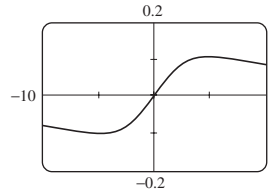
23. No 24. No 25. Yes, 2 26. Yes, 1 27. -4
 28. -6 29. $\frac{5}{14}$ 30. -4 31. $\pm 4\sqrt{2} \approx \pm 5.7$
 32. $-2\sqrt[3]{2} \approx -2.52$ 33. 2.5, -2.5 34. $\frac{3}{2}\sqrt[5]{16} \approx 2.61$
 35. $5 + 2\sqrt[4]{5} \approx 7.99$, $5 - 2\sqrt[4]{5} \approx 2.01$
 36. $-2 + \frac{2}{3}\sqrt[5]{81} \approx -0.39$ 37. 3.00, 4.00 38. 0.25, 0.50
 39. 1.00, 2.00, 3.00 40. -1.00, -0.25, 0.25 41. 1.62
 42. 0.00, 2.31 43. -1.00, 0.00, 1.00 44. 0.00, 3.31
 45. 2.55 46. -0.51, 0.51, 2.78 47. -2.05, 0, 1.05
 48. -2.31, 1.79 49. [-2.00, 5.00] 50. [-2, 0.25]
 51. $(-\infty, 1.00] \cup [2.00, 3.00]$
 52. $(-1, -0.25) \cup (-0.25, \infty)$ 53. $(-1.00, 0) \cup (1.00, \infty)$
 54. $(-\infty, -0.535] \cup [0.535, \infty)$ 55. $(-\infty, 0)$
 56. [2.148, ∞) 57. 0, 0.01

58. (a)

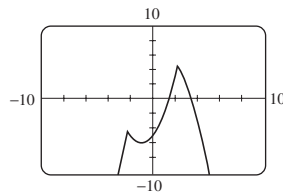


- (b) 101 cooktops
 (c) $279 < x < 400$

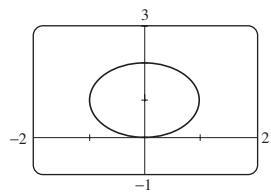
16.



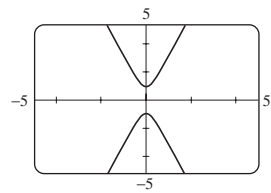
18.



20.

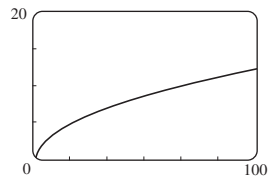


22.



23. No 24. No 25. Yes, 2 26. Yes, 1 27. -4
 28. -6 29. $\frac{5}{14}$ 30. -4 31. $\pm 4\sqrt{2} \approx \pm 5.7$
 32. $-2\sqrt[3]{2} \approx -2.52$ 33. 2.5, -2.5 34. $\frac{3}{2}\sqrt[5]{16} \approx 2.61$
 35. $5 + 2\sqrt[4]{5} \approx 7.99$, $5 - 2\sqrt[4]{5} \approx 2.01$
 36. $-2 + \frac{2}{3}\sqrt[5]{81} \approx -0.39$ 37. 3.00, 4.00 38. 0.25, 0.50
 39. 1.00, 2.00, 3.00 40. -1.00, -0.25, 0.25 41. 1.62
 42. 0.00, 2.31 43. -1.00, 0.00, 1.00 44. 0.00, 3.31
 45. 2.55 46. -0.51, 0.51, 2.78 47. -2.05, 0, 1.05
 48. -2.31, 1.79 49. [-2.00, 5.00] 50. [-2, 0.25]
 51. $(-\infty, 1.00] \cup [2.00, 3.00]$
 52. $(-1, -0.25) \cup (-0.25, \infty)$ 53. $(-1.00, 0) \cup (1.00, \infty)$
 54. $(-\infty, -0.535] \cup [0.535, \infty)$ 55. $(-\infty, 0)$
 56. [2.148, ∞) 57. 0, 0.01

59. (a)

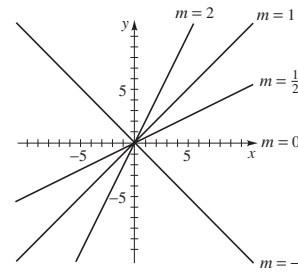


- (b) 67 mi

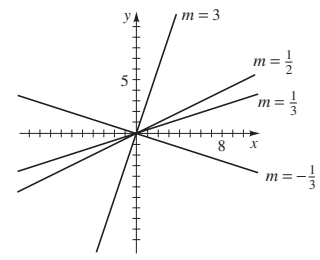
Section 1.10 ■ page 120

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

10. (a)

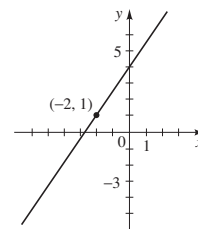


(b)

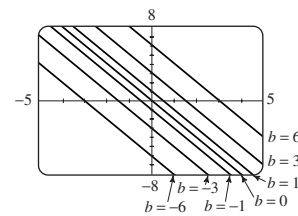


11. $x + y - 4 = 0$ 12. $2x - y + 4 = 0$
 13. $3x - 2y - 6 = 0$ 14. $4x + 3y + 12 = 0$
 15. $x - y + 1 = 0$ 16. $x + y - 2 = 0$
 17. $2x - 3y + 19 = 0$
 18. $7x + 2y + 31 = 0$
 19. $5x + y - 11 = 0$
 20. $x - y - 1 = 0$
 21. $3x - y - 2 = 0$
 22. $2x - 5y + 20 = 0$
 23. $3x - y - 3 = 0$
 24. $3x - 4y + 24 = 0$
 25. $y = 5$ 26. $x = 4$ 27. $x + 2y + 11 = 0$
 28. $2x + 3y - 18 = 0$ 29. $x = -1$
 30. $x = 2$ 31. $5x - 2y + 1 = 0$
 32. $6x + 3y - 1 = 0$ 33. $x - y + 6 = 0$
 34. $2x - y - 7 = 0$

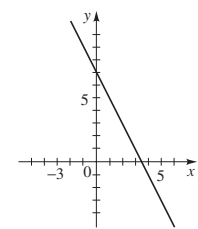
35. (a)



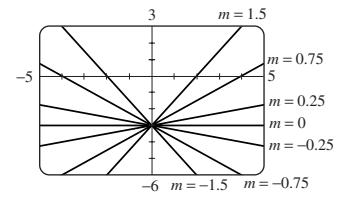
- (b) $3x - 2y + 8 = 0$
 37. They all have the same slope.



36. (a)

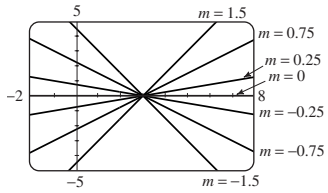


- (b) $2x + y - 7 = 0$
 38. They all have the same y-intercept.

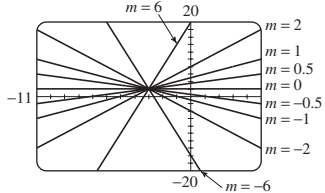


A10 Answers to Exercises and Chapter Tests

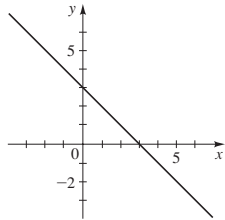
39. They all have the same x -intercept.



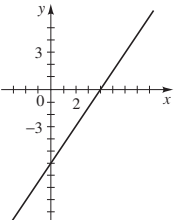
40. They all pass through the point $(-3, 2)$.



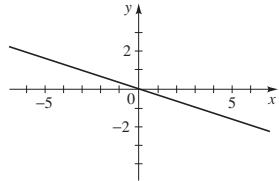
41. $-1, 3$



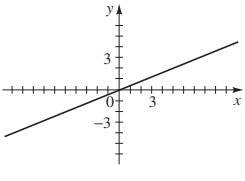
42. $\frac{3}{2}, -6$



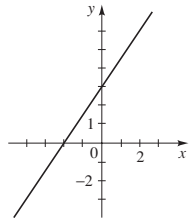
43. $-\frac{1}{3}, 0$



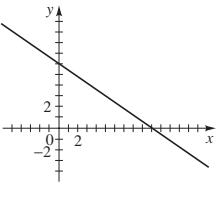
44. $\frac{2}{5}, 0$



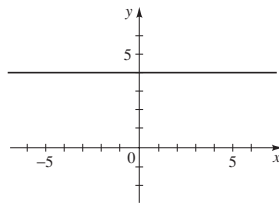
45. $\frac{3}{2}, 3$



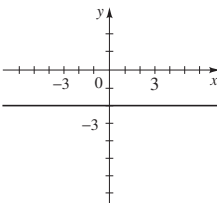
46. $-\frac{3}{5}, 6$



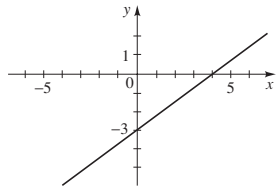
47. $0, 4$



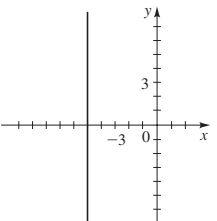
48. $0, -2$



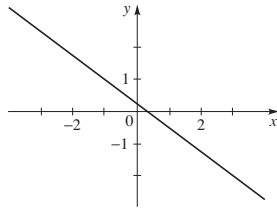
49. $\frac{3}{4}, -3$



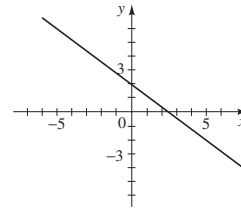
50. Undefined, none



51. $-\frac{3}{4}, \frac{1}{4}$



52. $-\frac{4}{5}, 2$



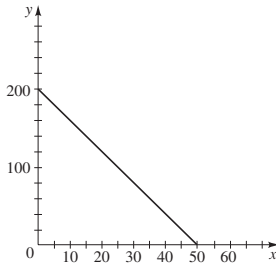
56. (a) Yes (b) No **57.** $x - y - 3 = 0$ **58.** 3

59. (b) $4x - 3y - 24 = 0$ **60.** (a) $3x - 4y - 25 = 0$

(b) $(-3, 4)$ **61.** 16,667 ft **62.** (a) The slope is the rate of increase in average surface temperature, and the T -intercept is the average surface temperature in 1900. (b) 12.5°C

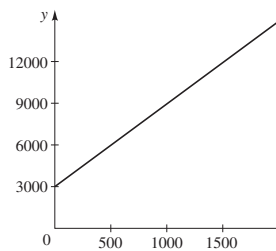
63. (a) 8.34; the slope represents the increase in dosage for a one-year increase in age. (b) 8.34 mg

64. (a)



(b) The slope is the rate of decline in number of spaces sold, the y -intercept is the number of spaces, and the x -intercept is the cost per space when the manager rents no spaces.

65. (a)



(b) The slope represents production cost per toaster; the y -intercept represents monthly fixed cost.

66. (a)

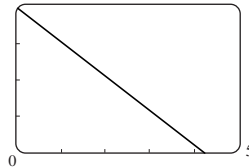
C	-30°	-20°	-10°	0°	10°	20°	30°
F	-22°	-4°	14°	32°	50°	68°	86°

(b) -40°

67. (a) $t = \frac{5}{24}n + 45$ (b) 76°F

68. (a) $V = -950t + 4000$

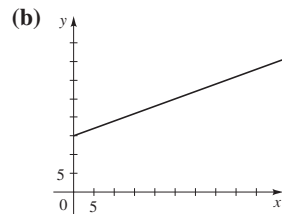
(b) 4100



(c) The slope is the rate of decrease in value of the computer, and the V -intercept is the price of the computer.

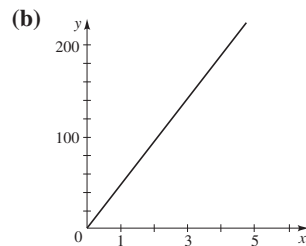
(d) \$1150

69. (a) $P = 0.434d + 15$, where P is pressure in lb/in^2 and d is depth in feet



(c) The slope is the rate of increase in water pressure, and the y-intercept is the air pressure at the surface. (d) 196 ft

70. (a) $d = 48t$



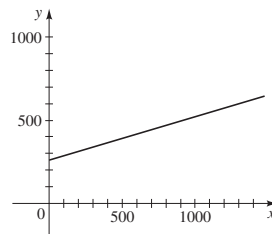
(c) 48, speed

71. (a) $C = \frac{1}{4}d + 260$

(b) \$635

(c) The slope represents cost per mile.

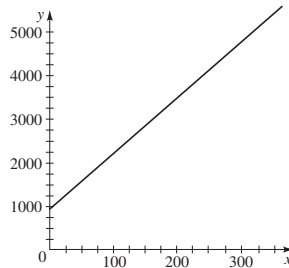
(d) The y-intercept represents monthly fixed cost.



72. (a) $y = 13x + 900$

(b) 13; slope is cost of producing each additional chair

(c) 900; y-intercept is fixed daily cost



Section 1.11 ■ page 127

1. $T = kx$ 2. $P = kw$ 3. $v = k/z$ 4. $w = kmn$
 5. $y = ks/t$ 6. $P = \frac{k}{T}$ 7. $z = k\sqrt{y}$ 8. $A = k\frac{t^2}{x^3}$
 9. $V = klwh$ 10. $S = kr^2\theta^2$ 11. $R = k\frac{i}{Pt}$
 12. $A = k\sqrt{xy}$ 13. $y = 7x$ 14. $z = 15/t$ 15. $M = 15x/y$
 16. $S = 9pq$ 17. $W = 360/r^2$ 18. $t = 50\frac{xy}{r}$
 19. $C = 16twh$ 20. $H = 81l^2w^2$ 21. $s = 500/\sqrt{t}$

22. $M = 32\frac{abc}{d}$ 23. (a) $F = kx$ (b) 8 (c) 32 N
 24. (a) $T = k\sqrt{l}$ (b) quadruple the length l
 25. (a) $C = kpm$ (b) 0.125 (c) \$57,500
 26. (a) $P = kT/V$ (b) 8.3 (c) 51.9 kPa 27. (a) $P = ks^3$
 (b) 0.012 (c) 324 28. 270 hp 29. 0.7 dB 30. 40 mi/h
 (for safety round down, not up) 31. 4 32. 1305.6 lb
 33. 5.3 mi/h 34. (a) $F = kus^2/r$ (b) 48 mi/h
 35. (a) $R = kL/d^2$ (b) 0.002916 (c) $R \approx 137 \Omega$
 36. (a) $T^2 = kd^3$ (b) 1.66×10^{-19} (c) 164 yr
 37. (a) 160,000 (b) 1,930,670,340 38. \$51,200 39. 36 lb
 40. 25.2 ft 41. (a) $f = k/L$ (b) Halves it
 42. (a) $r = kx(P - x)$ (b) Infection rate when 1000 people are infected is 80 times larger. (c) 0, since no more people can be infected

Chapter 1 Review ■ page 131

1. Commutative Property for addition
 2. Commutative Property for multiplication
 3. Distributive Property 4. Distributive Property
 5. $-2 \leq x < 6$

6. $x \leq 4$

7. $[5, \infty)$

8. $(-1, 5]$

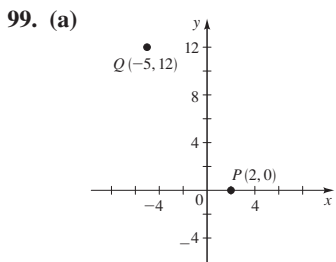
9. 6 10. 1 11. $\frac{1}{72}$ 12. -5 13. $\frac{1}{6}$ 14. 16 15. 11
 16. 6 17. 4 18. 10 19. $16x^3$ 20. b^{14} 21. $12xy^8$
 22. $r^{10}s^2$ 23. x^2y^2 24. $|x|y^2$ 25. $3x^{3/2}y^2$
 26. x^8 27. $\frac{4r^{5/2}}{s^7}$ 28. $\frac{4a^4c^6}{b^{12}}$ 29. 7.825×10^{10}
 30. 0.0000000208 31. 1.65×10^{-32} 32. 3.8×10^9 times
 33. $3xy^2(4xy^2 - y^3 + 3x^2)$ 34. $(x - 6)(x - 3)$
 35. $(x - 2)(x + 5)$ 36. $(3x - 4)(2x + 3)$
 37. $(4t + 3)(t - 4)$ 38. $(x - 1)^2(x + 1)^2$
 39. $(5 - 4t)(5 + 4t)$ 40. $2y^2(y^2 + 4)(y + 2)(y - 2)$
 41. $(x - 1)(x^2 + x + 1)(x + 1)(x^2 - x + 1)$
 42. $(y - 2)(y - 1)(y + 1)$ 43. $x^{-1/2}(x - 1)^2$
 44. $ab^2(a + b)(a^2 - ab + b^2)$ 45. $(x - 2)(4x^2 + 3)$
 46. $(2x + y^2)(4x^2 - 2xy^2 + y^4)$ 47. $\sqrt{x^2 + 2(x^2 + x + 2)^2}$
 48. $(3x - 2)(x^2 + 6)$ 49. $6x^2 - 21x + 3$ 50. $4y^2 - 49$
 51. $-7 + x$ 52. $2x^{3/2} + x - x^{1/2}$ 53. $2x^3 - 6x^2 + 4x$
 54. $\frac{x - 3}{2x + 3}$ 55. $\frac{3(x + 3)}{x + 4}$ 56. $\frac{t^2 + t + 1}{t + 1}$ 57. $\frac{x + 1}{x - 4}$
 58. $\frac{3x^2 - 7x + 8}{x(x - 2)^2}$ 59. $\frac{1}{x + 1}$ 60. $\frac{x^2 - 2x - 5}{(x - 2)(x + 1)(x + 2)}$
 61. $-\frac{1}{2x}$ 62. $\frac{1}{2x + 1}$ 63. $3\sqrt{2} - 2\sqrt{3}$
 64. $\frac{1}{\sqrt{x + h} + \sqrt{x}}$ 65. 5 66. -2 67. No solution

A12 Answers to Exercises and Chapter Tests

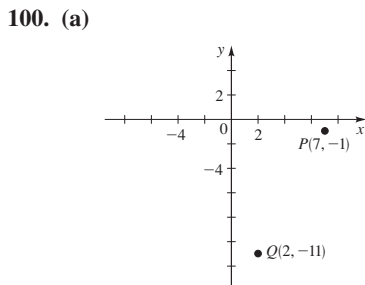
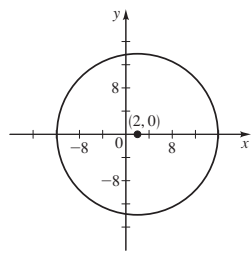
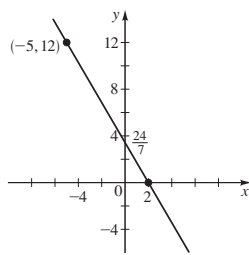
68. 1 69. 2, 7 70. -12 71. $-1, \frac{1}{2}$ 72. $-2, \frac{1}{3}$
 73. $0, \pm \frac{5}{2}$ 74. $2, \pm \sqrt{5}$ 75. $\frac{-2 \pm \sqrt{7}}{3}$ 76. $\frac{3 \pm \sqrt{6}}{3}$
 77. -5 78. ± 3 79. 3, 11 80. -2, 7 81. 20 lb raisins,
 30 lb nuts 82. 4:00 P.M. 83. $\frac{1}{4}(\sqrt{329} - 3) \approx 3.78$ mi/h
 84. 12 cm, 16 cm 85. 1 h 50 min 86. 10 ft by 8 ft or 12 ft
 by 6.67 ft



95. -1, 7 96. -2.50, 2.76 97. $[1, 3]$ 98. $(5.07, \infty)$

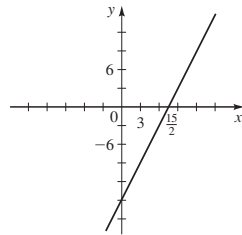


- (b) $\sqrt{193}$ (c) $(-\frac{3}{2}, 6)$
 (d) $y = -\frac{12}{7}x + \frac{24}{7}$ (e) $(x - 2)^2 + y^2 = 193$

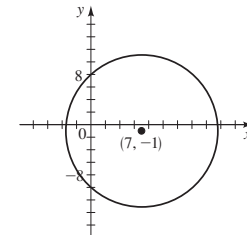


- (b) $5\sqrt{5}$ (c) $(\frac{9}{2}, -6)$

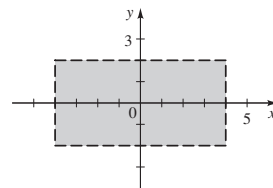
(d) $y = 2x - 15$



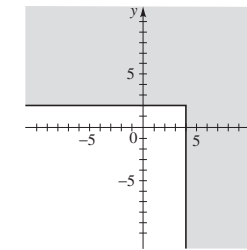
(e) $(x - 7)^2 + (y + 1)^2 = 125$



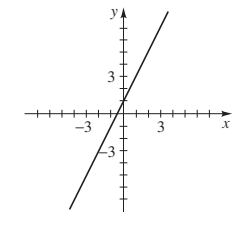
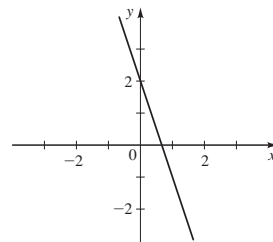
101.



102.

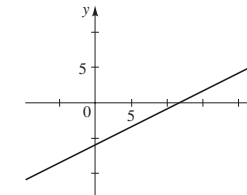
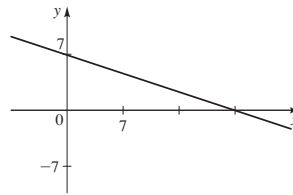


103. B 104. $(x - 2)^2 + (y + 5)^2 = 2$
 105. $(x + 5)^2 + (y + 1)^2 = 26$
 106. $(x - \frac{1}{2})^2 + (y - \frac{11}{2})^2 = \frac{17}{2}$
 107. Circle, center $(-1, 3)$, radius 1
 108. Circle; $(\frac{1}{2}, -2)$, $3/\sqrt{2}$ 109. No graph 110. Point
 111. No symmetry 112. No symmetry



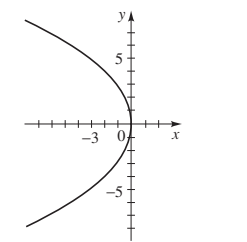
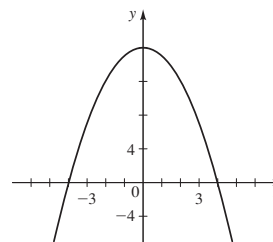
113. No symmetry

114. No symmetry

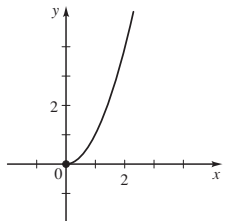


115. Symmetry about y-axis

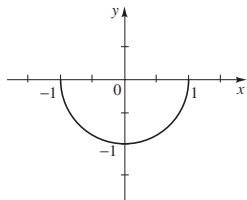
116. Symmetry about x-axis



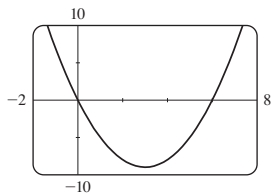
117. No symmetry



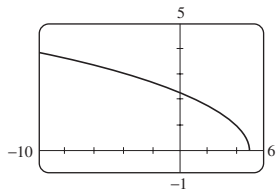
118. Symmetry about y-axis



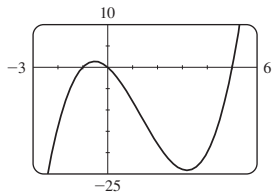
119.



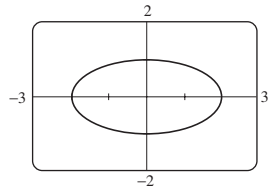
120.



121.


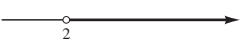




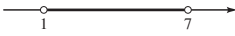

122.

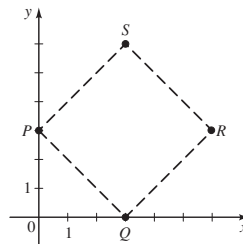


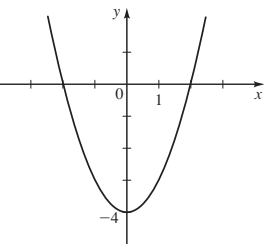
123. $2x - 3y - 16 = 0$ 124. $2y + x = 0$
 125. $3x + y - 12 = 0$ 126. $3x + y - 10 = 0$
 127. $x + 5y = 0$ 128. $5x - 4y - 17 = 0$
 129. $x^2 + y^2 = 169$, $5x - 12y + 169 = 0$
 130. $(x - 5)^2 + (y - 5)^2 = 25$, $4x + 3y - 35 = 0$
 131. (a) The slope represents the amount the spring lengthens for a one-pound increase in weight. The S -intercept represents the unstretched length of the spring. (b) 4 in.
 132. (a) $S = 3,500t + 60,000$ (b) The slope is her annual increase in salary and the S -intercept is her initial salary.
 (c) \$102,000 133. $M = 8z$ 134. $z = \frac{192}{y}$
 135. (a) $I = k/d^2$ (b) 64,000 (c) 160 candles 136. 8 in.
 137. 11.0 mi/h 138. 329.4 ft

Chapter 1 Test ■ page 135

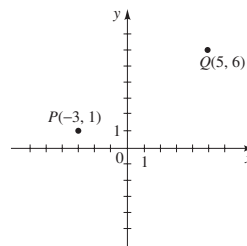
1. (a) 

 (b) $(-\infty, 3]$, $[-1, 4)$ (c) 16
 2. (a) 81 (b) -81 (c) $\frac{1}{81}$ (d) 25 (e) $\frac{9}{4}$ (f) $\frac{1}{8}$
 3. (a) 1.86×10^{11} (b) 3.965×10^{-7}
 4. (a) $6\sqrt{2}$ (b) $48a^5b^7$ (c) $\frac{x}{9y^7}$ (d) $\frac{x+2}{x-2}$ (e) $\frac{1}{x-2}$

- (f) $-(x+y)$ 5. $5\sqrt{2} + 2\sqrt{10}$
 6. (a) $11x - 2$ (b) $4x^2 + 7x - 15$ (c) $a - b$
 (d) $4x^2 + 12x + 9$ (e) $x^3 + 6x^2 + 12x + 8$
 7. (a) $(2x - 5)(2x + 5)$ (b) $(2x - 3)(x + 4)$
 (c) $(x - 3)(x - 2)(x + 2)$
 (d) $x(x + 3)(x^2 - 3x + 9)$
 (e) $3x^{-1/2}(x - 1)(x - 2)$ (f) $xy(x - 2)(x + 2)$
 8. (a) 6 (b) 1 (c) -3, 4 (d) $-1 \pm \frac{\sqrt{2}}{2}$
 (e) No real solution (f) $\pm 1, \pm \sqrt{2}$ (g) $\frac{2}{3}, \frac{22}{3}$ 9. 120 mi
 10. 50 ft by 120 ft
 11. (a) $[-4, 3)$ 
 (b) $(-2, 0) \cup (1, \infty)$ 
 (c) $(1, 7)$ 
 (d) $(-1, 4]$ 
 12. Between 41°F and 50°F 13. $0 \leq x \leq 6$
 14. (a) -2.94, -0.11, 3.05 (b) $[-1, 2]$
 15. (a) $S(3, 6)$ (b) 18



16. (a) 
 (b) x -intercepts -2, 2
 y -intercept -4
 (c) Symmetric about y -axis

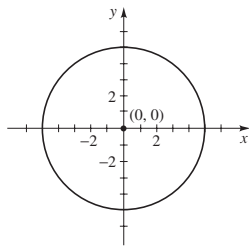
17. (a)



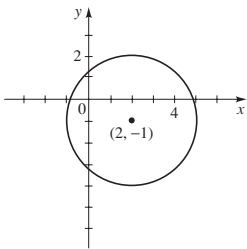
- (b) $\sqrt{89}$ (c) $(1, \frac{7}{2})$ (d) $\frac{5}{8}$ (e) $y = -\frac{8}{5}x + \frac{51}{10}$
 (f) $(x - 1)^2 + (y - \frac{7}{2})^2 = \frac{89}{4}$

A14 Answers to Exercises and Chapter Tests

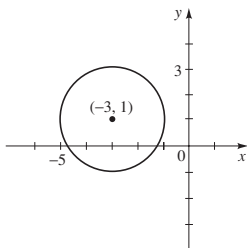
18. (a) $(0, 0), 5$



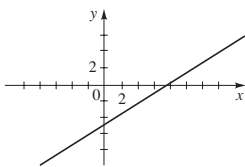
(b) $(2, -1), 3$



(c) $(-3, 1), 2$



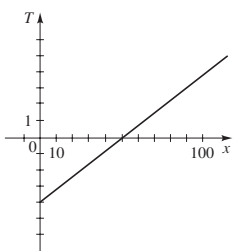
19. $y = \frac{2}{3}x - 5$



slope $\frac{2}{3}$; y-intercept -5

20. (a) $3x + y - 3 = 0$ (b) $2x + 3y - 12 = 0$

21. (a) 4°C (b)



(c) The slope is the rate of change in temperature, the x -intercept is the depth at which the temperature is 0°C , and the T -intercept is the temperature at ground level.

22. (a) $M = kwh^2/L$ (b) 400 (c) 12,000 lb

Focus on Problem Solving ■ page 141

1. 37.5 mi/h 2. It can't go fast enough. 3. 150 mi
 4. 40% discount 5. $427, 3n + 1$ 6. 57 min 7. 75 s
 8. No, not necessarily. 9. The same amount

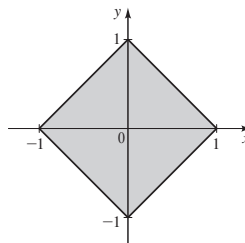
10. It remains the same. 11. 2π 13. 8.49 15. 7

16. 15,999,999,999,992,000,000,000,001

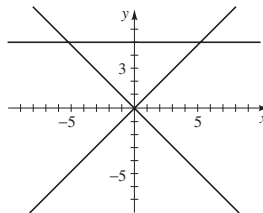
19. The North Pole is one such point. There are infinitely many others near the South Pole. 21. π

23. $1^3 + 12^3 = 9^3 + 10^3 = 1729$ 24. (a) 2 (b) 2

27. Infinitely far 29.



30.



Chapter 2

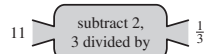
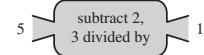
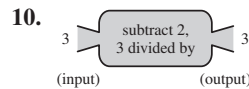
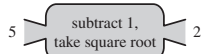
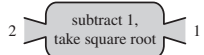
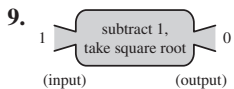
Section 2.1 ■ page 155

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

4. $f(x) = \frac{1}{3}(\sqrt{x} + 8)$ 5. Subtract 4, then divide by 3

6. Divide by 3, then subtract 4 7. Square, then add 2

8. Add 2, then take the square root



11.

x	$f(x)$
-1	8
0	2
1	0
2	2
3	8

12.

x	$g(x)$
-3	3
-2	1
0	3
1	5
3	9

13. 3, -3, 2, $2a + 1$, $-2a + 1$, $2a + 2b + 1$

14. 0, 15, 3, $a^2 + 2a$, $x^2 - 2x$, $\frac{1}{a^2} + \frac{2}{a}$

15. $-\frac{1}{3}$, -3, $\frac{1}{3}$, $\frac{1-a}{1+a}$, $\frac{2-a}{a}$, undefined

16. 2, -2, $\frac{5}{2}$, $\frac{5}{2}$, $x + \frac{1}{x}$, $\frac{1}{x} + x$

17. $-4, 10, -2, 3\sqrt{2}, 2x^2 + 7x + 1, 2x^2 - 3x - 4$
 18. $0, -3, -5, -\frac{45}{8}, \frac{x^3}{8} - x^2, x^6 - 4x^4$
 19. $6, 2, 1, 2, 2|x|, 2(x^2 + 1)$
 20. $-1, -1, \text{not defined}, 1, 1, x/|x|$ 21. $4, 1, 1, 2, 3$
 22. $5, 5, 5, 3, 7$ 23. $8, -\frac{3}{4}, -1, 0, -1$ 24. $-15, 1, 2, 3, 9$
 25. $x^2 + 4x + 5, x^2 + 6$ 26. $6x - 1, 6x - 2$
 27. $x^2 + 4, x^2 + 8x + 16$ 28. $2x - 18, 2x - 6$
 29. $3a + 2, 3(a + h) + 2, 3$
 30. $a^2 + 1, a^2 + 2ah + h^2 + 1, 2a + h$
 31. $5, 5, 0$ 32. $\frac{1}{a+1}, \frac{1}{a+h+1}, \frac{-1}{(a+1)(a+h+1)}$
 33. $\frac{a}{a+1}, \frac{a+h}{a+h+1}, \frac{1}{(a+h+1)(a+1)}$
 34. $\frac{2a}{a-1}, \frac{2(a+h)}{a+h-1}, \frac{-2}{(a+h-1)(a-1)}$
 35. $3 - 5a + 4a^2, 3 - 5a - 5h + 4a^2 + 8ah + 4h^2, -5 + 8a + 4h$ 36. $a^3, a^3 + 3a^2h + 3ah^2 + h^3, 3a^2 + 3ah + h^2$ 37. $(-\infty, \infty)$ 38. $(-\infty, \infty)$ 39. $[-1, 5]$
 40. $[0, 5]$ 41. $\{x | x \neq 3\}$ 42. $\{x | x \neq 2\}$ 43. $\{x | x \neq \pm 1\}$
 44. $\{x | x \neq -3, x \neq 2\}$ 45. $[5, \infty)$ 46. $[-9, \infty)$
 47. $(-\infty, \infty)$ 48. $(-\infty, \frac{7}{3}]$ 49. $[\frac{5}{2}, \infty)$
 50. $(-\infty, -3] \cup [3, \infty)$ 51. $[-2, 3) \cup (3, \infty)$
 52. $[0, \frac{1}{2}) \cup (\frac{1}{2}, \infty)$ 53. $(-\infty, 0] \cup [6, \infty)$
 54. $(-\infty, -2] \cup [4, \infty)$ 55. $(4, \infty)$ 56. $(-\infty, 6)$
 57. $(\frac{1}{2}, \infty)$ 58. $(-3, 3)$
 59. (a) $C(10) = 1532.1, C(100) = 2100$ (b) The cost of producing 10 yd and 100 yd (c) $C(0) = 1500$
 60. (a) $50.27, 113.10$ (b) $S(2)$ is the surface area of a sphere of radius 2, and $S(3)$ is the surface area of a sphere of radius 3.
 61. (a) $D(0.1) = 28.1, D(0.2) = 39.8$ (b) 41.3 mi (c) 235.6 mi 62. (a) $50, 0$ (b) $V(0)$ is the volume of the full tank, and $V(20)$ is the volume of the empty tank, 20 minutes later.

(c)

x	$V(x)$
0	50
5	28.125
10	12.5
15	3.125
20	0

63. (a) $v(0.1) = 4440, v(0.4) = 1665$
 (b) Flow is faster near central axis.

(c)

r	$v(r)$
0	4625
0.1	4440
0.2	3885
0.3	2960
0.4	1665
0.5	0

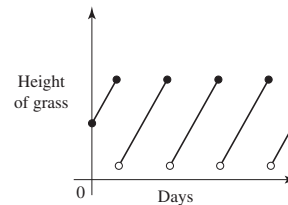
64. (a) $2, 1.66, 1.48$

(b)

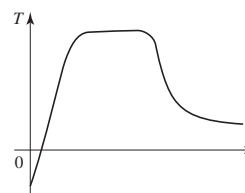
x	$R(x)$
1	2
10	1.66
100	1.48
200	1.44
500	1.41
1000	1.39

65. (a) 8.66 m, 6.61 m, 4.36 m
 (b) It will appear to get shorter.
 66. (a) $T(5000) = 0, T(12,000) = 960, T(25,000) = 5350$
 (b) The amount of tax paid on incomes of 5000, 12,000, and 25,000
 67. (a) $\$90, \$105, \$100, \105
 (b) Total cost of an order, including shipping
 68. (a) $T(x) = \begin{cases} 75x & \text{if } 0 \leq x \leq 2 \\ 150 + 50(x - 2) & \text{if } x > 2 \end{cases}$
 (b) $\$150, \$200, \$300$ (c) Total cost of staying at the hotel
 69. (a) $F(x) = \begin{cases} 15(40 - x) & \text{if } 0 < x < 40 \\ 0 & \text{if } 40 \leq x \leq 65 \\ 15(x - 65) & \text{if } x > 65 \end{cases}$
 (b) $\$150, \$0, \$150$ (c) Fines for violating the speed limits

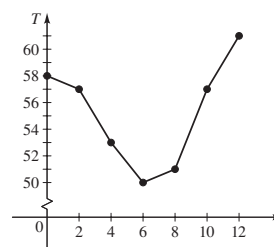
70.



71.

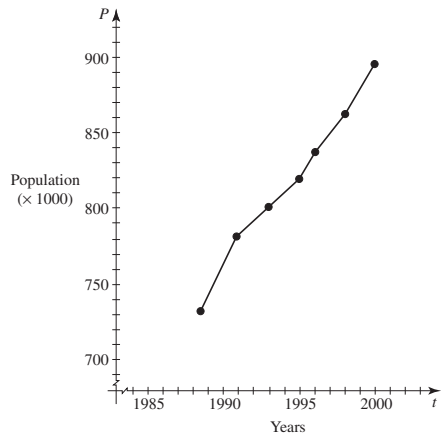


72.



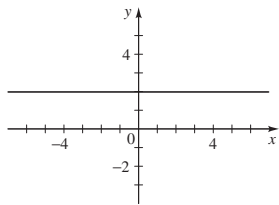
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73.

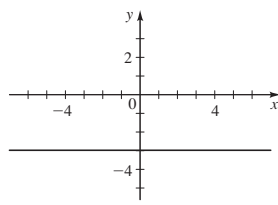


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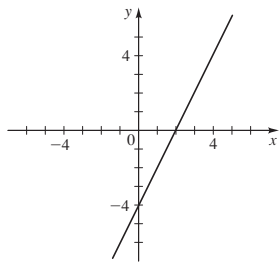
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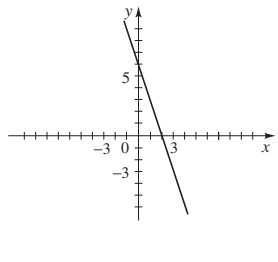
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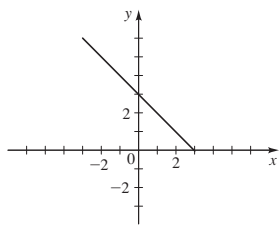
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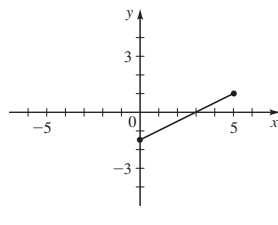
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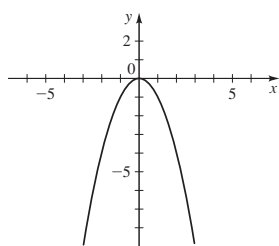
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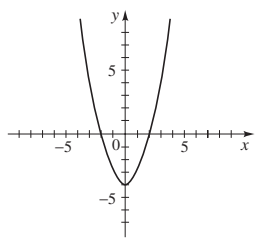
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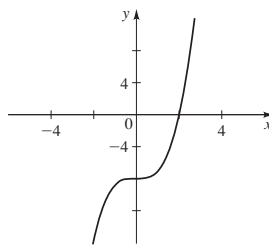
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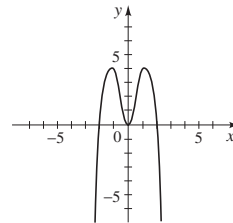
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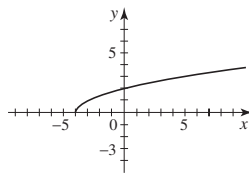
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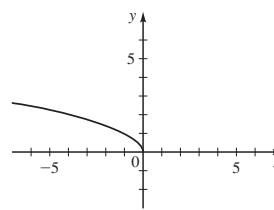
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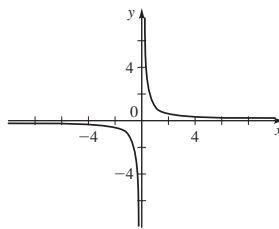
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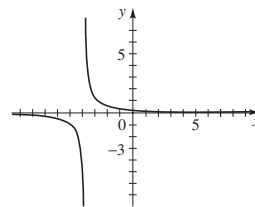
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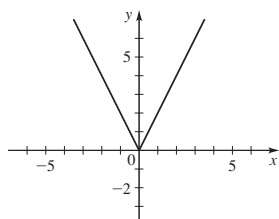
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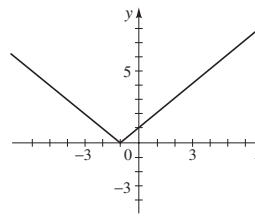
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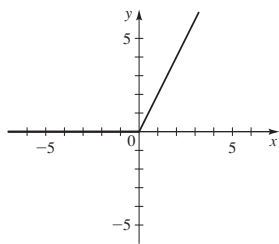
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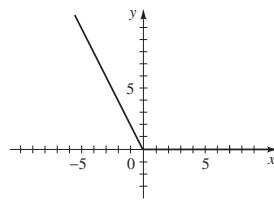
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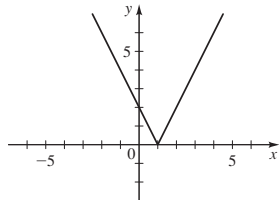
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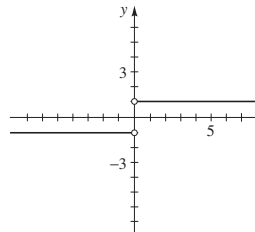
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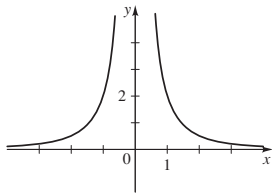
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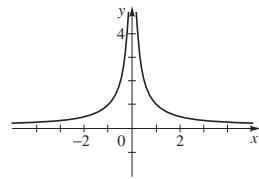
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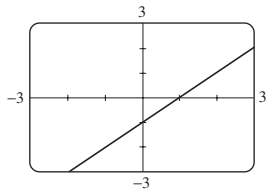
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22.

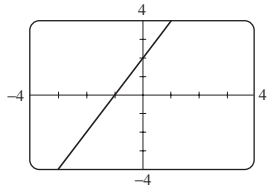


23. (a) 1, -1, 3, 4 (b) Domain $[-3, 4]$, range $[-1, 4]$
 24. (a) 3, 2, -2, 1, 0 (b) Domain $[-4, 4]$, range $[-2, 3]$
 25. (a) $f(0)$ (b) $g(-3)$ (c) -2, 2
 26. (a) 1.2 (b) 2.1 (c) 0.4, 3.6
 27. (a)



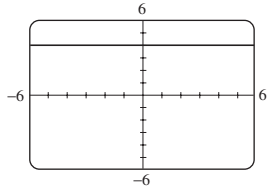
(b) Domain $(-\infty, \infty)$, range $(-\infty, \infty)$

28. (a)



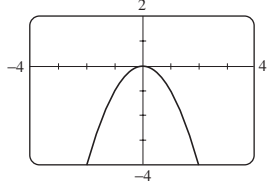
(b) Domain $(-\infty, \infty)$, range $(-\infty, \infty)$

29. (a)



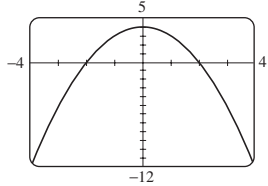
(b) Domain $(-\infty, \infty)$, range $\{4\}$

30. (a)



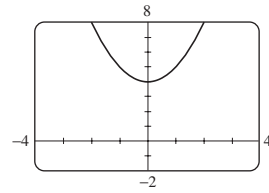
(b) Domain $(-\infty, \infty)$, range $(-\infty, 0]$

31. (a)



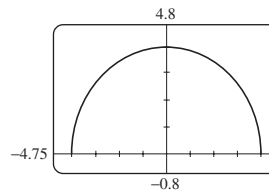
(b) Domain $(-\infty, \infty)$, range $(-\infty, 4]$

32. (a)



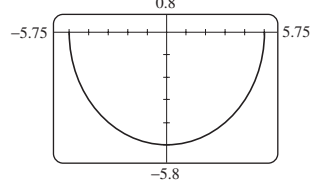
(b) Domain $(-\infty, \infty)$, range $[4, \infty)$

33. (a)



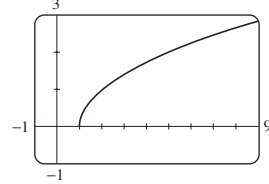
(b) Domain $[-4, 4]$, range $[0, 4]$

34. (a)



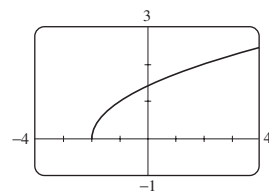
(b) Domain $[-5, 5]$, range $[-5, 0]$

35. (a)



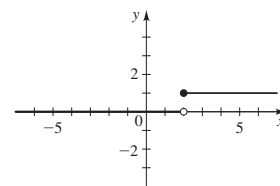
(b) Domain $[1, \infty)$, range $[0, \infty)$

36. (a)

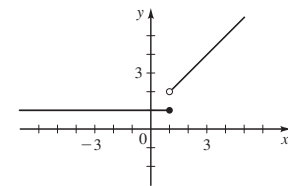


(b) Domain $[-2, \infty)$, range $[0, \infty)$

37.

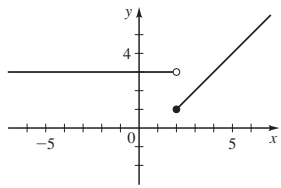


38.

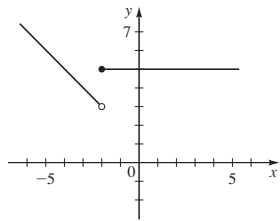


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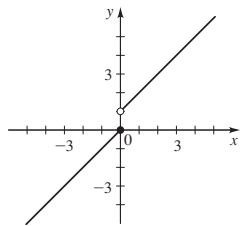
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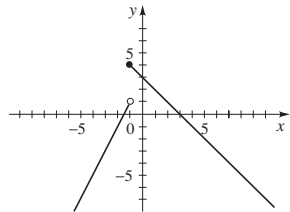
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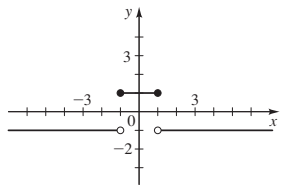
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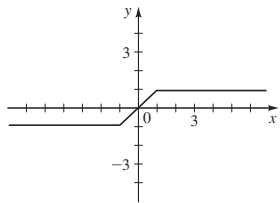
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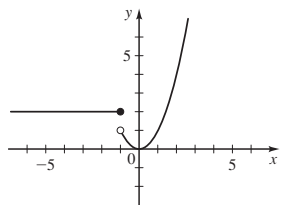
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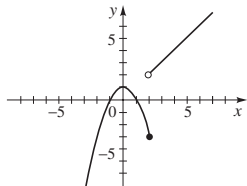
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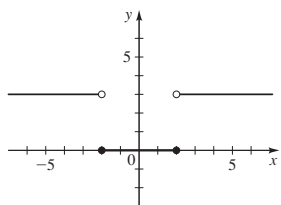
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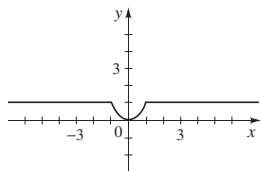
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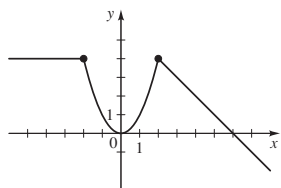
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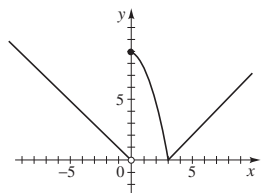
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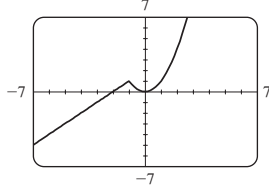
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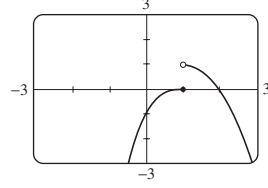
50.



51.



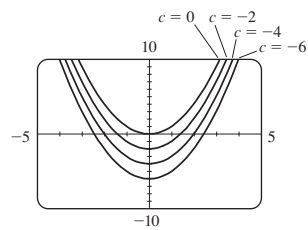
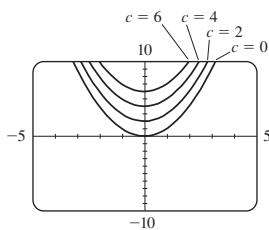
52.



$$53. f(x) = \begin{cases} -2 & \text{if } x < -2 \\ x & \text{if } -2 \leq x \leq 2 \\ 2 & \text{if } x > 2 \end{cases}$$

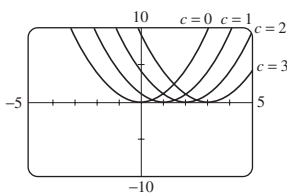
$$54. f(x) = \begin{cases} 1 & \text{if } x \leq -1 \\ 1 - x & \text{if } -1 < x \leq 2 \\ -2 & \text{if } x > 2 \end{cases}$$

55. (a) Yes (b) No (c) Yes (d) No 56. (a) No (b) Yes (c) Yes (d) No 57. Function, domain $[-3, 2]$, range $[-2, 2]$ 58. Not a function 59. Not a function 60. Function, domain $[-3, 2]$, range $\{-2\} \cup (0, 3]$ 61. Yes 62. Yes 63. No 64. No 65. No 66. Yes 67. Yes 68. Yes 69. Yes 70. No 71. Yes 72. No 73. (a)

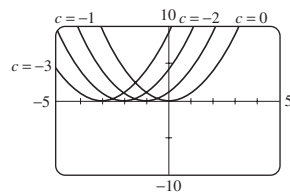


(c) If $c > 0$, then the graph of $f(x) = x^2 + c$ is the same as the graph of $y = x^2$ shifted upward c units. If $c < 0$, then the graph of $f(x) = x^2 + c$ is the same as the graph of $y = x^2$ shifted downward c units.

74. (a)

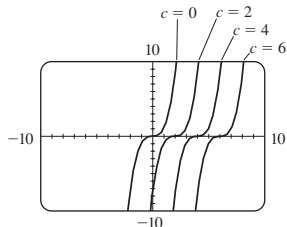


(b)

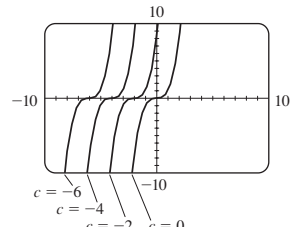


(c) The graphs in part (a) are obtained by shifting the graph of $y = x^2$ to the right 1, 2, and 3 units, while the graphs in part (b) are obtained by shifting the graph of $y = x^2$ to the left, 1, 2, and 3 units.

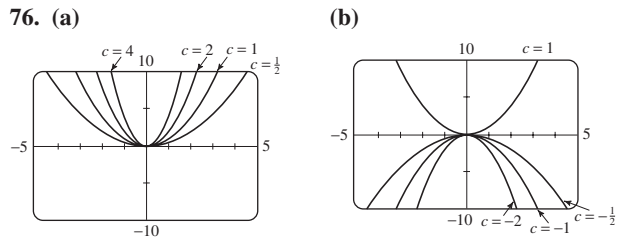
75. (a)



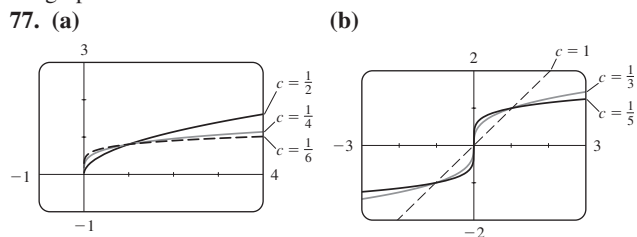
(b)



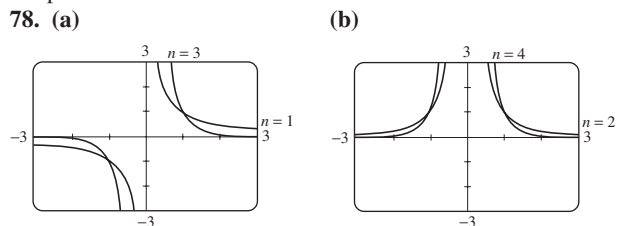
(c) If $c > 0$, then the graph of $f(x) = (x - c)^3$ is the same as the graph of $y = x^3$ shifted right c units. If $c < 0$, then the graph of $f(x) = (x - c)^3$ is the same as the graph of $y = x^3$ shifted left c units.



(c) As $|c|$ increases, the graph of $f(x) = cx^2$ is stretched vertically. As $|c|$ decreases, the graph of f is flattened. When $c < 0$, the graph is reflected about the x -axis.



(c) Graphs of even roots are similar to \sqrt{x} ; graphs of odd roots are similar to $\sqrt[3]{x}$. As c increases, the graph of $y = \sqrt[c]{x}$ becomes steeper near 0 and flatter when $x > 1$.



(c) As n increases, the graphs of $y = 1/x^n$ go to zero faster for x large. Also, as n increases and x goes to 0, the graphs of $y = 1/x^n$ go to infinity faster. The graphs of $y = 1/x^n$ for n odd are similar to each other. Likewise, the graphs for n even are similar to each other. **79.** $f(x) = -\frac{7}{6}x - \frac{4}{3}$, $-2 \leq x \leq 4$

80. $f(x) = \frac{5}{9}x - \frac{1}{3}$, $-3 \leq x \leq 6$

81. $f(x) = \sqrt{9 - x^2}$, $-3 \leq x \leq 3$

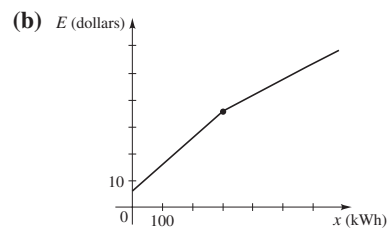
82. $f(x) = -\sqrt{9 - x^2}$, $-3 \leq x \leq 3$

83. This person's weight increases as he grows, then continues to increase; the person then goes on a crash diet (possibly) at age 30, then gains weight again, the weight gain eventually leveling off. **84.** The salesman travels away from home and stops to make a sales call between 9 A.M. and 10 A.M., and then travels farther from home for a sales call between 12 noon and 1 P.M. Next he travels along a route that takes him closer to home before taking him farther away from home. He makes a final sales call between 5 P.M. and 6 P.M. and then returns home. **85.** A won the race. All runners finished. Runner B

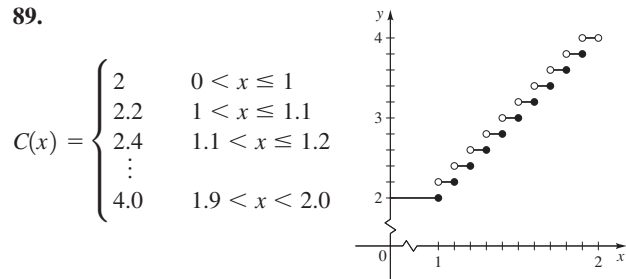
fell, but got up again to finish second. **86. (a)** 500 MW, 725 MW **(b)** Between 3:00 A.M. and 4:00 A.M.

(c) Just before noon **87. (a)** 5 s **(b)** 30 s **(c)** 17 s

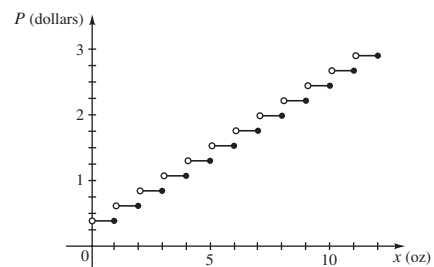
88. (a) $E(x) = \begin{cases} 6 + 0.10x & 0 \leq x \leq 300 \\ 36 + 0.06(x - 300), & x > 300 \end{cases}$



89.



90. $P(x) = \begin{cases} 0.37 & \text{if } 0 < x \leq 1 \\ 0.60 & \text{if } 1 < x \leq 2 \\ 0.83 & \text{if } 2 < x \leq 3 \\ \vdots & \\ 2.90 & \text{if } 11 < x \leq 12 \end{cases}$



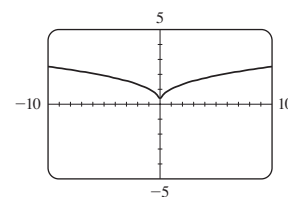
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1. (a) $[-1, 1], [2, 4]$ **(b)** $[1, 2]$ **2. (a)** $[0, 1]$ **(b)** $[-2, 0],$

$[1, 3]$ **3. (a)** $[-2, -1], [1, 2]$ **(b)** $[-3, -2], [-1, 1], [2, 3]$

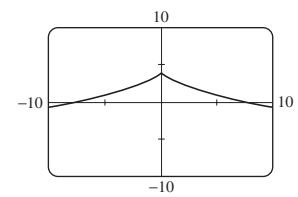
4. (a) $[-1, 1]$ **(b)** $[-2, -1], [1, 2]$

5. (a)



(b) Increasing on $[0, \infty)$; decreasing on $(-\infty, 0]$

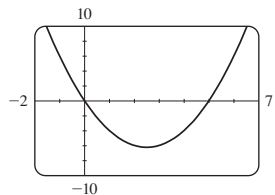
6. (a)



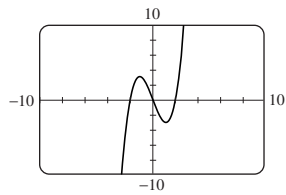
(b) Increasing on $(-\infty, 0]$; decreasing on $[0, \infty)$

A20 Answers to Exercises and Chapter Tests

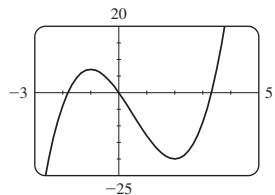
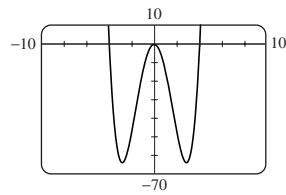
7. (a)

(b) Increasing on $[2.5, \infty)$; decreasing on $(-\infty, 2.5]$

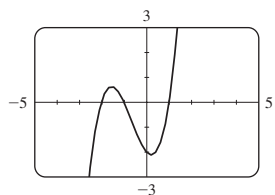
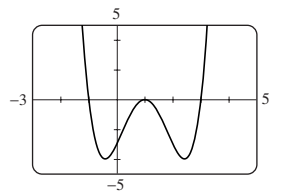
8. (a)

(b) Increasing on $(\infty, -1.15]$, $[1.15, \infty)$; decreasing on $[-1.15, 1.15]$

9. (a)

(b) Increasing on $(-\infty, -1]$, $[2, \infty)$; decreasing on $[-1, 2]$ (b) Increasing on $[-2.83, 0]$, $[2.83, \infty)$; decreasing on $[-\infty, -2.83]$, $[0, 2.83]$

11. (a)

(b) Increasing on $(-\infty, -1.55]$, $[0.22, \infty)$; decreasing on $[-1.55, 0.22]$ (b) Increasing on $[-0.4, 1]$, $[2.4, \infty)$; decreasing on $(-\infty, -0.4]$, $[1, 2.4]$ 13. $\frac{2}{3}$ 14. $-\frac{1}{2}$ 15. $-\frac{4}{5}$ 16. $\frac{2}{3}$ 17. 3 18. $\frac{1}{2}$ 19. 520. 6 21. 60 22. 21 23. $12 + 3h$ 24. $-2 - h$ 25. $-\frac{1}{a}$ 26. $-\frac{2}{h+1}$ 27. $\frac{-2}{a(a+h)}$ 28. $\frac{1}{\sqrt{a+h} + \sqrt{a}}$ 29. (a) $\frac{1}{2}$ 30. (a) -4 31. (a) Increasing on $[0, 150]$, $[300, 365]$; decreasing on $[150, 300]$ (b) -0.25 ft/day32. (a) Increasing on $[0, 25]$; decreasing on $[25, 50]$

(b) 0 (c) In this period the population increased the same amount as it decreased. 33. (a) 245 persons/yr

(b) -328.5 persons/yr (c) 1997–2001 (d) 2001–2006

34. (a) 4.76 m/s (b) 2.68 m/s

(c) 6.25 m/s, 5.56 m/s, 5.00 m/s, 4.55 m/s, 3.92 m/s, 3.33 m/s, 2.78 m/s, 2.60 m/s; he is slowing down.

35. (a) 7.2 units/yr (b) 8 units/yr (c) -55 units/yr

(d) 2000–2001, 2001–2002

36.

Year	Number of Books
1980	420
1981	460
1982	500
1985	620
1990	820
1992	900
1995	1020
1997	1100
1998	1140
1999	1180
2000	1220

Section 2.4 ■ page 190

1. (a) Shift downward 5 units (b) Shift right 5 units

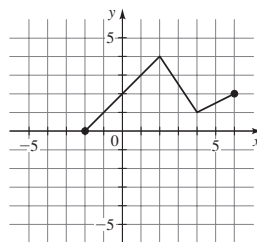
2. (a) Shift left 7 units (b) Shift up 7 units 3. (a) Shift left $\frac{1}{2}$ unit (b) Shift up $\frac{1}{2}$ unit4. (a) Reflect in the x -axis(b) Reflect in the y -axis 5. (a) Reflect in the x -axis and stretch vertically by a factor of 2 (b) Reflect in the x -axis and shrink vertically by a factor of $\frac{1}{2}$ 6. (a) Reflect in the x -axis, then shift up 5 units (b) Stretch vertically by a factor of 3, then shift down 5 units7. (a) Shift right 4 units and upward $\frac{3}{4}$ unit (b) Shift left 4 units and downward $\frac{3}{4}$ unit

8. (a) Shift left 2 units, stretch vertically by a factor of 2, then shift down 2 units (b) Shift right 2 units, stretch vertically by a factor of 2, then shift up 2 units

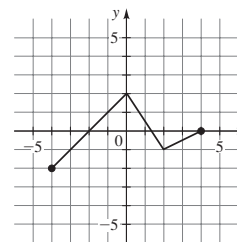
9. (a) Shrink horizontally by a factor of $\frac{1}{4}$ (b) Stretch horizontally by a factor of 410. (a) Shrink horizontally by a factor of $\frac{1}{2}$, then reflect in the x -axis (b) Shrink horizontally by a factor of $\frac{1}{2}$, then shift down 1 unit11. $g(x) = (x - 2)^2$ 12. $g(x) = x^3 + 3$ 13. $g(x) = |x + 1| + 2$ 14. $g(x) = 2|x|$ 15. $g(x) = -\sqrt{x + 2}$ 16. $g(x) = -(x - 2)^2 + 1$ 17. (a) 3 (b) 1 (c) 2

(d) 4 18. (a) 2 (b) 3 (c) 1 (d) 4

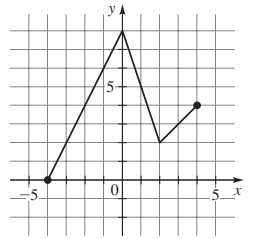
19. (a)



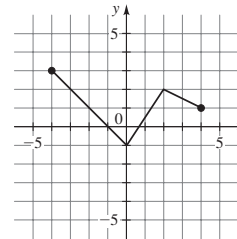
(b)



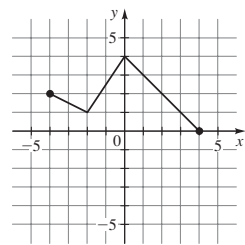
(c)



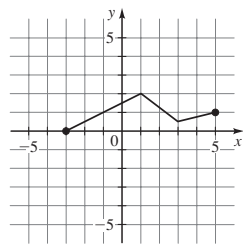
(d)



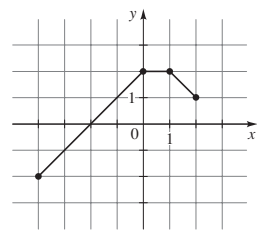
(e)



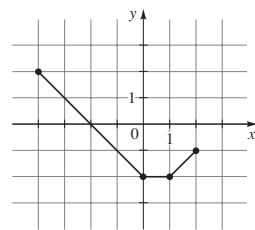
(f)



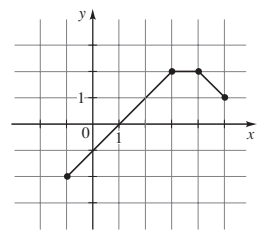
20. (a)



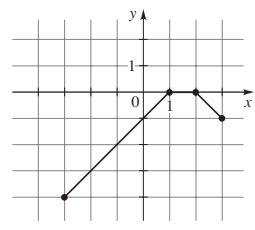
(b)



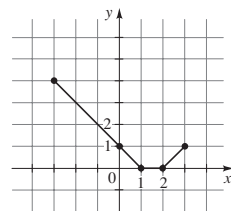
(c)



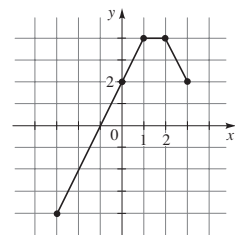
(d)



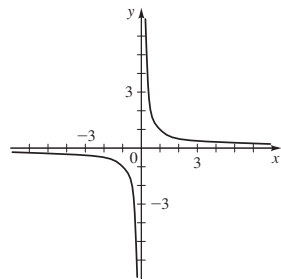
(e)



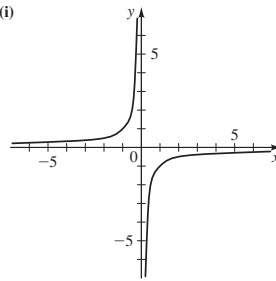
(f)



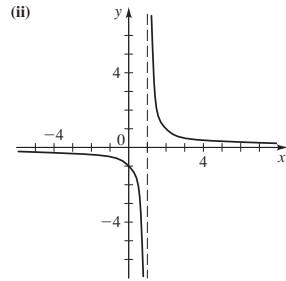
21. (a)



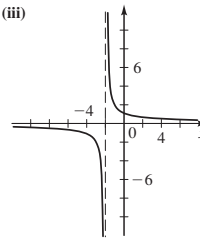
(b) (i)



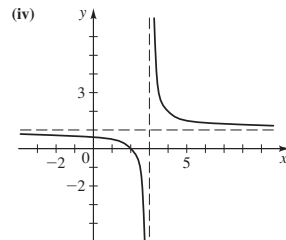
(ii)



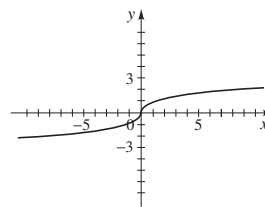
(iii)



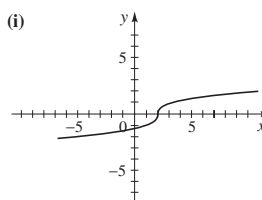
(iv)



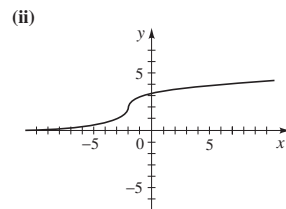
22. (a)



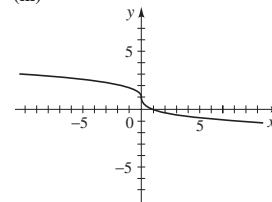
(b) (i)



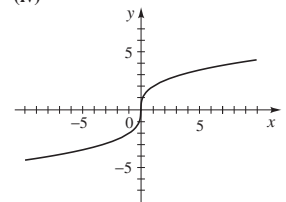
(ii)



(iii)



(iv)



23. (a) Shift left 2 units (b) Shift up 2 units

24. (a) Shift right 4 units (b) Shift down 4 units

25. (a) Stretch vertically by a factor of 2

(b) Shift right 2 units, then shrink vertically by a factor of $\frac{1}{2}$

26. (a) Stretch vertically by a factor of 3, then shift up 1 unit

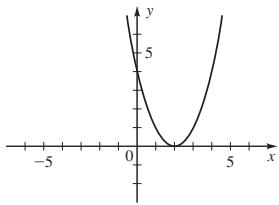
(b) Shift left 1 unit, then reflect in the x -axis

27. $g(x) = (x - 2)^2 + 3$ 28. $g(x) = (x + 4)^3 - 1$

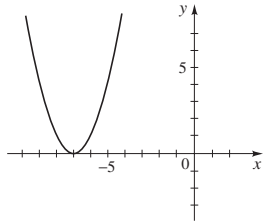
29. $g(x) = -5\sqrt{x + 3}$ 30. $g(x) = \frac{1}{2}\sqrt[3]{-x + \frac{3}{5}}$

A22 Answers to Exercises and Chapter Tests

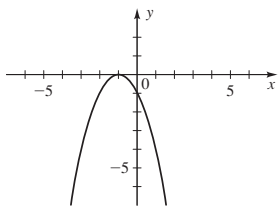
31. $g(x) = 0.1|x - \frac{1}{2}| - 2$
33.



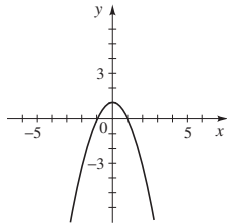
32. $g(x) = 3|x + 1| + 10$
34.



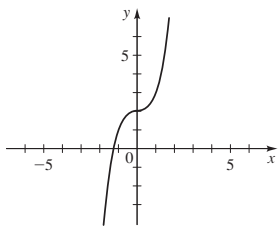
35.



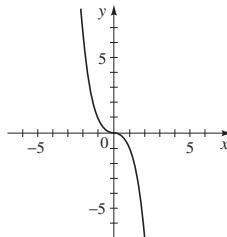
36.



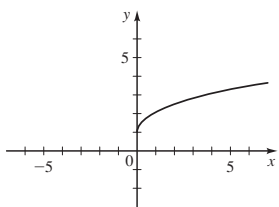
37.



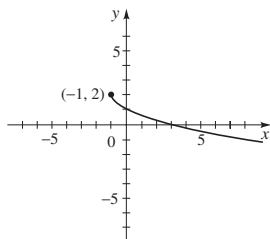
38.



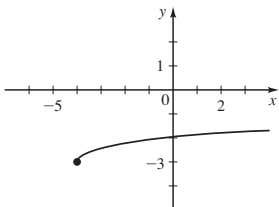
39.



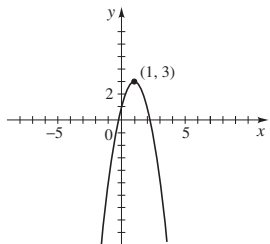
40.



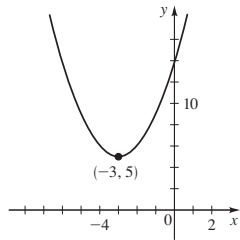
41.



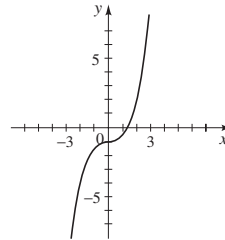
42.



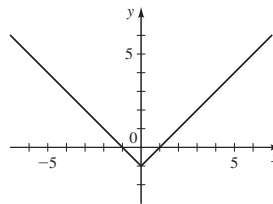
43.



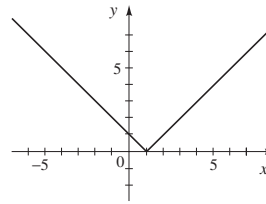
44.



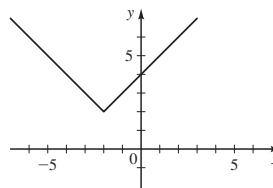
45.



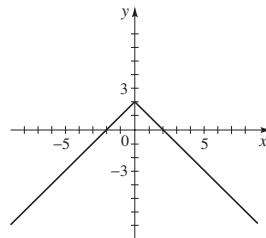
46.



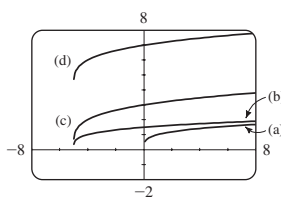
47.



48.

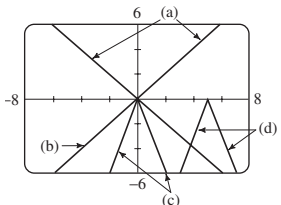


49.



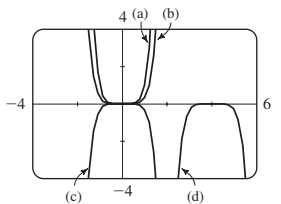
For part (b) shift the graph in (a) left 5 units; for part (c) shift the graph in (a) left 5 units and stretch vertically by a factor of 2; for part (d) shift the graph in (a) left 5 units, stretch vertically by a factor of 2, and then shift upward 4 units.

50.

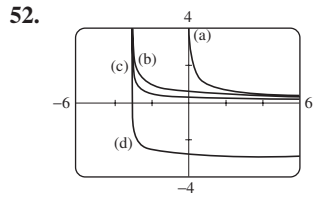


For (b), reflect in the x -axis; for (c), stretch vertically by a factor of 3 and reflect in the x -axis; for (d), shift right 5 units, stretch vertically by a factor of 3, and reflect in the x -axis.

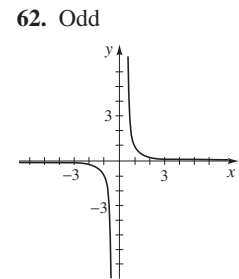
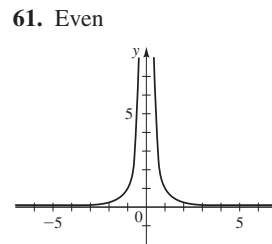
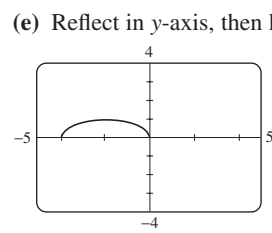
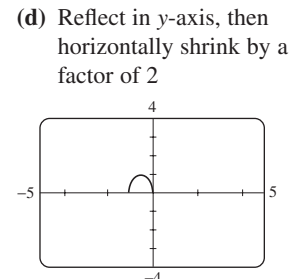
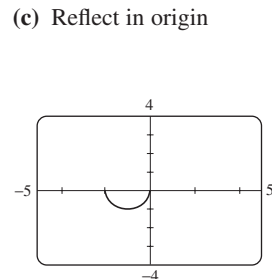
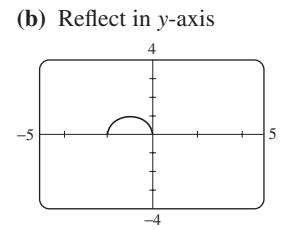
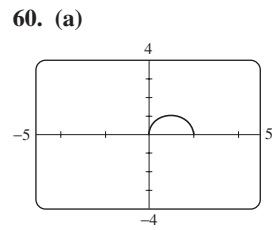
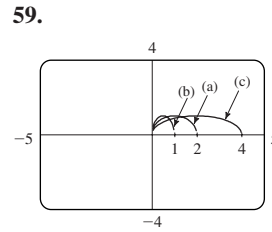
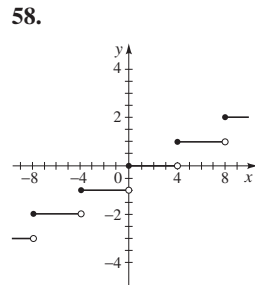
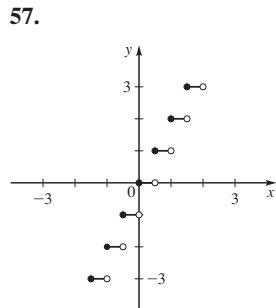
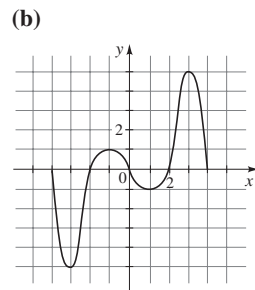
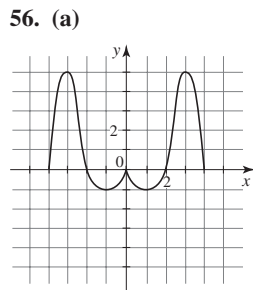
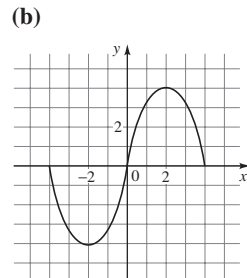
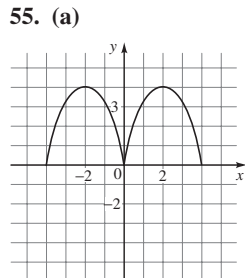
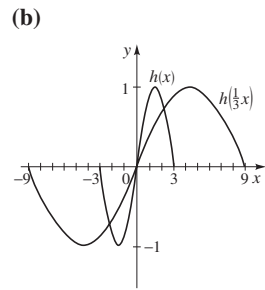
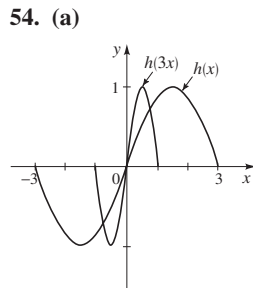
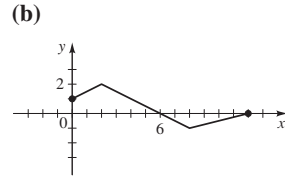
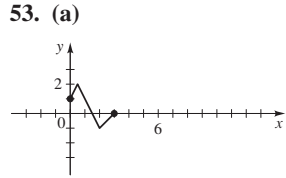
51.



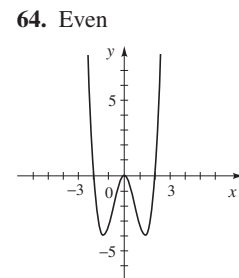
For part (b) shrink the graph in (a) vertically by a factor of $\frac{1}{3}$; for part (c) shrink the graph in (a) vertically by a factor of $\frac{1}{3}$ and reflect in the x -axis; for part (d) shift the graph in (a) right 4 units, shrink vertically by a factor of $\frac{1}{3}$, and then reflect in the x -axis.



For (b), shift left 3 units; for (c), shift left 3 units and shrink vertically by a factor of $\frac{1}{2}$; for (d), shift left 3 units, shrink vertically by factor of $\frac{1}{2}$, and then shift down 3 units.

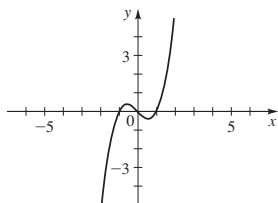


63. Neither



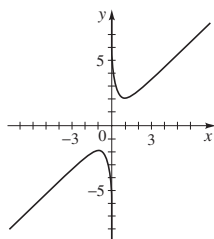
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65. Odd



66. Neither

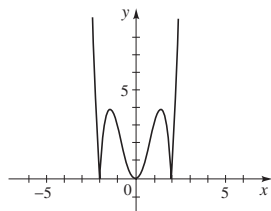
68. Odd



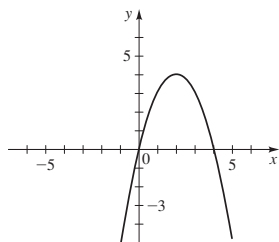
67. Neither

69. To obtain the graph of g , reflect in the x -axis the part of the graph of f that is below the x -axis.

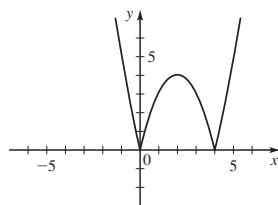
70.



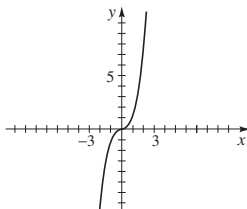
71. (a)



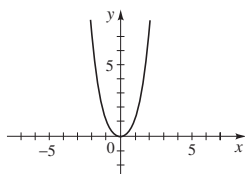
(b)



72. (a)



(b)



73. (a) Shift up 4 units, shrink vertically by a factor of 0.01

(b) Shift right 10 units; $g(t) = 4 + 0.01(t - 10)^2$ 74. (a) Shrink vertically by a factor of $\frac{1}{2}$, then shift up 2 units(b) Stretch vertically by a factor of $\frac{9}{5}$, then shift up 32 units;

$$F(t) = \frac{9}{10}t^2 + \frac{178}{5}$$

Section 2.5 ■ page 200

1. (a) (3, 4) (b) 4 2. (a) (-2, 8) (b) 8 3. (a) (1, -3)

(b) -3 4. (a) (-1, -4) (b) -4

5. (a) $f(x) = (x - 3)^2 - 9$ 6. (a) $f(x) = (x + 4)^2 - 16$

(b) Vertex (3, -9)

(b) Vertex (-4, -16)

x-intercepts 0, 6

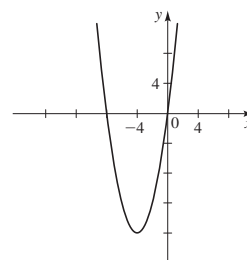
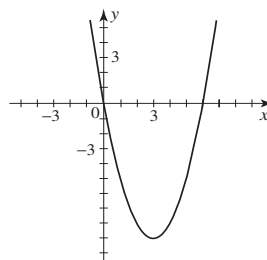
x-intercepts 0, -8

y-intercept 0

y-intercept 0

(c)

(c)

7. (a) $f(x) = 2(x + \frac{3}{2})^2 - \frac{9}{2}$ (b) Vertex $(-\frac{3}{2}, -\frac{9}{2})$

x-intercepts 0, -3,

y-intercept 0

(c)

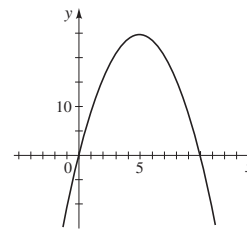
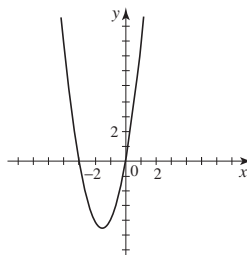
8. (a) $f(x) = -(x - 5)^2 + 25$

(b) Vertex (5, 25)

x-intercepts 0, 10

y-intercept 0

(c)

9. (a) $f(x) = (x + 2)^2 - 1$

(b) Vertex (-2, -1)

x-intercepts -1, -3

y-intercept 3

(c)

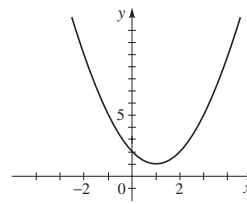
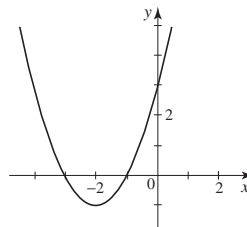
10. (a) $f(x) = (x - 1)^2 + 1$

(b) Vertex (1, 1)

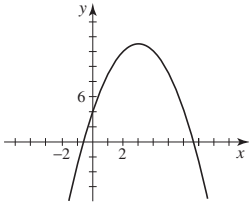
no x-intercepts

y-intercept 2

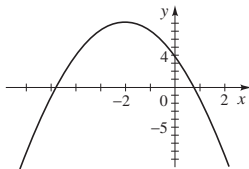
(c)



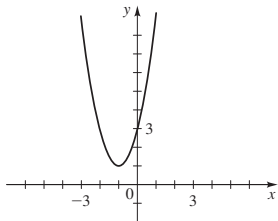
- 11. (a)** $f(x) = -(x - 3)^2 + 13$ **(b)** Vertex $(3, 13)$;
 x -intercepts $3 \pm \sqrt{13}$; y -intercept 4
(c)



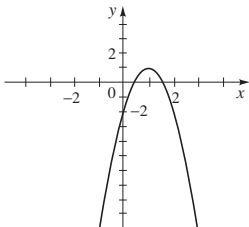
- 12. (a)** $f(x) = -(x + 2)^2 + 8$ **(b)** Vertex $(-2, 8)$;
 x -intercepts $-2 \pm 2\sqrt{2}$; y -intercept 4
(c)



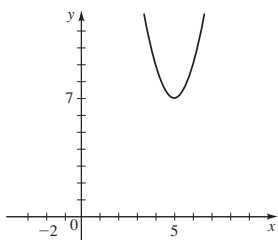
- 13. (a)** $f(x) = 2(x + 1)^2 + 1$ **(b)** Vertex $(-1, 1)$;
no x -intercept; y -intercept 3
(c)



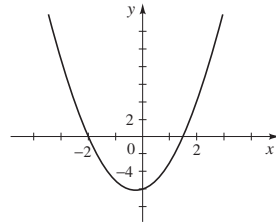
- 14. (a)** $f(x) = -3(x - 1)^2 + 1$ **(b)** Vertex $(1, 1)$;
 x -intercepts $1 \pm \sqrt{\frac{1}{3}}$; y -intercept -2
(c)



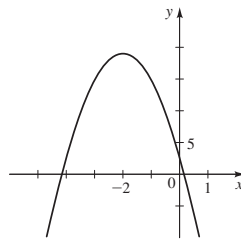
- 15. (a)** $f(x) = 2(x - 5)^2 + 7$ **(b)** Vertex $(5, 7)$;
no x -intercept; y -intercept 57
(c)



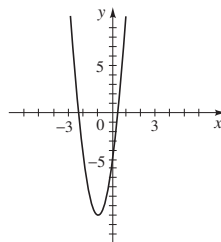
- 16. (a)** $f(x) = 2(x + \frac{1}{4})^2 - \frac{49}{8}$ **(b)** Vertex $(-\frac{1}{4}, -\frac{49}{8})$;
 x -intercepts $-2, \frac{3}{2}$; y -intercept -6
(c)



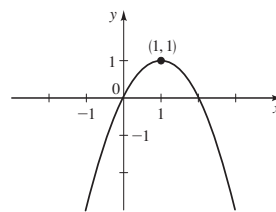
- 17. (a)** $f(x) = -4(x + 2)^2 + 19$ **(b)** Vertex $(-2, 19)$;
 x -intercepts $-2 \pm \frac{1}{2}\sqrt{19}$; y -intercept 3
(c)



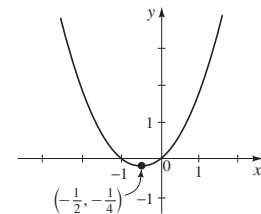
- 18. (a)** $f(x) = 6(x + 1)^2 - 11$ **(b)** Vertex $(-1, -11)$;
 x -intercepts $\frac{-6 \pm \sqrt{66}}{6}$; y -intercept -5
(c)



- 19. (a)** $f(x) = -(x - 1)^2 + 1$ **(b)** $f(x) = (x + \frac{1}{2})^2 - \frac{1}{4}$



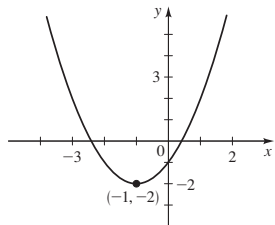
(c) Maximum $f(1) = 1$



(c) Minimum $f(-\frac{1}{2}) = -\frac{1}{4}$

A26 Answers to Exercises and Chapter Tests

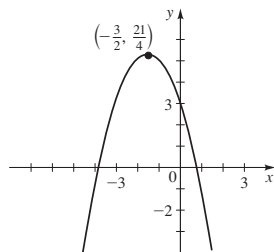
21. (a) $f(x) = (x + 1)^2 - 2$
(b)



(c) Minimum $f(-1) = -2$

23. (a) $f(x) = -(x + \frac{3}{2})^2 + \frac{21}{4}$

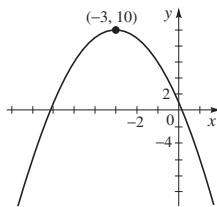
(b)



(c) Maximum $f(-\frac{3}{2}) = \frac{21}{4}$

24. (a) $f(x) = -(x + 3)^2 + 10$

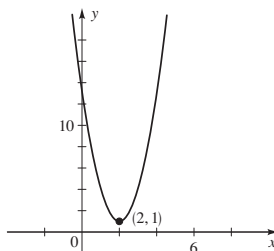
(b)



(c) Maximum $f(-3) = 10$

25. (a) $g(x) = 3(x - 2)^2 + 1$

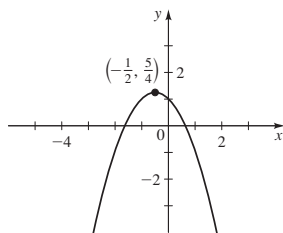
(b)



(c) Minimum $g(2) = 1$

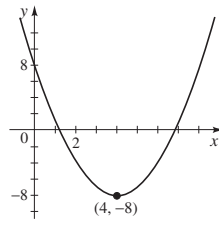
27. (a) $h(x) = -(x + \frac{1}{2})^2 + \frac{5}{4}$

(b)



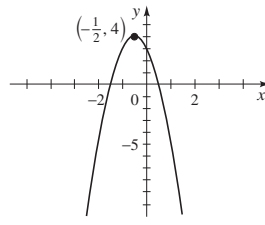
(c) Maximum $h(-\frac{1}{2}) = \frac{5}{4}$

22. (a) $f(x) = (x - 4)^2 - 8$
(b)



(c) Minimum $f(4) = -8$

28. (a) $h(x) = -4(x + \frac{1}{2})^2 + 4$
(b)



(c) Maximum $h(-\frac{1}{2}) = 4$

29. Minimum $f(-\frac{1}{2}) = \frac{3}{4}$ 30. Maximum $f(\frac{3}{2}) = \frac{13}{4}$

31. Maximum $f(-3.5) = 185.75$ 32. Minimum $f(-2) = 73$

33. Minimum $f(0.6) = 15.64$ 34. Minimum $g(\frac{15}{2}) = -5625$

35. Minimum $h(-2) = -8$ 36. Maximum $f(-3) = 10$

37. Maximum $f(-1) = \frac{7}{2}$ 38. Minimum $g(2) = -1$

39. $f(x) = 2x^2 - 4x$ 40. $f(x) = -3(x - 3)^2 + 4$

41. $(-\infty, \infty), (-\infty, 1]$ 42. $(-\infty, \infty), [-4, \infty)$

43. $(-\infty, \infty), (-\frac{23}{2}, \infty)$ 44. $(-\infty, \infty), (-\infty, 7)$

45. (a) -4.01 (b) -4.011025

46. (a) 1.18 (b) $\frac{8 + \sqrt{2}}{8} \approx 1.176777$

47. Local maximum 2; local minimums $-1, 0$ 48. Local maximums 1, 2; local minimum -1 49. Local maximums 0, 1; local minimums $-2, -1$

50. Local maximums 2, 3; local minimums 0, -1 51. Local maximum ≈ 0.38 when $x \approx -0.58$; local minimum ≈ -0.38 when $x \approx 0.58$

52. Local maximum ≈ 4.00 when $x \approx 1.00$; local minimum ≈ 2.81 when $x \approx -0.33$

53. Local maximum ≈ 0 when $x = 0$; local minimum ≈ -13.61 when $x \approx -1.71$; local minimum ≈ -73.32 when $x \approx 3.21$

54. Local maximum ≈ 13.02 when $x \approx 1.04$; local maximum ≈ -7.87 when $x \approx -1.93$; local minimum ≈ -13.02 when $x \approx -1.04$; local minimum ≈ 7.87 when $x \approx 1.93$

55. Local maximum ≈ 5.66 when $x \approx 4.00$

56. Local maximum ≈ 0.32 when $x \approx 0.75$ 57. Local maximum ≈ 0.38 when $x \approx -1.73$; local minimum ≈ -0.38 when $x \approx 1.73$ 58. Local maximum ≈ 1.33 when $x \approx -0.50$

59. 25 ft 60. (a) 55 ft (b) 204.9 ft 61. \$4000, 100 units

62. \$450, 1500 cans 63. 30 times 64. 150 min, 4.5 mg/L

65. 50 trees per acre 66. 7.5 mi/h 67. 20 mi/h 68. 3.96°C

69. $r \approx 0.67$ cm

70. Local maximum ≈ 5.66 when $x \approx 4.00$

71. Local maximum ≈ 0.32 when $x \approx 0.75$ 72. Local maximum ≈ 0.38 when $x \approx -1.73$; local minimum ≈ -0.38 when $x \approx 1.73$ 73. Local maximum ≈ 1.33 when $x \approx -0.50$

74. 25 ft 75. (a) 55 ft (b) 204.9 ft 76. \$4000, 100 units

77. \$450, 1500 cans 78. 30 times 79. 150 min, 4.5 mg/L

80. 50 trees per acre 81. 7.5 mi/h 82. 20 mi/h 83. 3.96°C

84. $r \approx 0.67$ cm

85. Local maximum ≈ 5.66 when $x \approx 4.00$

86. Local maximum ≈ 0.32 when $x \approx 0.75$ 87. Local maximum ≈ 0.38 when $x \approx -1.73$; local minimum ≈ -0.38 when $x \approx 1.73$ 88. Local maximum ≈ 1.33 when $x \approx -0.50$

89. 25 ft 90. (a) 55 ft (b) 204.9 ft 91. \$4000, 100 units

92. \$450, 1500 cans 93. 30 times 94. 150 min, 4.5 mg/L

95. 50 trees per acre 96. 7.5 mi/h 97. 20 mi/h 98. 3.96°C

99. $r \approx 0.67$ cm

100. Local maximum ≈ 5.66 when $x \approx 4.00$

101. Local maximum ≈ 0.32 when $x \approx 0.75$ 102. Local maximum ≈ 0.38 when $x \approx -1.73$; local minimum ≈ -0.38 when $x \approx 1.73$ 103. Local maximum ≈ 1.33 when $x \approx -0.50$

104. 25 ft 105. (a) 55 ft (b) 204.9 ft 106. \$4000, 100 units

107. \$450, 1500 cans 108. 30 times 109. 150 min, 4.5 mg/L

110. 50 trees per acre 111. 7.5 mi/h 112. 20 mi/h 113. 3.96°C

114. $r \approx 0.67$ cm

115. Local maximum ≈ 5.66 when $x \approx 4.00$

116. Local maximum ≈ 0.32 when $x \approx 0.75$ 117. Local maximum ≈ 0.38 when $x \approx -1.73$; local minimum ≈ -0.38 when $x \approx 1.73$ 118. Local maximum ≈ 1.33 when $x \approx -0.50$

119. 25 ft 120. (a) 55 ft (b) 204.9 ft 121. \$4000, 100 units

122. \$450, 1500 cans 123. 30 times 124. 150 min, 4.5 mg/L

125. 50 trees per acre 126. 7.5 mi/h 127. 20 mi/h 128. 3.96°C

129. $r \approx 0.67$ cm

130. Local maximum ≈ 5.66 when $x \approx 4.00$

131. Local maximum ≈ 0.32 when $x \approx 0.75$ 132. Local maximum ≈ 0.38 when $x \approx -1.73$; local minimum ≈ -0.38 when $x \approx 1.73$ 133. Local maximum ≈ 1.33 when $x \approx -0.50$

134. 25 ft 135. (a) 55 ft (b) 204.9 ft 136. \$4000, 100 units

137. \$450, 1500 cans 138. 30 times 139. 150 min, 4.5 mg/L

140. 50 trees per acre 141. 7.5 mi/h 142. 20 mi/h 143. 3.96°C

144. $r \approx 0.67$ cm

Section 2.6 ■ page 210

1. $A(w) = 3w^2, w > 0$ 2. $A(w) = w^2 + 10w$

3. $V(w) = \frac{1}{2}w^3, w > 0$ 4. $V(r) = 4\pi r^3$

5. $A(x) = 10x - x^2, 0 < x < 10$ 6. $P(x) = 2x + \frac{32}{x}, x > 0$

7. $A(x) = (\sqrt{3}/4)x^2, x > 0$ 8. $S(V) = 6V^{2/3}, V > 0$

9. $r(A) = \sqrt{A/\pi}, A > 0$ 10. $A(C) = C^2/(4\pi), C > 0$

11. $S(x) = 2x^2 + 240/x, x > 0$ 12. $L(d) = \frac{5}{7}d$

13. $D(t) = 25t, t \geq 0$ 14. $P(x) = 60x - x^2$

15. $A(b) = b\sqrt{4-b}, 0 < b < 4$ 16. $P(x) = (3 + \sqrt{5})x$

17. $A(h) = 2h\sqrt{100 - h^2}$, $0 < h < 10$
 18. $h(r) = 300/(\pi r^2)$ 19. (b) $p(x) = x(19 - x)$
 (c) 9.5, 9.5 20. 50, 50 21. -12, -12 22. 5 ft by 5 ft
 23. (b) $A(x) = x(2400 - 2x)$ (c) 600 ft by 1200 ft
 24. (a) $A(w) = -\frac{5}{2}(w^2 - 150w)$ (b) 14,062.5 ft²
 25. (a) $f(w) = 8w + 7200/w$ (b) Width along road is 30 ft,
 length is 40 ft (c) 15 ft to 60 ft
 26. (a) $A(x) = \frac{1}{8}x^2 - \frac{5}{4}x + \frac{25}{4}$ (b) 5 cm
 27. (a) $R(p) = -3000p^2 + 57,000p$ (b) \$19 (c) \$9.50
 28. (a) $P(x) = 80 + 12x - 2x^2$ (b) \$13, \$98
 29. (a) $A(x) = 15x - \left(\frac{\pi + 4}{8}\right)x^2$
 (b) Width \approx 8.40 ft, height of rectangular part \approx 4.20 ft
 30. (a) $V(x) = 4x^3 - 64x^2 + 240x$, $0 < x < 6$
 (b) $1.174 \leq x \leq 3.898$ (c) 262.682 in³
 31. (a) $A(x) = x^2 + 48/x$ (b) Height \approx 1.44 ft,
 width \approx 2.88 ft 32. 3.27 by 5.33
 33. (a) $A(x) = 2x + 200/x$ (b) 10 m by 10 m
 34. (a) $T(x) = \frac{1}{2}\sqrt{x^2 - 14x + 53} + \frac{1}{3}x$ (b) 6.13 mi from
 point B 35. (a) $E(x) = 14\sqrt{25 + x^2} + 10(12 - x)$
 (b) To point C, 5.1 mi from point B 36. (b) 9.23 by 13.00

Section 2.7 ■ page 219

1. $(f + g)(x) = x^2 + x - 3$, $(-\infty, \infty)$;
 $(f - g)(x) = -x^2 + x - 3$, $(-\infty, \infty)$;
 $(fg)(x) = x^3 - 3x^2$, $(-\infty, \infty)$;
 $\left(\frac{f}{g}\right)(x) = \frac{x - 3}{x^2}$, $(-\infty, 0) \cup (0, \infty)$
 2. $(f + g)(x) = 4x^2 + 2x - 1$, $(-\infty, \infty)$;
 $(f - g)(x) = -2x^2 + 2x + 1$, $(-\infty, \infty)$;
 $(fg)(x) = 3x^4 + 6x^3 - x^2 - 2x$, $(-\infty, \infty)$;
 $\left(\frac{f}{g}\right)(x) = \frac{x^2 + 2x}{3x^2 - 1}$, $x \neq \pm \frac{1}{\sqrt{3}}$
 3. $(f + g)(x) = \sqrt{4 - x^2} + \sqrt{1 + x}$, $[-1, 2]$;
 $(f - g)(x) = \sqrt{4 - x^2} - \sqrt{1 + x}$, $[-1, 2]$;
 $(fg)(x) = \sqrt{-x^3 - x^2 + 4x + 4}$, $[-1, 2]$;
 $\left(\frac{f}{g}\right)(x) = \sqrt{\frac{4 - x^2}{1 + x}}$, $(-1, 2]$
 4. $(f + g)(x) = \sqrt{9 - x^2} + \sqrt{x^2 - 4}$, $[-3, -2] \cup [2, 3]$;
 $(f - g)(x) = \sqrt{9 - x^2} - \sqrt{x^2 - 4}$, $[-3, -2] \cup [2, 3]$;
 $(fg)(x) = \sqrt{-x^4 + 13x^2 - 36}$, $[-3, -2] \cup [2, 3]$;
 $\left(\frac{f}{g}\right)(x) = \sqrt{\frac{9 - x^2}{x^2 - 4}}$, $[-3, -2] \cup (2, 3]$

$$5. (f + g)(x) = \frac{6x + 8}{x^2 + 4x}, x \neq -4, x \neq 0;$$

$$(f - g)(x) = \frac{-2x + 8}{x^2 + 4x}, x \neq -4, x \neq 0;$$

$$(fg)(x) = \frac{8}{x^2 + 4x}, x \neq -4, x \neq 0;$$

$$\left(\frac{f}{g}\right)(x) = \frac{x + 4}{2x}, x \neq -4, x \neq 0$$

$$6. (f + g)(x) = \frac{2 + x}{x + 1}, x \neq -1;$$

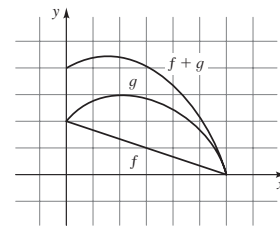
$$(f - g)(x) = \frac{2 - x}{x + 1}, x \neq -1;$$

$$(fg)(x) = \frac{2x}{(x + 1)^2}, x \neq -1; \left(\frac{f}{g}\right)(x) = \frac{2}{x}, x \neq -1, x \neq 0$$

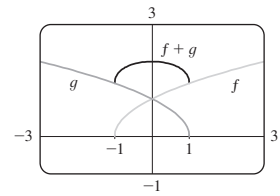
$$7. [0, 1] \quad 8. [-1, 0) \cup (0, \infty) \quad 9. (3, \infty)$$

$$10. [-3, 1) \cup (1, \infty)$$

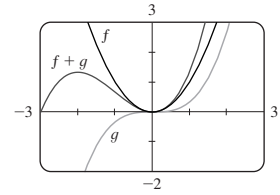
11.



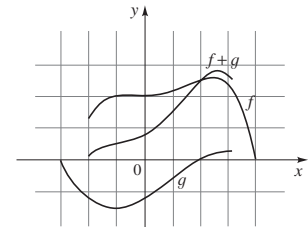
13.



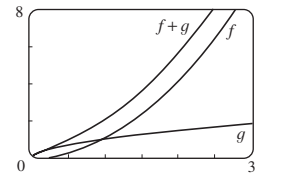
15.



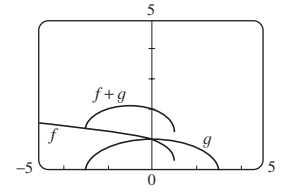
12.



14.



16.



17. (a) 1 (b) -23 18. (a) 16 (b) -47 19. (a) -11
 (b) -119 20. (a) -29 (b) -2 21. (a) $-3x^2 + 1$
 (b) $-9x^2 + 30x - 23$ 22. (a) $9x - 20$ (b) $-x^4 + 4x^2 - 2$
 23. 4 24. 3 25. 5 26. 0 27. 4 28. -2
 29. $(f \circ g)(x) = 8x + 1$, $(-\infty, \infty)$;
 $(g \circ f)(x) = 8x + 11$, $(-\infty, \infty)$;
 $(f \circ f)(x) = 4x + 9$, $(-\infty, \infty)$;
 $(g \circ g)(x) = 16x - 5$, $(-\infty, \infty)$
 30. $(f \circ g)(x) = 3x - 5$, $(-\infty, \infty)$;
 $(g \circ f)(x) = 3x - \frac{5}{2}$, $(-\infty, \infty)$;
 $(f \circ f)(x) = 36x - 35$, $(-\infty, \infty)$; $(g \circ g)(x) = \frac{x}{4}$, $(-\infty, \infty)$

A28 Answers to Exercises and Chapter Tests

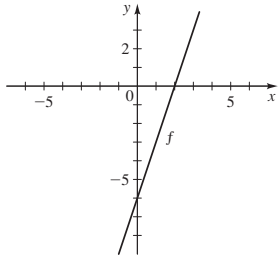
31. $(f \circ g)(x) = (x + 1)^2, (-\infty, \infty);$
 $(g \circ f)(x) = x^2 + 1, (-\infty, \infty); (f \circ f)(x) = x^4, (-\infty, \infty);$
 $(g \circ g)(x) = x + 2, (-\infty, \infty)$
32. $(f \circ g)(x) = x + 2, (-\infty, \infty);$
 $(g \circ f)(x) = \sqrt[3]{x^3 + 2}, (-\infty, \infty);$
 $(f \circ f)(x) = x^9 + 6x^6 + 12x^3 + 10, (-\infty, \infty);$
 $(g \circ g)(x) = x^{1/9}, (-\infty, \infty)$
33. $(f \circ g)(x) = \frac{1}{2x + 4}, x \neq -2; (g \circ f)(x) = \frac{2}{x} + 4, x \neq 0;$
 $(f \circ f)(x) = x, x \neq 0, (g \circ g)(x) = 4x + 12, (-\infty, \infty)$
34. $(f \circ g)(x) = x - 3, [3, \infty);$
 $(g \circ f)(x) = \sqrt{x^2 - 3}, (-\infty, -\sqrt{3}] \cup [\sqrt{3}, \infty);$
 $(f \circ f)(x) = x^4, (-\infty, \infty);$
 $(g \circ g)(x) = \sqrt{\sqrt{x - 3} - 3}, [12, \infty)$
35. $(f \circ g)(x) = |2x + 3|, (-\infty, \infty);$
 $(g \circ f)(x) = 2|x| + 3, (-\infty, \infty); (f \circ f)(x) = |x|, (-\infty, \infty);$
 $(g \circ g)(x) = 4x + 9, (-\infty, \infty)$
36. $(f \circ g)(x) = |x + 4| - 4, (-\infty, \infty);$
 $(g \circ f)(x) = |x|, (-\infty, \infty); (f \circ f)(x) = x - 8, (-\infty, \infty);$
 $(g \circ g)(x) = |x + 4| + 4, (-\infty, \infty)$
37. $(f \circ g)(x) = \frac{2x - 1}{2x}, x \neq 0;$
 $(g \circ f)(x) = \frac{2x}{x + 1} - 1, x \neq -1;$
 $(f \circ f)(x) = \frac{x}{2x + 1}, x \neq -1, x \neq -\frac{1}{2};$
 $(g \circ g)(x) = 4x - 3, (-\infty, \infty)$
38. $(f \circ g)(x) = \frac{1}{\sqrt{x^2 - 4x}}, (-\infty, 0) \cup (4, \infty);$
 $(g \circ f)(x) = \frac{1}{x} - \frac{4}{\sqrt{x}}, (0, \infty); (f \circ f)(x) = x^{1/4}, (0, \infty);$
 $(g \circ g)(x) = x^4 - 8x^3 + 12x^2 + 16x, (-\infty, \infty)$
39. $(f \circ g)(x) = \sqrt[12]{x}, [0, \infty); (g \circ f)(x) = \sqrt[12]{x}, [0, \infty);$
 $(f \circ f)(x) = \sqrt[9]{x}, (-\infty, \infty); (g \circ g)(x) = \sqrt[16]{x}, [0, \infty)$
40. $(f \circ g)(x) = \frac{2x + 4}{x}, x \neq -2, x \neq 0;$
 $(g \circ f)(x) = \frac{1}{1 + x}, x \neq -1, x \neq 0; (f \circ f)(x) = x, x \neq 0;$
 $(g \circ g)(x) = \frac{x}{3x + 4}, x \neq -2, x \neq -\frac{4}{3}$
41. $(f \circ g \circ h)(x) = \sqrt{x - 1} - 1$
42. $(f \circ g \circ h)(x) = \frac{1}{x^6 + 6x^4 + 12x^2 + 8}$
43. $(f \circ g \circ h)(x) = (\sqrt{x} - 5)^4 + 1$
44. $(f \circ g \circ h)(x) = \sqrt{\frac{\sqrt[3]{x}}{\sqrt[3]{x} - 1}}$ 45. $g(x) = x - 9, f(x) = x^5$

46. $g(x) = \sqrt{x}, f(x) = x + 1$
47. $g(x) = x^2, f(x) = x/(x + 4)$
48. $g(x) = x + 3, f(x) = 1/x$ 49. $g(x) = 1 - x^3, f(x) = |x|$
50. $g(x) = \sqrt{x}, f(x) = \sqrt{1 + x}$
51. $h(x) = x^2, g(x) = x + 1, f(x) = 1/x$
52. $h(x) = \sqrt{x}, g(x) = x - 1, f(x) = \sqrt[3]{x}$
53. $h(x) = \sqrt[3]{x}, g(x) = 4 + x, f(x) = x^9$
54. $h(x) = \sqrt{x}, g(x) = 3 + x, f(x) = 2/x^2$
55. $R(x) = 0.15x - 0.000002x^2$
56. $P(x) = 0.055x - 0.0000015x^2$ 57. (a) $g(t) = 60t$
 (b) $f(r) = \pi r^2$ (c) $(f \circ g)(t) = 3600\pi t^2$ 58. (a) $f(t) = t$
 (b) $g(r) = \frac{4}{3}\pi r^3$ (c) $(g \circ f)(t) = \frac{4}{3}\pi t^3$; the volume as a
 function of time 59. $A(t) = 16\pi t^2$ 60. (a) $f(x) = 0.80x$
 (b) $g(x) = x - 50$ (c) $(f \circ g)(x) = 0.80x - 40;$
 $(g \circ f)(x) = 0.80x - 50$; applying the 20% discount, then \$50
 coupon ($g \circ f$) gives the lower price 61. (a) $f(x) = 0.9x$
 (b) $g(x) = x - 100$ (c) $f \circ g(x) = 0.9x - 90,$
 $g \circ f(x) = 0.9x - 100, f \circ g$: first rebate, then discount,
 $g \circ f$: first discount, then rebate, $g \circ f$ is the better deal
62. (a) $s = \sqrt{1 + d^2}$ (b) $d = 350t$
 (c) $s(t) = \sqrt{1 + 122,500t^2}$

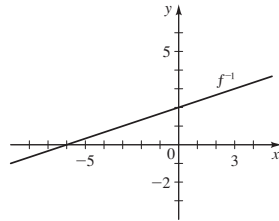
Section 2.8 ■ page 230

1. No 2. Yes 3. Yes 4. No 5. No 6. Yes 7. Yes
 8. Yes 9. Yes 10. No 11. No 12. Yes 13. No
 14. Yes 15. No 16. Yes 17. (a) 2 (b) 3
 18. (a) 5 (b) 4 19. 1 20. 1
 31. $f^{-1}(x) = \frac{1}{2}(x - 1)$ 32. $f^{-1}(x) = 6 - x$
 33. $f^{-1}(x) = \frac{1}{4}(x - 7)$ 34. $f^{-1}(x) = \frac{1}{5}(3 - x)$
 35. $f^{-1}(x) = 2x$ 36. $f^{-1}(x) = 1/\sqrt{x}, x > 0$
 37. $f^{-1}(x) = (1/x) - 2$
 38. $f^{-1}(x) = \frac{-2(x + 1)}{x - 1}$
 39. $f^{-1}(x) = (5x - 1)/(2x + 3)$
 40. $f^{-1}(x) = \sqrt[3]{\frac{1}{4}(5 - x)}$
 41. $f^{-1}(x) = \frac{1}{5}(x^2 - 2), x \geq 0$
 42. $f^{-1}(x) = \sqrt{x + \frac{1}{4}} - \frac{1}{2}, x \geq -\frac{1}{4}$
 43. $f^{-1}(x) = \sqrt{4 - x}, x \leq 4$
 44. $f^{-1}(x) = \frac{1}{2}(x^2 + 1), x \geq 0$
 45. $f^{-1}(x) = (x - 4)^3$ 46. $f^{-1}(x) = \sqrt[3]{2 - \sqrt[5]{x}}$
 47. $f^{-1}(x) = x^2 - 2x, x \geq 1$
 48. $f^{-1}(x) = \sqrt{9 - x^2}, 0 \leq x \leq 3$ 49. $f^{-1}(x) = \sqrt[4]{x}$
 50. $f^{-1}(x) = \sqrt[3]{1 - x}$

51. (a)

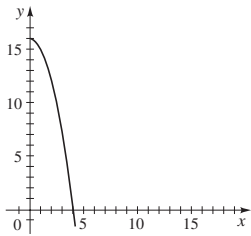


(b)

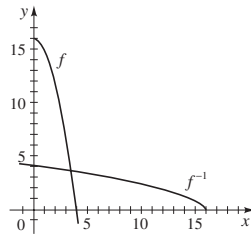


(c) $f^{-1}(x) = \frac{1}{3}(x + 6)$

52. (a)

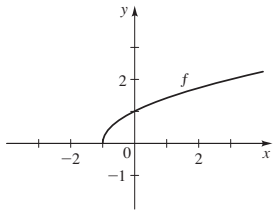


(b)

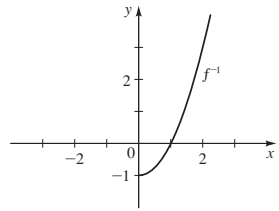


(c) $f^{-1}(x) = \sqrt{16 - x}, x \leq 16$

53. (a)

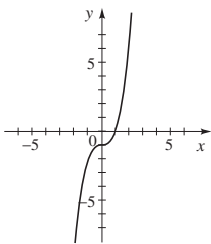


(b)

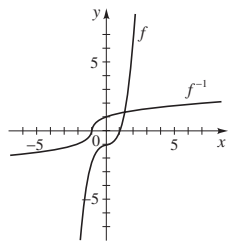


(c) $f^{-1}(x) = x^2 - 1, x \geq 0$

54. (a)

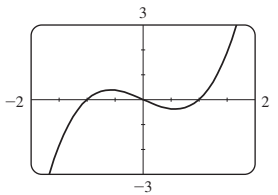


(b)

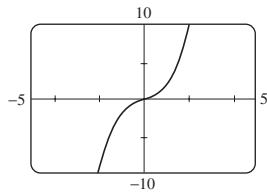


(c) $f^{-1}(x) = \sqrt[3]{x + 1}$

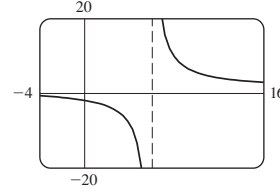
55. Not one-to-one



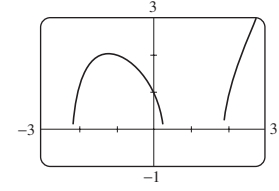
56. One-to-one



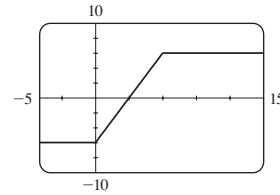
57. One-to-one



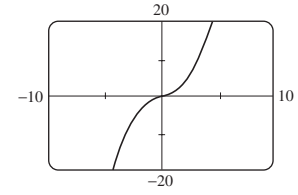
58. Not one-to-one



59. Not one-to-one

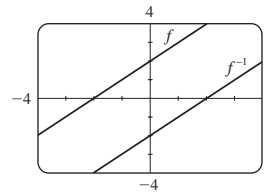


60. One-to-one

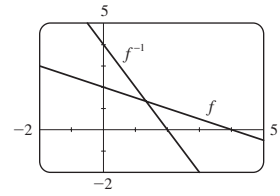


61. (a) $f^{-1}(x) = x - 2$

(b)

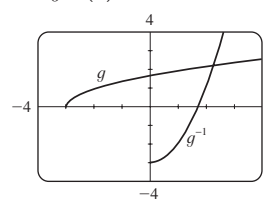


62. (a) $f^{-1}(x) = 4 - 2x$

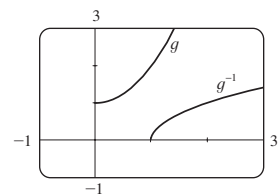


63. (a) $g^{-1}(x) = x^2 - 3, x \geq 0$

(b)



64. (a) $g^{-1}(x) = \sqrt{x - 1}$



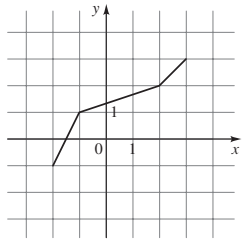
65. $x \geq 0, f^{-1}(x) = \sqrt{4 - x}$

66. $x \geq 1, g^{-1}(x) = 1 + \sqrt{x}$

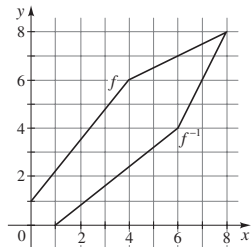
67. $x \geq -2, h^{-1}(x) = \sqrt{x} - 2$ **68.** $x \geq 3, k^{-1}(x) = 3 + x$

A30 Answers to Exercises and Chapter Tests

69.



70.



71. (a) $f(x) = 500 + 80x$ (b) $f^{-1}(x) = \frac{1}{80}(x - 500)$, the number of hours worked as a function of the fee (c) 9; if he charges \$1220, he worked 9 h 72. (a) $V^{-1}(t) = 40 - 4\sqrt{t}$, time elapsed since the tank started to leak (b) 24.5 min; in 24.5 min the tank drained 15 gal of water

73. (a) $v^{-1}(t) = \sqrt{0.25 - \frac{t}{18,500}}$ (b) 0.498; at a

distance 0.498 from the central axis, the velocity is 30

74. (a) $D^{-1}(p) = 50 - \frac{1}{3}p$, the price associated with the demand D (b) 40; when the demand is 30 units, the price is \$40 75. (a) $F^{-1}(x) = \frac{5}{9}(x - 32)$; the Celsius temperature when the Fahrenheit temperature is x (b) $F^{-1}(86) = 30$; when the temperature is 86°F , it is 30°C

76. (a) $f(x) = 0.8159x$ (b) $f^{-1}(x) = 1.2256x$, the exchange rate from U.S. dollars to Canadian dollars (c) \$15,014.09 in Canadian currency

77. (a) $f(x) = \begin{cases} 0.1x & \text{if } 0 \leq x \leq 20,000 \\ 2000 + 0.2(x - 20,000) & \text{if } x > 20,000 \end{cases}$

(b) $f^{-1}(x) = \begin{cases} 10x & \text{if } 0 \leq x \leq 2000 \\ 10,000 + 5x & \text{if } x > 2000 \end{cases}$

If you pay x euros in taxes, your income is $f^{-1}(x)$.

(c) $f^{-1}(10,000) = 60,000$ 78. (a) $f(x) = 0.85x$

(b) $g(x) = x - 1000$ (c) $H = 0.85x - 850$

(d) $H^{-1}(x) = 1.176x + 1000$, the original sticker price for a given discounted price (e) \$16,288, the original price of the car when the discounted price (\$1000 rebate, then 15% off) is \$13,000 79. $f^{-1}(x) = \frac{1}{2}(x - 7)$. A pizza costing x dollars has $f^{-1}(x)$ toppings.

Chapter 2 Review ■ page 234

1. 6, 2, 18, $a^2 - 4a + 6$, $a^2 + 4a + 6$, $x^2 - 2x + 3$, $4x^2 - 8x + 6$, $2x^2 - 8x + 10$ 2. 1, $4 - \sqrt{21}$, $4 - \sqrt{3a}$, $4 - \sqrt{-3x - 6}$, $4 - \sqrt{3x^2 - 6}$, $3x - 8\sqrt{3x - 6} + 10$

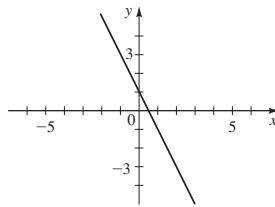
3. (a) -1, 2 (b) $[-4, 5]$ (c) $[-4, 4]$ (d) Increasing on $[-4, -2]$ and $[-1, 4]$; decreasing on $[-2, -1]$ and $[4, 5]$

(e) No 4. (a) Not a function (b) Function (c) Function, one-to-one (d) Not a function 5. Domain $[-3, \infty)$, range $[0, \infty)$ 6. Domain $(-\infty, \infty)$, range $[4, \infty)$ 7. $(-\infty, \infty)$

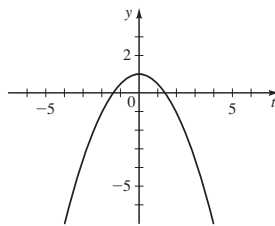
8. $x \neq \frac{1}{2}$ 9. $[-4, \infty)$ 10. $(-1, \infty)$ 11. $\{x \mid x \neq -2, -1, 0\}$

12. $x \neq -\frac{1}{2}, x \neq 3$ 13. $(-\infty, -1] \cup [1, 4]$ 14. $x \neq -4$

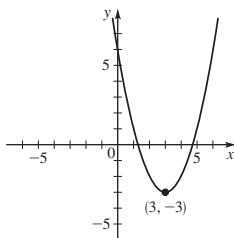
15.



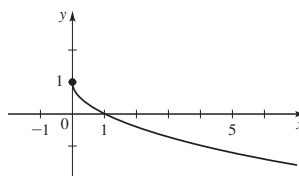
17.



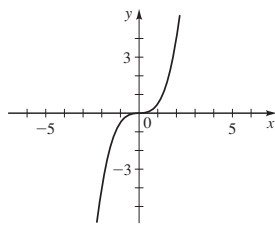
19.



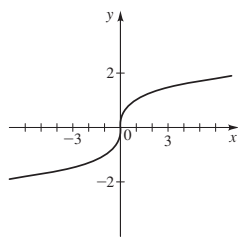
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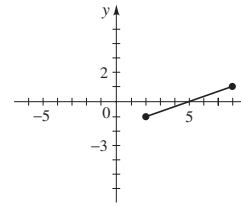
23.



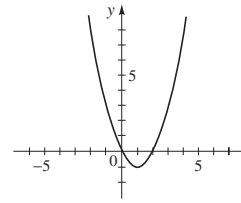
25.



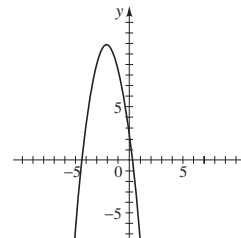
16.



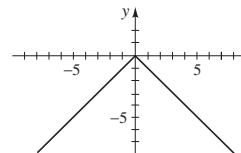
18.



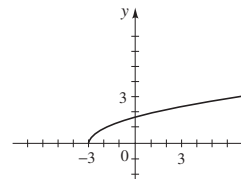
20.



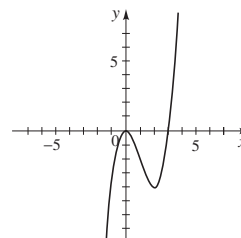
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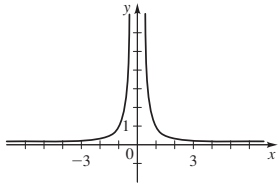
24.



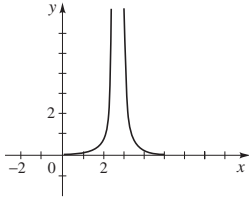
26.



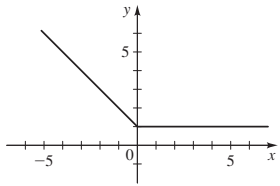
27.



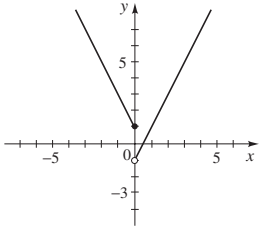
28.



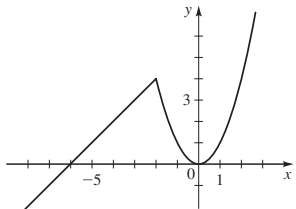
29.



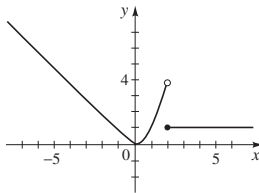
30.



31.

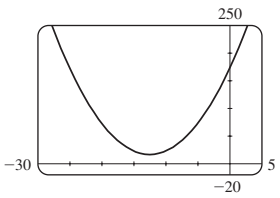


32.



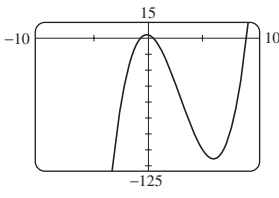
33. (iii)

35.

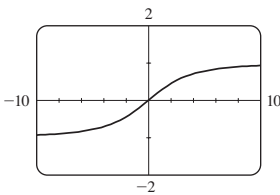


34. (iii)

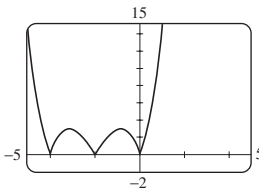
36.



37.



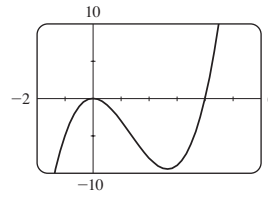
38.



39. $[-2.1, 0.2] \cup [1.9, \infty)$ 40. $[-7.10, \infty)$ 41. 5

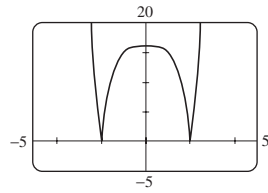
42. $-\frac{1}{12}$ 43. $\frac{-1}{3(3+h)}$ 44. $2a + h + 2$

45.



Increasing on $(-\infty, 0]$, $[2.67, \infty)$; decreasing on $[0, 2.67]$

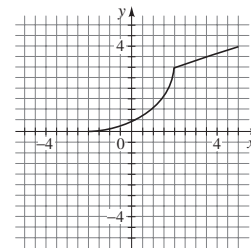
46.



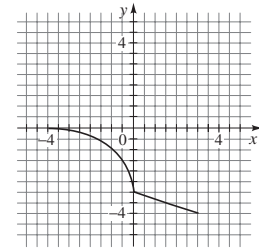
Increasing on $[-2, 0]$, $[2, \infty)$; decreasing on $(-\infty, -2]$, $[0, 2]$

47. (a) Shift upward 8 units (b) Shift left 8 units
 (c) Stretch vertically by a factor of 2, then shift upward 1 unit
 (d) Shift right 2 units and downward 2 units (e) Reflect in y -axis
 (f) Reflect in y -axis, then in x -axis
 (g) Reflect in x -axis (h) Reflect in line $y = x$

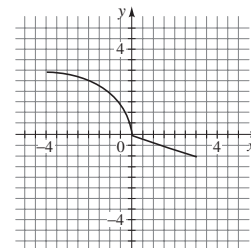
48. (a)



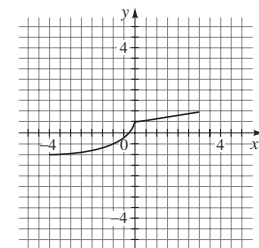
(b)



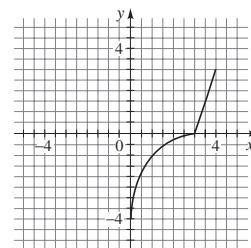
(c)



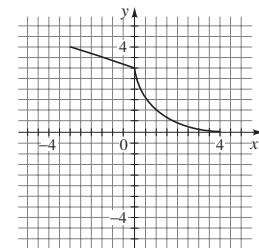
(d)



(e)



(f)

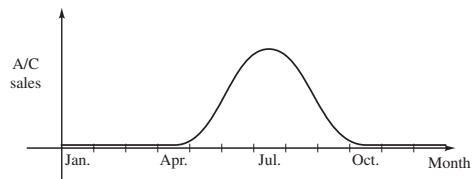


49. (a) Neither (b) Odd (c) Even (d) Neither
 50. (a) Odd (b) Neither (c) Even (d) Neither
 51. $f(x) = (x + 2)^2 - 3$ 52. $f(x) = -2(x - 3)^2 + 30$

A32 Answers to Exercises and Chapter Tests

53. $g(-1) = -7$ 54. $\frac{5}{4}$ 55. 68 ft 56. \$88,500, 15,000 units 57. Local maximum ≈ 3.79 when $x \approx 0.46$; local minimum ≈ 2.81 when $x \approx -0.46$
58. Local maximum ≈ 3.175 when $x \approx 4.00$; local minimum = 0 when $x = 0$

59.



60. $A = b\sqrt{4-b}$

61. (a) $A(x) = 5\sqrt{3}x - \frac{\sqrt{3}}{2}x^2$ (b) 5 cm by $\frac{5\sqrt{3}}{2}$ cm

62. (a) $A(x) = \frac{x^2}{16} + \frac{\sqrt{3}(10-x)^2}{36}$, $0 \leq x \leq 10$

(b) 4.35 m 63. (a) $(f+g)(x) = x^2 - 6x + 6$

(b) $(f-g)(x) = x^2 - 2$

(c) $(fg)(x) = -3x^3 + 13x^2 - 18x + 8$

(d) $(f/g)(x) = (x^2 - 3x + 2)/(4 - 3x)$

(e) $(f \circ g)(x) = 9x^2 - 15x + 6$

(f) $(g \circ f)(x) = -3x^2 + 9x - 2$ 64. (a) $(f \circ g)(x) = x$

(b) $(g \circ f)(x) = |x|$ (c) 2 (d) 26

(e) $(f \circ g \circ f)(x) = 1 + x^2$ (f) $(g \circ f \circ g)(x) = \sqrt{x-1}$

65. $(f \circ g)(x) = -3x^2 + 6x - 1$, $(-\infty, \infty)$;

$(g \circ f)(x) = -9x^2 + 12x - 3$, $(-\infty, \infty)$; $(f \circ f)(x) = 9x - 4$,

$(-\infty, \infty)$; $(g \circ g)(x) = -x^4 + 4x^3 - 6x^2 + 4x$, $(-\infty, \infty)$

66. $(f \circ g)(x) = \sqrt{\frac{2}{x-4}}$, $(4, \infty)$; $(g \circ f)(x) = \frac{2}{\sqrt{x-4}}$,

$[0, 16) \cup (16, \infty)$; $(f \circ f)(x) = x^{1/4}$, $[0, \infty)$;

$(g \circ g)(x) = \frac{x-4}{9-2x}$, $x \neq 4, x \neq \frac{9}{2}$

67. $(f \circ g \circ h)(x) = 1 + \sqrt{x}$

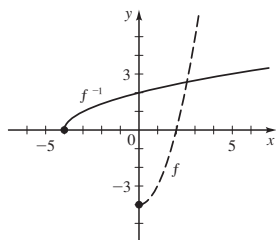
68. $h(x) = \sqrt{x}$, $g(x) = 1 + x$,

$f(x) = 1/\sqrt{x}$ 69. Yes 70. No 71. No 72. Yes 73. No

74. Yes 75. $f^{-1}(x) = \frac{x+2}{3}$ 76. $f^{-1}(x) = \frac{1}{2}(3x-1)$

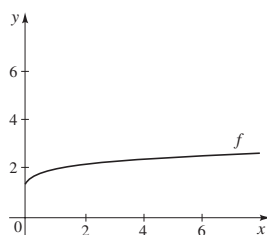
77. $f^{-1}(x) = \sqrt[3]{x} - 1$ 78. $f^{-1}(x) = 2 + (x-1)^5$

79. (a), (b)

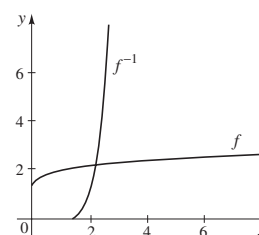


(c) $f^{-1}(x) = \sqrt{x+4}$

80. (b)



(c)



(d) $f^{-1}(x) = (x-1)^4$, $x \geq 1$

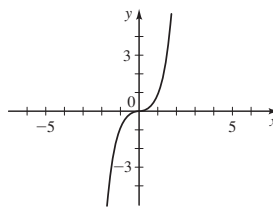
Chapter 2 Test ■ page 237

1. (a) and (b) are graphs of functions, (a) is one-to-one

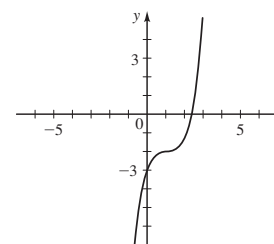
2. (a) $2/3$, $\sqrt{6}/5$, $\sqrt{a}/(a-1)$ (b) $[-1, 0) \cup (0, \infty)$

3. 5

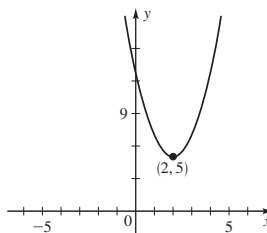
4. (a)



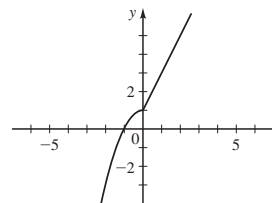
(b)



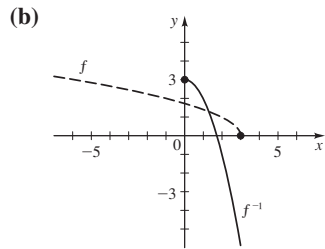
5. (a) Shift right 3 units, then shift upward 2 units

(b) Reflect in y-axis 6. (a) $f(x) = 2(x-2)^2 + 5$ (b) (c) $f(2) = 5$ 

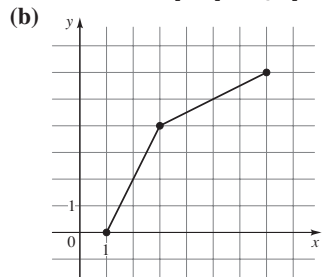
7. (a) -3, 3 (b)

8. (a) $A(x) = -3x^2 + 900x$ (b) 150 ft9. (a) $(f \circ g)(x) = (x-3)^2 + 1$ (b) $(g \circ f)(x) = x^2 - 2$ (c) 2 (d) 2 (e) $(g \circ g \circ g)(x) = x - 9$

10. (a) $f^{-1}(x) = 3 - x^2, x \geq 0$



11. (a) Domain $[0, 6]$, range $[1, 7]$

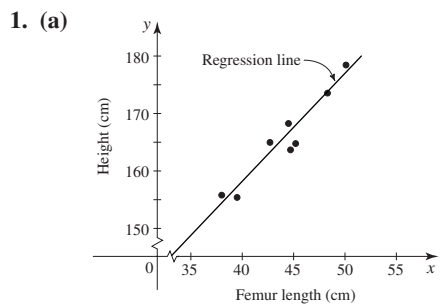


(c) $\frac{5}{4}$

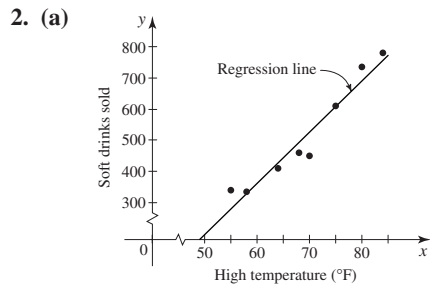
12. (a)  (b) No

(c) Local minimum ≈ -27.18 when $x \approx -1.61$; local maximum ≈ -2.55 when $x \approx 0.18$; local minimum ≈ -11.93 when $x \approx 1.43$ (d) $[-27.18, \infty)$ (e) Increasing on $[-1.61, 0.18] \cup [1.43, \infty)$; decreasing on $(-\infty, -1.61] \cup [0.18, 1.43]$

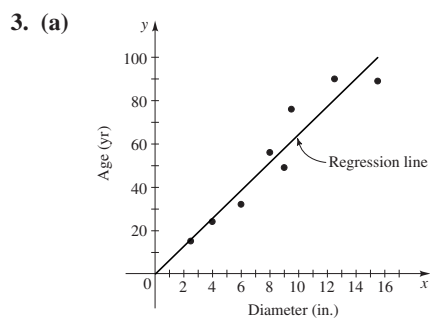
Focus on Modeling ■ page 243



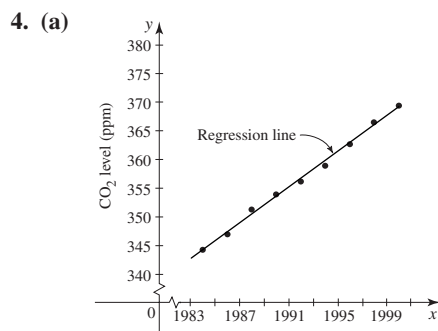
(b) $y = 1.8807x + 82.65$ (c) 191.7 cm



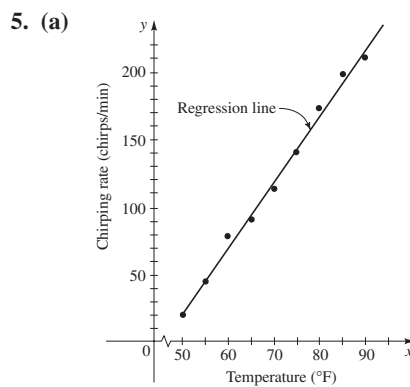
(b) $y = 16.4163x - 621.83$ (c) 938 cans



(b) $y = 6.451x - 0.1523$ (c) 116 years



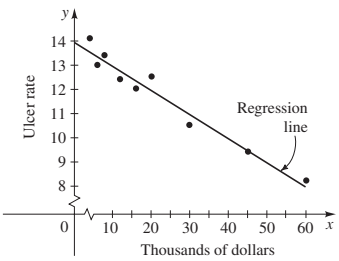
(b) $y = 1.555x - 2740.8$ (c) 370.7 ppm



(b) $y = 4.857x - 220.97$ (c) 265 chirps/min

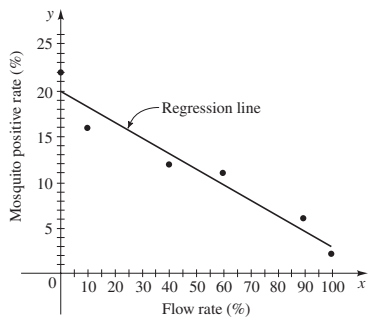
A34 Answers to Exercises and Chapter Tests

6. (a)



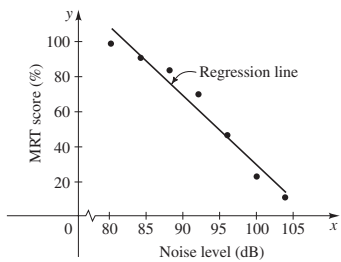
(b) $y = -0.0995x + 13.9$, x in thousands of dollars
(c) 11.4 per 100 population **(d)** 5.9 per 100 population

7. (a)



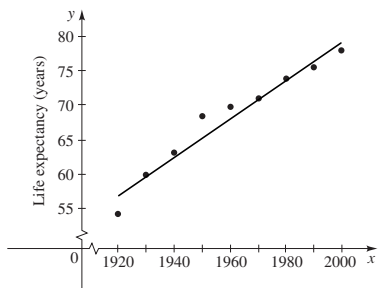
(b) $y = -0.168x + 19.89$ **(c)** 8.13%

8. (a)



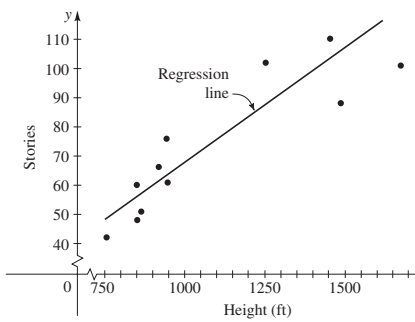
(b) $y = -3.9018x + 419.7$ **(c)** The correlation coefficient is -0.98 , so a linear model is appropriate. **(d)** 53%

9. (a)



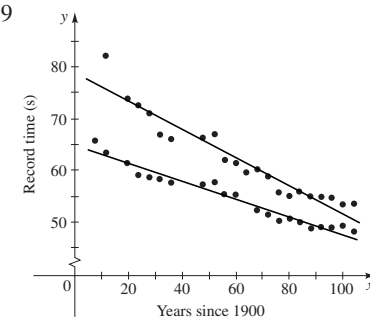
(b) $y = 0.2708x - 462.9$ **(c)** 78.2 years

10. (a)



(b) $y = 0.0669x + 0.23$ **(c)** 0.0669; fraction of a story per foot of height

11. (a) $y = -0.1729x + 64.717$, $y = -0.269x + 78.667$
(b) 2039

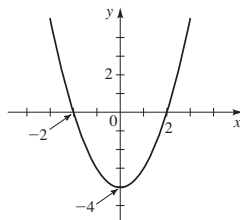


12. (a) $y = 0.7804x + 15.5$

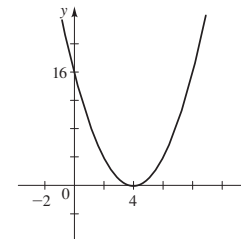
Chapter 3

Section 3.1 ■ page 262

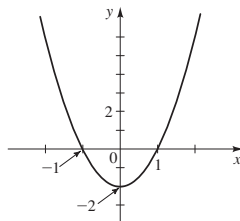
1. (a)



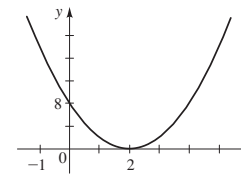
(b)

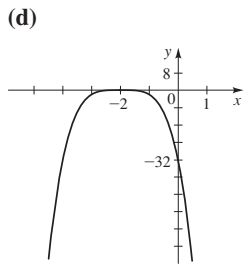
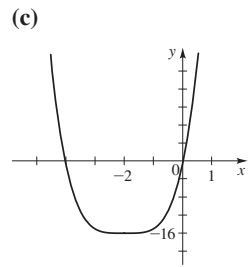
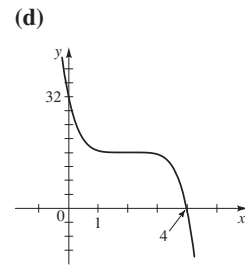
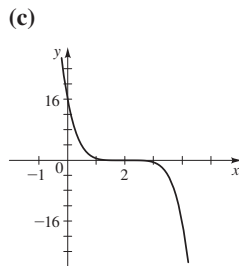
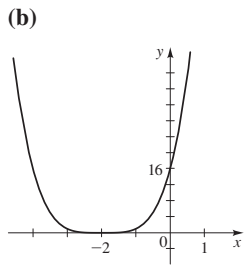
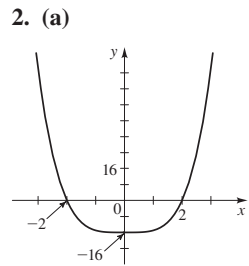


(c)

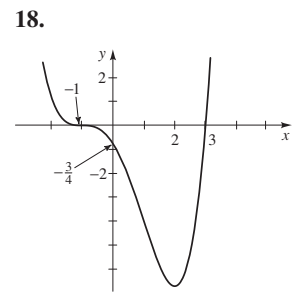
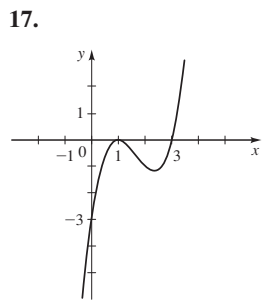
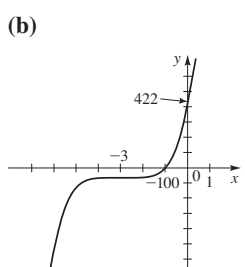
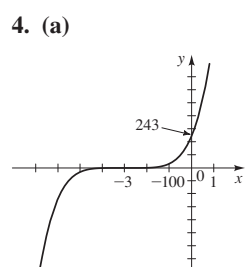
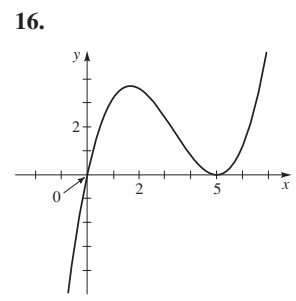
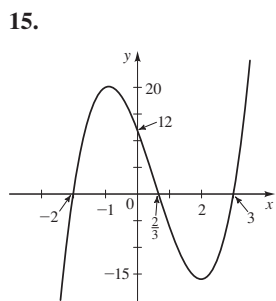
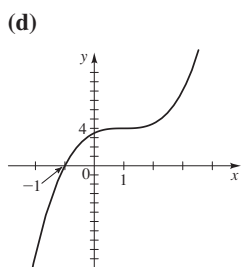
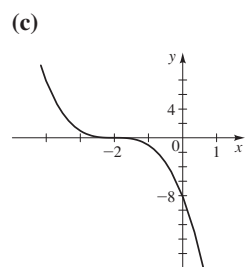
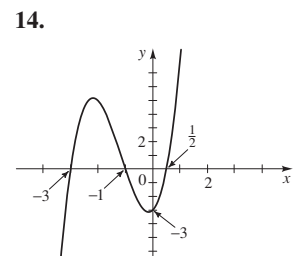
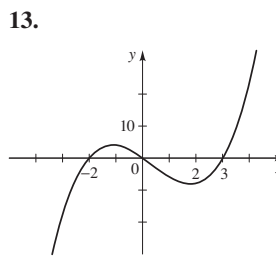
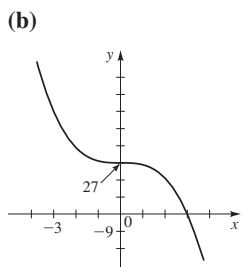
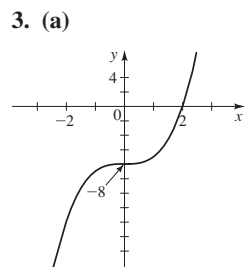
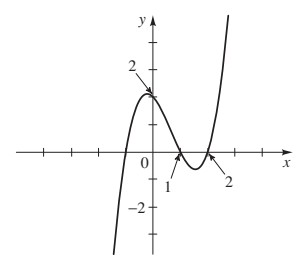
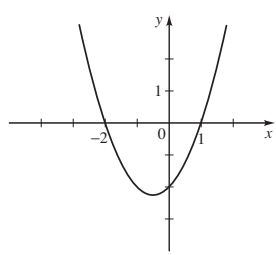


(d)



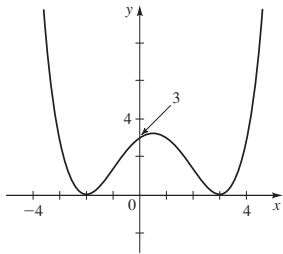


5. III 6. I 7. V 8. II 9. VI 10. IV

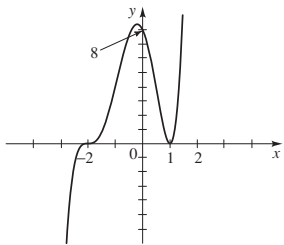
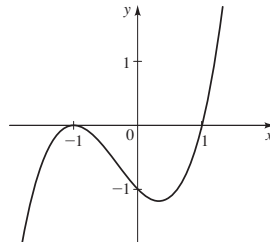
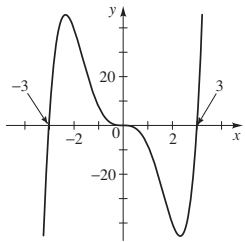


A36 Answers to Exercises and Chapter Tests

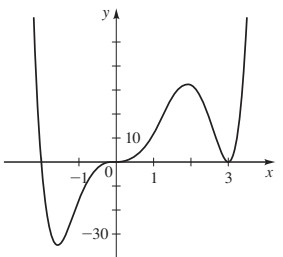
19.



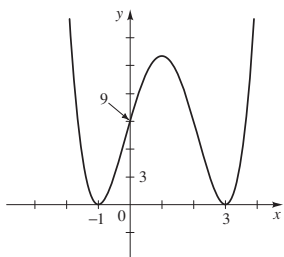
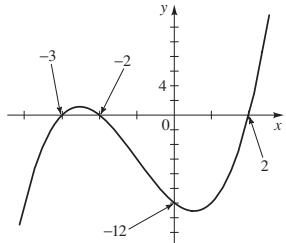
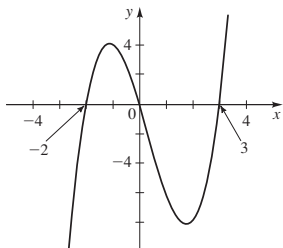
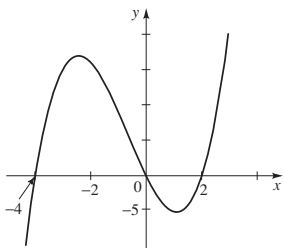
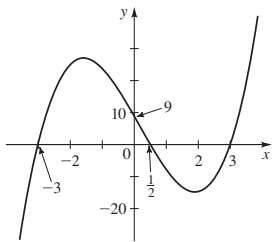
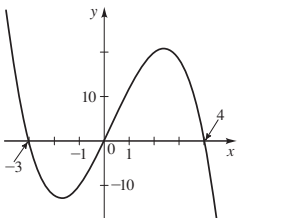
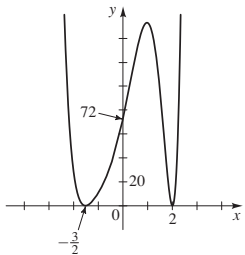
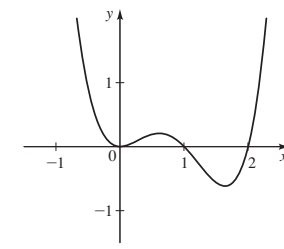
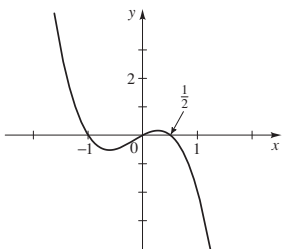
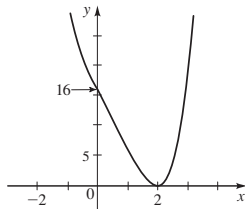
20.

28. $P(x) = x^3(x+3)(x-3)$ 29. $P(x) = (x+1)^2(x-1)$ 

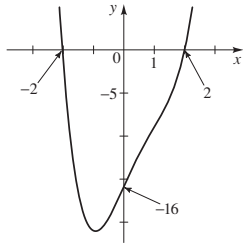
21.



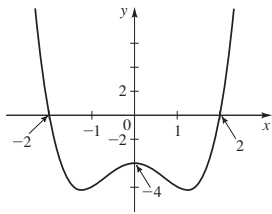
22.

30. $P(x) = (x+3)(x-2)(x+2)$ 23. $P(x) = x(x+2)(x-3)$ 24. $P(x) = x(x-2)(x+4)$ 31. $P(x) = (2x-1)(x+3)(x-3)$ 25. $P(x) = -x(x+3)(x-4)$ 32. $P(x) = \frac{1}{8}(x-2)^2(2x+3)^2(x^2+2x+4)^2$ 26. $P(x) = -x(2x-1)(x+1)$ 27. $P(x) = x^2(x-1)(x-2)$ 33. $P(x) = (x-2)^2(x^2+2x+4)$ 

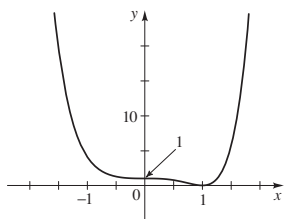
34. $P(x) = (x + 2)(x - 2)(x^2 - 2x + 4)$



35. $P(x) = (x^2 + 1)(x + 2)(x - 2)$



36. $P(x) = (x - 1)^2(x^2 + x + 1)^2$



37. $y \rightarrow \infty$ as $x \rightarrow \infty$, $y \rightarrow -\infty$ as $x \rightarrow -\infty$

38. $y \rightarrow -\infty$ as $x \rightarrow \infty$, $y \rightarrow \infty$ as $x \rightarrow -\infty$

39. $y \rightarrow \infty$ as $x \rightarrow \pm\infty$

40. $y \rightarrow -\infty$ as $x \rightarrow \infty$, $y \rightarrow \infty$ as $x \rightarrow -\infty$

41. $y \rightarrow \infty$ as $x \rightarrow \infty$, $y \rightarrow -\infty$ as $x \rightarrow -\infty$

42. $y \rightarrow -\infty$ as $x \rightarrow \pm\infty$

43. (a) x -intercepts 0, 4; y -intercept 0 (b) (2, 4)

44. (a) x -intercepts 0, 4.5; y -intercept 0

(b) (0, 0), (3, -3)

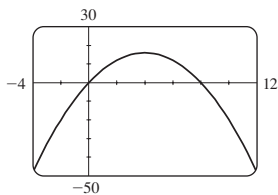
45. (a) x -intercepts -2, 1; y -intercept -1

(b) (-1, -2), (1, 0)

46. (a) x -intercepts 0, 4; y -intercept 0

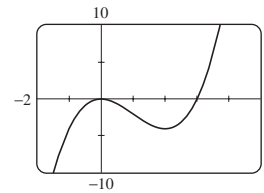
(b) (3, -3)

47.



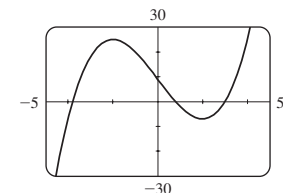
local maximum (4, 16)

48.



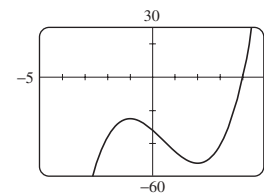
local minimum (2, -4),
local maximum (0, 0)

49.



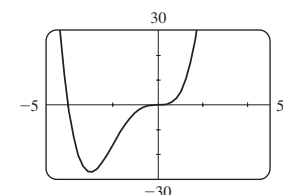
local maximum (-2, 25),
local minimum (2, -7)

50.



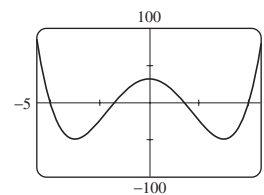
local minimum (2, -52),
local maximum (-1, -25)

51.



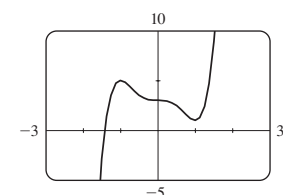
local minimum (-3, -27)

52.



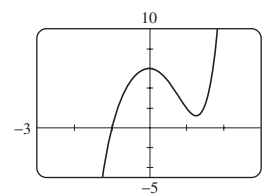
local minima (-3, -49)
and (3, -49),
local maximum (0, 32)

53.



local maximum (-1, 5),
local minimum (1, 1)

54.



local maximum (0, 6),
local minimum (1.26, 1.24)

55. One local maximum,
no local minimum

56. No local extremum

57. One local maximum, one local minimum

58. No local extremum

59. One local maximum, two local minima

60. Two local maxima, two local minima

61. No local extrema

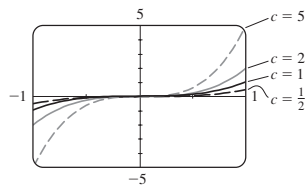
62. One local minimum

63. One local maximum, two local minima

64. One local maximum, one local minimum

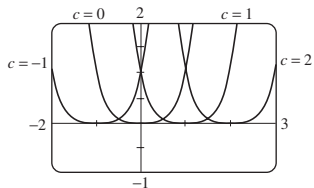
A38 Answers to Exercises and Chapter Tests

65.



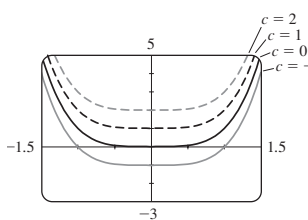
Increasing the value of c stretches the graph vertically.

66.



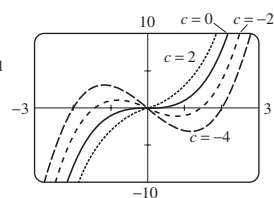
Increasing the value of c shifts the graph to the right.

67.



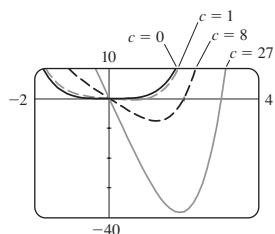
Increasing the value of c moves the graph up.

68.



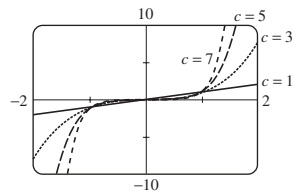
Increasing the value of c makes the "bumps" in the graph flatter.

69.



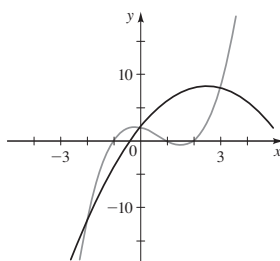
Increasing the value of c causes a deeper dip in the graph in the fourth quadrant and moves the positive x -intercept to the right.

70.



The larger c gets, the flatter the graph is near the origin, and the steeper it is away from the origin.

71. (a)

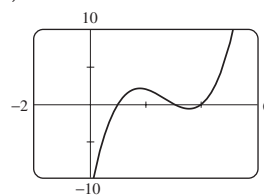


(b) Three **(c)** $(0, 2)$, $(3, 8)$, $(-2, -12)$

72. ① is $y = x^4$; ② is $y = x^2$; ③ is $y = x^6$; ④ is $y = x^3$; ⑤ is $y = x^5$

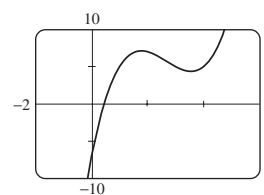
73. (d) $P(x) = P_O(x) + P_E(x)$, where $P_O(x) = x^5 + 6x^3 - 2x$ and $P_E(x) = -x^2 + 5$

74. (a)



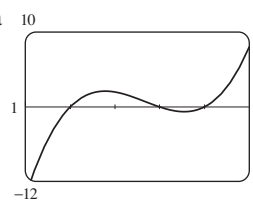
local maximum $(1.8, 2.1)$
local minimum $(3.6, -0.6)$

(b)



local maximum $(1.8, 7.1)$
local minimum $(3.5, 4.4)$

75. (a) Two local extrema



76. (a) Three x -intercepts, two local extrema

(b) One x -intercept, no local extrema

(c) Three x -intercepts, two local extrema; one x -intercept, no local extrema

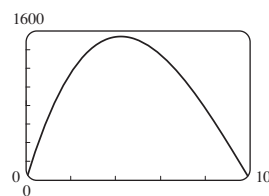
77. (a) 26 blenders

(b) No; \$3276.22 **78. (a)** 1380 rabbits, after 4.2 months

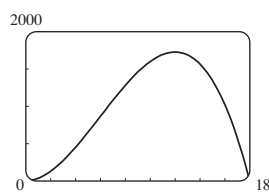
(b) After 8.4 months

79. (a) $V(x) = 4x^3 - 120x^2 + 800x$ **(b)** $0 < x < 10$

(c) Maximum volume $\approx 1539.6 \text{ cm}^3$



80. (b) Domain $\{x \mid 0 < x < 18\}$ **(c)** 1728 in^3



Section 3.2 ■ page 270

1. $(x + 3)(3x - 4) + 8$ 2. $(x - 1)(x^2 + 5x - 1)$

3. $(2x - 3)(x^2 - 1) - 3$ 4. $(2x + 1)(2x^2 - x + 4) + 5$

5. $(x^2 + 3)(x^2 - x - 3) + (7x + 11)$

6. $(x^2 - 2)(2x^3 + 4x^2 + 8) + (-x + 13)$
 7. $x + 1 + \frac{-11}{x + 3}$ 8. $x^2 + 4x + 22 + \frac{93}{x - 4}$
 9. $2x - \frac{1}{2} + \frac{-15}{2x - 1}$ 10. $2x^2 + 3x + \frac{5}{3x - 4}$
 11. $2x^2 - x + 1 + \frac{4x - 4}{x^2 + 4}$ 12. $x^3 - x + 1 + \frac{-x + 2}{x^2 + x - 1}$

In answers 13–36, the first polynomial given is the quotient and the second is the remainder.

13. $x - 2, -16$ 14. $x^2 + x, 6$ 15. $2x^2 - 1, -2$
 16. $\frac{1}{3}x^2 + \frac{1}{3}x + \frac{2}{3}, -1$ 17. $x + 2, 8x - 1$
 18. $3x^2 - 8x - 1, 5x - 2$ 19. $3x + 1, 7x - 5$
 20. $3, 20x + 5$ 21. $x^4 + 1, 0$
 22. $\frac{1}{2}x^3 - x^2 - \frac{5}{2}x - \frac{7}{4}, \frac{19}{2}x + 1$ 23. $x - 2, -2$
 24. $x - 4, 0$ 25. $3x + 23, 138$ 26. $4x - 20, 97$
 27. $x^2 + 2, -3$ 28. $3x^2 + 3x + 6, 31$
 29. $x^2 - 3x + 1, -1$ 30. $x^3 + x^2 + 3x + 5, 12$
 31. $x^4 + x^3 + 4x^2 + 4x + 4, -2$ 32. $x^2 - 6x + 9, 0$
 33. $2x^2 + 4x, 1$ 34. $6x^3 + 6x^2 + x + \frac{1}{3}, \frac{7}{9}$
 35. $x^2 + 3x + 9, 0$ 36. $x^3 - 2x^2 + 4x - 8, 0$ 37. -3
 38. 6 39. 12 40. 2 41. -7 42. 20 43. -483
 44. -273 45. 2159 46. 100 47. $\frac{7}{3}$ 48. $\frac{49}{64}$
 49. -8.279 50. (a) 1 (b) 1 55. $-1 \pm \sqrt{6}$
 56. $-1, 3$ 57. $x^3 - 3x^2 - x + 3$
 58. $x^4 - 4x^3 - 4x^2 + 16x$ 59. $x^4 - 8x^3 + 14x^2 + 8x - 15$
 60. $x^5 - 5x^3 + 4x$ 61. $-\frac{3}{2}x^3 + 3x^2 + \frac{15}{2}x - 9$
 62. $2x^4 - 5x^3 + 5x - 2$ 63. $(x + 1)(x - 1)(x - 2)$
 64. $(x + 1)(x - 2)^2$ 65. $(x + 2)^2(x - 1)^2$
 66. $(x + 2)(x + 1)(x - 1)^2$

Section 3.3 ■ page 279

1. $\pm 1, \pm 3$ 2. $\pm 1, \pm 2, \pm 4, \pm 8$ 3. $\pm 1, \pm 2, \pm 4, \pm 8, \pm \frac{1}{2}$
 4. $\pm 1, \pm 2, \pm 3, \pm 4, \pm 6, \pm 12, \pm \frac{1}{2}, \pm \frac{3}{2}, \pm \frac{1}{3}, \pm \frac{2}{3}, \pm \frac{4}{3}, \pm \frac{1}{6}$
 5. $\pm 1, \pm 7, \pm \frac{1}{2}, \pm \frac{7}{2}, \pm \frac{1}{4}, \pm \frac{7}{4}$
 6. $\pm 1, \pm 2, \pm 4, \pm 8, \pm \frac{1}{2}, \pm \frac{1}{3}, \pm \frac{2}{3}, \pm \frac{4}{3}, \pm \frac{8}{3}, \pm \frac{1}{4}, \pm \frac{1}{6}, \pm \frac{1}{12}$
 7. (a) $\pm 1, \pm \frac{1}{5}$ (b) $-1, 1, \frac{1}{5}$ 8. (a) $\pm 1, \pm 2, \pm \frac{1}{3}, \pm \frac{2}{3}$
 (b) $-1, \frac{2}{3}$ 9. (a) $\pm 1, \pm 3, \pm \frac{1}{2}, \pm \frac{3}{2}$ (b) $-\frac{1}{2}, 1, 3$
 10. (a) $\pm 1, \pm \frac{1}{2}, \pm \frac{1}{4}$ (b) $\frac{1}{4}, 1$ 11. $-2, 1$ 12. $1, 2, 4$
 13. $-1, 2$ 14. $-3, 2$ 15. 2 16. $-3, 2$ 17. $-1, 2, 3$
 18. $-2, 1, 5$ 19. -1 20. 3 21. $\pm 1, \pm 2$ 22. $-2, 1, 2$
 23. $1, -1, -2, -4$ 24. $-3, 2, 5$ 25. $\pm 2, \pm \frac{3}{2}$
 26. $-1, 2$ 27. -2 28. $-2, \frac{1}{2}$ 29. $-1, -\frac{1}{2}, \frac{1}{2}$
 30. $-1, 1, \frac{3}{2}$ 31. $-\frac{3}{2}, \frac{1}{2}, 1$ 32. $-1, -\frac{3}{4}, \frac{1}{2}$
 33. $-\frac{5}{2}, -1, \frac{3}{2}$ 34. $-2, -\frac{1}{3}, \frac{1}{2}$ 35. $-1, \frac{1}{2}, 2$
 36. $-1, -\frac{1}{3}, \frac{1}{2}, 2$ 37. $-3, -2, 1, 3$ 38. $-2, -1, 2, 3$
 39. $-1, -\frac{1}{3}, 2, 5$ 40. $-3, 2, \frac{1}{2}$ 41. $-2, -1 \pm \sqrt{2}$
 42. $3, 1 \pm \sqrt{5}$ 43. $-1, 4, \frac{3 \pm \sqrt{13}}{2}$

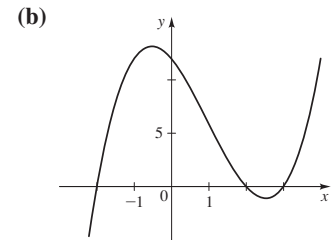
44. $-2, 1, \frac{-1 \pm \sqrt{5}}{2}$ 45. $3, \frac{1 \pm \sqrt{5}}{2}$

46. $-1, 2, 2 \pm \sqrt{2}$ 47. $\frac{1}{2}, \frac{1 \pm \sqrt{3}}{2}$

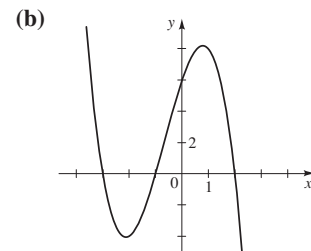
48. $-\frac{1}{3}, 1 \pm \sqrt{3}$ 49. $-1, -\frac{1}{2}, -3 \pm \sqrt{10}$

50. $\frac{1}{2}, 3, \frac{-2 \pm \sqrt{6}}{2}$

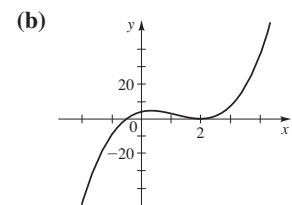
51. (a) $-2, 2, 3$



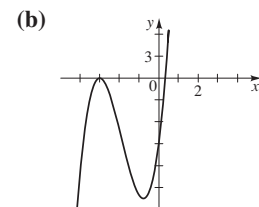
52. (a) $2, -1, -3$



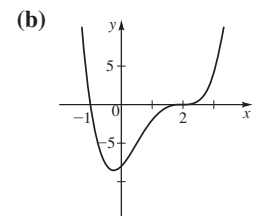
53. (a) $-\frac{1}{2}, 2$



54. (a) $-3, \frac{1}{3}$

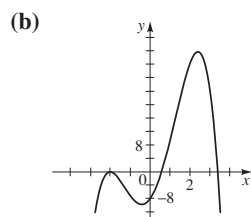


55. (a) $-1, 2$

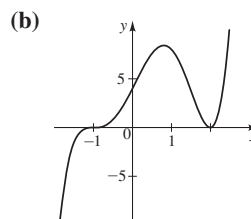


A40 Answers to Exercises and Chapter Tests

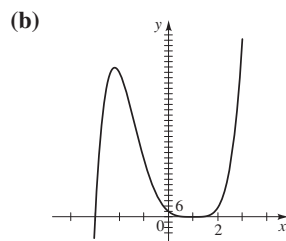
56. (a) $-2, 2 \pm \sqrt{2}$



57. (a) $-1, 2$



58. (a) $-3, 1$



59. 1 positive, 2 or 0 negative; 3 or 1 real
 60. 3 or 1 positive, no negative; 1 or 3 real
 61. 1 positive, 1 negative; 2 real
 62. No positive, 4, 2, or 0 negative; 0, 2, or 4 real
 63. 2 or 0 positive, 0 negative; 3 or 1 real (since 0 is a zero but is neither positive nor negative) 64. 6, 4, 2, or 0 positive, no negative; 6, 4, 2, or 0 real 69. 3, -2 70. 3, -2
 71. 3, -1 72. 1, -1 73. $-2, \frac{1}{2}, \pm 1$
 74. $-2, -\frac{1}{2}, \frac{-5 \pm \sqrt{17}}{2}$
 75. $\pm \frac{1}{2}, \pm \sqrt{5}$ 76. $-1, 0, \frac{1}{2}, \frac{5}{3}$ 77. $-2, 1, 3, 4$
 78. $-2, \frac{3}{4}, 1, \frac{2 \pm \sqrt{2}}{2}$ 83. $-2, 2, 3$ 84. $-2, -1, 1, 2$
 85. $-\frac{3}{2}, -1, 1, 4$ 86. -2 87. $-1.28, 1.53$ 88. 3
 89. -1.50 90. $-1.71, -1.20, -0.80$ 93. 11.3 ft
 94. 47 ft by 106 ft 95. (a) It began to snow again.
 (b) No (c) Just before midnight on Saturday night
 96. 5 cm by 10 cm by 30 cm or 3.49 cm by 13.03 cm by 33.03 cm
 97. 2.76 m 98. (b) 1.45 ft by 1.34 ft or 2.31 ft by 0.53 ft
 99. 88 in. (or 3.21 in.)

Section 3.4 ■ page 289

1. Real part 5, imaginary part -7 2. Real part -6 , imaginary part 4 3. Real part $-\frac{2}{3}$, imaginary part $-\frac{5}{3}$ 4. Real part 2, imaginary part $\frac{7}{2}$ 5. Real part 3, imaginary part 0 6. Real part $-\frac{1}{2}$, imaginary part 0 7. Real part 0, imaginary part $-\frac{2}{3}$

8. Real part 0, imaginary part $\sqrt{3}$ 9. Real part $\sqrt{3}$, imaginary part 2 10. Real part 2, imaginary part $-\sqrt{5}$
 11. $5 - i$ 12. $6 - i$ 13. $3 + 5i$ 14. $-2 - \frac{7}{3}i$
 15. $6 - i$ 16. 1 17. $2 - 2i$ 18. $-6 + 6i$
 19. $-19 + 4i$ 20. $-4 + 7i$ 21. $-\frac{1}{4} + \frac{1}{2}i$
 22. $-1.1 + 2.5i$ 23. $-4 + 8i$ 24. $2 + i$ 25. $30 + 10i$
 26. $8 + 2i$ 27. $-33 - 56i$ 28. $-\frac{2591}{9} + 18i$ 29. $27 - 8i$
 30. $1 + 17i$ 31. $-i$ 32. $\frac{1}{2} - \frac{1}{2}i$ 33. $\frac{8}{5} + \frac{1}{5}i$
 34. $\frac{11}{25} - \frac{23}{25}i$ 35. $-5 + 12i$ 36. $4 + 3i$ 37. $-4 + 2i$
 38. $\frac{2}{13} + \frac{3}{13}i$ 39. $2 - \frac{4}{3}i$ 40. $\frac{1}{3} + \frac{1}{5}i$ 41. $-i$ 42. $3 + i$
 43. $-i$ 44. 16 45. 1 46. -1 47. $5i$ 48. $\frac{3}{2}i$
 49. -6 50. $3i$ 51. $(3 + \sqrt{5}) + (3 - \sqrt{5})i$ 52. $-i$
 53. 2 54. $-\sqrt{2} - 4\sqrt{6}i$ 55. $-i\sqrt{2}$ 56. $-\frac{7}{2}$ 57. $\pm 3i$
 58. $\pm \frac{2}{3}i$ 59. $2 \pm i$ 60. $-1 \pm i$ 61. $-\frac{1}{2} \pm \frac{\sqrt{3}}{2}i$
 62. $\frac{3}{2} \pm \frac{\sqrt{3}}{2}i$ 63. $\frac{1}{2} \pm \frac{1}{2}i$ 64. $\frac{1}{2} \pm \frac{\sqrt{5}}{2}i$ 65. $-\frac{3}{2} \pm \frac{\sqrt{3}}{2}i$
 66. $-2 \pm 2\sqrt{2}i$ 67. $\frac{-6 \pm \sqrt{6}i}{6}$ 68. $2 \pm \frac{\sqrt{3}}{2}i$
 69. $1 \pm 3i$ 70. $-\frac{1}{4} \pm \frac{\sqrt{15}}{4}i$

Section 3.5 ■ page 298

1. (a) 0, $\pm 2i$ (b) $x^2(x - 2i)(x + 2i)$ 2. (a) 0, $\pm 3i$
 (b) $x^3(x - 3i)(x + 3i)$ 3. (a) 0, $1 \pm i$
 (b) $x(x - 1 - i)(x - 1 + i)$ 4. (a) 0, $-\frac{1}{2} \pm \frac{1}{2}i\sqrt{3}$
 (b) $x(x + \frac{1}{2} - \frac{1}{2}i\sqrt{3})(x + \frac{1}{2} + \frac{1}{2}i\sqrt{3})$ 5. (a) $\pm i$
 (b) $(x - i)^2(x + i)^2$ 6. (a) $\pm \sqrt{2}, \pm i$
 (b) $(x - \sqrt{2})(x + \sqrt{2})(x - i)(x + i)$
 7. (a) $\pm 2, \pm 2i$ (b) $(x - 2)(x + 2)(x - 2i)(x + 2i)$
 8. (a) $\pm i\sqrt{3}$ (b) $(x - i\sqrt{3})^2(x + i\sqrt{3})^2$
 9. (a) $-2, 1 \pm i\sqrt{3}$
 (b) $(x + 2)(x - 1 - i\sqrt{3})(x - 1 + i\sqrt{3})$
 10. (a) 2, $-1 \pm i\sqrt{3}$
 (b) $(x - 2)(x + 1 - i\sqrt{3})(x + 1 + i\sqrt{3})$
 11. (a) $\pm 1, \frac{1}{2} \pm \frac{1}{2}i\sqrt{3}, -\frac{1}{2} \pm \frac{1}{2}i\sqrt{3}$
 (b) $(x - 1)(x + 1)(x - \frac{1}{2} - \frac{1}{2}i\sqrt{3})(x - \frac{1}{2} + \frac{1}{2}i\sqrt{3}) \times$
 $(x + \frac{1}{2} - \frac{1}{2}i\sqrt{3})(x + \frac{1}{2} + \frac{1}{2}i\sqrt{3})$
 12. (a) $-1, 2, -1 \pm i\sqrt{3}, \frac{1}{2} \pm \frac{1}{2}i\sqrt{3}$
 (b) $(x + 1)(x - 2)(x + 1 - i\sqrt{3})(x + 1 + i\sqrt{3}) \times$
 $(x - \frac{1}{2} - \frac{1}{2}i\sqrt{3})(x - \frac{1}{2} + \frac{1}{2}i\sqrt{3})$

In answers 13–30, the factored form is given first, then the zeros are listed with the multiplicity of each in parentheses.

13. $(x - 5i)(x + 5i); \pm 5i(1)$

14. $(2x - 3i)(2x + 3i); \pm \frac{3}{2}i(1)$
 15. $[x - (-1 + i)][x - (-1 - i)]; -1 + i(1), -1 - i(1)$
 16. $(x - 4 - i)(x - 4 + i); 4 + i(1), 4 - i(1)$
 17. $x(x - 2i)(x + 2i); 0(1), 2i(1), -2i(1)$
 18. $x(x - \frac{1}{2} - \frac{1}{2}i\sqrt{3})(x - \frac{1}{2} + \frac{1}{2}i\sqrt{3}); 0(1), \frac{1}{2} \pm \frac{1}{2}i\sqrt{3}(1)$
 19. $(x - 1)(x + 1)(x - i)(x + i); 1(1), -1(1), i(1), -i(1)$
 20. $(x - 5)(x + 5)(x - 5i)(x + 5i); \pm 5(1), \pm 5i(1)$
 21. $16(x - \frac{3}{2})(x + \frac{3}{2})(x - \frac{3}{2}i)(x + \frac{3}{2}i);$
 $\frac{3}{2}(1), -\frac{3}{2}(1), \frac{3}{2}i(1), -\frac{3}{2}i(1)$
 22. $(x - 4)(x + 2 - 2i\sqrt{3})(x + 2 + 2i\sqrt{3});$
 $4(1), -2 \pm 2i\sqrt{3}(1)$
 23. $(x + 1)(x - 3i)(x + 3i); -1(1), 3i(1), -3i(1)$
 24. $(x - 3)(x + 3)(x - \frac{3}{2} - \frac{3}{2}i\sqrt{3})(x - \frac{3}{2} + \frac{3}{2}i\sqrt{3}) \times$
 $(x + \frac{3}{2} - \frac{3}{2}i\sqrt{3})(x + \frac{3}{2} + \frac{3}{2}i\sqrt{3}); \pm 3(1),$
 $\frac{3}{2} \pm \frac{3}{2}i\sqrt{3}(1), -\frac{3}{2} \pm \frac{3}{2}i\sqrt{3}(1)$
 25. $(x - i)^2(x + i)^2; i(2), -i(2)$
 26. $(x - i\sqrt{5})^2(x + i\sqrt{5})^2; \pm i\sqrt{5}(2)$
 27. $(x - 1)(x + 1)(x - 2i)(x + 2i); 1(1), -1(1),$
 $2i(1), -2i(1)$
 28. $x^3(x - i\sqrt{7})(x + i\sqrt{7}); 0(3), \pm i\sqrt{7}(1)$
 29. $x(x - i\sqrt{3})^2(x + i\sqrt{3})^2; 0(1), i\sqrt{3}(2), -i\sqrt{3}(2)$
 30. $(x + 2)^2(x - 1 - i\sqrt{3})^2(x - 1 + i\sqrt{3})^2;$
 $-2(2), 1 \pm i\sqrt{3}(2)$
 31. $P(x) = x^2 - 2x + 2$
 32. $x^2 - 2x + 3$ 33. $Q(x) = x^3 - 3x^2 + 4x - 12$
 34. $x^3 + x$ 35. $P(x) = x^3 - 2x^2 + x - 2$
 36. $x^3 + x^2 - 4x + 6$
 37. $R(x) = x^4 - 4x^3 + 10x^2 - 12x + 5$
 38. $x^4 + 13x^2 + 36$
 39. $T(x) = 6x^4 - 12x^3 + 18x^2 - 12x + 12$
 40. $4x^5 + 6x^4 + 4x^3 + 4x^2 - 2$ 41. $-2, \pm 2i$
 42. $3, 2 \pm i$ 43. $1, \frac{1 \pm i\sqrt{3}}{2}$ 44. $-3, -2 \pm i\sqrt{2}$
 45. $2, \frac{1 \pm i\sqrt{3}}{2}$ 46. $2, -1 \pm i\sqrt{2}$ 47. $-\frac{3}{2}, -1 \pm i\sqrt{2}$
 48. $3, \frac{1}{2} \pm \frac{1}{2}i\sqrt{5}$ 49. $-2, 1, \pm 3i$ 50. $3, -1, \pm i$
 51. $1, \pm 2i, \pm i\sqrt{3}$ 52. $-2, \pm i, 1 \pm i\sqrt{3}$
 53. 3 (multiplicity 2), $\pm 2i$ 54. $-1, 1 \pm i$
 55. $-\frac{1}{2}$ (multiplicity 2), $\pm i$ 56. $-\frac{1}{2}, 1, -\frac{1}{2} \pm \frac{1}{2}i$
 57. 1 (multiplicity 3), $\pm 3i$ 58. $2, \pm i$
 59. (a) $(x - 5)(x^2 + 4)$ (b) $(x - 5)(x - 2i)(x + 2i)$
 60. (a) $(x - 2)(x^2 + 2x + 2)$
 (b) $(x - 2)(x + 1 - i)(x + 1 + i)$
 61. (a) $(x - 1)(x + 1)(x^2 + 9)$
 (b) $(x - 1)(x + 1)(x - 3i)(x + 3i)$

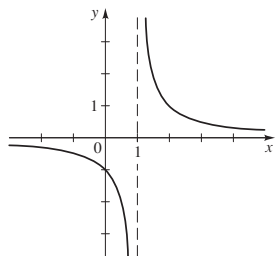
62. (a) $(x^2 + 4)^2$ (b) $(x - 2i)^2(x + 2i)^2$
 63. (a) $(x - 2)(x + 2)(x^2 - 2x + 4)(x^2 + 2x + 4)$
 (b) $(x - 2)(x + 2)[x - (1 + i\sqrt{3})][x - (1 - i\sqrt{3})] \times$
 $[x + (1 + i\sqrt{3})][x + (1 - i\sqrt{3})]$
 64. (a) $x(x - 2)(x + 2)(x^2 + 4)$
 (b) $x(x - 2)(x + 2)(x - 2i)(x + 2i)$
 65. (a) 4 real (b) 2 real, 2 imaginary (c) 4 imaginary
 66. (a) $\frac{1}{2} - 2i$ (b) $0, i$ (c) $-i$ (d) $-1 \pm i\sqrt{2}$
 68. (a) $x^4 - 2x^3 + 3x^2 - 2x + 2$
 (b) $x^2 - (1 + 2i)x - 1 + i$

Section 3.6 ■ page 312

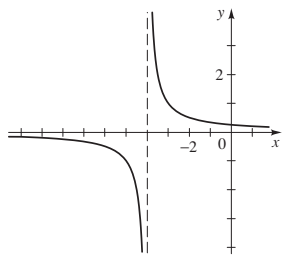
1. (a) $-3, -19, -199, -1999;$
 $5, 21, 201, 2001;$
 $1.2500, 1.0417, 1.0204, 1.0020;$
 $0.8333, 0.9615, 0.9804, 0.9980$
 (b) $r(x) \rightarrow -\infty$ as $x \rightarrow 2^-; r(x) \rightarrow \infty$ as $x \rightarrow 2^+$
 (c) Horizontal asymptote $y = 1$
 2. (a) $-14, -86, -896, -8996;$
 $22, 94, 904, 9004;$
 $5.1250, 4.1875, 4.0918, 4.0090;$
 $3.2500, 3.8269, 3.9118, 3.9910$
 (b) $r(x) \rightarrow -\infty$ as $x \rightarrow 2^-; r(x) \rightarrow \infty$ as $x \rightarrow 2^+$
 (c) Horizontal asymptote $y = 4$
 3. (a) $-22, -430, -40,300, -4,003,000;$
 $-10, -370, -39,700, -3,997,000;$
 $0.3125, 0.0608, 0.0302, 0.0030;$
 $-0.2778, -0.0592, -0.0298, -0.0030$
 (b) $r(x) \rightarrow -\infty$ as $x \rightarrow 2^-; r(x) \rightarrow -\infty$ as $x \rightarrow 2^+$
 (c) Horizontal asymptote $y = 0$
 4. (a) $31, 1183, 128,803, 12,988,003;$
 $79, 1423, 131,203, 13,012,003;$
 $4.7031, 3.2556, 3.1238, 3.0120;$
 $2.0903, 2.7740, 2.8836, 2.9880$
 (b) $r(x) \rightarrow \infty$ as $x \rightarrow 2^-; r(x) \rightarrow \infty$ as $x \rightarrow 2^+$
 (c) Horizontal asymptote $y = 3$
 5. x -intercept 1, y -intercept $-\frac{1}{4}$ 6. x -intercept 0, y -intercept 0
 7. x -intercepts $-1, 2$; y -intercept $\frac{1}{3}$ 8. no x -intercept,
 y -intercept $-\frac{1}{2}$ 9. x -intercepts $-3, 3$; no y -intercept
 10. x -intercept -2 , y -intercept 2 11. x -intercept 3,
 y -intercept 3, vertical $x = 2$; horizontal $y = 2$
 12. x -intercept 0, y -intercept 0, vertical $x = -1, x = 2$;
 horizontal $y = 0$ 13. x -intercepts $-1, 1$; y -intercept $\frac{1}{4}$;
 vertical $x = -2, x = 2$; horizontal $y = 1$
 14. x -intercepts $-2, 2$; y -intercept -6 ; horizontal $y = 2$
 15. Vertical $x = -2$; horizontal $y = 0$
 16. Vertical $x = 1$; horizontal $y = 2$
 17. Vertical $x = 3, x = -2$; horizontal $y = 1$
 18. Vertical $x = -1$; horizontal $y = 0$
 19. Horizontal $y = 0$
 20. Vertical $x = 3, x = 4$; horizontal $y = 1$
 21. Vertical $x = -6, x = 1$; horizontal $y = 0$
 22. Horizontal $y = 3$ 23. Vertical $x = 1$
 24. Vertical $x = 2, x = -2$

A42 Answers to Exercises and Chapter Tests

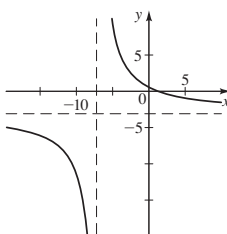
25.



26.

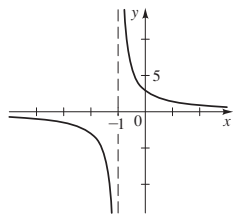


35.

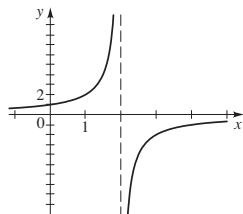


x -intercept $\frac{4}{3}$
 y -intercept $\frac{4}{7}$
 vertical $x = -7$
 horizontal $y = -3$

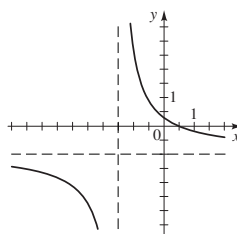
27.



28.

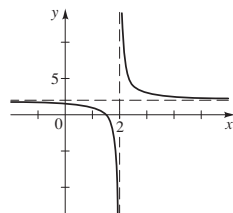


36.

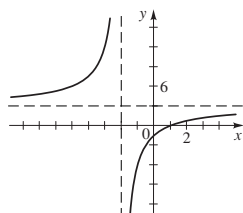


x -intercept $\frac{1}{2}$
 y -intercept $\frac{1}{3}$
 vertical $x = -\frac{3}{2}$
 horizontal $y = -1$

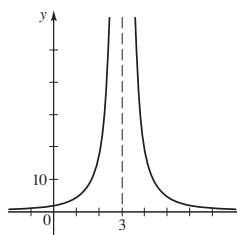
29.



30.

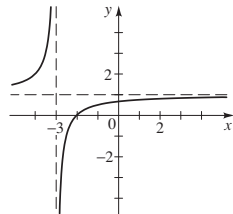


37.

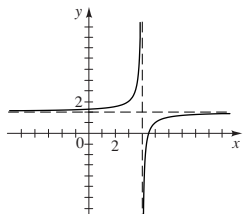


y -intercept 2
 vertical $x = 3$
 horizontal $y = 0$

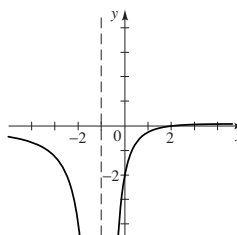
31.



32.

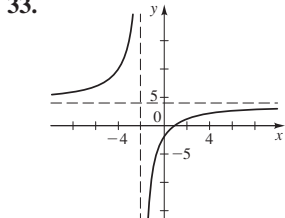


38.



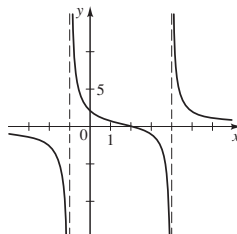
x -intercept 2
 y -intercept -2
 vertical $x = -1$
 horizontal $y = 0$

33.



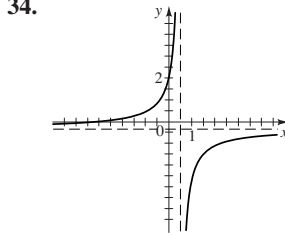
x -intercept 1
 y -intercept -2
 vertical $x = -2$
 horizontal $y = 4$

39.



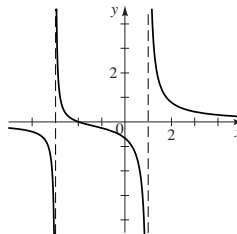
x -intercept 2
 y -intercept 2
 vertical $x = -1, x = 4$
 horizontal $y = 0$

34.



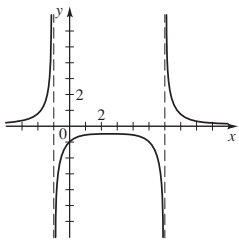
x -intercept -3
 y -intercept 2
 vertical $x = \frac{1}{2}$
 horizontal $y = -\frac{1}{3}$

40.



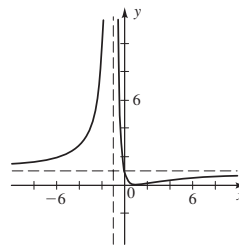
x -intercept -2
 y -intercept $-\frac{2}{3}$
 vertical $x = -3, x = 1$
 horizontal $y = 0$

41.



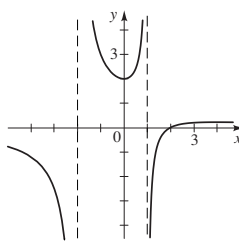
y-intercept -1
 vertical $x = -1, x = 6$
 horizontal $y = 0$

47.



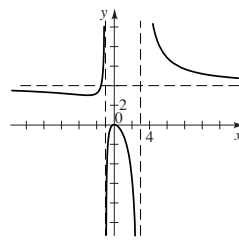
x-intercept 1
 y-intercept 1
 vertical $x = -1, x = 3$
 horizontal $y = 1$

42.



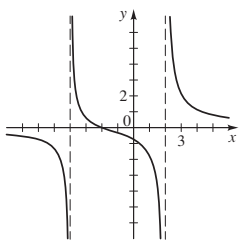
x-intercept 2
 y-intercept 2
 vertical $x = -2, x = 1$
 horizontal $y = 0$

48.



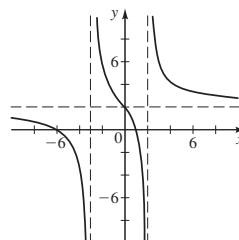
x-intercept 0
 y-intercept 0
 vertical $x = -1, x = 4$
 horizontal $y = 2$

43.



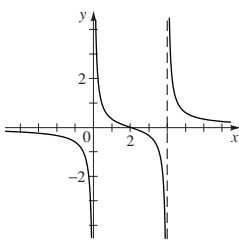
x-intercept -2
 y-intercept $-\frac{3}{4}$
 vertical $x = -4, x = 2$
 horizontal $y = 0$

49.



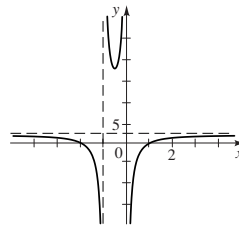
x-intercepts $-6, 1$
 y-intercept 2
 vertical $x = -3, x = 2$
 horizontal $y = 2$

44.



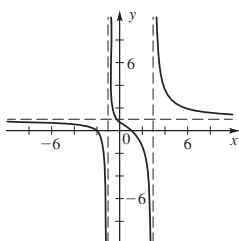
x-intercept 2
 vertical $x = 0, x = 4$
 horizontal $y = 0$

50.



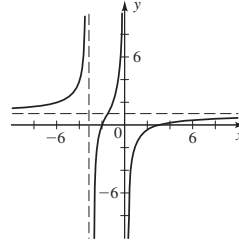
x-intercepts $1, -2$
 vertical $x = -1, x = 0$
 horizontal $y = 2$

45.



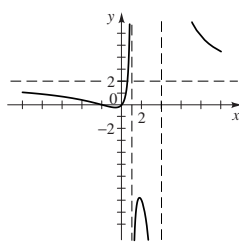
x-intercepts $-2, 1$
 y-intercept $\frac{2}{3}$
 vertical $x = -1, x = 3$
 horizontal $y = 1$

51.



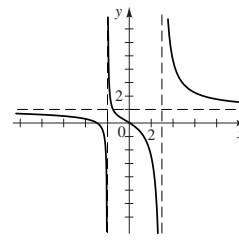
x-intercepts $-2, 3$
 vertical $x = -3, x = 0$
 horizontal $y = 1$

46.



x-intercepts $0, -2$
 y-intercept 0
 vertical $x = 1, x = 4$
 horizontal $y = 2$

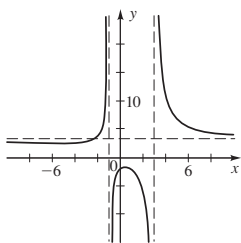
52.



x-intercepts $0, -3$
 y-intercept 0
 vertical $x = -2, x = 3$
 horizontal $y = 1$

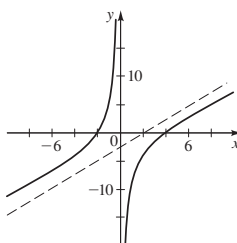
A44 Answers to Exercises and Chapter Tests

53.



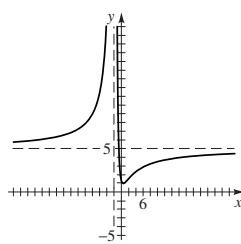
y-intercept -2
 vertical $x = -1, x = 3$
 horizontal $y = 3$

59.



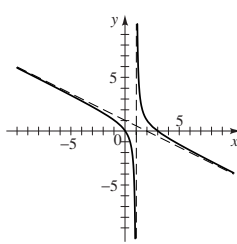
slant $y = x - 2$
 vertical $x = 0$

54.



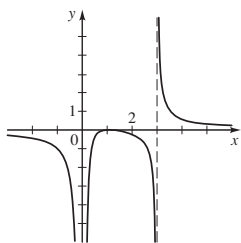
y-intercept $\frac{5}{4}$
 vertical $x = -2$
 horizontal $y = 5$

60.



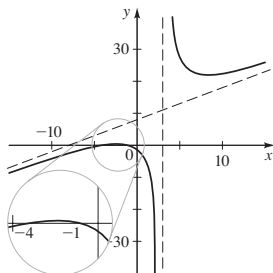
slant $y = -\frac{1}{2}x + 1$
 vertical $x = 1$

55.



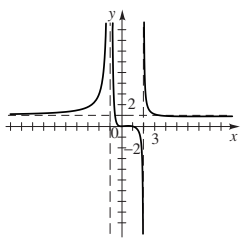
x-intercept 1
 vertical $x = 0, x = 3$
 horizontal $y = 0$

61.



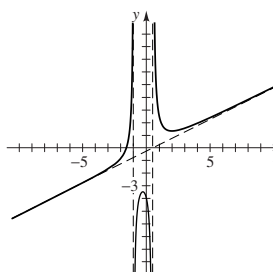
slant $y = x + 8$
 vertical $x = 3$

56.



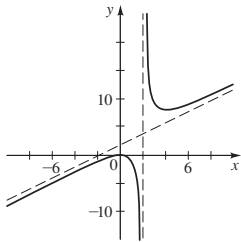
x-intercepts $0, 1$
 y-intercept 0
 vertical $x = -1, x = 2$
 horizontal $y = 1$

62.



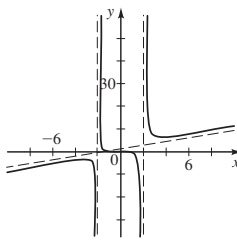
slant $y = \frac{1}{2}x - \frac{1}{4}$
 vertical $x = -1, x = \frac{1}{2}$

57.



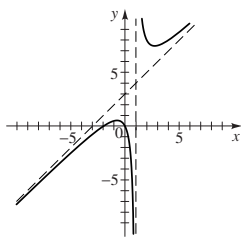
slant $y = x + 2$
 vertical $x = 2$

63.

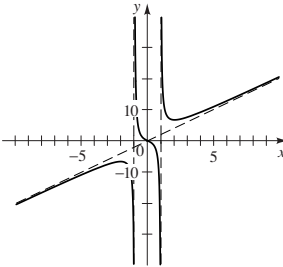
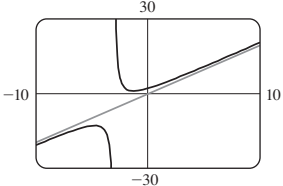
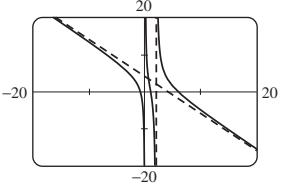
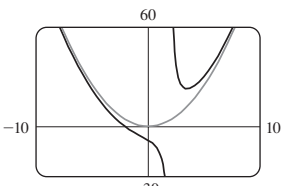
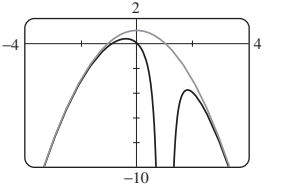
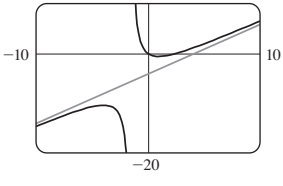
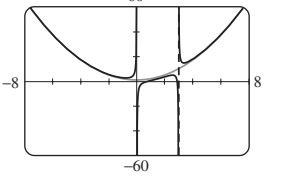


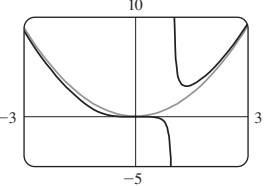
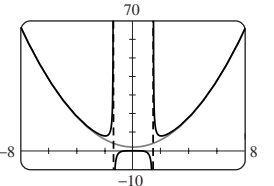
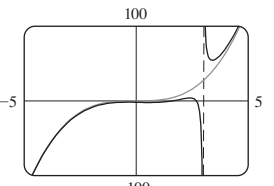
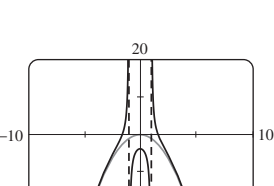
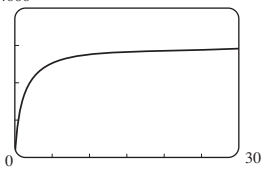
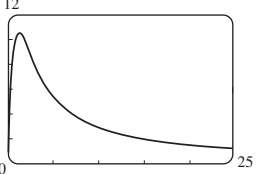
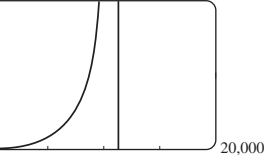
slant $y = x + 1$
 vertical $x = 2, x = -2$

58.

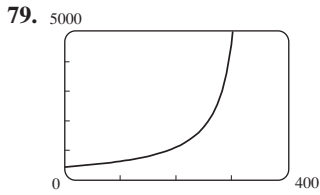


slant $y = x + 3$
 vertical $x = 1$

- 64.**  slant $y = 2x$
vertical $x = -1, x = 1$
- 65.**  vertical $x = -3$
- 66.**  vertical $x = 0, x = 2$
- 67.**  vertical $x = 2$
- 68.**  vertical $x = 1$
- 69.**  vertical $x = -1.5$
 x -intercepts 0, 2.5
 y -intercept 0, local maximum $(-3.9, -10.4)$
local minimum $(0.9, -0.6)$
end behavior: $y = x - 4$
- 70.**  vertical $x = 0, x = 3$
 x -intercept 0.82, local maximum $(2.56, 4.88)$
local minima $(-0.80, 2.63)$
 $(3.38, 14.76)$
end behavior: $y = x^2 + 1$

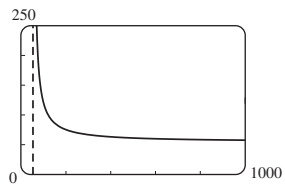
- 71.**  vertical $x = 1$
 x -intercept 0
 y -intercept 0
local minimum $(1.4, 3.1)$
end behavior: $y = x^2$
- 72.**  vertical $x = -1.41, x = 1.41$
 x -intercept 0
 y -intercept 0
local maximum $(0, 0)$
local minima $(-2, 8), (2, 8)$
end behavior: $y = x^2 + 2$
- 73.**  vertical $x = 3$
 x -intercepts 1.6, 2.7
 y -intercept -2
local maxima $(-0.4, -1.8), (2.4, 3.8),$
local minima $(0.6, -2.3), (3.4, 54.3)$
end behavior: $y = x^3$
- 74.**  vertical $x = -1, x = 1$
 x -intercepts -1.6, 1.6
 y -intercept -4
local maximum $(0, -4)$
end behavior: $y = -x^2$
- 75. (a)**  **(b)** It levels off at 3000.
- 76. (a)**  **(b)** It decreases to 0.
- 77. (a)** 2.50 mg/L **(b)** It decreases to 0. **(c)** 16.61 h
- 78.**  The vertical asymptote represents the escape velocity from the earth's gravitational pull.

A46 Answers to Exercises and Chapter Tests



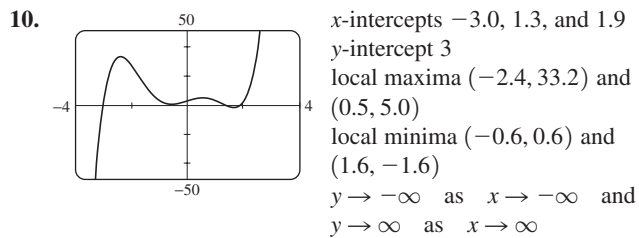
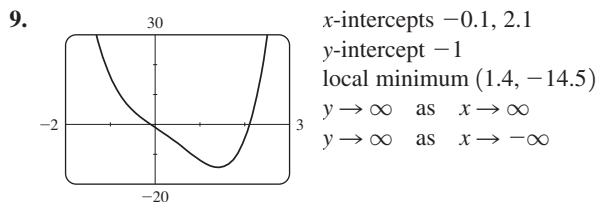
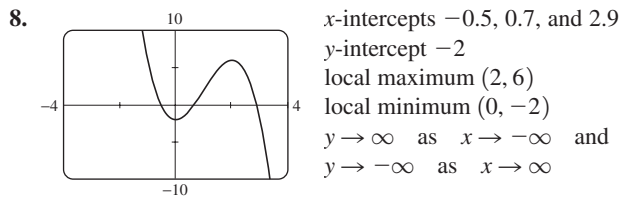
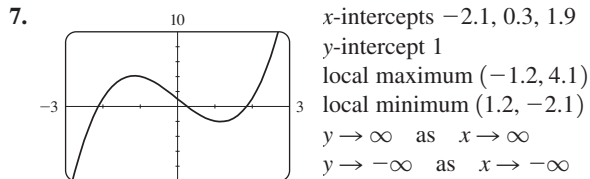
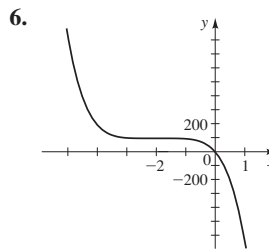
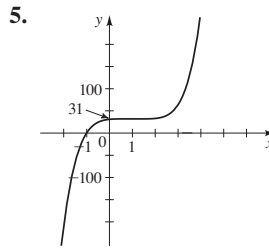
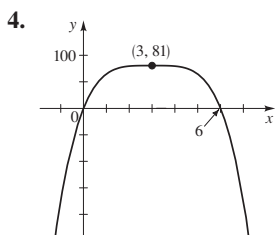
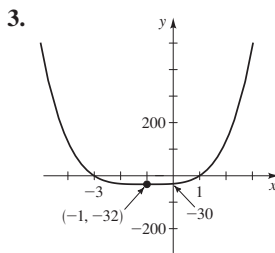
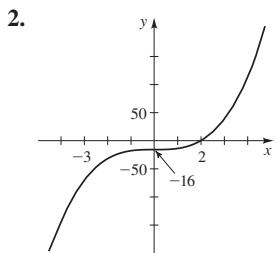
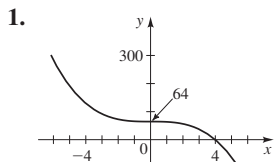
If the speed of the train approaches the speed of sound, then the pitch increases indefinitely (a sonic boom).

80. (a) $y = \frac{55x}{x - 55}$

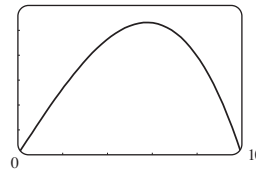


(b) y approaches 55 mm (c) y approaches ∞

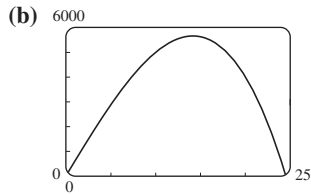
Chapter 3 Review ■ page 316



11. (a) $S = 13.8x(100 - x^2)$ (b) $0 \leq x \leq 10$
 (c) 6000 (d) 5.8 in.



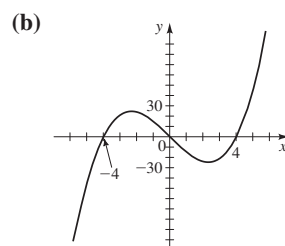
12. (a) $V(x) = 600x - x^3$
 (c) 14.14 in. by 28.28 in.



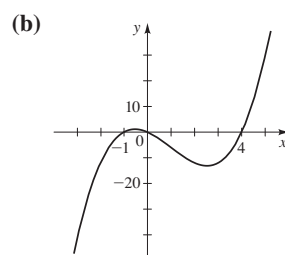
In answers 13–20, the first polynomial given is the quotient and the second is the remainder.

13. $x - 1, 3$ 14. $x + 4, 0$ 15. $x^2 + 3x + 23, 94$
 16. $x^2 - x + 3, -19$ 17. $x^3 - 5x^2 + 17x - 83, 422$
 18. $2x^3 - 5x^2 + 20x - 80, 308$ 19. $2x - 3, 12$
 20. $x^2 + x - 4, 12$ 21. 3 22. 21 25. 8 26. 0
 27. (a) $\pm 1, \pm 2, \pm 3, \pm 6, \pm 9, \pm 18$
 (b) 2 or 0 positive, 3 or 1 negative
 28. (a) $\pm 1, \pm 2, \pm 4, \pm \frac{1}{2}, \pm \frac{1}{3}, \pm \frac{2}{3}, \pm \frac{4}{3}, \pm \frac{1}{6}$
 (b) 0 positive, 0, 2, or 4 negative

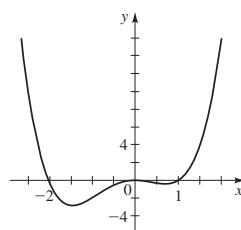
29. (a) $-4, 0, 4$



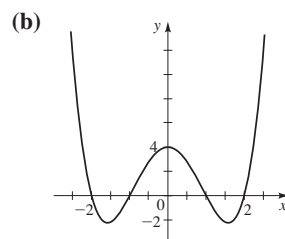
30. (a) $-1, 0, 4$



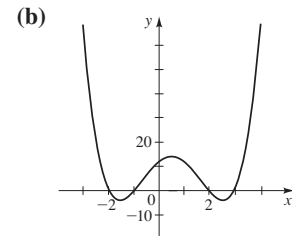
31. (a) $-2, 0$ (multiplicity 2), 1 (b)



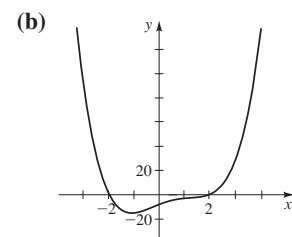
32. (a) $-2, -1, 1, 2$



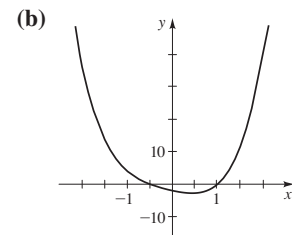
33. (a) $-2, -1, 2, 3$



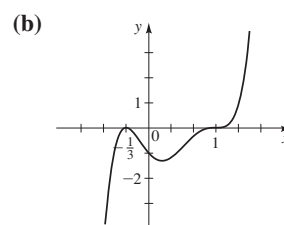
34. (a) $-2, 2$



35. (a) $-\frac{1}{2}, 1$



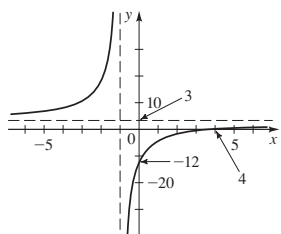
36. (a) $-\frac{1}{3}$ (multiplicity 2), 1 (multiplicity 3)



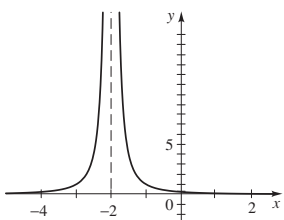
37. $3 + i$ 38. $-3 - 2i$ 39. $8 - i$ 40. $2 + 8i$
 41. $\frac{6}{5} + \frac{8}{5}i$ 42. $\frac{41}{25} - \frac{12}{25}i$ 43. i 44. $-2 + 2i$ 45. 2
 46. -20 47. $4x^3 - 18x^2 + 14x + 12$
 48. $x^4 - 8x^3 + 25x^2 - 72x + 144$ 49. No; since the complex conjugates of imaginary zeros will also be zeros, the polynomial would have 8 zeros, contradicting the requirement that it have degree 4. 51. $-3, 1, 5$ 52. $-3, -1, \frac{3}{2}$
 53. $-1 \pm 2i, -2$ (multiplicity 2) 54. $-4, -1, -1 \pm \sqrt{6}$
 55. $\pm 2, 1$ (multiplicity 3)
 56. $-3, 3, \pm 3i$ 57. $\pm 2, \pm 1 \pm i\sqrt{3}$
 58. $\frac{1}{2}, -\frac{1}{3}$ (multiplicity 2) 59. 1, 3, $\frac{-1 \pm i\sqrt{7}}{2}$
 60. $\pm 3i, \pm i\sqrt{6}$ 61. $x = -0.5, 3$
 62. $x = -3, -2, 4$ 63. $x \approx -0.24, 4.24$ 64. $x \approx 1.34$

A48 Answers to Exercises and Chapter Tests

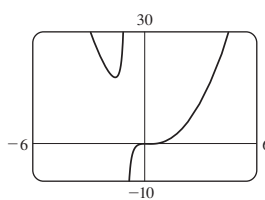
65.



66.



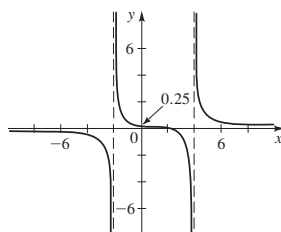
74.



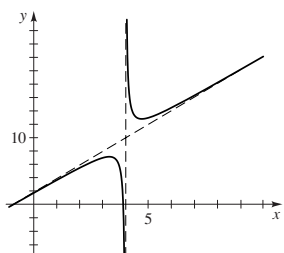
x -intercepts $0, \frac{1}{2}$
 y -intercept 0 ; vertical $x = -1$
 local maximum $(0, 0)$
 local minimums
 $(-1.57, 17.90)$,
 $(0.32, -0.03)$
 end behavior
 $y = 2x^2 - 3x + 3$

75. $(-2, -28), (1, 26), (2, 68), (5, 770)$

67.

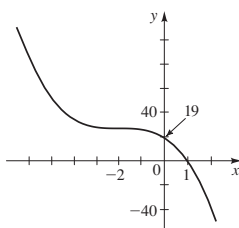


68.



Chapter 3 Test ■ page 319

1.

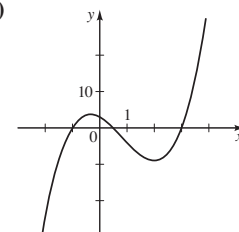


2. (a) $x^3 + 2x^2 + 2, 9$ (b) $x^3 + 2x^2 + \frac{1}{2}, \frac{15}{2}$

3. (a) $\pm 1, \pm 3, \pm \frac{1}{2}, \pm \frac{3}{2}$ (b) $2(x - 3)(x - \frac{1}{2})(x + 1)$

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

(d)



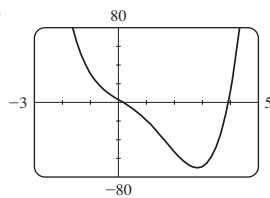
4. (a) $7 + i$ (b) $-1 - 5i$ (c) $18 + i$ (d) $\frac{6}{25} - \frac{17}{25}i$

(e) 1 (f) $6 - 2i$ **5.** $3, -1 \pm i$

6. $(x - 1)^2(x - 2i)(x + 2i)$ **7.** $x^4 + 2x^3 + 10x^2 + 18x + 9$

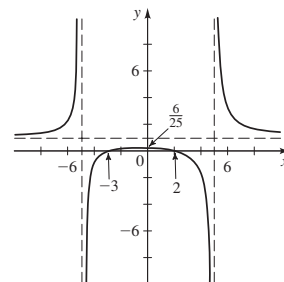
8. (a) 4, 2, or 0 positive; 0 negative

(c) 0.17, 3.93

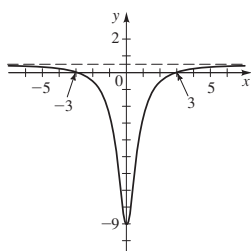


(d) Local minimum $(2.8, -70.3)$

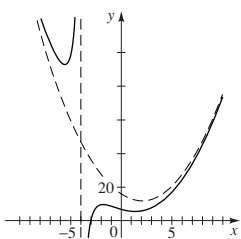
9. (a) r, u (b) s (c) s (d)



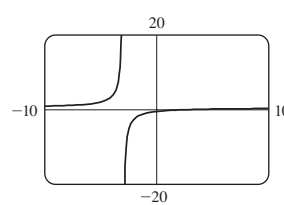
69.



70.



71.



x -intercept 3

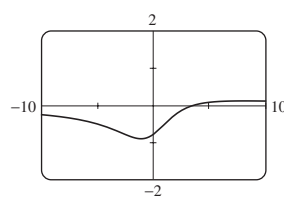
y -intercept -0.5

vertical $x = -3$

horizontal $y = 0.5$

no local extrema

72.



x -intercept 3.5

y -intercept -0.78

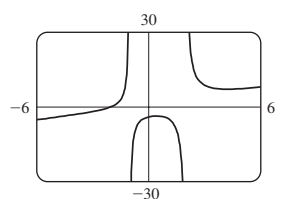
horizontal $y = 0$

local minimum

$(-1.11, -0.90)$

local maximum $(8.11, 0.12)$

73.



x -intercept -2

y -intercept -4

vertical $x = -1, x = 2$

slant $y = x + 1$

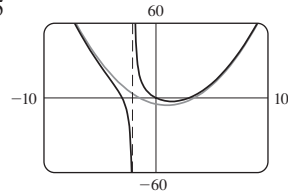
local maximum

$(0.425, -3.599)$

local minimum

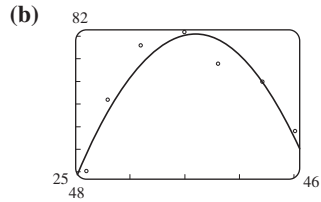
$(4.216, 7.175)$

(e) $x^2 - 2x - 5$



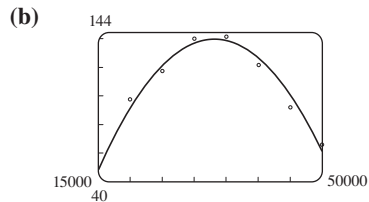
Focus on Modeling ■ page 323

1. (a) $y = -0.275428x^2 + 19.7485x - 273.5523$

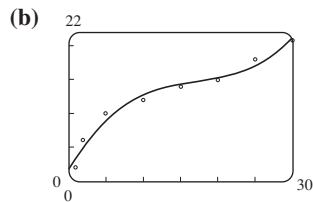


(c) 35.85 lb/in²

2. (a) $y = -0.0000002783333x^2 + 0.0184655x - 166.732$

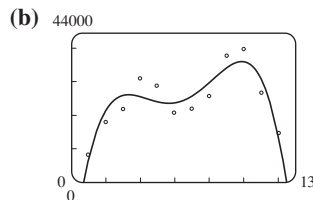


(c) ≈ 135 bushels/acre 3. (a) $y = 0.00203708x^3 - 0.104521x^2 + 1.966206x + 1.45576$



(c) 43 vegetables (d) 2.0 s

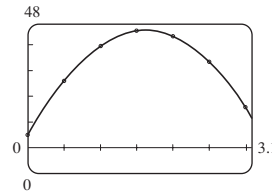
4. (a) $y = -55.908x^4 + 1414.88x^3 - 12199.1x^2 + 42577.2x - 25714.6$



(c) Yes, since there are two peaks in sales.

5. (a) Degree 2

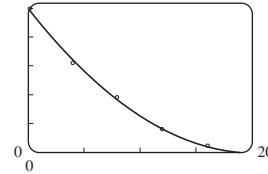
(b) $y = -16.0x^2 + 51.8429x + 4.20714$



(c) 0.3 s and 2.9 s (d) 46.2 ft

6. (a) $y = 0.0120536x^2 - 0.490357x + 4.96571$

(b) 5.1 (c) 19.0 min



Chapter 4

Section 4.1 ■ page 336

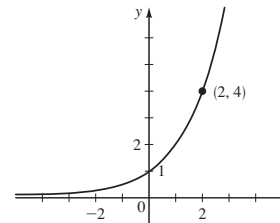
1. 2.000, 7.103, 77.880, 1.587

2. 0.577, 20.115, 59.439, 0.760

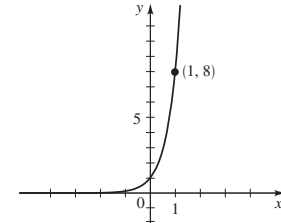
3. 0.885, 0.606, 0.117, 1.837

4. 0.668, 0.467, 0.833, 0.681

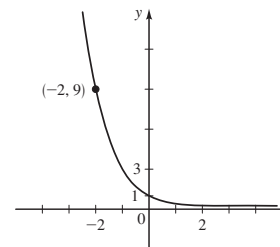
5.



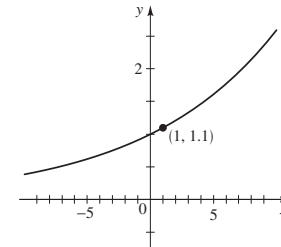
6.



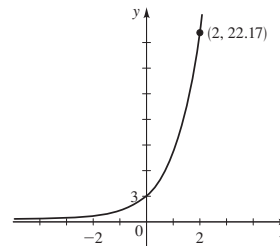
7.



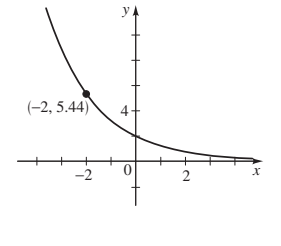
8.



9.

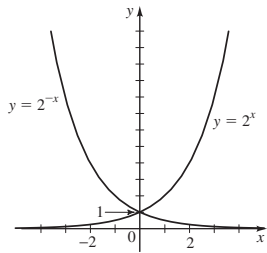


10.

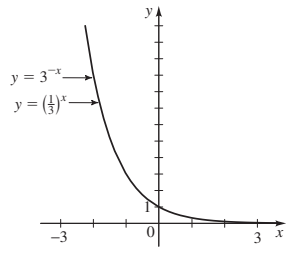


A50 Answers to Exercises and Chapter Tests

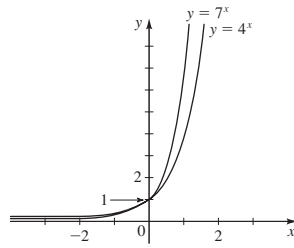
11.



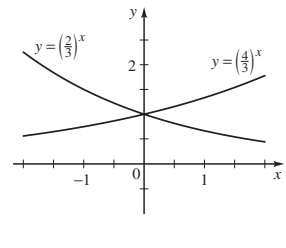
12.



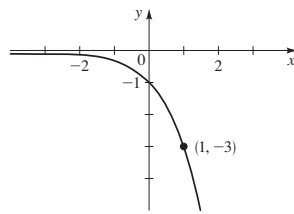
13.



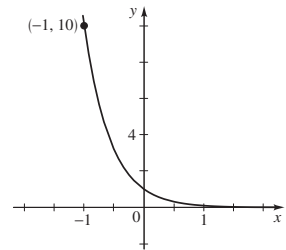
14.



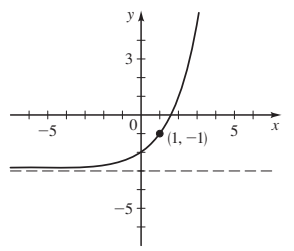
- 15.** $f(x) = 3^x$ **16.** $f(x) = 5^x$ **17.** $f(x) = (\frac{1}{4})^x$
18. $f(x) = (\frac{1}{2})^x$ **19.** III **20.** V **21.** I **22.** VI
23. II **24.** IV
25. $\mathbb{R}, (-\infty, 0), y = 0$



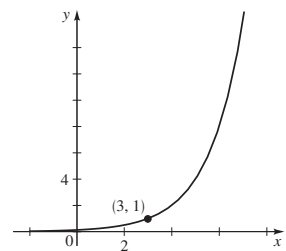
26. $\mathbb{R}, (0, \infty), y = 0$



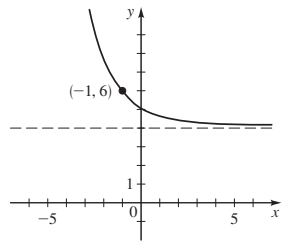
27. $\mathbb{R}, (-3, \infty), y = -3$



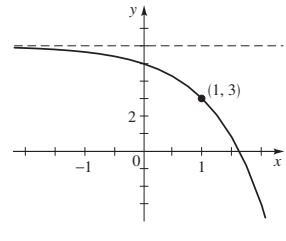
28. $\mathbb{R}, (0, \infty), y = 0$



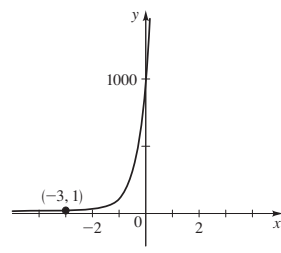
29. $\mathbb{R}, (4, \infty), y = 4$



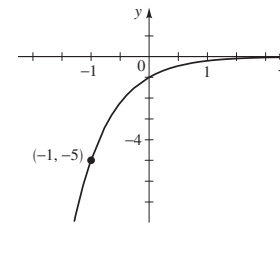
30. $\mathbb{R}, (-\infty, 6), y = 6$



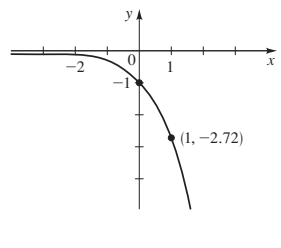
31. $\mathbb{R}, (0, \infty), y = 0$



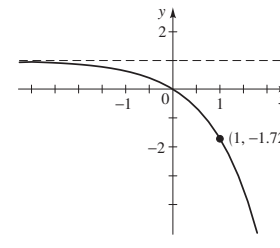
32. $\mathbb{R}, (-\infty, 0), y = 0$



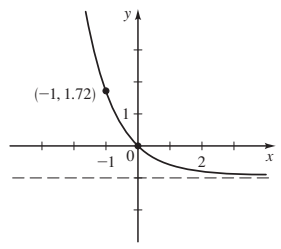
33. $\mathbb{R}, (-\infty, 0), y = 0$



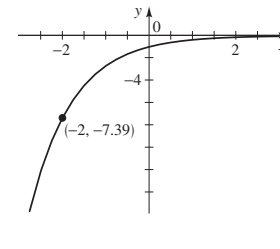
34. $\mathbb{R}, (-\infty, 1), y = 1$



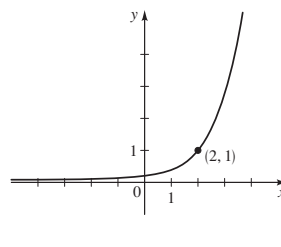
35. $\mathbb{R}, (-1, \infty), y = -1$



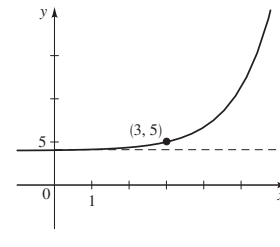
36. $\mathbb{R}, (-\infty, 0), y = 0$



37. $\mathbb{R}, (0, \infty), y = 0$

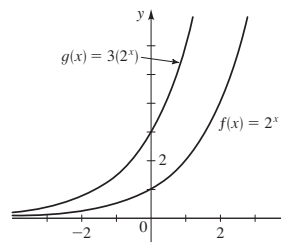


38. $\mathbb{R}, (4, \infty), y = 4$



39. $y = 3(2^x)$

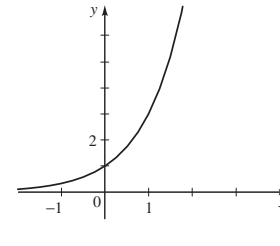
41. (a)



(b) The graph of g is steeper than that of f .

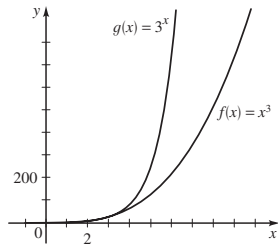
40. $f(x) = 5(\frac{1}{3})^x$

42. (a)

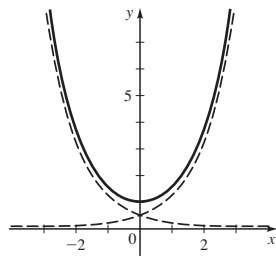


(b) The graphs of $f(x)$ and $g(x)$ are the same.

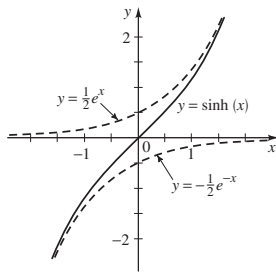
44.



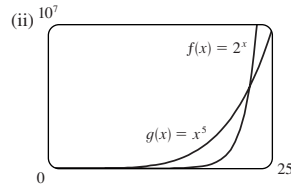
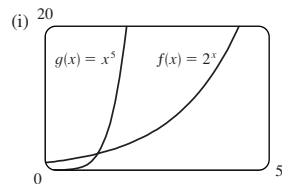
45.



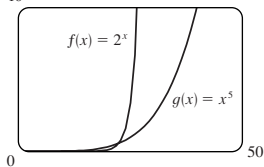
46.



51. (a)



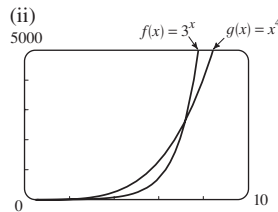
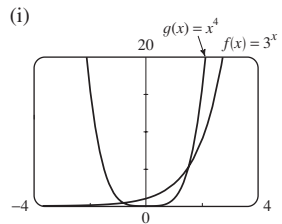
(iii) 10^8



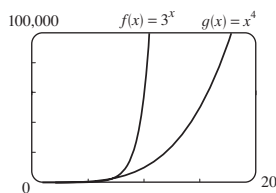
The graph of f ultimately increases much more quickly than g .

(b) 1.2, 22.4

52. (a)

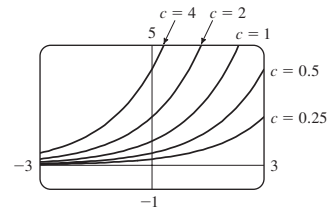


(iii) $100,000$



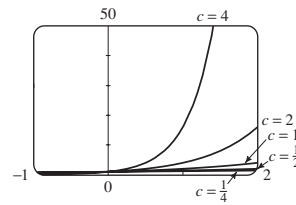
(b) -0.80, 1.52, 7.17

53.



The larger the value of c , the more rapidly the graph increases.

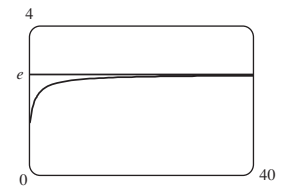
54.



The larger the value of c , the more rapidly the graph increases.

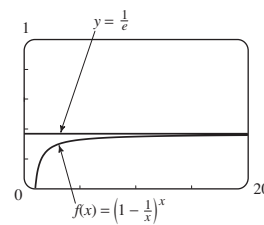
55.

55.



The larger the value of c , the more rapidly the graph increases.

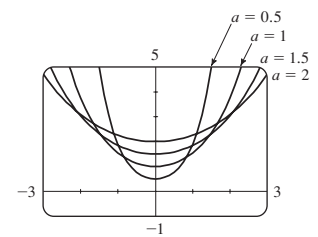
56.



The function $f(x)$ approaches $1/e$ as $x \rightarrow \infty$.

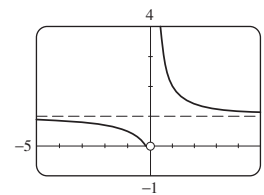
57. (a)

57. (a)



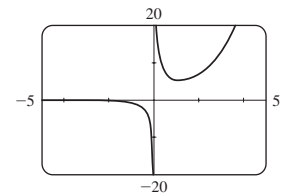
(b) The larger the value of a , the wider the graph.

58.



vertical asymptote $x = 0$
horizontal asymptote $y = 1$

59.



vertical asymptote $x = 0$
horizontal asymptote $y = 0$,
left side only

60. Local minimum (0.37, 0.69)

61. Local minimum \approx (0.27, 1.75)

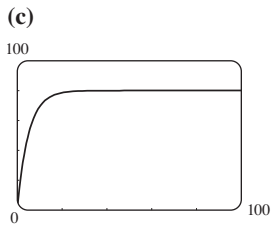
62. (a) Increasing on $(-\infty, 0.50]$; decreasing on $[0.50, \infty)$
(b) (0, 1.78]

63. (a) Increasing on $(-\infty, 1.00]$, decreasing on $[1.00, \infty)$

(b) $(-\infty, 0.37]$ 64. 27.4 mg 65. (a) 13 kg (b) 6.6 kg

66. (a) 6 g (b) 1 g

A52 Answers to Exercises and Chapter Tests

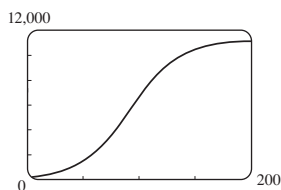
67. (a) 0 (b) 50.6 ft/s,
69.2 ft/s

(d) 80 ft/s

69. (a) 100 (b) 482, 999, 1168 (c) 1200

70. (a) 200

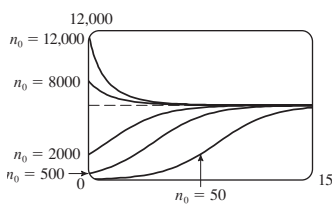
(b)



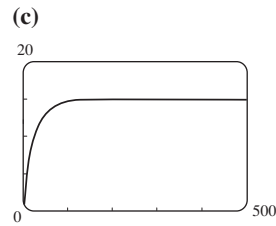
71. 1.6 ft

72. (a) 5164

(b)



68. (a) 2.7 lb (b) 4.9 lb



(d) 15 lb; yes

(c) 11,200

(c) 6000

73. \$5203.71, \$5415.71, \$5636.36, \$5865.99, \$6104.98,
\$6353.7174. \$5256.25, \$5525.39, \$5808.08, \$6104.98, \$6416.79,
\$6744.25

75. (a) \$16,288.95 (b) \$26,532.98 (c) \$43,219.42

76. (a) \$7,491.92 (b) \$10,253.22 (c) \$14,032.23

77. (a) \$4,615.87 (b) \$4,658.91 (c) \$4,697.04

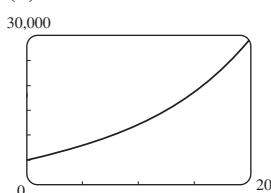
(d) \$4,703.11 (e) \$4,704.68 (f) \$4,704.93

(g) \$4,704.94 78. (a) \$5,387.42 (b) \$5,521.68

(c) \$5,659.11 (d) \$5,943.79 79. (i) 80. (i)

81. (a) \$7,678.96 (b) \$67,121.04 82. (a) $5000(1.092025)^t$

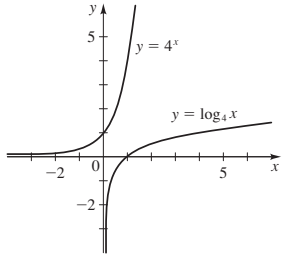
(b)



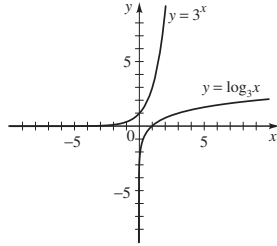
Section 4.2 ■ page 349

- | 1. Logarithmic form | Exponential form |
|----------------------------|-------------------------|
| $\log_8 8 = 1$ | $8^1 = 8$ |
| $\log_8 64 = 2$ | $8^2 = 64$ |
| $\log_8 4 = \frac{2}{3}$ | $8^{2/3} = 4$ |
| $\log_8 512 = 3$ | $8^3 = 512$ |
| $\log_8 \frac{1}{8} = -1$ | $8^{-1} = \frac{1}{8}$ |
| $\log_8 \frac{1}{64} = -2$ | $8^{-2} = \frac{1}{64}$ |
-
- | 2. Logarithmic form | Exponential form |
|--------------------------------------|---------------------------|
| $\log_4 64 = 3$ | $4^3 = 64$ |
| $\log_4 2 = \frac{1}{2}$ | $4^{1/2} = 2$ |
| $\log_4 8 = \frac{3}{2}$ | $4^{3/2} = 8$ |
| $\log_4 \frac{1}{16} = -2$ | $4^{-2} = \frac{1}{16}$ |
| $\log_4 \frac{1}{2} = -\frac{1}{2}$ | $4^{-1/2} = \frac{1}{2}$ |
| $\log_4 \frac{1}{32} = -\frac{5}{2}$ | $4^{-5/2} = \frac{1}{32}$ |
3. (a) $5^2 = 25$ (b) $5^0 = 1$ 4. (a) $10^{-1} = 0.1$
 (b) $8^3 = 512$ 5. (a) $8^{1/3} = 2$ (b) $2^{-3} = \frac{1}{8}$ 6. (a) $3^4 = 81$
 (b) $8^{2/3} = 4$ 7. (a) $e^x = 5$ (b) $e^5 = y$ 8. (a) $e^2 = x + 1$
 (b) $e^4 = x - 1$ 9. (a) $\log_5 125 = 3$
 (b) $\log_{10} 0.0001 = -4$
 10. (a) $\log_{10} 1000 = 3$ (b) $\log_{81} 9 = \frac{1}{2}$
 11. (a) $\log_8 \frac{1}{8} = -1$ (b) $\log_2 \frac{1}{8} = -3$
 12. (a) $\log_4 0.125 = -\frac{3}{2}$ (b) $\log_7 343 = 3$
 13. (a) $\ln 2 = x$ (b) $\ln y = 3$ 14. (a) $\ln 0.5 = x + 1$
 (b) $\ln t = 0.5x$ 15. (a) 1 (b) 0 (c) 2 16. (a) 4 (b) 3
 (c) 1 17. (a) 2 (b) 2 (c) 10 18. (a) 5 (b) 17 (c) 0
 19. (a) -3 (b) $\frac{1}{2}$ (c) -1 20. (a) 3 (b) $\frac{1}{2}$ (c) $\frac{1}{4}$
 21. (a) 37 (b) 8 (c) $\sqrt{5}$ 22. (a) π (b) 5 (c) 87
 23. (a) $-\frac{2}{3}$ (b) 4 (c) -1 24. (a) $\frac{1}{4}$ (b) $-\frac{1}{2}$ (c) $\frac{3}{2}$
 25. (a) 32 (b) 4 26. (a) 625 (b) -1 27. (a) 5
 (b) 27 28. (a) $\frac{1}{2}$ (b) 16 29. (a) 100 (b) 25
 30. (a) 10 (b) 5 31. (a) 2 (b) 4 32. (a) 36 (b) 27
 33. (a) 0.3010 (b) 1.5465 (c) -0.1761 34. (a) 1.6990
 (b) 0.1505 (c) 0.6276 35. (a) 1.6094 (b) 3.2308
 (c) 1.0051 36. (a) 3.2958 (b) 2.0001 (c) 4.0000
 37. $y = \log_5 x$ 38. $y = \log_2 x$ 39. $y = \log_9 x$
 40. $y = \log_3 x$ 41. II 42. V 43. III 44. IV
 45. VI 46. I

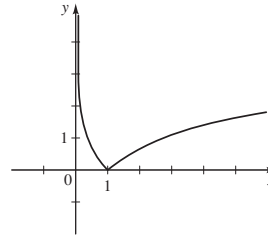
47.



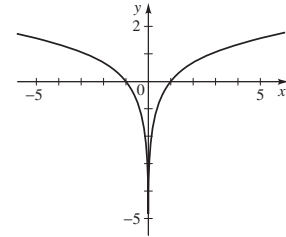
48.



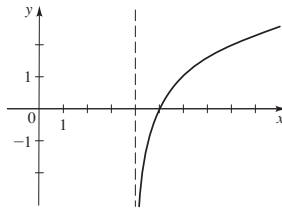
57. $(0, \infty)$, $[0, \infty)$, $x = 0$



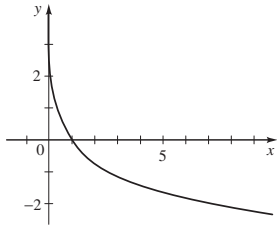
58. $(-\infty, 0) \cup (0, \infty)$, \mathbb{R} , $x = 0$



49. $(4, \infty)$, \mathbb{R} , $x = 4$



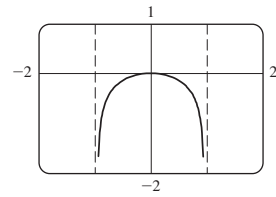
50. $(0, \infty)$, \mathbb{R} , $x = 0$



59. $(-3, \infty)$ 60. $(-\infty, 4)$ 61. $(-\infty, -1) \cup (1, \infty)$

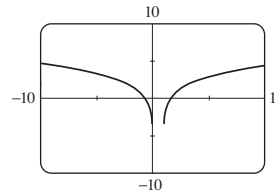
62. $(0, 1)$ 63. $(0, 2)$ 64. $[2, 10)$

65.



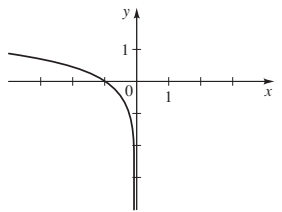
domain $(-1, 1)$
vertical asymptotes $x = 1$,
 $x = -1$
local maximum $(0, 0)$

66.

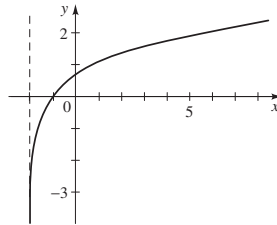


domain $(-\infty, 0) \cup (1, \infty)$
vertical asymptotes $x = 0$
and $x = 1$
no local extrema

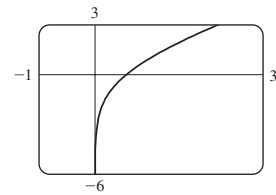
51. $(-\infty, 0)$, \mathbb{R} , $x = 0$



52. $(-2, \infty)$, \mathbb{R} , $x = -2$

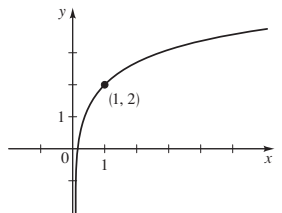


67.

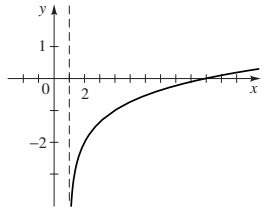


domain $(0, \infty)$
vertical asymptote $x = 0$
no maximum or minimum

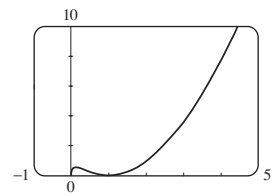
53. $(0, \infty)$, \mathbb{R} , $x = 0$



54. $(1, \infty)$, \mathbb{R} , $x = 1$

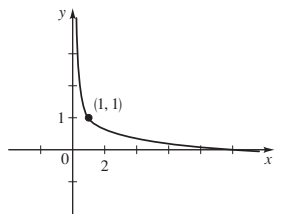


68.

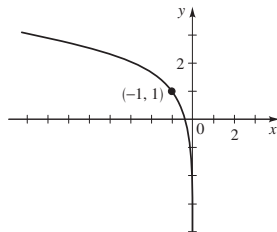


domain $(0, \infty)$
vertical asymptote none
local minimum $(1, 0)$
local maximum $(0.14, 0.54)$

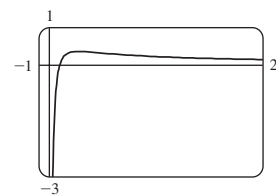
55. $(0, \infty)$, \mathbb{R} , $x = 0$



56. $(-\infty, 0)$, \mathbb{R} , $x = 0$



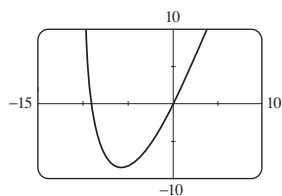
69.



domain $(0, \infty)$
vertical asymptote $x = 0$
horizontal asymptote $y = 20$
local maximum
 $\approx (2.72, 0.37)$

A54 Answers to Exercises and Chapter Tests

70.

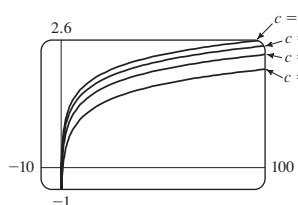


domain $(-10, \infty)$
vertical asymptote $x = -10$
local minimum
 $\approx (-5.87, -3.62)$

71. The graph of f grows more slowly than g .

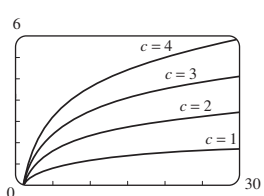
72. (b) 13.50

73. (a)



(b) The graph of
 $f(x) = \log(cx)$ is
the graph of
 $f(x) = \log(x)$
shifted upward
 $\log c$ units.

74. (a)



(b) As c increases,
the graph of
 $f(x) = c \log(x)$ stretches
vertically by a
factor of c .

75. (a) $(1, \infty)$ (b) $f^{-1}(x) = 10^{2x}$ 76. (a) (e, ∞) (b) $f^{-1}(x) = e^{e^{e^x}}$ 77. (a) $f^{-1}(x) = \log_2\left(\frac{x}{1-x}\right)$ (b) $(0, 1)$ 78. 891.69 M 79. 2602 yr 80. 42.86 h

81. 11.5 yr, 9.9 yr, 8.7 yr 82. 0.58 h 83. 5.32, 4.32

Section 4.3 ■ page 356

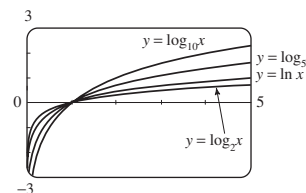
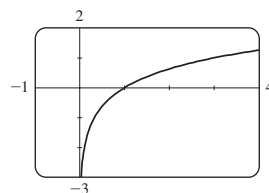
1. $\frac{3}{2}$ 2. 5 3. 2 4. $-\frac{3}{2}$ 5. 3 6. 2 7. 3 8. -29. 200 10. 99 11. 4 12. 200 13. $1 + \log_2 x$ 14. $\log_3 5 + \log_3 y$ 15. $\log_2 x + \log_2(x-1)$ 16. $\log_5 x - \log_5 2$ 17. $10 \log 6$ 18. $\frac{1}{2} \ln z$ 19. $\log_2 A + 2 \log_2 B$ 20. $\frac{1}{4} \log_6 17$ 21. $\log_3 x + \frac{1}{2} \log_3 y$ 22. $10(\log_2 x + \log_2 y)$ 23. $\frac{1}{3} \log_5(x^2 + 1)$ 24. $2 \log_a x - (\log_a y + 3 \log_a z)$ 25. $\frac{1}{2}(\ln a + \ln b)$ 26. $\frac{1}{3}(\ln 3 + 2 \ln r + \ln s)$ 27. $3 \log x + 4 \log y - 6 \log z$ 28. $2 \log a - (4 \log b + \frac{1}{2} \log c)$ 29. $\log_2 x + \log_2(x^2 + 1) - \frac{1}{2} \log_2(x^2 - 1)$ 30. $\frac{1}{2}[\log_5(x-1) - \log_5(x+1)]$ 31. $\ln x + \frac{1}{2}(\ln y - \ln z)$ 32. $\ln 3 + 2 \ln x - 10 \ln(x+1)$ 33. $\frac{1}{4} \log(x^2 + y^2)$ 34. $\log x - \frac{1}{3} \log(1-x)$ 35. $\frac{1}{2}[\log(x^2 + 4) - \log(x^2 + 1) - 2 \log(x^3 - 7)]$ 36. $\frac{1}{2} \log x + \frac{1}{4} \log y + \frac{1}{8} \log z$ 37. $3 \ln x + \frac{1}{2} \ln(x-1) - \ln(3x+4)$ 38. $x - [\log x + \log(x^2 + 1) + \log(x^4 + 2)]$ 39. $\log_3 160$ 40. $\log(6\sqrt{7})$ 41. $\log_2(AB/C^2)$ 42. $\log_5(x+1)$ 43. $\log\left(\frac{x^4(x-1)^2}{\sqrt[3]{x^2+1}}\right)$ 44. $\ln \frac{a^2 - b^2}{c^2}$ 45. $\ln(5x^2(x^2 + 5)^3)$ 46. $\log_5 \frac{x^2 y^4}{z^6}$ 47. $\log\left(\frac{\sqrt[3]{2x+1} \sqrt{(x-4)/(x^4-x^2-1)}}{s^r}\right)$ 48. $\log_a \frac{bd^c}{s^r}$

49. 2.321928 50. 0.430677 51. 2.523719 52. 2.523658

53. 0.493008 54. 3.503061 55. 3.482892 56. 0.368743

57.

58.



The graph of $y = \log_c x$ is obtained from the graph of $y = \ln x$ by either shrinking or stretching vertically by a factor of $1/(\ln c)$ depending on whether $\ln c > 1$ or $\ln c < 1$ (respectively).

60. $\log_2 7$ 62. 30 63. (a) $P = c/W^k$ (b) 1866, 6464. (a) $S = cA^k$ 65. (a) $M = -2.5 \log B + 2.5 \log B_0$

Section 4.4 ■ page 366

1. 1.3979 2. -0.6021 3. -0.9730 4. 0.8283

5. -0.5850 6. 1.2325 7. 1.2040 8. 0.1783 9. 0.0767

10. 0.0194 11. 0.2524 12. 1.6958 13. 1.9349

14. -29.3426 15. -43.0677 16. 0.0455 17. 2.1492

18. -3.1144 19. 6.2126 20. 0.5624 21. -2.9469

22. 0.6232 23. -2.4423 24. -1.3863 25. 14.0055

26. 9.2708 27. ± 1 28. 2, -1 29. $0, \frac{4}{3}$ 30. $\frac{-1 \pm \sqrt{5}}{2}$ 31. $\ln 2 \approx 0.6931, 0$ 32. 1.098633. $\frac{1}{2} \ln 3 \approx 0.5493$ 34. 1.3863 35. $e^{10} \approx 22026$ 36. 0.7183 37. 0.01 38. 1004 39. $\frac{95}{3}$ 40. -2541. $3 - e^2 \approx -4.3891$ 42. -2, 343. 5 44. 2, 4 45. 5 46. 4 47. $\frac{13}{12}$ 48. 5 49. 650. 1.7290 51. $\frac{3}{2}$ 52. 1, 0.0185, 53.957453. $1/\sqrt{5} \approx 0.4472$ 54. 43,046,721

55. 2.21 56. 0.01, 1.47 57. 0.00, 1.14 58. -1.96, 1.06

59. -0.57 60. 1.38 61. 0.36 62. -0.89, 0.71

63. $2 < x < 4$ or $7 < x < 9$ 64. $8 \leq x \leq 16$ 65. $\log 2 < x < \log 5$ 66. $-\sqrt{2} < x < \sqrt{2}$

67. (a) \$6435.09 (b) 8.24 yr 68. (a) \$7328.73

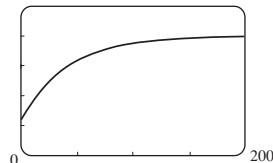
(b) 3.46 yr 69. 6.33 yr 70. 2.34 yr 71. 8.15 yr

72. 9.25% 73. 8.30% 74. 5.65% 75. 13 days 76. 10 s

77. (a) 7337 (b) 1.73 yr 78. (a) 7.87 lumens

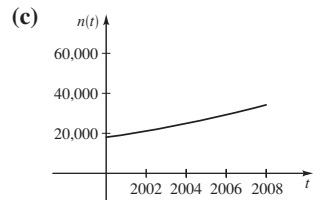
(b) 86.6 ft 79. (a) $P = P_0 e^{-kt}$ (b) 56.47 kPa80. (a) $T = 200e^{-0.11t} + 20$ (b) 42.2°F81. (a) $t = -\frac{5}{13} \ln(1 - \frac{13}{60}I)$ (b) 0.218 s82. (a) $t = -\frac{1}{k} \ln\left(\frac{M-P}{C}\right)$ (b) 23 months

(c) 25

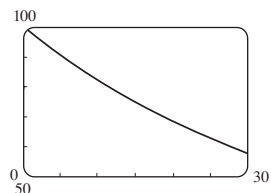


Section 4.5 ■ page 379

1. (a) 500 (b) 45% (c) 1929 (d) 6.66 h 2. (a) 1.2%
 (b) 12.74 million (c) 76.36 yr
 3. (a) $n(t) = 18,000e^{0.08t}$ (b) 34,137



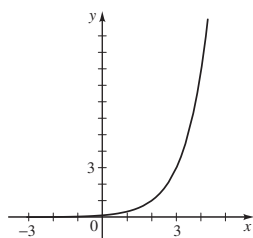
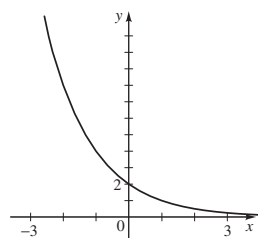
4. (a) 233 million (b) 181 million
 5. (a) $n(t) = 112,000e^{0.04t}$ (b) About 142,000 (c) 2008
 6. (a) $n(t) = 85e^{0.18t}$ (b) 146 (c) 10.86 yr 7. (a) 20,000
 (b) $n(t) = 20,000e^{0.1096t}$ (c) About 48,000 (d) 2010
 8. (a) $n(t) = 1500e^{0.023t}$ (b) 24,000 (c) 42.6 min
 9. (a) $n(t) = 8600e^{0.1508t}$ (b) About 11,600 (c) 4.6 h
 10. (a) 104% (b) 50 (c) $n(t) = 50e^{1.04t}$ (d) 5400
 (e) 6.64 h 11. (a) 2029 (b) 2049
 12. (a) $n(t) = 10,586,223e^{0.0268t}$ (b) 25.86 yr
 (c) 40,429,000 13. 22.85 h 14. (a) $m(t) = 22e^{-0.000433t}$
 (b) 3.9 mg (c) 463.4 yr 15. (a) $n(t) = 10e^{-0.0231t}$
 (b) 1.6 g (c) 70 yr 16. (a) 8 g (b) 50 days (c) 25 days
 17. 18 yr 18. 130 s 19. 149 h 20. (a) 3.82 days
 (b) 9 days 21. 3560 yr 22. 4360 yr 23. (a) 210°F
 (b) 153°F (c) 28 min 24. (a) $T(t) = 60 + 38.6e^{-0.1947t}$
 (b) 6 h 25. (a) 137°F (b) 116 min
 26. 63°C



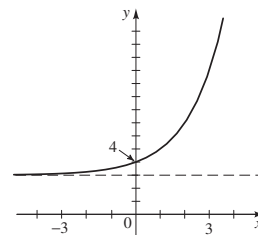
27. (a) 2.3 (b) 3.5 (c) 8.3 28. 7.5, basic
 29. (a) 10^{-3} M (b) 3.2×10^{-7} M 30. (a) 2.5×10^{-5} M
 (b) 5.0×10^{-8} M 31. $4.8 \leq \text{pH} \leq 6.4$ 32. 1.58×10^{-4} to
 1.58×10^{-3} 33. $\log 20 \approx 1.3$ 34. 2500 times
 35. Twice as intense 36. 2.5 times 37. 8.2 38. 73 dB
 39. 6.3×10^{-3} W/m² 40. 25 41. (b) 106 dB

Chapter 4 Review ■ page 383

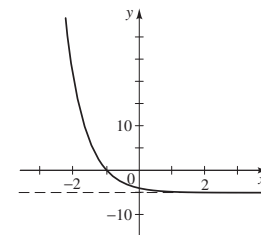
1. $\mathbb{R}, (0, \infty), y = 0$ 2. $\mathbb{R}, (0, \infty), y = 0$



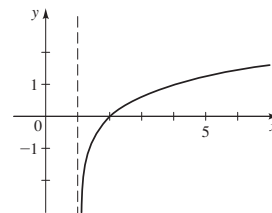
3. $\mathbb{R}, (3, \infty), y = 3$



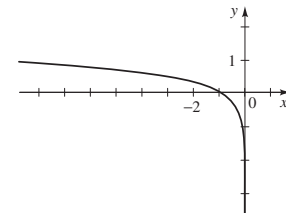
4. $\mathbb{R}, (-5, \infty), y = -5$



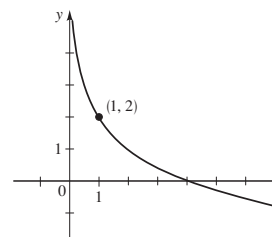
5. $(1, \infty), \mathbb{R}, x = 1$



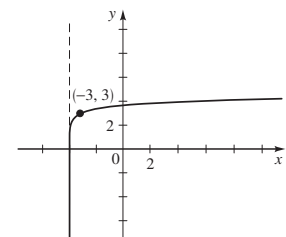
6. $(-\infty, 0), \mathbb{R}, x = 0$



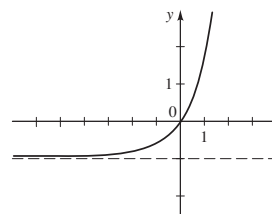
7. $(0, \infty), \mathbb{R}, x = 0$



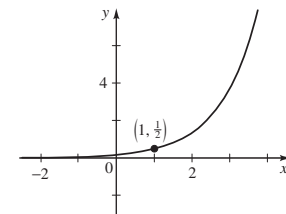
8. $(-4, \infty), \mathbb{R}, x = -4$



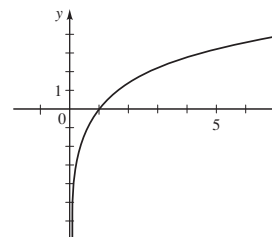
9. $\mathbb{R}, (-1, \infty), y = -1$



10. $\mathbb{R}, (0, \infty), y = 0$

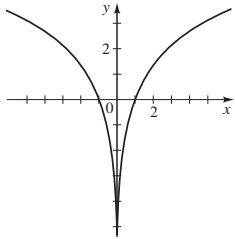


11. $(0, \infty), \mathbb{R}, x = 0$



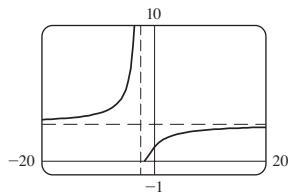
A56 Answers to Exercises and Chapter Tests

12. $(-\infty, 0) \cup (0, \infty), \mathbb{R}, x = 0$



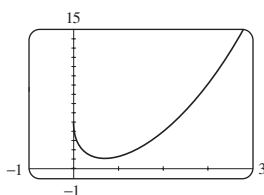
13. $(-\infty, \frac{1}{2})$ 14. $(-1, 2)$ 15. $(-\infty, -2) \cup (2, \infty)$
 16. $(-\infty, 0) \cup (0, \infty)$ 17. $2^{10} = 1024$ 18. $6^x = 37$
 19. $10^y = x$ 20. $e^{17} = c$ 21. $\log_2 64 = 6$ 22. $\log_{49} \frac{1}{7} = -\frac{1}{2}$
 23. $\log 74 = x$ 24. $\ln m = k$ 25. 7 26. 0 27. 45
 28. -6 29. 6 30. $\frac{3}{2}$ 31. -3 32. 13 33. $\frac{1}{2}$ 34. 49
 35. 2 36. $\frac{5}{2}$ 37. 92 38. 3 39. $\frac{2}{3}$ 40. 2
 41. $\log A + 2 \log B + 3 \log C$ 42. $\log_2 x + \frac{1}{2} \log_2(x^2 + 1)$
 43. $\frac{1}{2}[\ln(x^2 - 1) - \ln(x^2 + 1)]$
 44. $\log 4 + 3 \log x - [2 \log y + 5 \log(x - 1)]$
 45. $2 \log_5 x + \frac{3}{2} \log_5(1 - 5x) - \frac{1}{2} \log_5(x^3 - x)$
 46. $\frac{1}{3} \ln(x^4 + 12) - [\ln(x + 16) + \frac{1}{2} \ln(x - 3)]$
 47. $\log 96$ 48. $\log(x^3 y^4)$ 49. $\log_2 \left(\frac{(x - y)^{3/2}}{(x^2 + y^2)^2} \right)$
 50. $\log_5 \left(\frac{2(x + 1)}{\sqrt[3]{3x + 7}} \right)$ 51. $\log \left(\frac{x^2 - 4}{\sqrt{x^2 + 4}} \right)$
 52. $\ln \sqrt{(x - 4)(x^2 + 4x)^5}$ 53. -15 54. 2.60
 55. $\frac{1}{3}(5 - \log_5 26) \approx 0.99$ 56. 601303.64
 57. $\frac{4}{3} \ln 10 \approx 3.07$ 58. -1.66 59. 3 60. 3.00 61. -4, 2
 62. 0.77 63. 0.430618 64. 2.602452 65. 2.303600
 66. -0.614023

67.



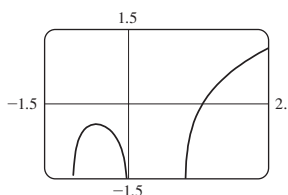
vertical asymptote
 $x = -2$
 horizontal asymptote
 $y = 2.72$
 no maximum or minimum

68.



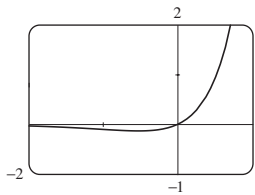
vertical asymptote $x = 0$
 one local minimum
 $\approx (0.5, 1.19)$

69.



vertical asymptotes
 $x = -1, x = 0, x = 1$
 local maximum
 $\approx (-0.58, -0.41)$

70.

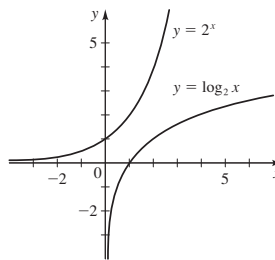
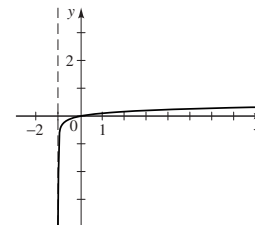


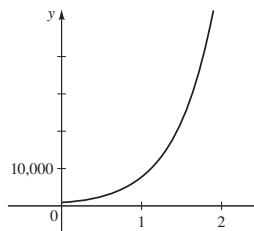
horizontal asymptote $y = 0$
 one local minimum
 $\approx (-0.5, -0.13)$

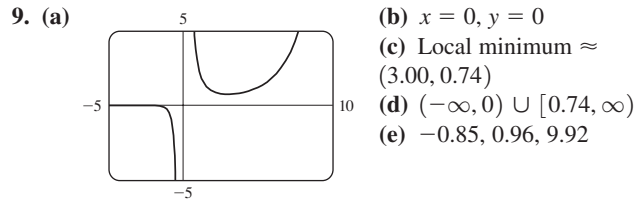
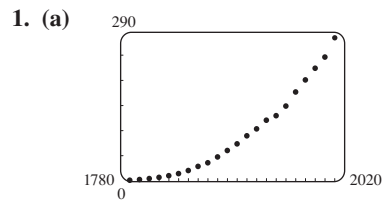
71. 2.42 72. -0.64, 2 73. $0.16 < x < 3.15$
 74. $(-\infty, -0.41) \cup (0.71, 4.31)$ 75. Increasing on
 $(-\infty, 0]$ and $[1.10, \infty)$, decreasing on $[0, 1.10]$
 76. $y = \frac{a}{e^a - 1}(x - 1)$ 77. 1.953445 78. $\sqrt[5]{10} \leq x < 100$
 79. $\log_4 258$ 80. $f^{-1}(x) = \log_3(\log_2 x)$; domain $(1, \infty)$,
 range $(-\infty, \infty)$ 81. (a) \$16,081.15 (b) \$16,178.18
 (c) \$16,197.64 (d) \$16,198.31 82. (a) \$5664.98 (b) 4 yr
 83. (a) $n(t) = 30e^{0.15t}$ (b) 55 (c) 19 yr 84. (a) 45 min
 (b) 156,250 85. (a) 9.97 mg (b) 1.39×10^5 yr
 86. (a) 5 days (b) 19% 87. (a) $n(t) = 150e^{-0.0004359t}$
 (b) 97.0 mg (c) 2520 yr 88. (a) 12 g
 (b) $m(t) = 12e^{-0.173t}$ (c) 7.1 g (d) 25 days
 89. (a) $n(t) = 1500e^{0.1515t}$ (b) 7940 90. 43 min
 91. 7.9, basic 92. 1.26×10^{-2} M 93. 8.0
 94. 2.51×10^{10}

Chapter 4 Test ■ page 385

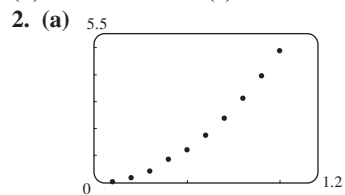
1.

2. $(-1, \infty), \mathbb{R}, x = -1$ 

3. (a) $\frac{3}{2}$ (b) 3 (c) $\frac{2}{3}$ (d) 2
 4. $\frac{1}{3}[\log(x + 2) - 4 \log x - \log(x^2 + 4)]$
 5. $\ln \left(\frac{x\sqrt{3 - x^4}}{(x^2 + 1)^2} \right)$ 6. (a) 4.32 (b) 0.77 (c) 5.39 (d) 2
 7. (a) $n(t) = 1000e^{2.07944t}$ (b) 22,627 (c) 1.3 h
 (d)
- 
8. (a) $A(t) = 12,000 \left(1 + \frac{0.056}{12} \right)^{12t}$
 (b) \$14,195.06 (c) 9.249 yr

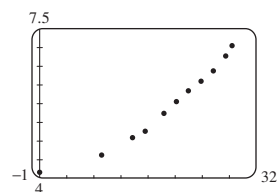
**Focus on Modeling** ■ page 393

(b) $y = ab^t$, where $a = 1.180609 \times 10^{-15}$, $b = 1.0204139$, and y is the population in millions in the year t (c) 515.9 million
 (d) 207.8 million (e) No



(b) $y = at^b$, where $a = 4.9622$ and $b = 2.0027$ (c) 44.792 m

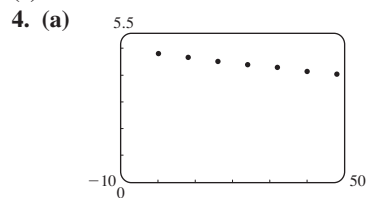
3. (a) Yes (b) Yes, the scatter plot appears linear.



(c) $\ln E = 4.494411 + 0.0970921464t$, where t is years since 1970 and E is expenditure in billions of dollars

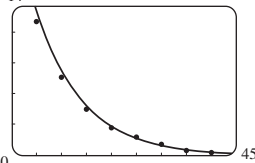
(d) $E = 89.51543173e^{at}$, where $a = 0.0970921464$

(e) 3948.2 billion dollars



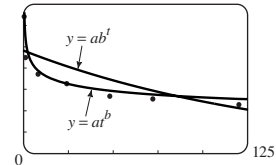
(b) $y = ab^t$, where $a = 4.79246$ and $b = 0.99642$ (c) 192.8 h

5. (a) $I_0 = 22.7586444$, $k = 0.1062398$

(b)  (c) 47.3 ft

6. (a) $y = at^b$, where $a = 49.70030$ and $b = -0.15437$;
 $y = ab^t$, where $a = 44.82418$ and $b = 0.99317$

(b) 70 (c) The power function

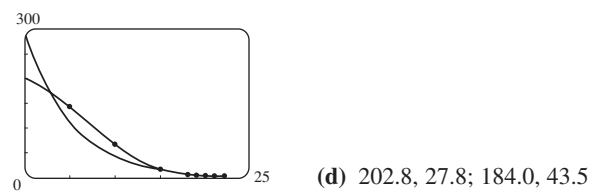


7. (a) $y = ab^t$, where $a = 301.813054$, $b = 0.819745$, and t is the number of years since 1970

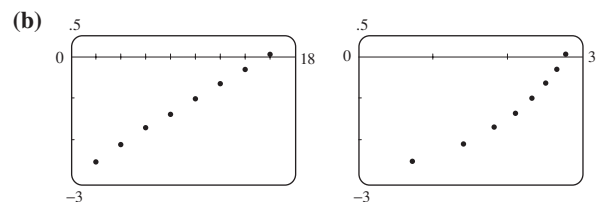
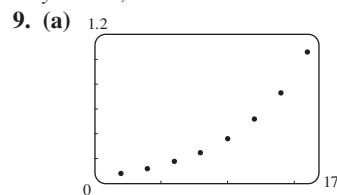
(b) $y = at^4 + bt^3 + ct^2 + dt + e$, where $a = -0.002430$,
 $b = 0.135159$, $c = -2.014322$, $d = -4.055294$,

$e = 199.092227$, and t is the number of years since 1970

(c) From the graphs we see that the fourth-degree polynomial is a better model.

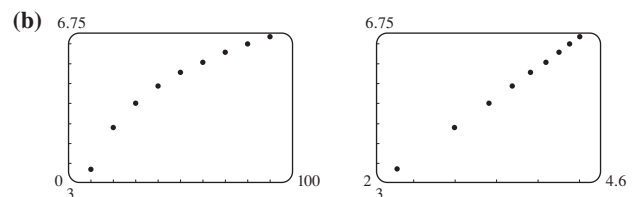
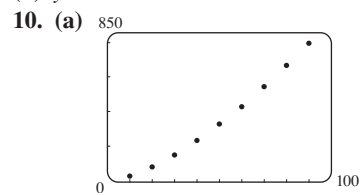


8. $y = ab^x$, where $a = 2.414$ and $b = 1.05452$



(c) Exponential function

(d) $y = ab^x$ where $a = 0.057697$ and $b = 1.200236$



A58 Answers to Exercises and Chapter Tests

(c) The power function

(d) $y = ax^b$, where $a = 0.893421326$ and $b = 1.50983$ 11. (a) $y = \frac{c}{1 + ae^{-bx}}$, where $a = 49.10976596$, $b = 0.4981144989$, and $c = 500.855793$ (b) 10.58 days12. (a) $y = a + b \ln t$ where $a = -7154.888$, $b = 1061.007$, and y is metric tons of coal produced in the year t

(b) 915 metric tons

Chapter 5

Section 5.1 ■ page 406

7. $-\frac{4}{5}$ 8. $\frac{24}{25}$ 9. $-2\sqrt{2}/3$ 10. $\sqrt{21}/5$ 11. $3\sqrt{5}/7$ 12. $\sqrt{5}/3$ 13. $P(\frac{4}{5}, \frac{3}{5})$ 14. $P(2\sqrt{2}/3, -\frac{1}{3})$ 15. $P(-\sqrt{5}/3, \frac{2}{3})$ 16. $P(2\sqrt{5}/5, -\sqrt{5}/5)$ 17. $P(-\sqrt{2}/3, -\sqrt{7}/3)$ 18. $P(-\frac{2}{5}, \sqrt{21}/5)$ 19. $t = \pi/4, (\sqrt{2}/2, \sqrt{2}/2); t = \pi/2, (0, 1);$ $t = 3\pi/4, (-\sqrt{2}/2, \sqrt{2}/2); t = \pi, (-1, 0);$ $t = 5\pi/4, (-\sqrt{2}/2, -\sqrt{2}/2); t = 3\pi/2, (0, -1);$ $t = 7\pi/4, (\sqrt{2}/2, -\sqrt{2}/2); t = 2\pi, (1, 0)$ 20. $t = \pi/6, (\sqrt{3}/2, \frac{1}{2}); t = \pi/3, (\frac{1}{2}, \sqrt{3}/2); t = \pi/2, (0, 1);$ $t = 2\pi/3, (-\frac{1}{2}, \sqrt{3}/2); t = 5\pi/6, (-\sqrt{3}/2, \frac{1}{2}); t = \pi, (-1, 0);$ $t = 7\pi/6, (-\sqrt{3}/2, -\frac{1}{2}); t = 4\pi/3, (-\frac{1}{2}, -\sqrt{3}/2);$ $t = 3\pi/2, (0, -1); t = 5\pi/3, (\frac{1}{2}, -\sqrt{3}/2);$ $t = 11\pi/6, (\sqrt{3}/2, -\frac{1}{2}); t = 2\pi, (1, 0)$ 21. $(0, 1)$ 22. $(0, -1)$ 23. $(-\sqrt{3}/2, \frac{1}{2})$ 24. $(-\sqrt{3}/2, -\frac{1}{2})$ 25. $(\frac{1}{2}, -\sqrt{3}/2)$ 26. $(\frac{1}{2}, -\sqrt{3}/2)$ 27. $(-\frac{1}{2}, \sqrt{3}/2)$ 28. $(0, -1)$ 29. $(-\sqrt{2}/2, -\sqrt{2}/2)$ 30. $(\sqrt{3}/2, -\frac{1}{2})$ 31. (a) $(-\frac{3}{5}, \frac{4}{5})$ (b) $(\frac{3}{5}, -\frac{4}{5})$ (c) $(-\frac{3}{5}, -\frac{4}{5})$ (d) $(\frac{3}{5}, \frac{4}{5})$ 32. (a) $(\frac{3}{4}, -\sqrt{7}/4)$ (b) $(\frac{3}{4}, \sqrt{7}/4)$ (c) $(-\frac{3}{4}, \sqrt{7}/4)$ (d) $(-\frac{3}{4}, -\sqrt{7}/4)$ 33. (a) $\pi/4$ (b) $\pi/3$ (c) $\pi/3$ (d) $\pi/6$ 34. (a) $\pi/6$ (b) $\pi/6$ (c) $\pi/3$ (d) $\pi/4$ 35. (a) $2\pi/7$ (b) $2\pi/9$ (c) $\pi - 3 \approx 0.14$ (d) $2\pi - 5 \approx 1.28$ 36. (a) $\pi/5$ (b) $2\pi/7$ (c) $2\pi - 6 \approx 0.28$ (d) $7 - 2\pi \approx 0.72$ 37. (a) $\pi/3$ (b) $(-\frac{1}{2}, \sqrt{3}/2)$ 38. (a) $\pi/3$ (b) $(-\frac{1}{2}, -\sqrt{3}/2)$ 39. (a) $\pi/4$ (b) $(-\sqrt{2}/2, \sqrt{2}/2)$ 40. (a) $\pi/3$ (b) $(\frac{1}{2}, \sqrt{3}/2)$ 41. (a) $\pi/3$ (b) $(-\frac{1}{2}, -\sqrt{3}/2)$ 42. (a) $\pi/6$ (b) $(-\sqrt{3}/2, \frac{1}{2})$ 43. (a) $\pi/4$ (b) $(-\sqrt{2}/2, -\sqrt{2}/2)$ 44. (a) $\pi/6$ (b) $(\sqrt{3}/2, \frac{1}{2})$ 45. (a) $\pi/6$ (b) $(-\sqrt{3}/2, -\frac{1}{2})$ 46. (a) $\pi/4$ (b) $(\sqrt{2}/2, \sqrt{2}/2)$ 47. (a) $\pi/3$ (b) $(\frac{1}{2}, \sqrt{3}/2)$ 48. (a) $\pi/6$ (b) $(-\sqrt{3}/2, -\frac{1}{2})$ 49. (a) $\pi/3$ (b) $(-\frac{1}{2}, -\sqrt{3}/2)$ 50. (a) $\pi/4$ (b) $(\sqrt{2}/2, -\sqrt{2}/2)$ 51. $(0.5, 0.8)$ 52. $(-0.8, 0.6)$ 53. $(0.5, -0.9)$ 54. $(-0.6, -0.9)$

Section 5.2 ■ page 416

1. $t = \pi/4, \sin t = \sqrt{2}/2, \cos t = \sqrt{2}/2; t = \pi/2, \sin t = 1,$ $\cos t = 0; t = 3\pi/4, \sin t = \sqrt{2}/2, \cos t = -\sqrt{2}/2;$ $t = \pi, \sin t = 0, \cos t = -1; t = 5\pi/4,$ $\sin t = -\sqrt{2}/2, \cos t = -\sqrt{2}/2; t = 3\pi/2, \sin t = -1,$ $\cos t = 0; t = 7\pi/4, \sin t = -\sqrt{2}/2, \cos t = \sqrt{2}/2;$ $t = 2\pi, \sin t = 0, \cos t = 1$ 2. $t = \pi/6, \sin t = \frac{1}{2}, \cos t = \sqrt{3}/2;$ $t = \pi/3, \sin t = \sqrt{3}/2, \cos t = \frac{1}{2};$ $t = \pi/2, \sin t = 1, \cos t = 0;$ $t = 2\pi/3, \sin t = \sqrt{3}/2, \cos t = -\frac{1}{2};$ $t = 5\pi/6, \sin t = \frac{1}{2}, \cos t = -\sqrt{3}/2;$ $t = \pi, \sin t = 0, \cos t = -1;$ $t = 7\pi/6, \sin t = -\frac{1}{2}, \cos t = -\sqrt{3}/2;$ $t = 4\pi/3, \sin t = -\sqrt{3}/2, \cos t = -\frac{1}{2};$ $t = 3\pi/2, \sin t = -1, \cos t = 0;$ $t = 5\pi/3, \sin t = -\sqrt{3}/2, \cos t = \frac{1}{2};$ $t = 11\pi/6, \sin t = -\frac{1}{2}, \cos t = \sqrt{3}/2;$ $t = 2\pi, \sin t = 0, \cos t = 1$ 3. (a) $\sqrt{3}/2$ (b) $-1/2$ (c) $-\sqrt{3}$ 4. (a) $1/2$ (b) $-\sqrt{3}/2$ (c) $-\sqrt{3}/3$ 5. (a) $-1/2$ (b) $-1/2$ (c) $-1/2$ 6. (a) $1/2$ (b) $1/2$ (c) $1/2$ 7. (a) $-\sqrt{2}/2$ (b) $-\sqrt{2}/2$ (c) $\sqrt{2}/2$ 8. (a) $\sqrt{2}/2$ (b) $-\sqrt{2}/2$ (c) $-\sqrt{2}/2$ 9. (a) $\sqrt{3}/2$ (b) $2\sqrt{3}/3$ (c) $\sqrt{3}/3$ 10. (a) $1/2$ (b) 2 (c) $-\sqrt{3}$ 11. (a) -1 (b) 0 (c) 0 12. (a) 1 (b) 0 (c) 0 13. (a) 2 (b) $-2\sqrt{3}/3$ (c) 2 14. (a) $-\sqrt{3}/2$ (b) $-2\sqrt{3}/3$ (c) -2 15. (a) $-\sqrt{3}/3$ (b) $\sqrt{3}/3$ (c) $-\sqrt{3}/3$ 16. (a) $-\sqrt{3}/3$ (b) $-\sqrt{3}/3$ (c) $-\sqrt{3}/3$ 17. (a) $\sqrt{2}/2$ (b) $-\sqrt{2}$ (c) -1 18. (a) $-\sqrt{2}/2$ (b) $-\sqrt{2}$ (c) 1 19. (a) -1 (b) 1 (c) -1 20. (a) -1 (b) -1 (c) 1 21. (a) 0 (b) 1 (c) 0 22. (a) 1 (b) 0 (c) 0 23. $\sin 0 = 0, \cos 0 = 1, \tan 0 = 0, \sec 0 = 1,$

others undefined

24. $\sin \pi/2 = 1, \cos \pi/2 = 0, \cot \pi/2 = 0, \csc \pi/2 = 1,$

others undefined

25. $\sin \pi = 0, \cos \pi = -1, \tan \pi = 0, \sec \pi = -1,$

others undefined

26. $\sin 3\pi/2 = -1, \cos 3\pi/2 = 0, \cot 3\pi/2 = 0,$ $\csc 3\pi/2 = -1,$ others undefined27. $\frac{4}{5}, \frac{3}{5}, \frac{4}{3}$ 28. $\frac{4}{5}, -\frac{3}{5}, -\frac{4}{3}$ 29. $-\sqrt{11}/4, \sqrt{5}/4, -\sqrt{55}/5$ 30. $-2\sqrt{2}/3, -1/3, 2\sqrt{2}$ 31. $\sqrt{13}/7, -6/7, -\sqrt{13}/6$ 32. $\frac{9}{41}, \frac{40}{41}, \frac{9}{40}$ 33. $-\frac{12}{13}, -\frac{5}{13}, \frac{12}{5}$ 34. $2\sqrt{5}/5, \sqrt{5}/5, 2$ 35. $\frac{21}{29}, -\frac{20}{29}, -\frac{21}{20}$ 36. $-\frac{7}{25}, \frac{24}{25}, -\frac{7}{24}$ 37. (a) 0.8 (b) 0.84147 38. (a) 0.7 (b) 0.69671 39. (a) 0.9 (b) 0.93204 40. (a) 0.3 (b) 0.28366 41. (a) 1 (b) 1.02964 42. (a) -3.6 (b) -3.60210 43. (a) -0.6 (b) -0.57482 44. (a) 0.9 (b) 0.88345 45. Negative 46. Negative

47. Negative 48. Positive 49. II 50. III 51. II 52. II

53. $\sin t = \sqrt{1 - \cos^2 t}$ 54. $\cos t = \sqrt{1 - \sin^2 t}$

55. $\tan t = (\sin t)/\sqrt{1 - \sin^2 t}$ 56. $\tan t = -\frac{\sqrt{1 - \cos^2 t}}{\cos t}$

57. $\sec t = -\sqrt{1 + \tan^2 t}$ 58. $\csc t = -\frac{\sqrt{1 + \cot^2 t}}{\cot t}$

59. $\tan t = \sqrt{\sec^2 t - 1}$ 60. $\sin t = -\frac{\sqrt{\sec^2 t - 1}}{\sec t}$

61. $\tan^2 t = (\sin^2 t)/(1 - \sin^2 t)$ 62. $\sec^2 t \sin^2 t = \frac{1 - \cos^2 t}{\cos^2 t}$

63. $\cos t = -\frac{4}{5}$, $\tan t = -\frac{3}{4}$, $\csc t = \frac{5}{3}$, $\sec t = -\frac{5}{4}$, $\cot t = -\frac{4}{3}$

64. $\sin t = -\frac{3}{5}$, $\tan t = \frac{3}{4}$, $\csc t = -\frac{5}{3}$, $\sec t = -\frac{5}{4}$, $\cot t = \frac{4}{3}$

65. $\sin t = -2\sqrt{2}/3$, $\cos t = \frac{1}{3}$, $\tan t = -2\sqrt{2}$,
 $\csc t = -\frac{3}{2\sqrt{2}}$, $\cot t = -\sqrt{2}/4$

66. $\sin t = -\sqrt{17}/17$, $\cos t = -4\sqrt{17}/17$,
 $\csc t = -\sqrt{17}$, $\sec t = -\sqrt{17}/4$, $\cot t = 4$

67. $\sin t = -\frac{3}{5}$, $\cos t = \frac{4}{5}$, $\csc t = -\frac{5}{3}$, $\sec t = \frac{5}{4}$, $\cot t = -\frac{4}{3}$

68. $\sin t = -\sqrt{3}/2$, $\cos t = \frac{1}{2}$, $\tan t = -\sqrt{3}$,
 $\csc t = -2\sqrt{3}/3$, $\cot t = -\sqrt{3}/3$

69. $\cos t = -\sqrt{15}/4$, $\tan t = \sqrt{15}/15$, $\csc t = -4$,
 $\sec t = -4\sqrt{15}/15$, $\cot t = \sqrt{15}$

70. $\sin t = 4\sqrt{17}/17$, $\cos t = -\sqrt{17}/17$,
 $\csc t = \sqrt{17}/4$, $\sec t = -\sqrt{17}$, $\cot t = -\frac{1}{4}$

71. Odd 72. Even 73. Odd 74. Neither 75. Even

76. Even 77. Neither 78. Even

79. $y(0) = 4$, $y(0.25) = -2.828$, $y(0.50) = 0$,
 $y(0.75) = 2.828$, $y(1.00) = -4$, $y(1.25) = 2.828$

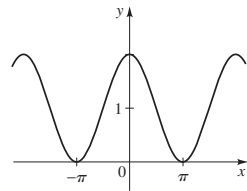
80. (a) 87 mmHg (b) 82.7 mmHg (c) 80 mmHg

(d) 73.9 mmHg 81. (a) 0.49870 amp (b) -0.17117 amp

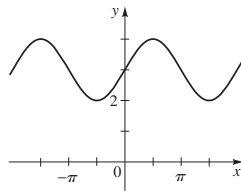
82. $H(0) = 175$ m, $H(1) = 150.4$ m, $H(2) = 100$ m,
 $H(4) = 38.6$ m, $H(6) = 100$ m, $H(8) = 150.3$ m,
 $H(12) = 58.8$ m

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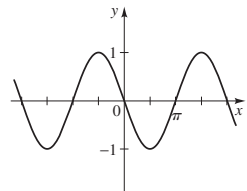
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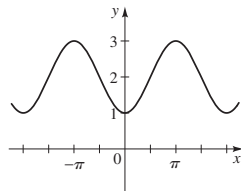
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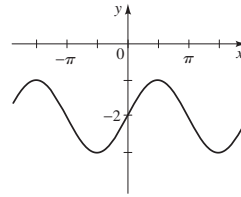
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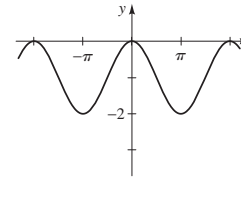
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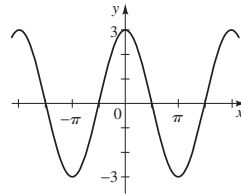
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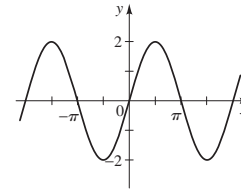
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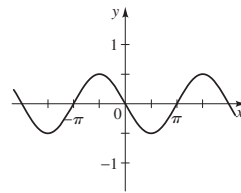
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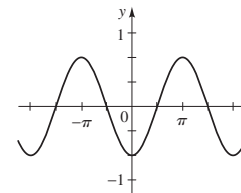
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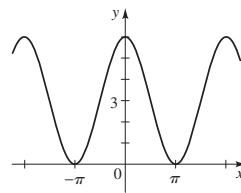
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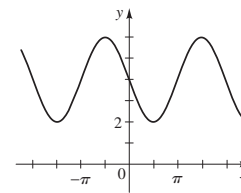
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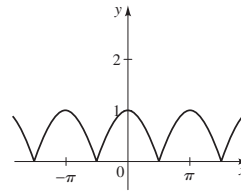
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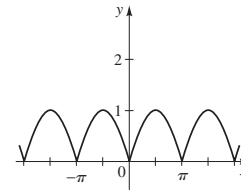
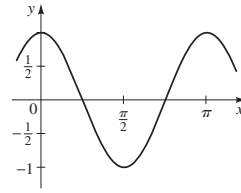
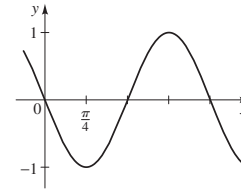
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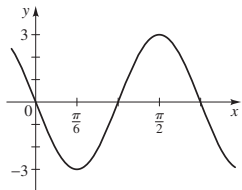
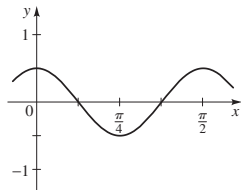
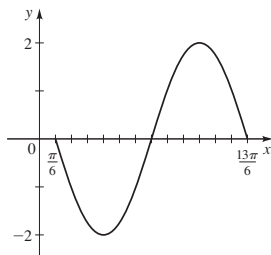
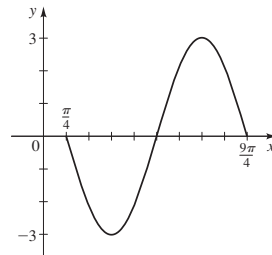
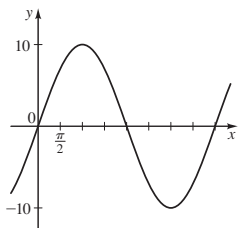
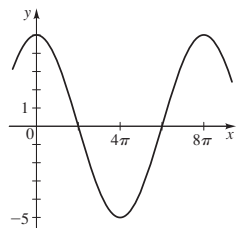
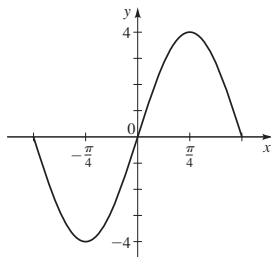
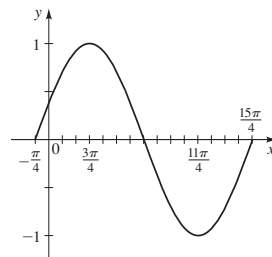
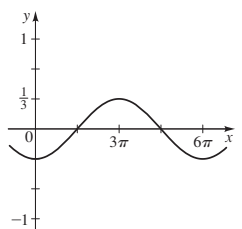
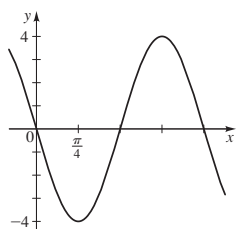
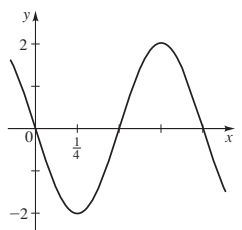
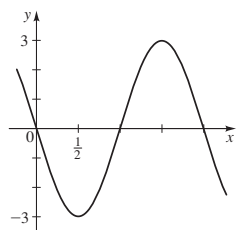
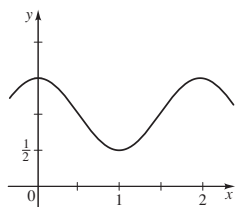
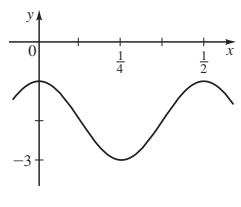
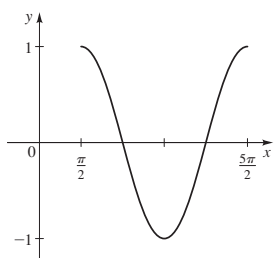
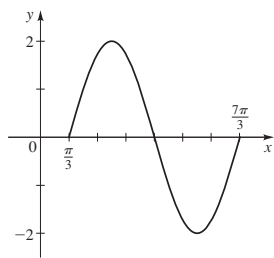
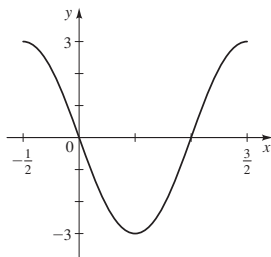
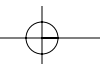
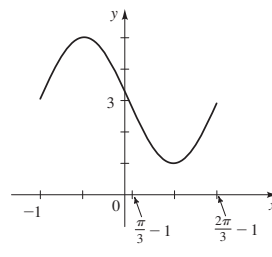
13.



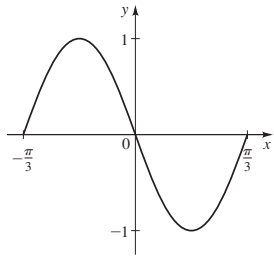
14.

15. $1, \pi$ 16. $1, \pi$ 

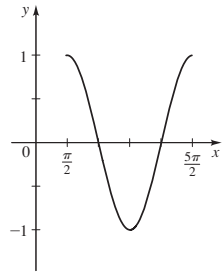
A60 Answers to Exercises and Chapter Tests

17. $3, 2\pi/3$ 18. $\frac{1}{2}, \pi/2$ 29. $2, 2\pi, \pi/6$ 30. $3, 2\pi, -\pi/4$ 19. $10, 4\pi$ 20. $5, 8\pi$ 31. $4, \pi, -\pi/2$ 32. $1, 4\pi, -\pi/4$ 21. $\frac{1}{3}, 6\pi$ 22. $4, \pi$ 23. $2, 1$ 24. $3, 2$ 25. $\frac{1}{2}, 2$ 26. $1, \frac{1}{2}$ 27. $1, 2\pi, \pi/2$ 28. $2, 2\pi, \pi/3$ 37. $3, 2, -\frac{1}{2}$ 38. $2, 2\pi/3, -1$ 

39. $1, 2\pi/3, -\pi/3$



40. $1, 2\pi, \pi/2$



41. (a) $4, 2\pi, 0$ (b) $y = 4 \sin x$

42. (a) $2, \pi, 0$ (b) $y = 2 \cos 2x$

43. (a) $\frac{3}{2}, \frac{2\pi}{3}, 0$ (b) $y = \frac{3}{2} \cos 3x$

44. (a) $3, 4\pi, 0$ (b) $y = 3 \sin \frac{1}{2}x$

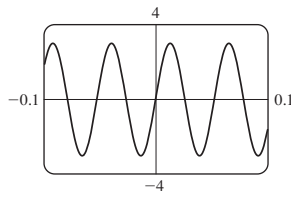
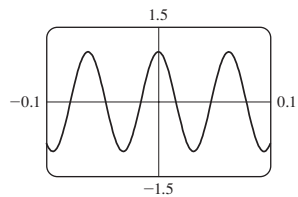
45. (a) $\frac{1}{2}, \pi, -\frac{\pi}{3}$ (b) $y = -\frac{1}{2} \cos 2(x + \pi/3)$

46. (a) $\frac{1}{10}, \pi, -\frac{3\pi}{4}$ (b) $y = -\frac{1}{10} \cos 2(x + 3\pi/4)$

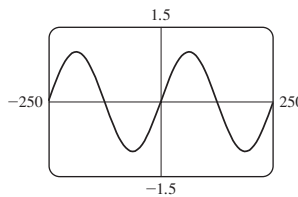
47. (a) $4, \frac{3}{2}, -\frac{1}{2}$ (b) $y = 4 \sin \frac{4\pi}{3}(x + \frac{1}{2})$

48. (a) $5, 1, -\frac{1}{4}$ (b) $y = 5 \sin 2\pi(x + \frac{1}{4})$

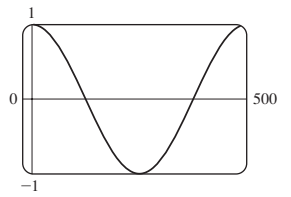
49.



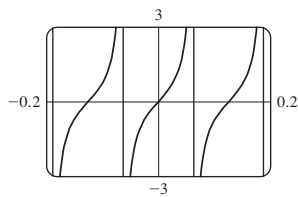
51.



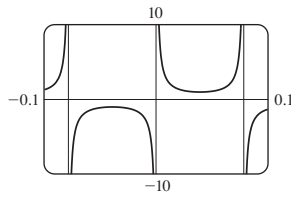
52.



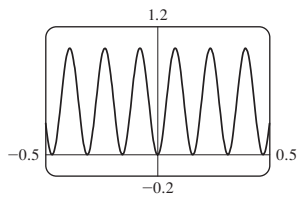
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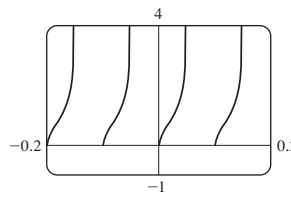
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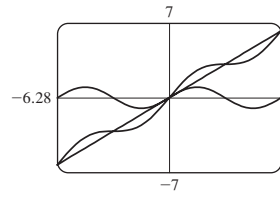
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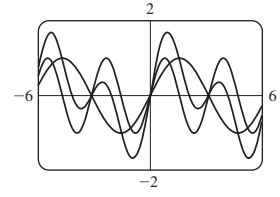
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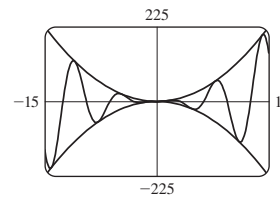
57.



58.

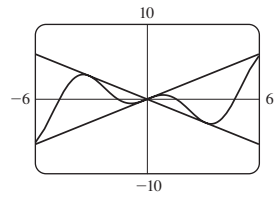


59.



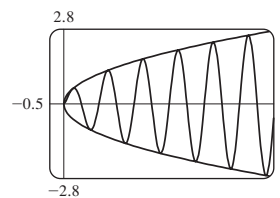
$y = x^2 \sin x$ is a sine curve that lies between the graphs of $y = x^2$ and $y = -x^2$

60.



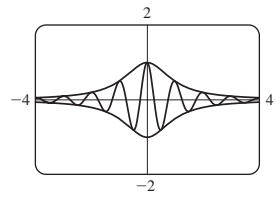
$y = x \cos x$ is a cosine curve that lies between the graphs of $y = x$ and $y = -x$

61.



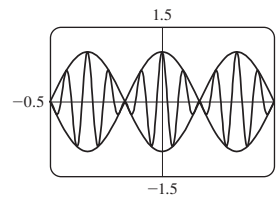
$y = \sqrt{x} \sin 5\pi x$ is a sine curve that lies between the graphs of $y = \sqrt{x}$ and $y = -\sqrt{x}$

62.



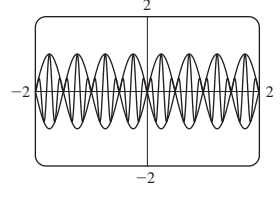
$y = \frac{\cos 2\pi x}{1+x^2}$ is a cosine curve that lies between the graphs of $y = \frac{1}{1+x^2}$ and $y = -\frac{1}{1+x^2}$

63.



$y = \cos 3\pi x \cos 21\pi x$ is a cosine curve that lies between the graphs of $y = \cos 3\pi x$ and $y = -\cos 3\pi x$

64.



$y = \sin 2\pi x \sin 10\pi x$ is a sine curve that lies between the graphs of $y = \sin 2\pi x$ and $y = -\sin 2\pi x$

A62 Answers to Exercises and Chapter Tests

65. Maximum value 1.76 when $x \approx 0.94$, minimum value -1.76 when $x \approx -0.94$ (The same maximum and minimum values occur at infinitely many other values of x .)

66. Maximum value 6.97 when $x \approx 5.24$, minimum value -0.68 when $x \approx 1.05$ (The same maximum and minimum values occur at infinitely many other values of x .)

67. Maximum value 3.00 when $x \approx 1.57$, minimum value -1.00 when $x \approx -1.57$ (The same maximum and minimum values occur at infinitely many other values of x .)

68. Maximum value 0.58 when $x \approx 5.76$ (exact value is $x = 11\pi/6$; Minimum value -0.58 when $x \approx 3.67$ (exact value is $x = 7\pi/6$) (The same maximum and minimum values occur at infinitely many other values of x .)

69. 1.16 **70.** 1.11 **71.** 0.34, 2.80 **72.** 0.74

73. (a) Odd **(b)** $0, \pm 2\pi, \pm 4\pi, \pm 6\pi, \dots$

(c)  **(d)** $f(x)$ approaches 0
(e) $f(x)$ approaches 0

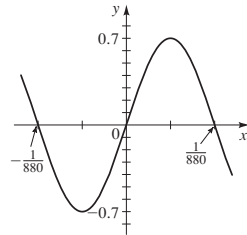
74. (a) Even

(b) $0, \pm\pi/4, \pm 2\pi/4, \pm 3\pi/4, \dots$

(c)  **(d)** $f(x)$ approaches 0
(e) $f(x)$ approaches 2

75. (a) 20 s **(b)** 6 ft

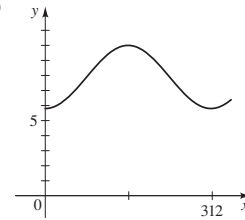
76. (a) $\frac{1}{440}$ s **(b)** 440 **(c)**



77. (a) $\frac{1}{80}$ min **(b)** 80

(c)  **(d)** $\frac{140}{90}$; it is higher than normal

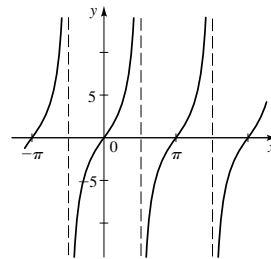
78. (a) 312 days **(b)** 10, 5.8 **(c)**



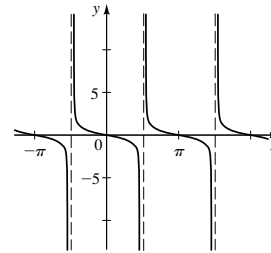
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1. II **2.** III **3.** VI **4.** I **5.** IV **6.** V

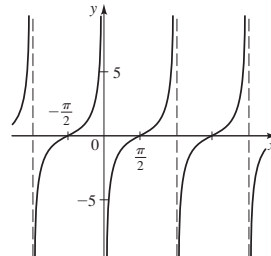
7. π **8.** π



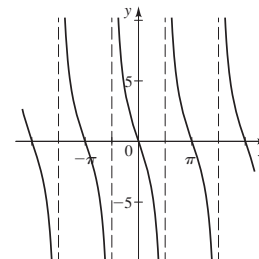
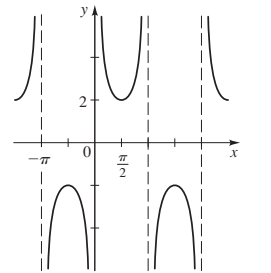
9. π



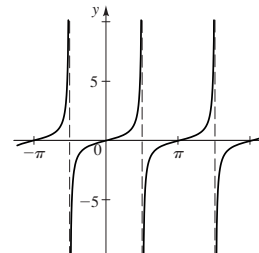
11. π



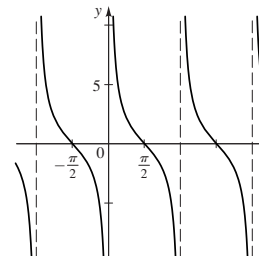
13. 2π



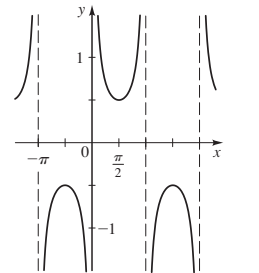
10. π

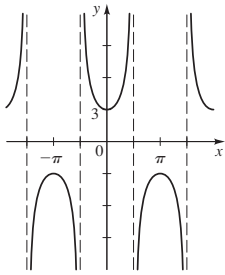
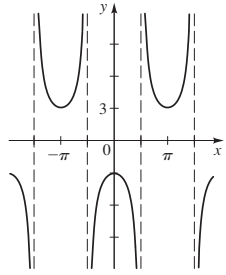
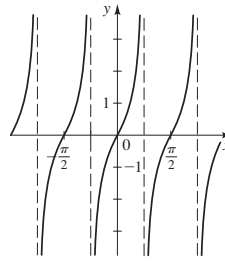
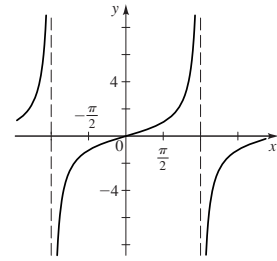
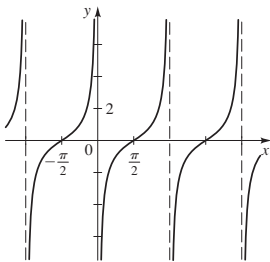
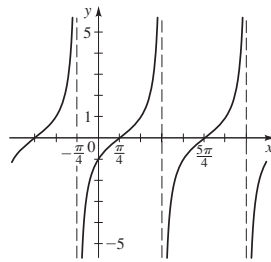


12. π

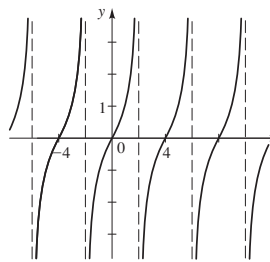


14. 2π

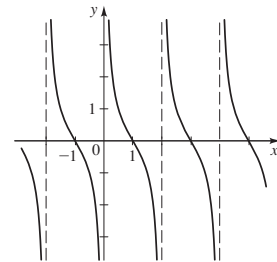
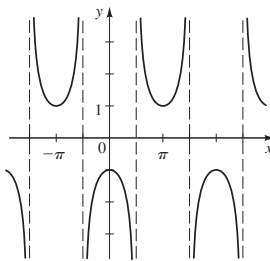
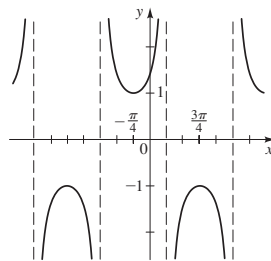
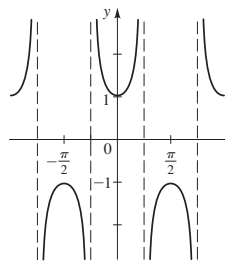
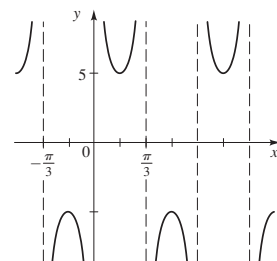
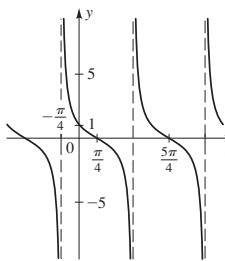
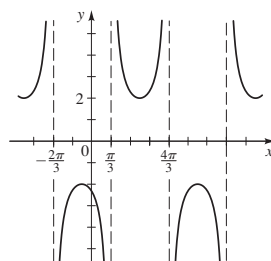
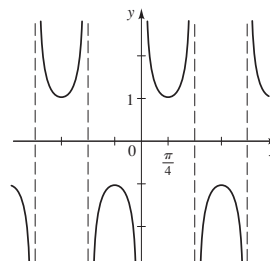
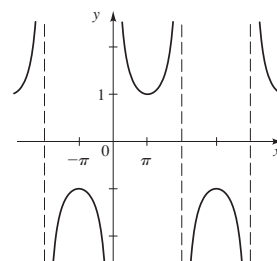
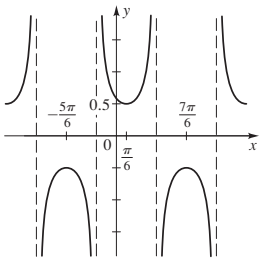
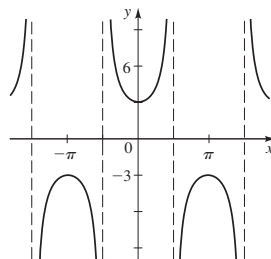
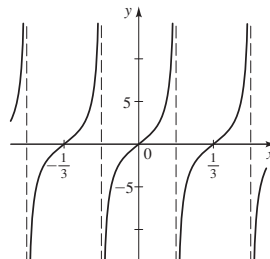


15. 2π 16. 2π 25. $\pi/2$ 26. 2π 17. π 18. π 

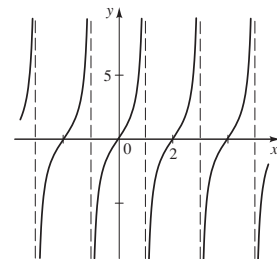
27. 4



28. 2

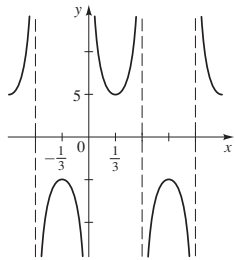
19. 2π 20. 2π 29. π 30. $2\pi/3$ 21. π 22. 2π 31. π 32. 4π 23. 2π 24. 2π 33. $\frac{1}{3}$ 

34. 2

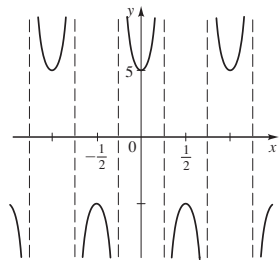


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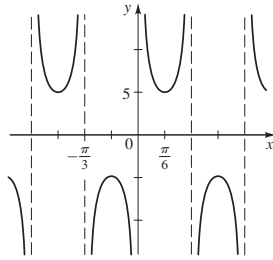
35. $\frac{4}{3}$



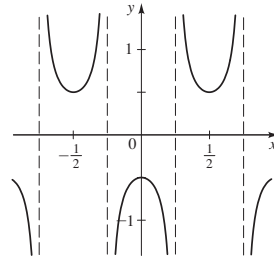
36. 1



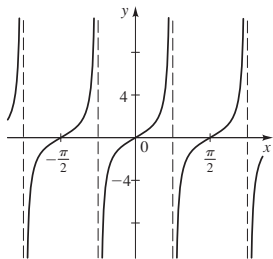
45. $2\pi/3$



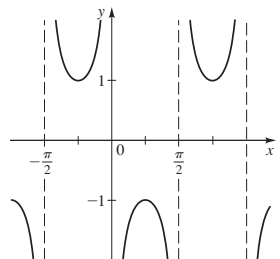
46. 1



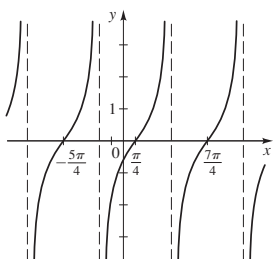
37. $\pi/2$



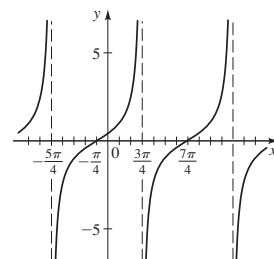
38. π



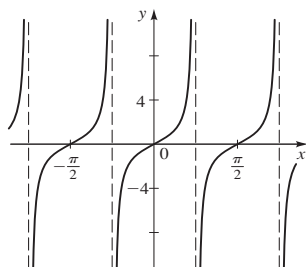
47. $3\pi/2$



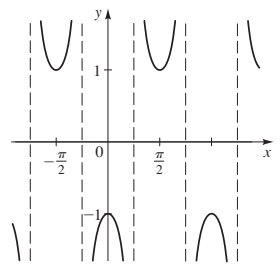
48. 2π



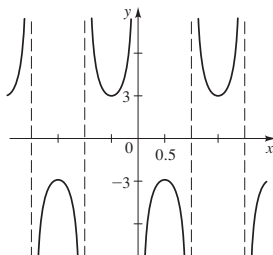
39. $\pi/2$



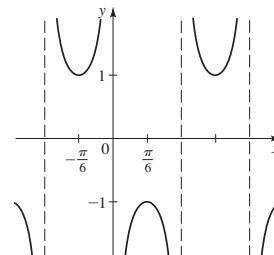
40. π



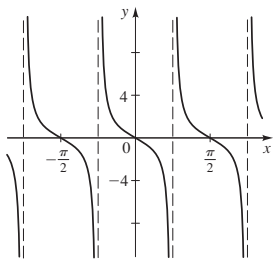
49. 2



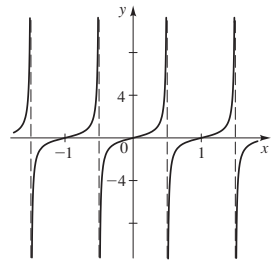
50. $2\pi/3$



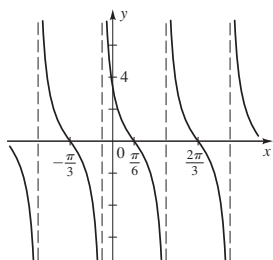
41. $\pi/2$



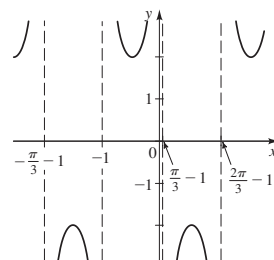
42. 1



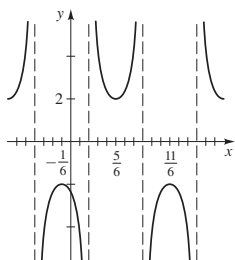
51. $\pi/2$



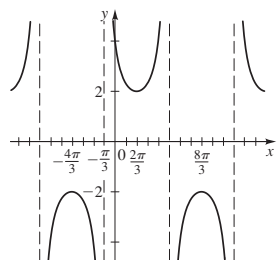
52. $2\pi/3$



43. 2

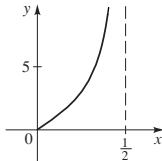


44. 4π



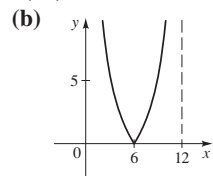
55. (a) 1.53 mi, 3.00 mi, 18.94 mi

(b)



(c) $d(t)$ approaches ∞

56. (a) $S(2) = 10.39$ ft, $S(8) = 3.46$ ft, $S(11\frac{3}{4}) = 91.54$ ft, $S(12)$ is undefined

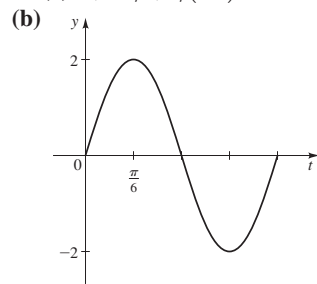


(c) 3, 9; 9:00 A.M., 3:00 P.M.

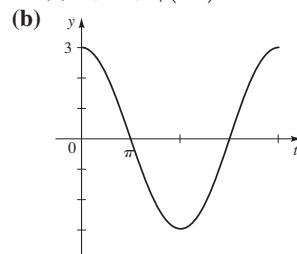
(d) The shadow gets increasingly longer.

Section 5.5 ■ page 451

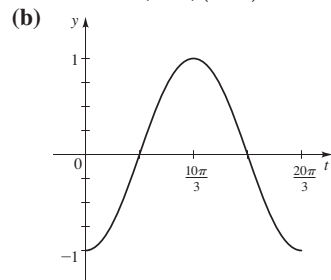
1. (a) $2, 2\pi/3, 3/(2\pi)$



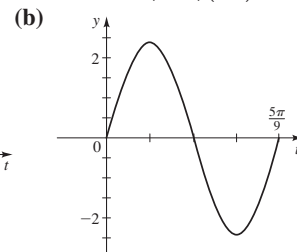
2. (a) $3, 4\pi, 1/(4\pi)$



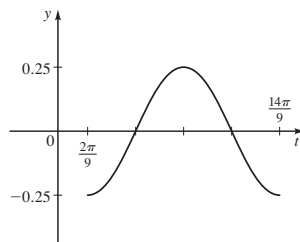
3. (a) $1, 20\pi/3, 3/(20\pi)$



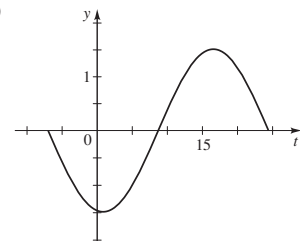
4. (a) $2.4, 5\pi/9, 9/(5\pi)$



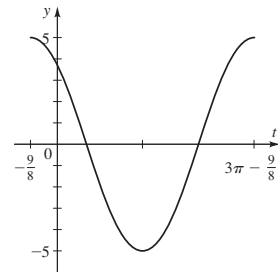
5. (a) $\frac{1}{4}, 4\pi/3, 3/(4\pi)$



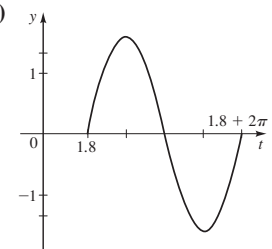
6. (a) $\frac{3}{2}, 10\pi, 1/(10\pi)$



7. (a) $5, 3\pi, 1/(3\pi)$



8. (a) $1.6, 2\pi, 1/(2\pi)$



9. $y = 10 \sin\left(\frac{2\pi}{3}t\right)$

10. $y = 24 \sin(\pi t)$

11. $y = 6 \sin(10t)$

12. $y = 1.2 \sin(\pi t)$

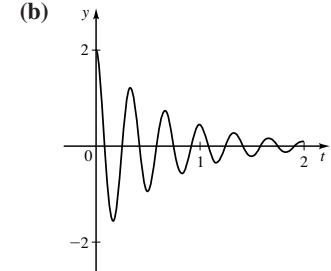
13. $y = 60 \cos(4\pi t)$

14. $y = 35 \cos\left(\frac{1}{4}\pi t\right)$

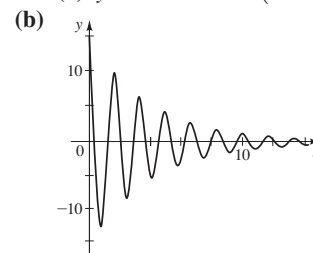
15. $y = 2.4 \cos(1500\pi t)$

16. $y = 6.25 \cos(120\pi t)$

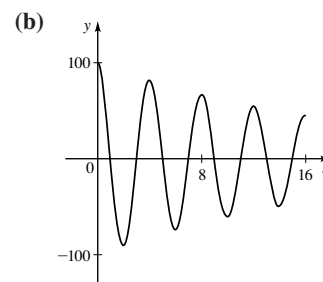
17. (a) $y = 2e^{-1.5t} \cos 6\pi t$



18. (a) $y = 15e^{-0.25t} \cos(1.2\pi t)$

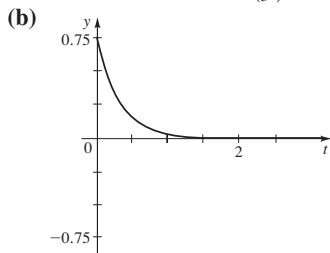


19. (a) $y = 100e^{-0.05t} \cos \frac{\pi}{2}t$

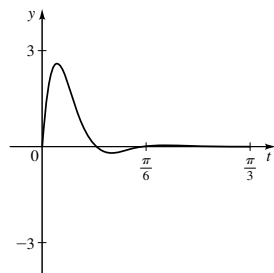


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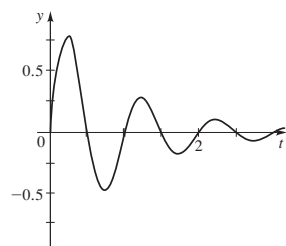
20. (a) $y = 0.75e^{-3t} \cos\left(\frac{2}{3}t\right)$



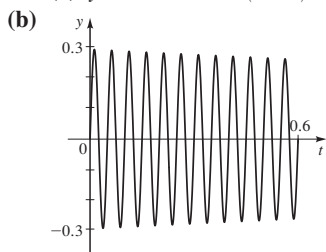
21. (a) $y = 7e^{-10t} \sin 12t$ (b)



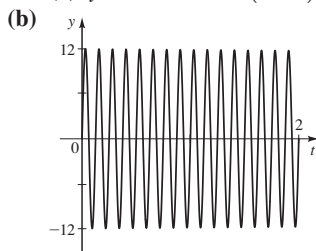
22. (a) $y = e^{-t} \sin(2\pi t)$ (b)



23. (a) $y = 0.3e^{-0.2t} \sin(40\pi t)$



24. (a) $y = 12e^{-0.01t} \sin(16\pi t)$



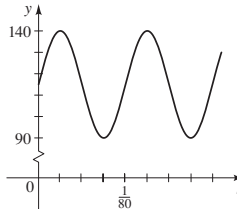
25. (a) 10 cycles per minute

(b) (c) 0.4 m

26. 1.09×10^{-8} , 9.15×10^7

27. (a) 8900 (b) about 3.14 yr

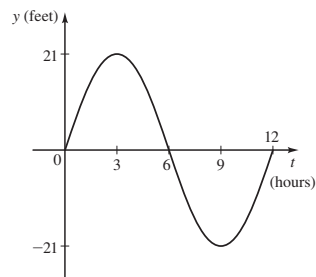
28. (a) 25, 0.0125, 80 (b)



(c) The period decreases and the frequency increases.

29. $d(t) = 5 \sin(5\pi t)$ 30. $y = -6 \sin\left(\frac{\pi}{6}t\right)$

31. $y = 21 \sin\left(\frac{\pi}{6}t\right)$



32. $y = -2 \cos 2\pi t$ 33. $y = 5 \cos(2\pi t)$

34. (a) $f(t) = 5 \cos\left(\sqrt{\frac{3}{10}}t\right)$ (b) $\frac{1}{2\pi} \sqrt{\frac{k}{m}}$

(c) The frequency decreases; slower

(d) The frequency increases; faster

35. $y = 11 + 10 \sin\left(\frac{\pi t}{10}\right)$ 36. $f(t) = 10 \sin \pi t$

37. $y = 3.8 + 0.2 \sin\left(\frac{\pi}{5}t\right)$

38. $R(t) = 20 + 1.5 \sin\left(\frac{2\pi}{5.4}t\right)$, where R is measured in millions of miles and t is measured in days

39. $E(t) = 310 \cos(200\pi t)$, 219.2 V

40. $f(t) = 10 \sin\left(\frac{\pi}{12}(t - 8)\right) + 90$

41. (a) 45 V (b) 40 (c) 40 (d) $E(t) = 45 \cos(80\pi t)$

42. (a) 553.9 Hz; 455.6 Hz (b) $y = A \sin(1107.8\pi t)$,
 $y = A \sin(911.2\pi t)$

43. $f(t) = e^{-0.9t} \sin \pi t$ 44. (a) $f(t) = 6e^{-2.8t} \cos 4\pi t$

(b) $\frac{\ln 12}{2.8} \approx 0.88$ s 45. $e = \frac{1}{3} \ln 4 \approx 0.46$

46. (a) $c = \frac{1}{2} \ln 5 \approx 0.80$ (b) $f(t) = 3e^{-0.8t} \cos 330\pi t$

Chapter 5 Review ■ page 455

1. (b) $\frac{1}{2}, -\sqrt{3}/2, -\sqrt{3}/3$ 2. (b) $-\frac{4}{5}, \frac{3}{5}, -\frac{4}{3}$

3. (a) $\pi/3$ (b) $(-\frac{1}{2}, \sqrt{3}/2)$

(c) $\sin t = \sqrt{3}/2, \cos t = -\frac{1}{2}, \tan t = -\sqrt{3}, \csc t = 2\sqrt{3}/3,$
 $\sec t = -2, \cot t = -\sqrt{3}/3$

4. (a) $\pi/3$ (b) $(\frac{1}{2}, -\sqrt{3}/2)$ (c) $\sin t = -\sqrt{3}/2, \cos t = \frac{1}{2},$
 $\tan t = -\sqrt{3}, \csc t = -2\sqrt{3}/3, \sec t = 2, \cot t = -\sqrt{3}/3$

5. (a) $\pi/4$ (b) $(-\sqrt{2}/2, -\sqrt{2}/2)$

(c) $\sin t = -\sqrt{2}/2, \cos t = -\sqrt{2}/2,$
 $\tan t = 1, \csc t = -\sqrt{2}, \sec t = -\sqrt{2}, \cot t = 1$

6. (a) $\pi/6$ (b) $(-\sqrt{3}/2, \frac{1}{2})$

(c) $\sin t = \frac{1}{2}, \cos t = -\sqrt{3}/2, \tan t = -\sqrt{3}/3,$
 $\csc t = 2, \sec t = -2\sqrt{3}/3, \cot t = -\sqrt{3}$

7. (a) $\sqrt{2}/2$ (b) $-\sqrt{2}/2$ 8. (a) $\sqrt{3}$ (b) $-\sqrt{3}$

9. (a) 0.89121 (b) 0.45360 10. (a) 0.80902 (b) 0.80902

11. (a) 0 (b) Undefined 12. (a) 0.43388 (b) 2.30476

13. (a) Undefined (b) 0 14. (a) 0 (b) Undefined

15. (a) $-\sqrt{3}/3$ (b) $-\sqrt{3}$ 16. (a) $\frac{1}{2}$ (b) $\frac{1}{2}$

17. $(\sin t)/(1 - \sin^2 t)$ 18. $\frac{1 - \cos^2 t}{\cos^3 t}$

19. $(\sin t)/\sqrt{1 - \sin^2 t}$ 20. $\frac{1}{-\sqrt{1 - \sin^2 t}}$

21. $\tan t = -\frac{5}{12}, \csc t = \frac{13}{5}, \sec t = -\frac{13}{12}, \cot t = -\frac{12}{5}$

22. $\cos t = \sqrt{3}/2, \tan t = -\sqrt{3}/3,$
 $\csc t = -2, \sec t = 2\sqrt{3}/3, \cot t = -\sqrt{3}$

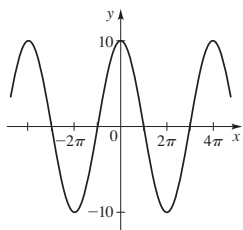
23. $\sin t = 2\sqrt{5}/5, \cos t = -\sqrt{5}/5,$
 $\tan t = -2, \sec t = -\sqrt{5}$

24. $\sin t = \frac{4}{5}, \tan t = -\frac{4}{3}, \csc t = \frac{5}{4}, \sec t = -\frac{5}{3}, \cot t = -\frac{3}{4}$

25. $(16 - \sqrt{17})/4$ 26. $-\frac{119}{120}$ 27. 3 28. 1

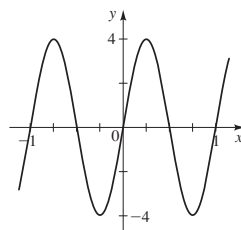
29. (a) 10, 4π , 0

(b)



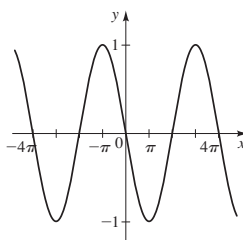
30. (a) 4, 1, 0

(b)



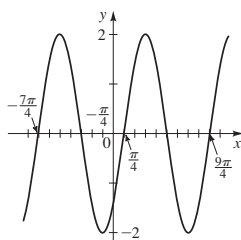
31. (a) 1, 4π , 0

(b)



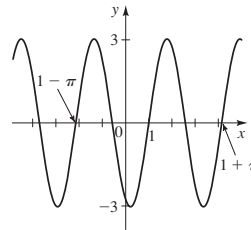
32. (a) 2, 2π , $\pi/4$

(b)



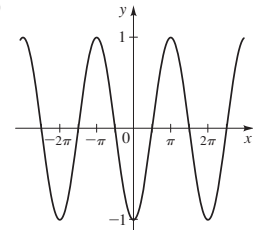
33. (a) 3, π , 1

(b)



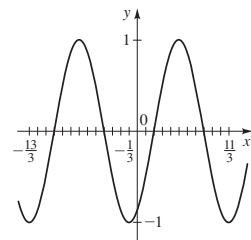
34. (a) 1, π , $\pi/2$

(b)



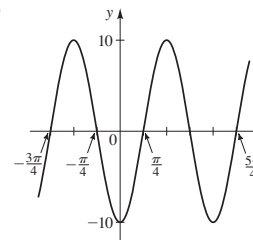
35. (a) 1, 4, $-\frac{1}{3}$

(b)



36. (a) 10, π , $\pi/4$

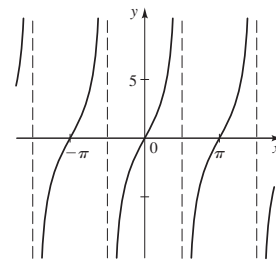
(b)



37. $y = 5 \sin 4x$

39. $y = \frac{1}{2} \sin 2\pi(x + \frac{1}{3})$

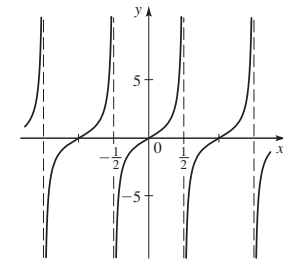
41. π



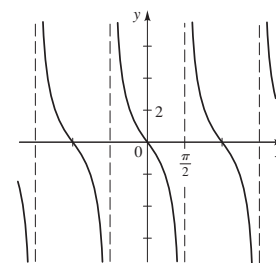
38. $y = 2 \sin(\frac{\pi}{2}x)$

40. $y = 4 \sin \frac{3}{2}(x + \pi/3)$

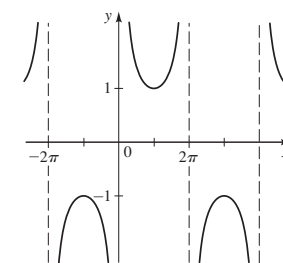
42. 1



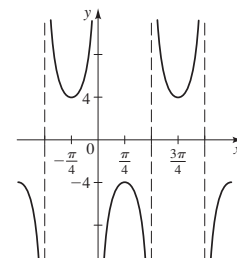
43. π



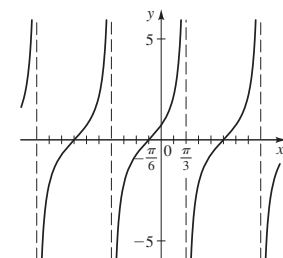
44. 4π



45. π

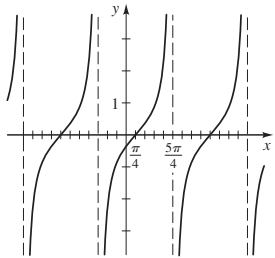


46. π

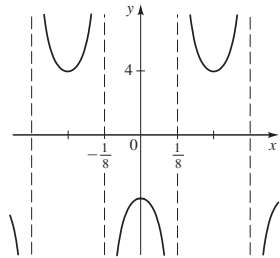


A68 Answers to Exercises and Chapter Tests

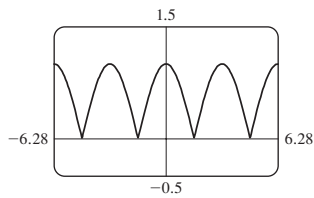
47. 2π



48. $\frac{1}{2}$



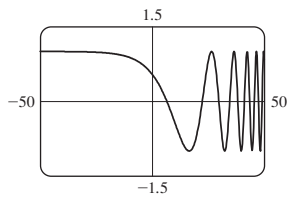
49. (a)



(b) Period π

(c) Even

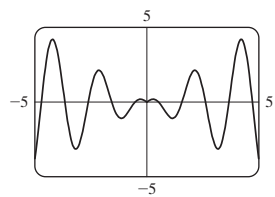
51. (a)



(b) Not periodic

(c) Neither

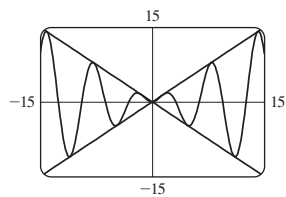
53. (a)



(b) Not periodic

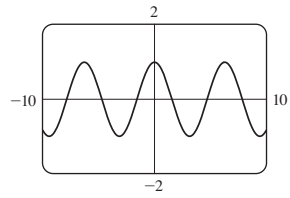
(c) Even

55.



$y = x \sin x$ is a sine function whose graph lies between those of $y = x$ and $y = -x$

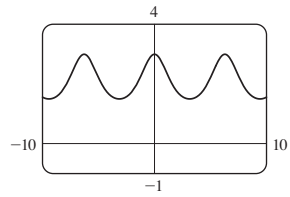
50. (a)



(b) Period 2π

(c) Even

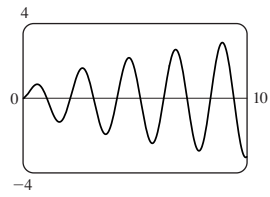
52. (a)



(b) Period 2π

(c) Even

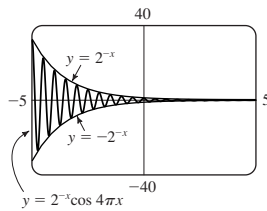
54. (a)



(b) Not periodic

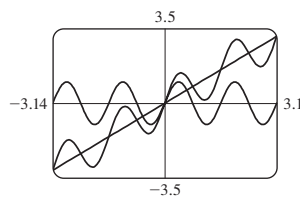
(c) Neither

56.



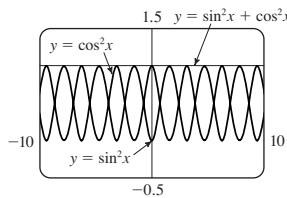
$y = 2^{-x} \cos 4\pi x$ is a cosine function whose graph lies between the graphs of $y = 2^{-x}$ and $y = -2^{-x}$

57.



The graphs are related by graphical addition.

58.

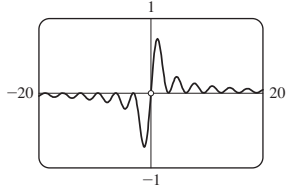


The graphs are related by graphical addition.

59. 1.76, -1.76 60. 1.25, -1 61. 0.30, 2.84 62. 0.390

63. (a) Odd (b) $0, \pm\pi, \pm2\pi, \dots$

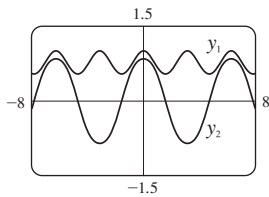
(c)



(d) $f(x)$ approaches 0

(e) $f(x)$ approaches 0

64. (a)



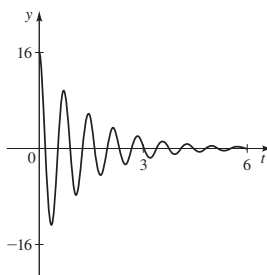
(b) y_1 has period π , y_2 has period 2π

(c) $\sin(\cos x) < \cos(\sin x)$, for all x 65. $y = 50 \cos(16\pi t)$

66. $y = -50 \cos(9\pi t)$ 67. $y = 4 \cos(\frac{\pi}{6}t)$

68. (a) $y = 16e^{-0.72t} \cos 2.8\pi t$

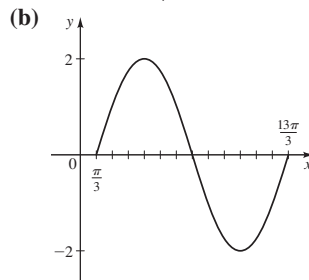
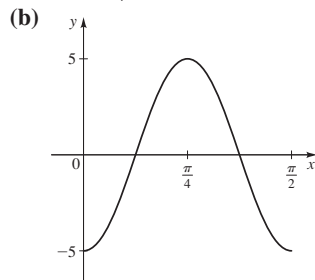
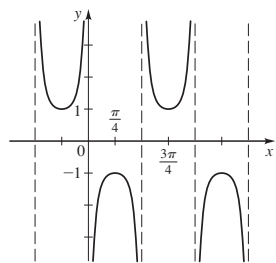
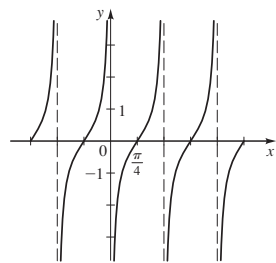
(b)



(c) 0.012 cm

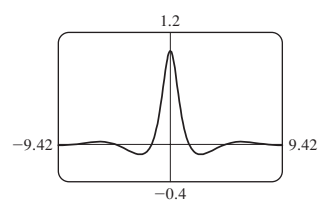
Chapter 5 Test ■ page 458

1. $y = -\frac{5}{6}$ 2. (a) $\frac{4}{5}$ (b) $-\frac{3}{5}$ (c) $-\frac{4}{3}$ (d) $-\frac{5}{3}$
 3. (a) $-\frac{1}{2}$ (b) $-\sqrt{2}/2$ (c) $\sqrt{3}$ (d) -1
 4. $\tan t = -(\sin t)/\sqrt{1 - \sin^2 t}$ 5. $-\frac{2}{15}$
 6. (a) $5, \pi/2, 0$ 7. (a) $2, 4\pi, \pi/3$

8. π 9. $\pi/2$ 

10. $y = 2 \sin 2(x + \pi/3)$

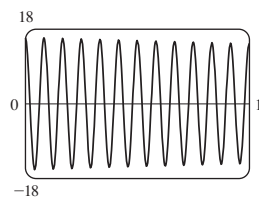
11. (a)



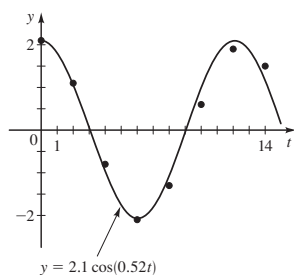
12. $y = 5 \sin(4\pi t)$

13. $y = 16e^{-0.1t} \cos 24\pi t$

(b) Even

(c) Minimum value -0.11 when $x \approx \pm 2.54$, maximum value 1 when $x = 0$ **Focus on Modeling ■ page 463**

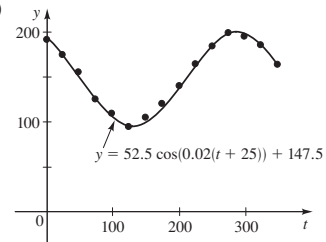
1. (a) and (c)



(b) $y = 2.1 \cos(0.52t)$

(d) $y = 2.05 \sin(0.50t + 1.55) - 0.01$ (e) The formula of (d) reduces to $y = 2.05 \cos(0.50t - 0.02) - 0.01$. Same as (b), correct to one decimal.

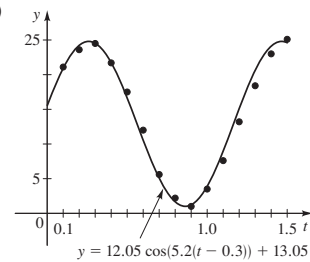
2. (a) and (c)



(b) $y = 52.5 \cos(0.02(t + 25)) + 147.5$

(d) $y = 49.70 \sin(0.02t + 2.09) + 149.13$ (e) The formula of (d) reduces to $y = 49.70 \cos(0.02t + 0.52) + 149.13$. Close, but not identical, to (b).

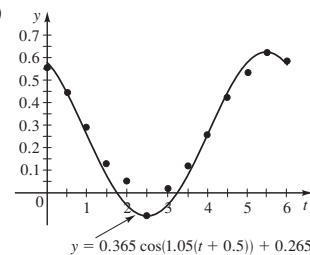
3. (a) and (c)



(b) $y = 12.05 \cos(5.2(t - 0.3)) + 13.05$

(d) $y = 11.72 \sin(5.05t + 0.24) + 12.96$ (e) The formula of (d) reduces to $y = 11.72 \cos(5.05(t - 0.26)) + 12.96$. Close, but not identical, to (b).

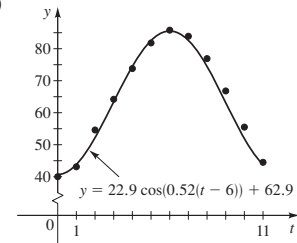
4. (a) and (c)



(b) $y = 0.365 \cos(1.05(t + 0.5)) + 0.265$

(d) $y = 0.33 \sin(1.02t + 2.12) + 0.29$ (e) The formula of (d) reduces to $y = 0.33 \cos(1.02(t + 0.52)) + 0.29$. Same as (b), correct to one decimal.

5. (a) and (c)

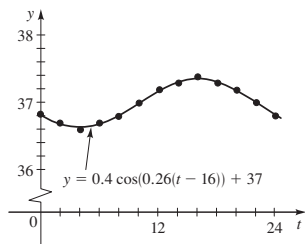


A70 Answers to Exercises and Chapter Tests

(b) $y = 22.9 \cos(0.52(t - 6)) + 62.9$, where y is temperature ($^{\circ}\text{F}$) and t is months (January = 0)

(d) $y = 23.4 \sin(0.48t - 1.36) + 62.2$

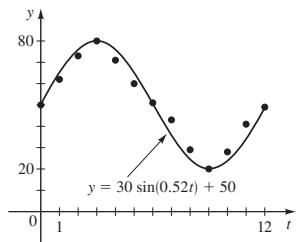
6. (a) and (c)



(b) $y = 0.4 \cos(0.26(t - 16)) + 37$, where y is the body temperature ($^{\circ}\text{C}$) and t is hours since midnight

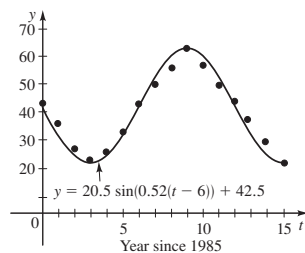
(d) $y = 0.37 \sin(0.26t - 2.62) + 37.0$

7. (a) and (c)



(b) $y = 30 \sin(0.52t) + 50$ where y is the owl population in year t (d) $y = 25.8 \sin(0.52t - 0.02) + 50.6$

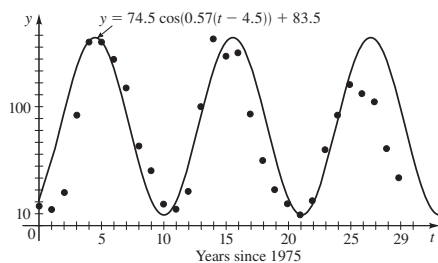
8. (a) and (c)



(b) $y = 20.5 \sin(0.52(t - 6)) + 42.5$, where y is the salmon population ($\times 1000$), and t is years since 1985

(d) $y = 17.8 \sin(0.52t + 3.11) + 42.4$

9. (a) and (c)



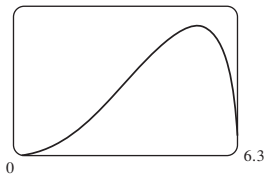
(b) $y = 74.5 \cos(0.57(t - 4.5)) + 83.5$, where y is the average daily sunspot count, and t is the years since 1975

(d) $y = 67.65 \sin(0.62t - 1.65) + 74.5$

Chapter 6

Section 6.1 ■ page 474

1. $2\pi/5 \approx 1.257$ rad
2. $3\pi/10 \approx 0.942$ rad
3. $-\pi/4 \approx -0.785$ rad
4. $-\pi/3 \approx -1.047$ rad
5. $-5\pi/12 \approx -1.309$ rad
6. $-5\pi/3 \approx -5.236$ rad
7. $6\pi \approx 18.850$ rad
8. $22\pi \approx 69.115$ rad
9. $8\pi/15 \approx 1.676$ rad
10. $\pi/12 \approx 0.262$ rad
11. $\pi/24 \approx 0.131$ rad
12. $9\pi/8 \approx 3.534$ rad
13. 210°
14. 660°
15. -225°
16. -270°
17. $540/\pi \approx 171.9^{\circ}$
18. $-360/\pi \approx 114.6^{\circ}$
19. $-216/\pi \approx 68.8^{\circ}$
20. $612/\pi \approx 194.8^{\circ}$
21. 18°
22. 50°
23. -24°
24. -195°
25. $410^{\circ}, 770^{\circ}, -310^{\circ}, -670^{\circ}$
26. $495^{\circ}, 855^{\circ}, -225^{\circ}, -585^{\circ}$
27. $11\pi/4, 19\pi/4, -5\pi/4, -13\pi/4$
28. $23\pi/6, 35\pi/6, -\pi/6, -13\pi/6$
29. $7\pi/4, 15\pi/4, -9\pi/4, -17\pi/4$
30. $315^{\circ}, 675^{\circ}, -405^{\circ}, -765^{\circ}$
31. Yes
32. Yes
33. Yes
34. No
35. Yes
36. No
37. 13°
38. 1°
39. 30°
40. 260°
41. 280°
42. 190°
43. $5\pi/6$
44. $5\pi/3$
45. π
46. $10 - 2\pi \approx 3.717$ rad
47. $\pi/4$
48. $3\pi/2$
49. $55\pi/9 \approx 19.2$
50. $360/\pi \approx 114.6^{\circ}$
51. 4
52. $5\pi/2 \approx 7.85$ m
53. 4 mi
54. $216/\pi \approx 68.8^{\circ}, 1.2$ rad
55. 2 rad $\approx 114.6^{\circ}$
56. 6.88 ft
57. $36/\pi \approx 11.459$ m
58. $16/(3\pi) \approx 1.698$ ft
59. (a) 35.45 (b) 25
60. (a) 5.855 (b) 3.028
61. 50 m²
62. 4.7 mi²
63. 4 m
64. 57.3°
65. 6 cm²
66. $\pi/4$ ft²
67. 13.9 mi
68. 672
69. 330π mi ≈ 1037 mi
70. 110π mi ≈ 346 mi
71. 1.6 million mi
72. 3979 mi, 25,000 mi
73. 1.15 mi
74. $70,000\pi \approx 219,911$ ft²
75. 360π in² ≈ 1130.97 in²
76. 3750π ft² $\approx 11,781$ ft²
77. $32\pi/15$ ft/s ≈ 6.7 ft/s
78. (a) 90π rad/min (b) 1440π in./min ≈ 4523.9 in./min
79. (a) 2000π rad/min (b) $50\pi/3$ ft/s ≈ 52.4 ft/s
80. 1039.6 mi/h
81. 39.3 mi/h
82. (a) 1100 rad/min (b) 175
83. 2.1 m/s
84. (a) 160 rad/min (b) 2080π ft/min ≈ 74.26 mi/h
85. (a) 10π cm ≈ 31.4 cm (b) 5 cm (c) 3.32 cm (d) 86.8 cm³
86. (b) 100

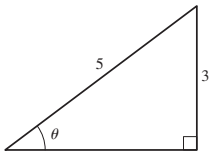


- (c) 5.13 rad
88. $11.5\pi \approx 36.128$ rad, $\frac{23\pi}{24} \approx 3.011$ rad

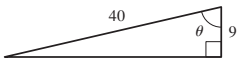
Section 6.2 ■ page 484

1. $\sin \theta = \frac{4}{5}, \cos \theta = \frac{3}{5}, \tan \theta = \frac{4}{3}, \csc \theta = \frac{5}{4}, \sec \theta = \frac{5}{3}, \cot \theta = \frac{3}{4}$
2. $\sin \theta = \frac{7}{25}, \cos \theta = \frac{24}{25}, \tan \theta = \frac{7}{24}, \csc \theta = \frac{25}{7}, \sec \theta = \frac{25}{24}, \cot \theta = \frac{24}{7}$
3. $\sin \theta = \frac{40}{41}, \cos \theta = \frac{9}{41}, \tan \theta = \frac{40}{9}, \csc \theta = \frac{41}{40}, \sec \theta = \frac{41}{9}, \cot \theta = \frac{9}{40}$
4. $\sin \theta = \frac{15}{17}, \cos \theta = \frac{8}{17}, \tan \theta = \frac{15}{8}, \csc \theta = \frac{17}{15}, \sec \theta = \frac{17}{8}, \cot \theta = \frac{8}{15}$

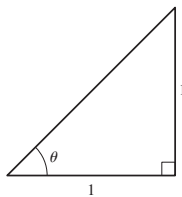
5. $\sin \theta = 2\sqrt{13}/13$, $\cos \theta = 3\sqrt{13}/13$, $\tan \theta = \frac{2}{3}$,
 $\csc \theta = \sqrt{13}/2$, $\sec \theta = \sqrt{13}/3$, $\cot \theta = \frac{3}{2}$
 6. $\sin \theta = \frac{7}{8}$, $\cos \theta = \frac{\sqrt{15}}{8}$, $\tan \theta = \frac{7\sqrt{15}}{15}$,
 $\csc \theta = \frac{8}{7}$, $\sec \theta = \frac{8\sqrt{15}}{15}$, $\cot \theta = \frac{\sqrt{15}}{7}$
 7. (a) $3\sqrt{34}/34$, $3\sqrt{34}/34$ (b) $\frac{3}{5}$, $\frac{3}{5}$ (c) $\sqrt{34}/5$, $\sqrt{34}/5$
 8. (a) $\frac{4}{7}$, $\frac{4}{7}$ (b) $4\sqrt{33}/33$, $4\sqrt{33}/33$ (c) $7\sqrt{33}/33$, $7\sqrt{33}/33$
 9. $\frac{25}{2}$ 10. $12\sqrt{2}$ 11. $13\sqrt{3}/2$ 12. $4\sqrt{3}$ 13. 16.51658
 14. 31.30339 15. $x = 28 \cos \theta$, $y = 28 \sin \theta$
 16. $x = 4 \tan \theta$, $y = 4 \sec \theta$
 17. $\cos \theta = \frac{4}{5}$, $\tan \theta = \frac{3}{4}$, $\csc \theta = \frac{5}{3}$, $\sec \theta = \frac{5}{4}$, $\cot \theta = \frac{4}{3}$



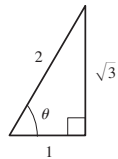
18. $\sin \theta = 7\sqrt{31}/40$, $\tan \theta = 7\sqrt{31}/9$, $\csc \theta = 40\sqrt{31}/217$,
 $\sec \theta = \frac{40}{9}$, $\cot \theta = 9\sqrt{31}/217$



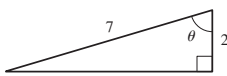
19. $\sin \theta = \sqrt{2}/2$, $\cos \theta = \sqrt{2}/2$, $\tan \theta = 1$,
 $\csc \theta = \sqrt{2}$, $\sec \theta = \sqrt{2}$



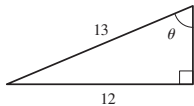
20. $\sin \theta = \sqrt{3}/2$, $\cos \theta = \frac{1}{2}$, $\csc \theta = 2\sqrt{3}/3$,
 $\sec \theta = 2$, $\cot \theta = \sqrt{3}/3$



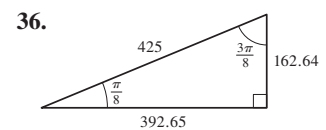
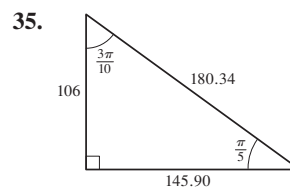
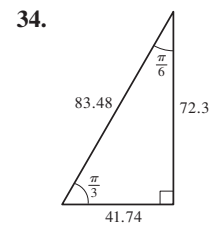
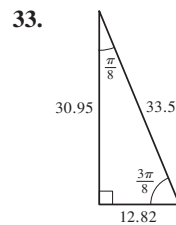
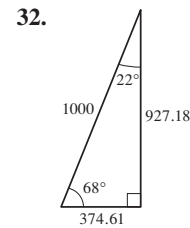
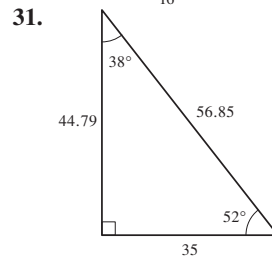
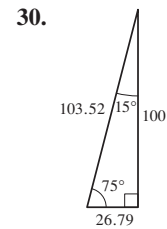
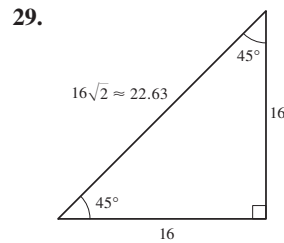
21. $\sin \theta = 3\sqrt{5}/7$, $\cos \theta = \frac{2}{7}$, $\tan \theta = 3\sqrt{5}/2$,
 $\csc \theta = 7\sqrt{5}/15$, $\cot \theta = 2\sqrt{5}/15$



22. $\sin \theta = \frac{12}{13}$, $\cos \theta = \frac{5}{13}$, $\tan \theta = \frac{12}{5}$, $\sec \theta = \frac{13}{5}$, $\cot \theta = \frac{5}{12}$



23. $(1 + \sqrt{3})/2$ 24. 1 25. 1 26. 1 27. $\frac{1}{2}$
 28. $\frac{1}{4}(2 - \sqrt{3})$



37. $\sin \theta \approx 0.45$, $\cos \theta \approx 0.89$, $\tan \theta = 0.50$, $\csc \theta \approx 2.24$,
 $\sec \theta \approx 1.12$, $\cot \theta = 2.00$ 38. $\sin 40^\circ \approx 0.64$,
 $\cos 40^\circ \approx 0.77$, $\tan 40^\circ \approx 0.83$, $\csc 40^\circ \approx 1.56$,
 $\sec 40^\circ \approx 1.39$, $\cot 40^\circ \approx 1.20$ 39. 230.9 40. 98.1
 41. 63.7 42. 5.8 43. $x = 10 \tan \theta \sin \theta$ 44. $a = \sin \theta$,
 $b = \tan \theta$, $c = \sec \theta$, $d = \cos \theta$ 45. 1026 ft
 46. (a) 93,431 ft (b) 86,628 ft 47. (a) 2100 mi (b) No
 48. 471 ft 49. 19 ft 50. 72.5° , 19 ft 51. 38.7° 52. 544 ft
 53. 345 ft 54. 104.5 ft 55. 415 ft, 152 ft 56. 11,379 ft
 57. 2570 ft 58. 3.7 mi 59. 5808 ft 60. 473 m
 61. 91.7 million mi 62. (a) 89.05° (b) 236,000 mi
 63. 3960 mi 64. 2.53×10^{13} mi 65. 0.723 AU

Section 6.3 ■ page 495

1. (a) 30° (b) 30° (c) 30° 2. (a) 60° (b) 30° (c) 60°
 3. (a) 45° (b) 90° (c) 75° 4. (a) 81° (b) 19° (c) 1°
 5. (a) $\pi/4$ (b) $\pi/6$ (c) $\pi/3$ 6. (a) $\pi/3$ (b) $\pi/4$
 (c) $\pi/6$ 7. (a) $2\pi/7$ (b) 0.4π (c) 1.4 8. (a) 0.3π
 (b) 0.84 (c) 0 9. $\frac{1}{2}$ 10. $-\sqrt{2}/2$ 11. $-\sqrt{2}/2$
 12. $\frac{1}{2}$ 13. $-\sqrt{3}$ 14. 2 15. 1 16. $\sqrt{3}$ 17. $-\sqrt{3}/2$
 18. -2 19. $\sqrt{3}/3$ 20. $\frac{1}{2}$ 21. $\sqrt{3}/2$ 22. $-\sqrt{3}/2$
 23. -1 24. $\frac{1}{2}$ 25. $\frac{1}{2}$ 26. $-\sqrt{3}/3$ 27. 2 28. $-\sqrt{2}$
 29. -1 30. $\sqrt{2}/2$ 31. Undefined 32. $-\frac{1}{2}$

A72 Answers to Exercises and Chapter Tests

33. III 34. IV 35. IV 36. II

37. $\tan \theta = -\sqrt{1 - \cos^2 \theta} / \cos \theta$ 38. $\cot \theta = -\frac{\sqrt{1 - \sin^2 \theta}}{\sin \theta}$

39. $\cos \theta = \sqrt{1 - \sin^2 \theta}$ 40. $\sec \theta = \frac{1}{\sqrt{1 - \sin^2 \theta}}$

41. $\sec \theta = -\sqrt{1 + \tan^2 \theta}$ 42. $\csc \theta = -\sqrt{1 + \cot^2 \theta}$

43. $\cos \theta = -\frac{4}{5}$, $\tan \theta = -\frac{3}{4}$, $\csc \theta = \frac{5}{3}$, $\sec \theta = -\frac{5}{4}$,
 $\cot \theta = -\frac{4}{3}$

44. $\sin \theta = -\sqrt{95}/12$, $\tan \theta = \sqrt{95}/7$, $\csc \theta = -12\sqrt{95}/95$,
 $\sec \theta = -12/7$, $\cot \theta = 7\sqrt{95}/95$

45. $\sin \theta = -\frac{3}{5}$, $\cos \theta = \frac{4}{5}$, $\csc \theta = -\frac{5}{3}$, $\sec \theta = \frac{5}{4}$, $\cot \theta = -\frac{4}{3}$

46. $\sin \theta = -2\sqrt{6}/5$, $\cos \theta = \frac{1}{5}$, $\tan \theta = -2\sqrt{6}$,
 $\csc \theta = -5\sqrt{6}/12$, $\cot \theta = -\sqrt{6}/12$

47. $\sin \theta = \frac{1}{2}$, $\cos \theta = \sqrt{3}/2$, $\tan \theta = \sqrt{3}/3$,
 $\sec \theta = 2\sqrt{3}/3$, $\cot \theta = \sqrt{3}$

48. $\sin \theta = -4\sqrt{17}/17$, $\cos \theta = -\sqrt{17}/17$, $\tan \theta = 4$,
 $\csc \theta = -\sqrt{17}/4$, $\sec \theta = -\sqrt{17}$

49. $\sin \theta = 3\sqrt{5}/7$, $\tan \theta = -3\sqrt{5}/2$, $\csc \theta = 7\sqrt{5}/15$,
 $\sec \theta = -\frac{7}{2}$, $\cot \theta = -2\sqrt{5}/15$

50. $\sin \theta = 4\sqrt{17}/17$, $\cos \theta = -\sqrt{17}/17$, $\csc \theta = \sqrt{17}/4$,
 $\sec \theta = -\sqrt{17}$, $\cot \theta = -\frac{1}{4}$ 51. (a) $\sqrt{3}/2$, $\sqrt{3}$

(b) $\frac{1}{2}$, $\sqrt{3}/4$ (c) $\frac{3}{4}$, 0.88967 52. 30.0 53. 19.1 54. 43.3

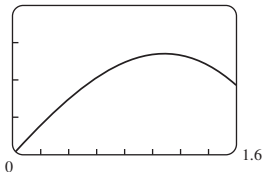
55. 66.1° 56. $\sqrt{96}$ cm ≈ 9.8 cm 57. $(4\pi/3) - \sqrt{3} \approx 2.46$

58. $120\pi + 36\sqrt{3} \approx 439.3$

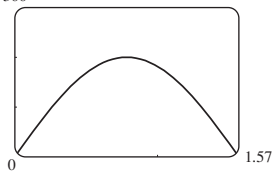
61. (b)

θ	20°	60°	80°	85°
h	1922	9145	29,944	60,351

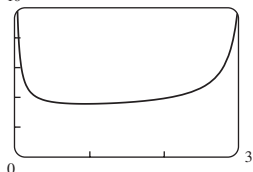
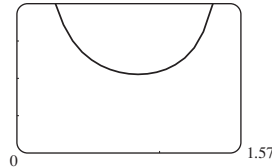
62. (b) 200

(c) 60° 63. (a) $A(\theta) = 400 \sin \theta \cos \theta$

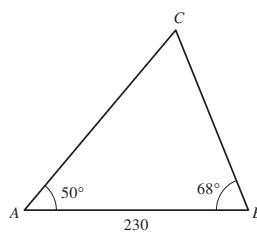
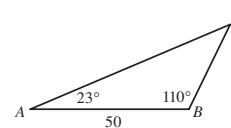
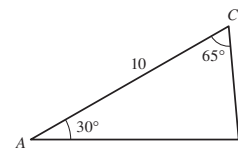
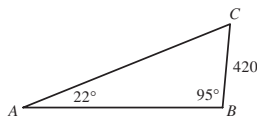
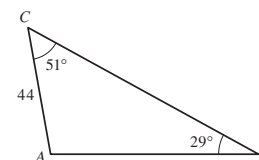
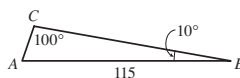
(b) 300

(c) width = depth ≈ 14.14 in. 64. $S(\theta) = 8000 k \cos \theta \sin^2 \theta$ 65. (a) $9\sqrt{3}/4$ ft ≈ 3.897 ft, $\frac{9}{16}$ ft = 0.5625 ft (b) 23.982 ft, 3.462 ft 66. 15.8 s

67. (a) 10

(b) 0.946 rad or 54° 68. (b) 40 (c) 21.07 69. 42° 

Section 6.4 ■ page 506

1. 318.8 2. 25.4 3. 24.8 4. 40.3° 5. 44° 6. 144.97. $\angle C = 114^\circ$, $a \approx 51$, $b \approx 24$ 8. $\angle B = 50^\circ$, $a \approx 1.31$, $c \approx 2.57$ 9. $\angle A = 44^\circ$, $\angle B = 68^\circ$, $a \approx 8.99$ 10. $\angle B \approx 31.0^\circ$, $\angle C \approx 69^\circ$, $c \approx 6.2$ 11. $\angle C = 62^\circ$, $a \approx 200$, $b \approx 242$ 12. $\angle C = 47^\circ$, $a \approx 26.7$, $b \approx 64.2$ 13. $\angle B = 85^\circ$, $a \approx 5$, $c \approx 9$ 14. $\angle C = 63^\circ$, $b \approx 1116.9$, $c \approx 999.0$ 15. $\angle A = 100^\circ$, $a \approx 89$, $c \approx 71$ 16. $\angle A = 70^\circ$, $a \approx 109.7$, $b \approx 20.3$ 17. $\angle B \approx 30^\circ$, $\angle C \approx 40^\circ$, $c \approx 19$ 18. $\angle B_1 \approx 89.6^\circ$, $\angle C_1 \approx 53.4^\circ$, $b_1 \approx 49.8$; $\angle B_2 \approx 16.4^\circ$, $\angle C_2 \approx 126.6^\circ$, $b_2 \approx 14.1$ 19. No solution

20. $\angle A_1 \approx 100.7^\circ$, $\angle B_1 \approx 41.3^\circ$, $a_1 \approx 67.0$;
 $\angle A_2 \approx 3.3^\circ$, $\angle B_2 \approx 138.7^\circ$, $a_2 \approx 3.9$
 21. $\angle A_1 \approx 125^\circ$, $\angle C_1 \approx 30^\circ$, $a_1 \approx 49$;
 $\angle A_2 \approx 5^\circ$, $\angle C_2 \approx 150^\circ$, $a_2 \approx 5.6$
 22. $\angle B_1 \approx 41.8^\circ$, $\angle C_1 \approx 108.2^\circ$, $c_1 \approx 142.5$;
 $\angle B_2 \approx 138.2^\circ$, $\angle C_2 \approx 11.8^\circ$, $c_2 \approx 30.7$ 23. No solution
 24. $\angle B \approx 34.4^\circ$, $\angle C = 10.6^\circ$, $c \approx 25.9$
 25. $\angle A_1 \approx 57.2^\circ$, $\angle B_1 \approx 93.8^\circ$, $b_1 \approx 30.9$;
 $\angle A_2 \approx 122.8^\circ$, $\angle B_2 \approx 28.2^\circ$, $b_2 \approx 14.6$
 26. $\angle A_1 \approx 49.7^\circ$, $\angle C_1 \approx 72.3^\circ$, $a_1 \approx 65.7$;
 $\angle A_2 \approx 14.3^\circ$, $\angle C_2 \approx 107.7^\circ$, $a_2 \approx 21.3$
 27. (a) 91.146° (b) 14.427° 28. 5.25 31. (a) 1018 mi
 (b) 1017 mi 32. (a) 3.77 mi (b) 2.00 mi 33. 219 ft
 34. 678.5 ft 35. 55.9 m 36. 161.1 ft 37. 175 ft
 38. 155 m 39. 192 m 40. 48.2° 41. 0.427 AU, 1.119 AU
 42. (b) 12 cm (c) A plane

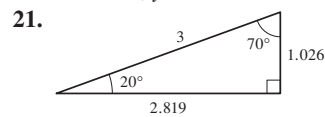
Section 6.5 ■ page 513

1. 28.9 2. 26.8 3. 47 4. 8.2 5. 29.89° 6. 111°
 7. 15 8. 130.54° 9. $\angle A \approx 39.4^\circ$, $\angle B \approx 20.6^\circ$, $c \approx 24.6$
 10. $\angle A \approx 63.0^\circ$, $\angle B \approx 15.5^\circ$, $\angle C \approx 101.5^\circ$
 11. $\angle A \approx 48^\circ$, $\angle B \approx 79^\circ$, $c \approx 3.2$
 12. $\angle B \approx 80.5^\circ$, $\angle C \approx 29.5^\circ$, $a \approx 57.2$
 13. $\angle A \approx 50^\circ$, $\angle B \approx 73^\circ$, $\angle C \approx 57^\circ$
 14. $\angle A \approx 38.6^\circ$, $\angle B \approx 48.5^\circ$, $\angle C \approx 92.9^\circ$
 15. $\angle A_1 \approx 83.6^\circ$, $\angle C_1 \approx 56.4^\circ$, $a_1 \approx 193$;
 $\angle A_2 \approx 16.4^\circ$, $\angle C_2 \approx 123.6^\circ$, $a_2 \approx 54.9$ 16. No such triangle
 17. No such triangle 18. $\angle A = 36^\circ$, $b \approx 109.4$, $c \approx 124.1$
 19. 2 20. 12.2 21. 25.4 22. 21.3° 23. 89.2°
 24. 126.5° 25. 24.3 26. 1180.8 27. 54 28. 0.97
 29. 26.83 30. 549.6 31. 5.33 32. 9.798 33. 40.77
 34. 2.46 35. 3.85 cm² 37. 2.30 mi 38. 7.3, 3.8
 39. 23.1 mi 40. 56.0 mi 41. 2179 mi 42. 28 mi
 43. (a) 62.6 mi (b) S 18.2° E 44. (a) 232.5 mi
 (b) N 50° E 45. 96° 46. 31° 47. 211 ft 48. 161 ft
 49. 3835 ft 50. 1679 ft 51. \$165,554

Chapter 6 Review ■ page 516

1. (a) $\pi/3$ (b) $11\pi/6$ (c) $-3\pi/4$ (d) $-\pi/2$
 2. (a) $2\pi/15$ (b) $-11\pi/6$ (c) $25\pi/6$ (d) $\pi/36$
 3. (a) 450° (b) -30° (c) 405° (d) $(558/\pi)^\circ \approx 177.6^\circ$
 4. (a) $(1440/\pi)^\circ \approx 458.37^\circ$ (b) $(450/\pi)^\circ \approx 143.24^\circ$
 (c) 330° (d) 108° 5. 8 m 6. 1.4 rad $\approx 80.2^\circ$
 7. 82 ft 8. 21,609 9. 0.619 rad $\approx 35.4^\circ$ 10. 25 m²
 11. 18,151 ft² 12. 0.4 rad $\approx 22.9^\circ$
 13. 300π rad/min ≈ 942.5 rad/min,
 7539.8 in./min = 628.3 ft/min
 14. (a) 7000π rad/min $\approx 21,991$ rad/min
 (b) 7777.8π rad/min $\approx 24,434.6$ rad/min
 (c) 268,780 in./min ≈ 255 mi/h
 15. $\sin \theta = 5/\sqrt{74}$, $\cos \theta = 7/\sqrt{74}$, $\tan \theta = \frac{5}{7}$,
 $\csc \theta = \sqrt{74}/5$, $\sec \theta = \sqrt{74}/7$, $\cot \theta = \frac{7}{5}$
 16. $\sin \theta = \frac{3}{10}$, $\cos \theta = \sqrt{91}/10$, $\tan \theta = 3\sqrt{91}/91$,
 $\csc \theta = \frac{10}{3}$, $\sec \theta = 10\sqrt{91}/91$, $\cot \theta = \sqrt{91}/3$

17. $x \approx 3.83$, $y \approx 3.21$ 18. $x \approx 2.44$, $y \approx 1.40$
 19. $x \approx 2.92$, $y \approx 3.11$ 20. $x \approx 3.46$, $y \approx 1.73$



- 22.
-
23. $a = \cot \theta$, $b = \csc \theta$ 24. 550 m
 25. 48 m
 26. $h = \sqrt{64 - 4 \cos^2 \theta} + 2 \sin \theta$
 27. 1076 mi 28. 14,400 ft
 29. $-\sqrt{2}/2$ 30. $\sqrt{2}$
 31. 1 32. $-\sqrt{3}/2$ 33. $-\sqrt{3}/3$
 34. $\sqrt{2}/2$ 35. $-\sqrt{2}/2$ 36. -2

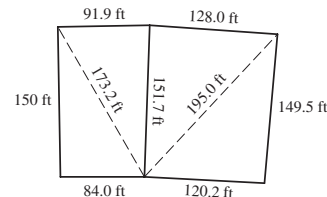
37. $2\sqrt{3}/3$ 38. $2\sqrt{3}/3$ 39. $-\sqrt{3}$ 40. -1
 41. $\sin \theta = \frac{12}{13}$, $\cos \theta = -\frac{5}{13}$, $\tan \theta = -\frac{12}{5}$,
 $\csc \theta = \frac{13}{12}$, $\sec \theta = -\frac{13}{5}$, $\cot \theta = -\frac{5}{12}$ 42. $\frac{1}{2}$ 43. 60°
 44. $\sin \theta = -\sqrt{5}/5$, $\cos \theta = -2\sqrt{5}/5$, $\tan \theta = \frac{1}{2}$,
 $\csc \theta = -\sqrt{5}$, $\sec \theta = -\sqrt{5}/2$, $\cot \theta = 2$
 45. $\tan \theta = -\sqrt{1 - \cos^2 \theta}/\cos \theta$
 46. $\sec \theta = -1/\sqrt{1 - \sin^2 \theta}$ 47. $\tan^2 \theta = \sin^2 \theta/(1 - \sin^2 \theta)$
 48. $\csc^2 \theta \cos^2 \theta = \frac{1}{\sin^2 \theta} - 1$
 49. $\sin \theta = \sqrt{7}/4$, $\cos \theta = \frac{3}{4}$, $\csc \theta = 4\sqrt{7}/7$, $\cot \theta = 3\sqrt{7}/7$
 50. $\sin \theta = -\frac{9}{41}$, $\cos \theta = \frac{40}{41}$, $\tan \theta = -\frac{9}{40}$, $\cot \theta = -\frac{40}{9}$
 51. $\cos \theta = -\frac{4}{5}$, $\tan \theta = -\frac{3}{4}$, $\csc \theta = \frac{5}{3}$, $\sec \theta = -\frac{5}{4}$,
 $\cot \theta = -\frac{4}{3}$
 52. $\sin \theta = -\frac{12}{13}$, $\cos \theta = -\frac{5}{13}$, $\tan \theta = \frac{12}{5}$, $\csc \theta = -\frac{13}{12}$,
 $\cot \theta = \frac{5}{12}$
 53. $-\sqrt{5}/5$ 54. $\sqrt{3}$ 55. 1 56. $-\sqrt{3}/2$ 57. 5.32
 58. 1.46 59. 148.07 60. 9.17 61. 77.82 62. 3.3
 63. 77.3 mi 64. 1160 ft 65. 3.9 mi 66. 80.8 mi
 67. 32.12 68. 14.98

Chapter 6 Test ■ page 520

1. $11\pi/6$, $-3\pi/4$ 2. 240° , -74.5°
 3. (a) 240π rad/min ≈ 753.98 rad/min
 (b) 12,063.7 ft/min = 137 mi/h 4. (a) $\sqrt{2}/2$
 (b) $\sqrt{3}/3$ (c) 2 (d) 1 5. $(26 + 6\sqrt{13})/39$
 6. $a = 24 \sin \theta$, $b = 24 \cos \theta$ 7. $(4 - 3\sqrt{2})/4$
 8. $-\frac{13}{12}$ 9. $\tan \theta = -\sqrt{\sec^2 \theta - 1}$ 10. 19.6 ft
 11. 9.1 12. 250.5 13. 8.4 14. 19.5 15. (a) 15.3 m²
 (b) 24.3 m 16. (a) 129.9° (b) 44.9 17. 554 ft

Focus on Modeling ■ page 523

1. 1.41 mi 2. 1.31 mi
 3. 14.3 m 4. 119.2 m
 5. (c) 2349.8 ft 6. 4194 ft
 7.



Chapter 7

Section 7.1 ■ page 533

1. $\sin t$ 2. $\cot t$ 3. $\tan \theta$ 4. $\sec \theta$ 5. -1 6. $\tan x$
 7. $\csc u$ 8. 1 9. $\tan \theta$ 10. $\sec \theta$ 11. 1 12. $\cos x$
 13. $\cos y$ 14. $\sin x$ 15. $\sin^2 x$ 16. $\sin x$ 17. $\sec x$
 18. 1 19. $2 \sec u$ 20. 1 21. $\cos^2 x$ 22. $\sin A + \cos A$
 23. $\cos \theta$ 24. $1 - \sin x$

$$25. \text{LHS} = \sin \theta \frac{\cos \theta}{\sin \theta} = \text{RHS}$$

$$26. \text{LHS} = \frac{\sin x}{\cos x} \cdot \cos x = \text{RHS}$$

$$27. \text{LHS} = \cos u \frac{1}{\cos u} \cot u = \text{RHS}$$

$$28. \text{LHS} = \frac{\cos x}{\sin x} \cdot \frac{1}{\cos x} \cdot \sin x = \text{RHS}$$

$$29. \text{LHS} = \frac{\sin y}{\cos y} \sin y = \frac{1 - \cos^2 y}{\cos y} = \sec y - \cos y = \text{RHS}$$

$$30. \text{LHS} = \cos v \cdot \frac{\cos v}{\sin v} = \frac{1 - \sin^2 v}{\sin v} = \text{RHS}$$

$$31. \text{LHS} = \sin B + \cos B \frac{\cos B}{\sin B}$$

$$= \frac{\sin^2 B + \cos^2 B}{\sin B} = \frac{1}{\sin B} = \text{RHS}$$

$$32. \text{LHS} = \cos x - (-\sin x) = \text{RHS}$$

$$33. \text{LHS} = -\frac{\cos \alpha}{\sin \alpha} \cos \alpha - \sin \alpha = \frac{-\cos^2 \alpha - \sin^2 \alpha}{\sin \alpha}$$

$$= \frac{-1}{\sin \alpha} = \text{RHS}$$

$$34. \text{LHS} = \csc^2 x - \sin x \csc x = \csc^2 x - 1 = \text{RHS}$$

$$35. \text{LHS} = \frac{\sin \theta}{\cos \theta} + \frac{\cos \theta}{\sin \theta} = \frac{\sin^2 \theta + \cos^2 \theta}{\cos \theta \sin \theta}$$

$$= \frac{1}{\cos \theta \sin \theta} = \text{RHS}$$

$$36. \text{LHS} = \sin^2 x + 2 \sin x \cos x + \cos^2 x = \text{RHS}$$

$$37. \text{LHS} = 1 - \cos^2 \beta = \sin^2 \beta = \text{RHS}$$

$$38. \text{LHS} = \cos^2 x + \sin^2 x = \text{RHS}$$

$$39. \text{LHS} = \frac{(\sin x + \cos x)^2}{(\sin x + \cos x)(\sin x - \cos x)} = \frac{\sin x + \cos x}{\sin x - \cos x}$$

$$= \frac{(\sin x + \cos x)(\sin x - \cos x)}{(\sin x - \cos x)(\sin x - \cos x)} = \text{RHS}$$

$$40. \text{LHS} = [(\sin x + \cos x)^2]^2$$

$$= (\sin^2 x + 2 \sin x \cos x + \cos^2 x)^2 = \text{RHS}$$

$$41. \text{LHS} = \frac{\frac{1}{\cos t} - \cos t}{\frac{1}{\cos t}} \cdot \frac{\cos t}{\cos t} = \frac{1 - \cos^2 t}{1} = \text{RHS}$$

$$42. \text{LHS} = \frac{1 - \sin x}{1 + \sin x} \cdot \frac{1 - \sin x}{1 - \sin x} = \frac{1 - 2 \sin x + \sin^2 x}{1 - \sin^2 x}$$

$$= \frac{1}{\cos^2 x} - \frac{2 \sin x}{\cos^2 x} + \frac{\sin^2 x}{\cos^2 x}$$

$$= \sec^2 x - 2 \sec x \tan x + \tan^2 x$$

$$= (\sec x - \tan x)^2 = \text{RHS}$$

$$43. \text{LHS} = \frac{1}{\cos^2 y} = \sec^2 y = \text{RHS}$$

$$44. \text{LHS} = \frac{1}{\sin x} - \sin x = \frac{1 - \sin^2 x}{\sin x} = \frac{\cos^2 x}{\sin x} = \text{RHS}$$

$$45. \text{LHS} = \cot x \cos x + \cot x - \csc x \cos x - \csc x$$

$$= \frac{\cos^2 x}{\sin x} + \frac{\cos x}{\sin x} - \frac{\cos x}{\sin x} - \frac{1}{\sin x} = \frac{\cos^2 x - 1}{\sin x}$$

$$= \frac{-\sin^2 x}{\sin x} = \text{RHS}$$

$$46. \text{LHS} = (\sin^2 \theta)^2 - (\cos^2 \theta)^2$$

$$= (\sin^2 \theta - \cos^2 \theta)(\sin^2 \theta + \cos^2 \theta) = \text{RHS}$$

$$47. \text{LHS} = \sin^2 x \left(1 + \frac{\cos^2 x}{\sin^2 x} \right) = \sin^2 x + \cos^2 x = \text{RHS}$$

$$48. \text{LHS} = \cos^2 x - (1 - \cos^2 x) = 2 \cos^2 x - 1 = \text{RHS}$$

$$49. \text{LHS} = 2(1 - \sin^2 x) - 1 = 2 - 2 \sin^2 x - 1 = \text{RHS}$$

$$50. \text{LHS} = \left(\frac{\sin y}{\cos y} + \frac{\cos y}{\sin y} \right) \sin y \cos y$$

$$= \sin^2 y + \cos^2 y = \text{RHS}$$

$$51. \text{LHS} = \frac{1 - \cos \alpha}{\sin \alpha} \cdot \frac{1 + \cos \alpha}{1 + \cos \alpha}$$

$$= \frac{1 - \cos^2 \alpha}{\sin \alpha(1 + \cos \alpha)} = \frac{\sin^2 \alpha}{\sin \alpha(1 + \cos \alpha)} = \text{RHS}$$

$$52. \text{LHS} = 1 + \tan^2 \alpha = \sec^2 \alpha = \text{RHS}$$

$$53. \text{LHS} = \frac{\sin^2 \theta}{\cos^2 \theta} - \frac{\sin^2 \theta \cos^2 \theta}{\cos^2 \theta}$$

$$= \frac{\sin^2 \theta(1 - \cos^2 \theta)}{\cos^2 \theta} = \frac{\sin^2 \theta \sin^2 \theta}{\cos^2 \theta} = \text{RHS}$$

$$54. \text{LHS} = \frac{\cos^2 \theta}{\sin^2 \theta} \cos^2 \theta = \frac{\cos^2 \theta(1 - \sin^2 \theta)}{\sin^2 \theta}$$

$$= \frac{\cos^2 \theta}{\sin^2 \theta} - \frac{\cos^2 \theta \sin^2 \theta}{\sin^2 \theta} = \text{RHS}$$

$$55. \text{LHS} = \frac{\sin x - 1}{\sin x + 1} \cdot \frac{\sin x + 1}{\sin x + 1} = \frac{\sin^2 x - 1}{(\sin x + 1)^2} = \text{RHS}$$

$$56. \text{LHS} = \frac{\sin w}{\sin w + \cos w} \cdot \frac{\frac{1}{\cos w}}{\frac{1}{\cos w}} = \frac{\frac{\sin w}{\cos w}}{\frac{\sin w}{\cos w} + \frac{\cos w}{\cos w}} = \text{RHS}$$

$$57. \text{LHS} = \frac{\sin^2 t + 2 \sin t \cos t + \cos^2 t}{\sin t \cos t}$$

$$= \frac{\sin^2 t + \cos^2 t}{\sin t \cos t} + \frac{2 \sin t \cos t}{\sin t \cos t} = \frac{1}{\sin t \cos t} + 2$$

$$= \text{RHS}$$

$$\begin{aligned} 58. \text{ LHS} &= \frac{1}{\cos t} \cdot \frac{1}{\sin t} \cdot \left(\frac{\sin t}{\cos t} + \frac{\cos t}{\sin t} \right) \\ &= \frac{1}{\cos^2 t} + \frac{1}{\sin^2 t} = \text{RHS} \end{aligned}$$

$$59. \text{ LHS} = \frac{1 + \frac{\sin^2 u}{\cos^2 u} \cdot \cos^2 u}{1 - \frac{\sin^2 u}{\cos^2 u} \cdot \cos^2 u} = \frac{\cos^2 u + \sin^2 u}{\cos^2 u - \sin^2 u} = \text{RHS}$$

$$60. \text{ LHS} = \frac{1 + \sec^2 x}{\sec^2 x} = \frac{1}{\sec^2 x} + 1 = \cos^2 x + 1 = \text{RHS}$$

$$\begin{aligned} 61. \text{ LHS} &= \frac{\sec x}{\sec x - \tan x} \cdot \frac{\sec x + \tan x}{\sec x + \tan x} \\ &= \frac{\sec x(\sec x + \tan x)}{\sec^2 x - \tan^2 x} = \text{RHS} \end{aligned}$$

$$62. \text{ LHS} = \frac{\frac{1}{\cos x} + \frac{1}{\sin x}}{\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x}} \cdot \frac{\sin x \cos x}{\sin x \cos x} = \frac{\sin x + \cos x}{\sin^2 x + \cos^2 x} = \text{RHS}$$

$$\begin{aligned} 63. \text{ LHS} &= (\sec v - \tan v) \cdot \frac{\sec v + \tan v}{\sec v + \tan v} \\ &= \frac{\sec^2 v - \tan^2 v}{\sec v + \tan v} = \text{RHS} \end{aligned}$$

$$\begin{aligned} 64. \text{ LHS} &= \frac{\sin A}{1 - \cos A} \cdot \frac{1 + \cos A}{1 + \cos A} - \cot A \\ &= \frac{\sin A(1 + \cos A)}{1 - \cos^2 A} - \cot A \\ &= \frac{\sin A(1 + \cos A)}{\sin^2 A} - \frac{\cos A}{\sin A} \\ &= \frac{1}{\sin A} + \frac{\cos A}{\sin A} - \frac{\cos A}{\sin A} = \text{RHS} \end{aligned}$$

$$\begin{aligned} 65. \text{ LHS} &= \frac{\sin x + \cos x}{\frac{1}{\cos x} + \frac{1}{\sin x}} = \frac{\sin x + \cos x}{\frac{\sin x + \cos x}{\cos x \sin x}} \\ &= (\sin x + \cos x) \frac{\cos x \sin x}{\sin x + \cos x} = \text{RHS} \end{aligned}$$

$$\begin{aligned} 66. \text{ LHS} &= \frac{1 - \cos x}{\sin x} \cdot \frac{1 - \cos x}{1 - \cos x} + \frac{\sin x}{1 - \cos x} \cdot \frac{\sin x}{\sin x} \\ &= \frac{1 - 2 \cos x + \cos^2 x + \sin^2 x}{\sin x(1 - \cos x)} = \frac{2 - 2 \cos x}{\sin x(1 - \cos x)} \\ &= \frac{2(1 - \cos x)}{\sin x(1 - \cos x)} = \text{RHS} \end{aligned}$$

$$\begin{aligned} 67. \text{ LHS} &= \frac{\frac{1}{\sin x} - \frac{\cos x}{\sin x}}{\frac{1}{\cos x} - 1} \cdot \frac{\sin x \cos x}{\sin x \cos x} = \frac{\cos x(1 - \cos x)}{\sin x(1 - \cos x)} \\ &= \frac{\cos x}{\sin x} = \text{RHS} \end{aligned}$$

$$68. \text{ LHS} = \frac{1}{\sec^2 x} = \cos^2 x = \text{RHS}$$

$$69. \text{ LHS} = \frac{\sin^2 u}{\cos^2 u} - \frac{\sin^2 u \cos^2 u}{\cos^2 u} = \frac{\sin^2 u}{\cos^2 u} (1 - \cos^2 u) = \text{RHS}$$

$$\begin{aligned} 70. \text{ LHS} &= \frac{\tan v \sin v}{\tan v + \sin v} \cdot \frac{\tan v - \sin v}{\tan v - \sin v} \\ &= \frac{\tan v \sin v (\tan v - \sin v)}{\tan^2 v - \sin^2 v} \\ &= \frac{\tan v \sin v (\tan v - \sin v)}{\sin^2 v (\sec^2 v - 1)} \\ &= \frac{\tan v \sin v (\tan v - \sin v)}{\sin^2 v \tan^2 v} = \text{RHS} \end{aligned}$$

$$71. \text{ LHS} = (\sec^2 x - \tan^2 x)(\sec^2 x + \tan^2 x) = \text{RHS}$$

$$\begin{aligned} 72. \text{ LHS} &= \frac{\cos \theta}{1 - \sin \theta} \cdot \frac{1 + \sin \theta}{1 + \sin \theta} = \frac{\cos \theta(1 + \sin \theta)}{1 - \sin^2 \theta} \\ &= \frac{\cos \theta(1 + \sin \theta)}{\cos^2 \theta} = \text{RHS} \end{aligned}$$

$$\begin{aligned} 73. \text{ RHS} &= \frac{\sin \theta - \frac{1}{\sin \theta}}{\cos \theta - \frac{\cos \theta}{\sin \theta}} = \frac{\frac{\sin^2 \theta - 1}{\sin \theta}}{\frac{\cos \theta \sin \theta - \cos \theta}{\sin \theta}} \\ &= \frac{\cos^2 \theta}{\cos \theta(\sin \theta - 1)} = \text{LHS} \end{aligned}$$

$$74. \text{ LHS} = \frac{1 + \frac{\sin x}{\cos x} \cdot \cos x}{1 - \frac{\sin x}{\cos x} \cdot \cos x} = \frac{\cos x + \sin x}{\cos x - \sin x} = \text{RHS}$$

$$\begin{aligned} 75. \text{ LHS} &= \frac{-\sin^2 t + \tan^2 t}{\sin^2 t} = -1 + \frac{\sin^2 t}{\cos^2 t} \cdot \frac{1}{\sin^2 t} \\ &= -1 + \sec^2 t = \text{RHS} \end{aligned}$$

$$\begin{aligned} 76. \text{ LHS} &= \frac{(1 + \sin x) - (1 - \sin x)}{(1 - \sin x)(1 + \sin x)} = \frac{2 \sin x}{1 - \sin^2 x} = \frac{2 \sin x}{\cos^2 x} \\ &= 2 \frac{1}{\cos x} \cdot \frac{\sin x}{\cos x} = \text{RHS} \end{aligned}$$

$$\begin{aligned} 77. \text{ LHS} &= \frac{\sec x - \tan x + \sec x + \tan x}{(\sec x + \tan x)(\sec x - \tan x)} \\ &= \frac{2 \sec x}{\sec^2 x - \tan^2 x} = \text{RHS} \end{aligned}$$

$$\begin{aligned} 78. \text{ LHS} &= \frac{(1 + \sin x)^2 - (1 - \sin x)^2}{(1 - \sin x)(1 + \sin x)} \\ &= \frac{1 + 2 \sin x + \sin^2 x - 1 + 2 \sin x - \sin^2 x}{1 - \sin^2 x} \\ &= \frac{4 \sin x}{\cos^2 x} = 4 \frac{\sin x}{\cos x} \cdot \frac{1}{\cos x} = \text{RHS} \end{aligned}$$

$$79. \text{ LHS} = \tan^2 x + 2 \tan x \cot x + \cot^2 x = \tan^2 x + 2 + \cot^2 x = (\tan^2 x + 1) + (\cot^2 x + 1) = \text{RHS}$$

$$80. \text{ LHS} = (\sec^2 x - 1) - (\csc^2 x - 1) = \sec^2 x - \csc^2 x = \text{RHS}$$

$$81. \text{ LHS} = \frac{\frac{1}{\cos u} - 1}{\frac{1}{\cos u} + 1} \cdot \frac{\cos u}{\cos u} = \text{RHS}$$

$$\begin{aligned} 82. \text{ LHS} &= \frac{\cot x + 1}{\cot x - 1} \cdot \frac{\tan x}{\tan x} = \frac{\tan x \cot x + \tan x}{\tan x \cot x - \tan x} \\ &= \frac{1 + \tan x}{1 - \tan x} = \text{RHS} \end{aligned}$$

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$$83. \text{LHS} = \frac{(\sin x + \cos x)(\sin^2 x - \sin x \cos x + \cos^2 x)}{\sin x + \cos x}$$

$$= \sin^2 x - \sin x \cos x + \cos^2 x = \text{RHS}$$

$$84. \text{LHS} = \frac{\tan v - \cot v}{(\tan v - \cot v)(\tan v + \cot v)}$$

$$= \frac{1}{\tan v + \cot v} = \frac{1}{\frac{\sin v}{\cos v} + \frac{\cos v}{\sin v}} \cdot \frac{\sin v \cos v}{\sin v \cos v}$$

$$= \frac{\sin v \cos v}{\sin^2 v + \cos^2 v} = \text{RHS}$$

$$85. \text{LHS} = \frac{1 + \sin x}{1 - \sin x} \cdot \frac{1 + \sin x}{1 + \sin x} = \frac{(1 + \sin x)^2}{1 - \sin^2 x}$$

$$= \frac{(1 + \sin x)^2}{\cos^2 x} = \left(\frac{1 + \sin x}{\cos x}\right)^2 = \text{RHS}$$

$$86. \text{LHS} = \frac{\frac{\sin x}{\cos x} + \frac{\sin y}{\cos y}}{\frac{\cos x}{\sin x} + \frac{\cos y}{\sin y}} = \left(\frac{\sin x \cos y + \cos x \sin y}{\cos x \cos y}\right)$$

$$\times \left(\frac{\sin x \sin y}{\cos x \sin y + \sin x \cos y}\right)$$

$$= \frac{\sin x \sin y}{\cos x \cos y} = \tan x \tan y = \text{RHS}$$

$$87. \text{LHS} = \left(\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x}\right)^4 = \left(\frac{\sin^2 x + \cos^2 x}{\sin x \cos x}\right)^4$$

$$= \left(\frac{1}{\sin x \cos x}\right)^4 = \text{RHS}$$

$$88. \text{LHS} = \left(\sin \alpha - \frac{\sin \alpha}{\cos \alpha}\right) \left(\cos \alpha - \frac{\cos \alpha}{\sin \alpha}\right)$$

$$= \sin \alpha \left(1 - \frac{1}{\cos \alpha}\right) \cdot \cos \alpha \left(1 - \frac{1}{\sin \alpha}\right)$$

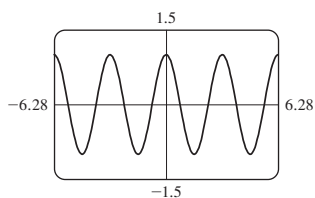
$$= \cos \alpha \left(1 - \frac{1}{\cos \alpha}\right) \sin \alpha \left(1 - \frac{1}{\sin \alpha}\right)$$

$$= (\cos \alpha - 1)(\sin \alpha - 1) = \text{RHS}$$

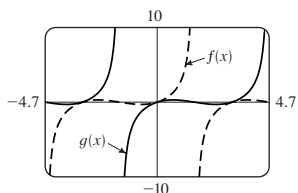
$$89. \tan \theta \quad 90. \sec \theta \quad 91. \tan \theta \quad 92. \frac{1}{8} \cot^2 \theta \cos \theta$$

$$93. 3 \cos \theta \quad 94. \sin \theta$$

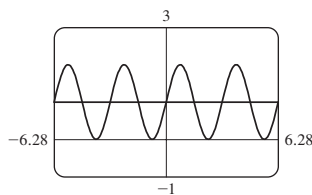
95. Yes



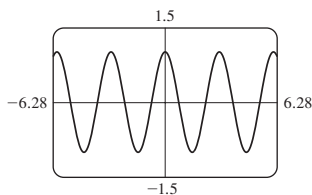
96. No



97. No



98. Yes



Section 7.2 ■ page 539

$$1. \frac{\sqrt{6} + \sqrt{2}}{4} \quad 2. \frac{\sqrt{6} - \sqrt{2}}{4} \quad 3. \frac{\sqrt{2} - \sqrt{6}}{4}$$

$$4. -\frac{\sqrt{2} + \sqrt{6}}{4} \quad 5. 2 - \sqrt{3} \quad 6. \sqrt{3} - 2$$

$$7. -\frac{\sqrt{6} + \sqrt{2}}{4} \quad 8. \frac{\sqrt{2} - \sqrt{6}}{4} \quad 9. \sqrt{3} - 2$$

$$10. -\frac{\sqrt{6} + \sqrt{2}}{4} \quad 11. -\frac{\sqrt{6} + \sqrt{2}}{4} \quad 12. -(2 + \sqrt{3})$$

$$13. \sqrt{2}/2 \quad 14. 0 \quad 15. \frac{1}{2} \quad 16. \sqrt{3}/3 \quad 17. \sqrt{3} \quad 18. -\frac{1}{2}$$

$$19. \text{LHS} = \frac{\sin(\frac{\pi}{2} - u)}{\cos(\frac{\pi}{2} - u)} = \frac{\sin \frac{\pi}{2} \cos u - \cos \frac{\pi}{2} \sin u}{\cos \frac{\pi}{2} \cos u + \sin \frac{\pi}{2} \sin u}$$

$$= \frac{\cos u}{\sin u} = \text{RHS}$$

$$20. \text{LHS} = \frac{\cos(\frac{\pi}{2} - u)}{\sin(\frac{\pi}{2} - u)} = \frac{\cos \frac{\pi}{2} \cos u + \sin \frac{\pi}{2} \sin u}{\sin \frac{\pi}{2} \cos u - \cos \frac{\pi}{2} \sin u}$$

$$= \frac{\sin u}{\cos u} = \text{RHS}$$

$$21. \text{LHS} = \frac{1}{\cos(\frac{\pi}{2} - u)} = \frac{1}{\cos \frac{\pi}{2} \cos u + \sin \frac{\pi}{2} \sin u}$$

$$= \frac{1}{\sin u} = \text{RHS}$$

$$22. \text{LHS} = \frac{1}{\sin(\frac{\pi}{2} - u)} = \frac{1}{\sin \frac{\pi}{2} \cos u - \cos \frac{\pi}{2} \sin u}$$

$$= \frac{1}{\cos u} = \text{RHS}$$

$$23. \text{LHS} = \sin x \cos \frac{\pi}{2} - \cos x \sin \frac{\pi}{2} = \text{RHS}$$

$$24. \text{LHS} = \cos x \cos \frac{\pi}{2} + \sin x \sin \frac{\pi}{2} = \text{RHS}$$

$$25. \text{LHS} = \sin x \cos \pi - \cos x \sin \pi = \text{RHS}$$

$$26. \text{LHS} = \cos x \cos \pi + \sin x \sin \pi = \text{RHS}$$

$$27. \text{LHS} = \frac{\tan x - \tan \pi}{1 + \tan x \tan \pi} = \text{RHS}$$

$$28. \text{LHS} = \sin\left(\frac{\pi}{2} - x\right) = \sin \frac{\pi}{2} \cos x - \cos \frac{\pi}{2} \sin x = \cos x$$

$$\text{RHS} = \sin\left(\frac{\pi}{2} + x\right) = \sin \frac{\pi}{2} \cos x + \cos \frac{\pi}{2} \sin x = \cos x$$

$$29. \text{LHS} = \cos x \cos \frac{\pi}{6} - \sin x \sin \frac{\pi}{6} + \sin x \cos \frac{\pi}{3} - \cos x \sin \frac{\pi}{3}$$

$$= \frac{\sqrt{3}}{2} \cos x - \frac{1}{2} \sin x + \frac{1}{2} \sin x - \frac{\sqrt{3}}{2} \cos x = \text{RHS}$$

$$30. \text{LHS} = \frac{\tan x - \tan \frac{\pi}{4}}{1 + \tan x \tan \frac{\pi}{4}} = \text{RHS}$$

$$31. \text{LHS} = \sin x \cos y + \cos x \sin y$$

$$- (\sin x \cos y - \cos x \sin y) = \text{RHS}$$

$$32. \text{LHS} = \cos x \cos y - \sin x \sin y + \cos x \cos y$$

$$+ \sin x \sin y = \text{RHS}$$

$$33. \text{LHS} = \frac{1}{\tan(x-y)} = \frac{1 + \tan x \tan y}{\tan x - \tan y}$$

$$= \frac{1 + \frac{1}{\cot x \cot y}}{\frac{1}{\cot x} - \frac{1}{\cot y}} \cdot \frac{\cot x \cot y}{\cot x \cot y} = \text{RHS}$$

$$34. \text{LHS} = \frac{1}{\tan(x+y)} = \frac{1 - \tan x \tan y}{\tan x + \tan y}$$

$$= \frac{1 - \frac{1}{\cot x \cot y}}{\frac{1}{\cot x} + \frac{1}{\cot y}} \cdot \frac{\cot x \cot y}{\cot x \cot y}$$

$$= \frac{\cot x \cot y - 1}{\cot x + \cot y} = \text{RHS}$$

$$35. \text{LHS} = \frac{\sin x}{\cos x} - \frac{\sin y}{\cos y} = \frac{\sin x \cos y - \cos x \sin y}{\cos x \cos y} = \text{RHS}$$

$$36. \text{LHS} = 1 - \frac{\sin x \sin y}{\cos x \cos y} = \frac{\cos x \cos y - \sin x \sin y}{\cos x \cos y} = \text{RHS}$$

$$37. \text{LHS} = \frac{\sin x \cos y + \cos x \sin y - (\sin x \cos y - \cos x \sin y)}{\cos x \cos y - \sin x \sin y + \cos x \cos y + \sin x \sin y}$$

$$= \frac{2 \cos x \sin y}{2 \cos x \cos y} = \text{RHS}$$

$$38. \text{LHS} = (\cos x \cos y - \sin x \sin y)(\cos x \cos y + \sin x \sin y)$$

$$= \cos^2 x \cos^2 y - \sin^2 x \sin^2 y$$

$$= \cos^2 x (1 - \sin^2 y) - (1 - \cos^2 x) \sin^2 y$$

$$= \cos^2 x - \sin^2 y \cos^2 x + \sin^2 y \cos^2 x - \sin^2 y = \text{RHS}$$

$$39. \text{LHS} = \sin((x+y)+z)$$

$$= \sin(x+y) \cos z + \cos(x+y) \sin z$$

$$= \cos z [\sin x \cos y + \cos x \sin y]$$

$$+ \sin z [\cos x \cos y - \sin x \sin y] = \text{RHS}$$

$$40. \text{LHS} = \tan(x-y+y-z)[1 - \tan(x-y) \tan(y-z)]$$

$$+ \tan(z-x)$$

$$= \tan(x-z)[1 - \tan(x-y) \tan(y-z)]$$

$$+ \tan(z-x)$$

$$= \tan(x-z) + \tan(z-x) - \tan(x-y)$$

$$\times \tan(y-z) \tan(x-z)$$

$$= \tan(x-z) - \tan(x-z) - \tan(x-y)$$

$$\times \tan(y-z) \tan(x-z)$$

$$= 0 - \tan(x-y) \tan(y-z) \tan(x-z) = \text{RHS}$$

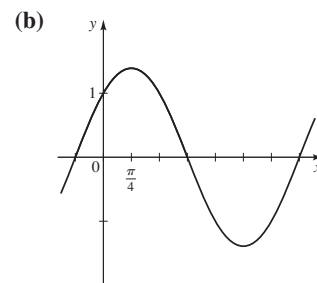
$$41. 2 \sin\left(x + \frac{5\pi}{6}\right)$$

$$42. \sqrt{2} \sin\left(x + \frac{\pi}{4}\right)$$

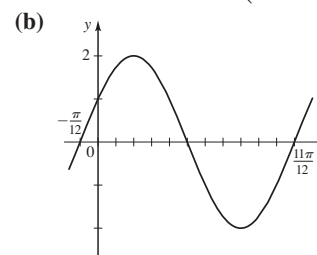
$$43. 5\sqrt{2} \sin\left(2x + \frac{7\pi}{4}\right)$$

$$44. 6 \sin \pi\left(x + \frac{1}{3}\right)$$

$$45. \text{(a)} f(x) = \sqrt{2} \sin\left(x + \frac{\pi}{4}\right)$$

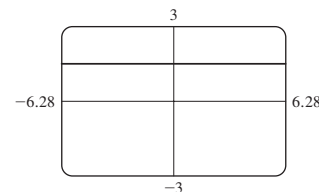


$$46. \text{(a)} g(x) = 2 \sin 2\left(x + \frac{\pi}{12}\right)$$



$$49. \tan \gamma = \frac{17}{6} \quad 50. \text{(c)} 3\pi/4$$

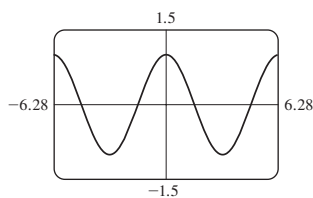
51. (a)



$$\sin^2\left(x + \frac{\pi}{4}\right) + \sin^2\left(x - \frac{\pi}{4}\right) = 1$$

A78 Answers to Exercises and Chapter Tests

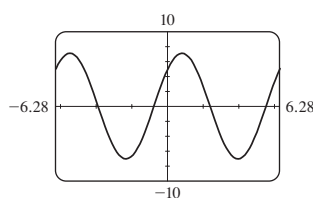
52. (a)



$$-\frac{1}{2}[\cos(x + \pi) + \cos(x - \pi)] = \cos x$$

53. $\pi/2$

54. (a)

(b) $k = 5\sqrt{2}$, $\phi = \pi/4$ 55. (b) $k = 10\sqrt{3}$, $\phi = \pi/6$

Section 7.3 ■ page 548

1. $\frac{120}{169}, \frac{119}{169}, \frac{120}{119}$ 2. $-\frac{24}{25}, -\frac{7}{25}, \frac{24}{7}$ 3. $-\frac{24}{25}, \frac{7}{25}, -\frac{24}{7}$
 4. $-\sqrt{15}/8, \frac{7}{8}, -\sqrt{15}/7$ 5. $\frac{24}{25}, \frac{7}{25}, \frac{24}{7}$ 6. $-\sqrt{3}/2, -\frac{1}{2}, \sqrt{3}$
 7. $-\frac{3}{5}, \frac{4}{5}, -\frac{3}{4}$ 8. $\frac{12}{13}, -\frac{5}{13}, -\frac{12}{5}$ 9. $\frac{1}{2}(\frac{3}{4} - \cos 2x + \frac{1}{4} \cos 4x)$
 10. $\frac{1}{2}(\frac{3}{4} + \cos 2x + \frac{1}{4} \cos 4x)$
 11. $\frac{1}{16}(1 - \cos 2x - \cos 4x + \cos 2x \cos 4x)$
 12. $\frac{1}{16}(1 - \cos 4x + \cos 2x - \cos 2x \cos 4x)$
 13. $\frac{1}{32}(\frac{3}{4} - \cos 4x + \frac{1}{4} \cos 8x)$
 14. $\frac{1}{16}(3 + 7 \cos 2x + \cos 4x + \cos 2x \cos 4x)$
 15. $\frac{1}{2}\sqrt{2 - \sqrt{3}}$ 16. $2 - \sqrt{3}$ 17. $\sqrt{2} - 1$
 18. $\frac{1}{2}\sqrt{2 + \sqrt{3}}$ 19. $-\frac{1}{2}\sqrt{2 + \sqrt{3}}$ 20. $-\frac{1}{2}\sqrt{2 - \sqrt{2}}$
 21. $\sqrt{2} - 1$ 22. $\frac{1}{2}\sqrt{2 - \sqrt{2}}$ 23. $\frac{1}{2}\sqrt{2 + \sqrt{3}}$
 24. $2 + \sqrt{3}$ 25. $-\frac{1}{2}\sqrt{2 - \sqrt{2}}$ 26. $\frac{1}{2}\sqrt{2 - \sqrt{3}}$
 27. (a) $\sin 36^\circ$ (b) $\sin 6\theta$
 28. (a) $\tan 14^\circ$ (b) $\tan 14\theta$
 29. (a) $\cos 68^\circ$ (b) $\cos 10\theta$
 30. (a) $\cos \theta$ (b) $\sin \theta$
 31. (a) $\tan 4^\circ$ (b) $\tan 2\theta$
 32. (a) $\sin 15^\circ$ (b) $\sin 4\theta$
 35. $\sqrt{10}/10, 3\sqrt{10}/10, \frac{1}{3}$ 36. $3\sqrt{10}/10, -\sqrt{10}/10, -3$
 37. $\sqrt{(3 + 2\sqrt{2})/6}, \sqrt{(3 - 2\sqrt{2})/6}, 3 + 2\sqrt{2}$
 38. $\frac{1}{2}\sqrt{2 - \sqrt{2}}, \frac{1}{2}\sqrt{2 + \sqrt{2}}, \sqrt{2} - 1$
 39. $\sqrt{6}/6, -\sqrt{30}/6, -\sqrt{3}/5$
 40. $\frac{1}{2}\sqrt{(26 + 5\sqrt{26})/13},$
 $-\frac{1}{2}\sqrt{(26 - 5\sqrt{26})/13}, -5 - \sqrt{26}$
 41. $\frac{1}{2}(\sin 5x - \sin x)$ 42. $\frac{1}{2}(\cos 4x - \cos 6x)$

43. $\frac{1}{2}(\sin 5x + \sin 3x)$ 44. $\frac{1}{2}(\cos 8x + \cos 2x)$

45. $\frac{3}{2}(\cos 11x + \cos 3x)$ 46. $\frac{11}{2}\left(\sin \frac{3x}{4} + \sin \frac{x}{4}\right)$

47. $2 \sin 4x \cos x$ 48. $-2 \cos \frac{5x}{2} \sin \frac{3x}{2}$

49. $2 \sin 5x \sin x$ 50. $2 \cos \frac{11x}{2} \cos \frac{7x}{2}$

51. $-2 \cos \frac{9}{2}x \sin \frac{5}{2}x$ 52. $2 \sin \frac{7x}{2} \cos \frac{x}{2}$

53. $(\sqrt{2} + \sqrt{3})/2$ 54. $\frac{3}{4}(\sqrt{2} + \sqrt{3})$ 55. $\frac{1}{4}(\sqrt{2} - 1)$

56. $\sqrt{6}/2$ 57. $\sqrt{2}/2$ 58. $\sqrt{6}/2$

59. LHS = $\cos(2 \cdot 5x) = \text{RHS}$

60. LHS = $\sin(2 \cdot 4x) = \text{RHS}$

61. LHS = $\sin^2 x + 2 \sin x \cos x + \cos^2 x$
 $= 1 + 2 \sin x \cos x = \text{RHS}$

62. LHS = $\frac{2 \tan x}{\sec^2 x} = 2 \cdot \frac{\sin x}{\cos x} \cos^2 x = 2 \sin x \cos x = \text{RHS}$

63. LHS = $\frac{2 \sin 2x \cos 2x}{\sin x} = \frac{2(2 \sin x \cos x)(\cos 2x)}{\sin x} = \text{RHS}$

64. LHS = $\frac{1 + 2 \sin x \cos x}{2 \sin x \cos x} = 1 + \frac{1}{2 \sin x \cos x} = \text{RHS}$

65. LHS = $\frac{2}{(\tan x + \cot x)(\tan x - \cot x)} = \frac{2}{\tan x + \cot x}$

$$= \frac{2}{\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x}} \cdot \frac{\sin x \cos x}{\sin x \cos x} = \frac{2 \sin x \cos x}{\sin^2 x + \cos^2 x}$$

$$= 2 \sin x \cos x = \text{RHS}$$

66. LHS = $\frac{1}{\tan 2x} = \frac{1}{\frac{2 \tan x}{1 - \tan^2 x}} = \text{RHS}$

67. LHS = $\tan(2x + x) = \frac{\tan 2x + \tan x}{1 - \tan 2x \tan x}$

$$= \frac{\frac{2 \tan x}{1 - \tan^2 x} + \tan x}{1 - \frac{2 \tan x}{1 - \tan^2 x} \tan x}$$

$$= \frac{2 \tan x + \tan x(1 - \tan^2 x)}{1 - \tan^2 x - 2 \tan x \tan x} = \text{RHS}$$

68. LHS = $4[(\sin^2 x + \cos^2 x)^3 - 3(\sin^4 x \cos^2 x + \sin^2 x \cos^4 x)]$

$$= 4[1 - 3 \sin^2 x \cos^2 x(\sin^2 x + \cos^2 x)]$$

$$= 4 - 12 \sin^2 x \cos^2 x = 4 - 3(2 \sin x \cos x)^2 = \text{RHS}$$

69. LHS = $(\cos^2 x + \sin^2 x)(\cos^2 x - \sin^2 x)$

$$= \cos^2 x - \sin^2 x = \text{RHS}$$

70. LHS = $\frac{1 - \cos 2(\frac{x}{2} + \frac{\pi}{4})}{1 + \cos 2(\frac{x}{2} + \frac{\pi}{4})} = \frac{1 - \cos(x + \frac{\pi}{2})}{1 + \cos(x + \frac{\pi}{2})}$

$$= \frac{1 - (-\sin x)}{1 + (-\sin x)} = \text{RHS}$$

71. LHS = $\frac{2 \sin 3x \cos 2x}{2 \cos 3x \cos 2x} = \frac{\sin 3x}{\cos 3x} = \text{RHS}$

72. LHS = $\frac{2 \sin 5x \cos 2x}{-2 \sin 5x \sin(-2x)} = \frac{\cos 2x}{\sin 2x} = \text{RHS}$

73. LHS = $\frac{2 \sin 5x \cos 5x}{2 \sin 5x \cos 4x} = \text{RHS}$

$$74. \frac{\sin x + \sin 3x + \sin 5x}{\cos x + \cos 3x + \cos 5x} = \frac{\sin x + \sin 5x + \sin 3x}{\cos x + \cos 5x + \cos 3x}$$

$$= \frac{2 \sin 3x \cos 2x + \sin 3x}{2 \cos 3x \cos 2x + \cos 3x} = \frac{\sin 3x(2 \cos 2x + 1)}{\cos 3x(2 \cos 2x + 1)}$$

$$= \tan 3x$$

$$75. \text{LHS} = \frac{2 \sin\left(\frac{x+y}{2}\right) \cos\left(\frac{x-y}{2}\right)}{2 \cos\left(\frac{x+y}{2}\right) \cos\left(\frac{x-y}{2}\right)}$$

$$= \frac{\sin\left(\frac{x+y}{2}\right)}{\cos\left(\frac{x+y}{2}\right)} = \text{RHS}$$

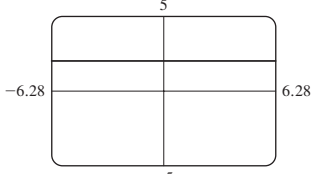
$$76. \frac{\sin(x+y) - \sin(x-y)}{\cos(x+y) + \cos(x-y)}$$

$$= \frac{2 \sin\left(\frac{x+y+x-y}{2}\right) \cos\left(\frac{x+y-x-y}{2}\right)}{2 \cos\left(\frac{x+y+x-y}{2}\right) \cos\left(\frac{x+y-x-y}{2}\right)} = \frac{\sin x}{\cos x} = \tan x$$

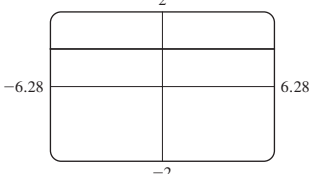
$$81. \text{LHS} = \frac{(\sin x + \sin 5x) + (\sin 2x + \sin 4x) + \sin 3x}{(\cos x + \cos 5x) + (\cos 2x + \cos 4x) + \cos 3x}$$

$$= \frac{2 \sin 3x \cos 2x + 2 \sin 3x \cos x + \sin 3x}{2 \cos 3x \cos 2x + 2 \cos 3x \cos x + \cos 3x}$$

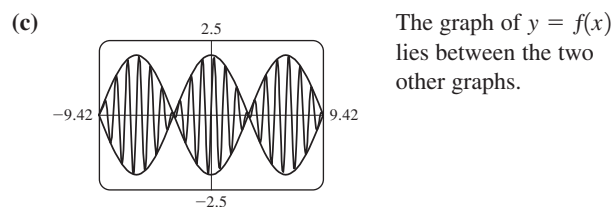
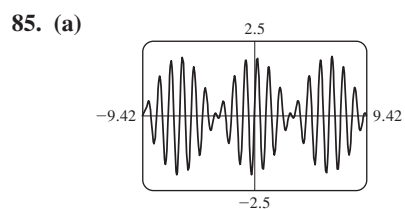
$$= \frac{\sin 3x(2 \cos 2x + 2 \cos x + 1)}{\cos 3x(2 \cos 2x + 2 \cos x + 1)} = \text{RHS}$$

$$83. \text{(a)}$$


$$\frac{\sin 3x}{\sin x} - \frac{\cos 3x}{\cos x} = 2$$

$$84. \text{(a)}$$


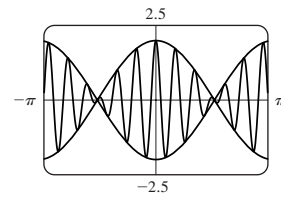
$$\cos 2x + 2 \sin^2 x = 1$$



$$87. \text{(a)} P(t) = 8t^4 - 8t^2 + 1 \quad \text{(b)} Q(t) = 16t^5 - 20t^3 + 5t$$

$$90. \text{(b)} 25 \text{ cm}^2 \quad \text{(c)} 7.07 \text{ cm} \times 3.54 \text{ cm}$$

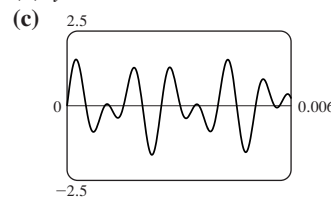
93. (a) and (c)



The graph of f lies between the graphs of $y = 2 \cos t$ and $y = -2 \cos t$. Thus, the loudness of the sound varies between $y = \pm 2 \cos t$.

94. (a) $y = \sin 1540\pi t + \sin 2418\pi t$

94. (b) $y = 2 \sin 1979\pi t \cos 439\pi t$

**Section 7.4 ■ page 557**

1. (a) $\pi/6$ (b) $\pi/3$ (c) Not defined

2. (a) $\pi/3$ (b) $\pi/6$ (c) $5\pi/6$

3. (a) $\pi/4$ (b) $\pi/4$ (c) $-\pi/4$

4. (a) $\pi/3$ (b) $-\pi/3$ (c) Not defined

5. (a) $\pi/2$ (b) 0 (c) π

6. (a) $\pi/4$ (b) $-\pi/4$ (c) 0

7. (a) $\pi/6$ (b) $-\pi/6$ (c) Not defined

8. (a) 0 (b) $\pi/2$ (c) $2\pi/3$

9. (a) 0.13889 (b) 2.75876

10. (a) 1.25364 (b) 1.53269

11. (a) 0.88998 (b) Not defined

12. (a) 1.83085 (b) -0.25168

13. $\frac{1}{4}$ 14. $\frac{3}{2}$ 15. 5 16. Not defined

17. $\pi/3$ 18. $\pi/6$ 19. $-\pi/6$ 20. $\pi/6$

21. $-\pi/3$ 22. $\pi/4$ 23. $\sqrt{3}/3$ 24. 0 25. $\frac{1}{2}$

26. 1 27. $\pi/3$ 28. $\pi/6$ 29. $\frac{4}{5}$ 30. $\frac{4}{3}$

31. $\frac{12}{13}$ 32. $\sqrt{26}/26$ 33. $\frac{13}{5}$ 34. $\frac{25}{24}$ 35. $\sqrt{5}/5$

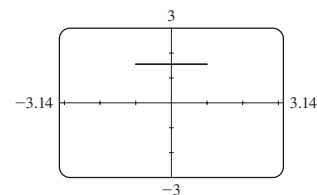
36. $\sqrt{5}/2$ 37. $\frac{24}{25}$ 38. $\frac{65}{72}$ 39. 1 40. $\frac{24}{25}$

41. $\sqrt{1-x^2}$ 42. $x/\sqrt{1+x^2}$ 43. $x/\sqrt{1-x^2}$

44. $1/\sqrt{1+x^2}$ 45. $\frac{1-x^2}{1+x^2}$ 46. $2x\sqrt{1-x^2}$

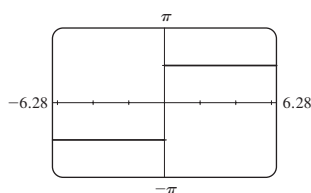
47. 0 48. $\frac{x\sqrt{1-x^2}-1}{\sqrt{1+x^2}}$

49. (a)

Conjecture: $y = \pi/2$ for $-1 \leq x \leq 1$

A80 Answers to Exercises and Chapter Tests

50. (a)



Conjecture: $y = \begin{cases} \pi/2, & x > 0 \\ -\pi/2, & x < 0 \end{cases}$

51. (a) 0.28 (b) $(-3 + \sqrt{17})/4$

52. (a) 0.71 (b) $\sqrt{2}/2$

53. (a) $h = 2 \tan \theta$ (b) $\theta = \tan^{-1}(h/2)$

54. (a) $\theta = \tan^{-1}\left(\frac{50}{s}\right)$ (b) $\theta \approx 68.2^\circ$

55. (a) $\theta = \sin^{-1}(h/680)$ (b) $\theta = 0.826$ rad

56. (a) $\theta = \cos^{-1}\left(\frac{3960}{h + 3960}\right)$ (b) $s = 7920 \theta$

(c) $s = 7920 \cos^{-1}\left(\frac{3960}{h + 3960}\right)$ (d) 1761.5 mi

(e) 197.3 mi

57. (a) 54.1° (b) $48.3^\circ, 32.2^\circ, 24.5^\circ$. The function \sin^{-1} is undefined for values outside the interval $[-1, 1]$.

Section 7.5 ■ page 568

1. $(2k + 1)\pi$ 2. $\frac{3\pi}{2} + 2k\pi$ 3. $\frac{\pi}{6} + 2k\pi, \frac{5\pi}{6} + 2k\pi$

4. $\frac{\pi}{4} + 2k\pi, \frac{7\pi}{4} + 2k\pi$ 5. $\frac{5\pi}{6} + k\pi$ 6. $\frac{3\pi}{4} + k\pi$

7. $\frac{\pi}{3} + k\pi, \frac{2\pi}{3} + k\pi$ 8. $\frac{\pi}{4} + k\pi, \frac{3\pi}{4} + k\pi$ 9. $\frac{(2k + 1)\pi}{4}$

10. $\frac{\pi}{6} + k\pi, \frac{5\pi}{6} + k\pi$ 11. $\frac{\pi}{3} + k\pi, \frac{2\pi}{3} + k\pi$

12. $\frac{\pi}{4} + k\pi, \frac{3\pi}{4} + k\pi$ 13. $\frac{\pi}{2} + k\pi, \frac{7\pi}{6} + 2k\pi, \frac{11\pi}{6} + 2k\pi$

14. $\frac{\pi}{4} + 2k\pi, \frac{7\pi}{4} + 2k\pi$ 15. $-\frac{\pi}{3} + k\pi$

16. $\frac{\pi}{6} + k\pi, \frac{5\pi}{6} + 2k\pi$ 17. $\frac{\pi}{2} + k\pi$ 18. $k\pi, \frac{3\pi}{4} + k\pi$

19. $\frac{\pi}{3} + 2k\pi, \frac{5\pi}{3} + 2k\pi$

20. $\frac{\pi}{2} + 2k\pi, \frac{7\pi}{6} + 2k\pi, \frac{11\pi}{6} + 2k\pi$ 21. $\frac{3\pi}{2} + 2k\pi$

22. $k\pi, \frac{\pi}{6} + k\pi, \frac{5\pi}{6} + k\pi$ 23. No solution

24. $\frac{\pi}{2} + 2k\pi, \frac{7\pi}{6} + 2k\pi, \frac{11\pi}{6} + 2k\pi$

25. $\frac{7\pi}{18} + \frac{2k\pi}{3}, \frac{11\pi}{18} + \frac{2k\pi}{3}$ 26. $\frac{\pi}{3} + k\pi, \frac{2\pi}{3} + k\pi$

27. $\frac{1}{4}\left(\frac{\pi}{3} + 2k\pi\right), \frac{1}{4}\left(-\frac{\pi}{3} + 2k\pi\right)$ 28. $\frac{5\pi}{18} + \frac{1}{3}k\pi$

29. $\frac{1}{2}\left(\frac{\pi}{6} + k\pi\right)$ 30. $\frac{\pi}{6} + \frac{k\pi}{3}$ 31. $4k\pi$

32. $4\pi + 6k\pi, 5\pi + 6k\pi$ 33. $4\left(\frac{2\pi}{3} + k\pi\right)$

34. $2k\pi$ 35. $\frac{k\pi}{3}$

36. $\frac{\pi}{4} + k\pi, \frac{\pi}{6} + k\pi, \frac{5\pi}{6} + k\pi$

37. $\frac{\pi}{6} + 2k\pi, \frac{2\pi}{3} + 2k\pi, \frac{5\pi}{6} + 2k\pi, \frac{4\pi}{3} + 2k\pi$

38. $\frac{k\pi}{2}$ 39. $\frac{\pi}{8} + \frac{k\pi}{2}, \frac{3\pi}{8} + \frac{k\pi}{2}$ 40. $k\pi$

41. $\frac{\pi}{9}, \frac{5\pi}{9}, \frac{7\pi}{9}, \frac{11\pi}{9}, \frac{13\pi}{9}, \frac{17\pi}{9}$ 42. $\frac{\pi}{3}, \frac{2\pi}{3}$

43. $\frac{\pi}{6}, \frac{3\pi}{4}, \frac{5\pi}{6}, \frac{7\pi}{4}$ 44. $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$

45. $\frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}$ 46. $\frac{\pi}{3}, \frac{5\pi}{3}, \pi$

47. $0, \frac{2\pi}{3}, \frac{4\pi}{3}$ 48. $0, \frac{\pi}{6}, \frac{5\pi}{6}, \pi, \frac{7\pi}{6}, \frac{11\pi}{6}$

49. (a) $1.15928 + 2k\pi, 5.12391 + 2k\pi$

(b) 1.15928, 5.12391

50. (a) $1.41815 + k\pi$ (b) 1.41815, 4.55974

51. (a) $1.36944 + 2k\pi, 4.91375 + 2k\pi$

(b) 1.36944, 4.91375

52. (a) $1.16590 + k\pi$ (b) 1.16590, 4.30750

53. (a) $0.46365 + k\pi, 2.67795 + k\pi$

(b) 0.46365, 2.67795, 3.60524, 5.81954

54. (a) $0.25268 + 2k\pi, 1.57080 + k\pi, 2.88891 + 2k\pi$

(b) 0.25268, 1.57080, 2.88891, 4.71239

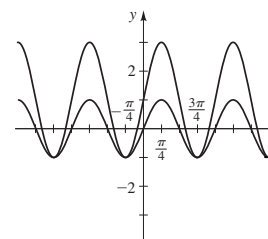
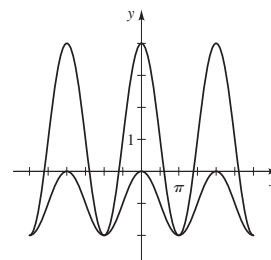
55. (a) $0.33984 + 2k\pi, 2.80176 + 2k\pi$

(b) 0.33984, 2.80176

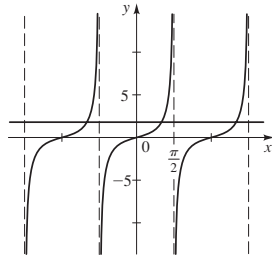
56. (a) $1.10715 + k\pi, 1.24905 + k\pi, 1.89255 + k\pi, 2.03444 + k\pi$

(b) 1.10715, 1.24905, 1.89255, 2.03444, 4.24874, 4.39064, 5.03414, 5.17604

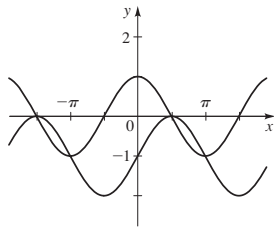
57. $((2k + 1)\pi, -2)$ 58. $\left(\frac{3\pi}{4} + k\pi, -1\right)$



59. $\left(\frac{\pi}{3} + k\pi, \sqrt{3}\right)$



60. $(\pi + 2k\pi, -1), \left(\frac{\pi}{2} + 2k\pi, 0\right)$



61. $\frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}$ 62. $\frac{\pi}{3}, \frac{5\pi}{3}$

63. $\frac{\pi}{9}, \frac{2\pi}{9}, \frac{7\pi}{9}, \frac{8\pi}{9}, \frac{13\pi}{9}, \frac{14\pi}{9}$ 64. $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$

65. $\frac{\pi}{2}, \frac{7\pi}{6}, \frac{3\pi}{2}, \frac{11\pi}{6}$ 66. $0, \frac{\pi}{2}, \frac{3\pi}{2}$ 67. 0

68. $\frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}$ 69. $\frac{k\pi}{2}$ 70. $\frac{k\pi}{6}$

71. $\frac{\pi}{9} + \frac{2k\pi}{3}, \frac{\pi}{2} + k\pi, \frac{5\pi}{9} + \frac{2k\pi}{3}$ 72. $\frac{(2k+1)\pi}{8}$

73. $0, \pm 0.95$ 74. $-2.94, -2.66, 1.17$ 75. 1.92

76. $0, \pm 0.93$ 77. ± 0.71 78. 0

79. 0.94721° or 89.05279° 80. $0, \frac{1}{2}, 1, \frac{3}{2}, \dots$

81. 44.95° 82. $\theta_1 = \sin^{-1}(v_1/v_2)$

83. (a) 34th day (February 3rd), 308th day (November 4th)

(b) 275 days

84. (a) 0° (b) $60^\circ, 120^\circ$ (c) $90^\circ, 270^\circ$ (d) 180°

85. (b) $1.047 \approx 60^\circ$

Chapter 7 Review ■ page 571

1. LHS = $\sin \theta \left(\frac{\cos \theta}{\sin \theta} + \frac{\sin \theta}{\cos \theta} \right) = \cos \theta + \frac{\sin^2 \theta}{\cos \theta}$
= $\frac{\cos^2 \theta + \sin^2 \theta}{\cos \theta} = \text{RHS}$

2. LHS = $\sec^2 \theta - 1 = \text{RHS}$

3. LHS = $(1 - \sin^2 x) \csc x - \csc x$
= $\csc x - \sin^2 x \csc x - \csc x$
= $-\sin^2 x \frac{1}{\sin x} = \text{RHS}$

4. LHS = $\frac{1}{\cos^2 x} = \sec^2 x = \text{RHS}$

5. LHS = $\frac{\cos^2 x}{\sin^2 x} - \frac{\tan^2 x}{\sin^2 x} = \cot^2 x - \frac{1}{\cos^2 x} = \text{RHS}$

6. LHS = $\frac{1}{\sec x} + 1 = 1 + \cos x = (1 + \cos x) \cdot \frac{1 - \cos x}{1 - \cos x}$
= $\frac{1 - \cos^2 x}{1 - \cos x} = \text{RHS}$

7. LHS = $\frac{\cos x}{\frac{1}{\cos x}(1 - \sin x)} = \frac{\cos x}{\frac{1}{\cos x} - \frac{\sin x}{\cos x}} = \text{RHS}$

8. LHS = $1 - \cot x - \tan x + \tan x \cot x$
= $2 - (\cot x + \tan x)$
= $2 - \left(\frac{\cos x}{\sin x} + \frac{\sin x}{\cos x} \right) = 2 - \frac{\cos^2 x + \sin^2 x}{\cos x \sin x}$
= $2 - \frac{1}{\cos x \sin x} = \text{RHS}$

9. LHS = $\sin^2 x \frac{\cos^2 x}{\sin^2 x} + \cos^2 x \frac{\sin^2 x}{\cos^2 x} = \cos^2 x + \sin^2 x = \text{RHS}$

10. LHS = $\left(\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x} \right)^2 = \left(\frac{\sin^2 x + \cos^2 x}{\cos x \sin x} \right)^2$
= $\left(\frac{1}{\cos x \sin x} \right)^2 = \text{RHS}$

11. LHS = $\frac{2 \sin x \cos x}{1 + 2 \cos^2 x - 1} = \frac{2 \sin x \cos x}{2 \cos^2 x} = \frac{2 \sin x}{2 \cos x} = \text{RHS}$

12. LHS = $\frac{\cos x \cos y - \sin x \sin y}{\cos x \sin y}$
= $\frac{\cos x \cos y}{\cos x \sin y} - \frac{\sin x \sin y}{\cos x \sin y} = \frac{\cos y}{\sin y} - \frac{\sin x}{\cos x} = \text{RHS}$

13. LHS = $\frac{1 - \cos x}{\sin x} = \frac{1}{\sin x} - \frac{\cos x}{\sin x} = \text{RHS}$

14. LHS = $\frac{2 \sin \left(\frac{(x+y)}{2} + \frac{(x-y)}{2} \right) \cos \left(\frac{(x+y)}{2} - \frac{(x-y)}{2} \right)}{2 \cos \left(\frac{(x+y)}{2} + \frac{(x-y)}{2} \right) \cos \left(\frac{(x+y)}{2} - \frac{(x-y)}{2} \right)}$
= $\frac{2 \sin x \cos y}{2 \cos x \cos y} = \text{RHS}$

15. LHS = $\frac{1}{2} [\cos((x+y) - (x-y)) - \cos((x+y) + (x-y))]$
= $\frac{1}{2} (\cos 2y - \cos 2x)$
= $\frac{1}{2} [1 - 2 \sin^2 y - (1 - 2 \sin^2 x)]$
= $\frac{1}{2} (2 \sin^2 x - 2 \sin^2 y) = \text{RHS}$

16. LHS = $\csc x - \frac{1 - \cos x}{\sin x}$
= $\csc x - (\csc x - \cot x) = \text{RHS}$

17. LHS = $1 + \frac{\sin x}{\cos x} \cdot \frac{1 - \cos x}{\sin x} = 1 + \frac{1 - \cos x}{\cos x}$
= $1 + \frac{1}{\cos x} - 1 = \text{RHS}$

A82 Answers to Exercises and Chapter Tests

$$\begin{aligned}
 18. \text{ LHS} &= \frac{\sin(x+2x) + \cos(x+2x)}{\cos x - \sin x} \\
 &= \frac{\sin x \cos 2x + \cos x \sin 2x + \cos x \cos 2x - \sin x \sin 2x}{\cos x - \sin x} \\
 &= \frac{\cos 2x(\sin x + \cos x) + \sin 2x(\cos x - \sin x)}{\cos x - \sin x} \\
 &= \frac{\cos 2x(\sin x + \cos x)}{\cos x - \sin x} + \sin 2x \\
 &= \frac{(\cos^2 x - \sin^2 x)(\sin x + \cos x)}{\cos x - \sin x} + \sin 2x \\
 &= (\cos x + \sin x)(\sin x + \cos x) + \sin 2x \\
 &= \sin^2 x + \cos^2 x + 2 \sin x \cos x + \sin 2x \\
 &= 1 + \sin 2x + \sin 2x = \text{RHS}
 \end{aligned}$$

$$\begin{aligned}
 19. \text{ LHS} &= \cos^2 \frac{x}{2} - 2 \sin \frac{x}{2} \cos \frac{x}{2} + \sin^2 \frac{x}{2} \\
 &= 1 - \sin(2 \cdot \frac{x}{2}) = \text{RHS}
 \end{aligned}$$

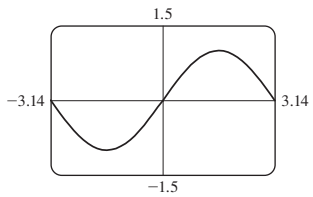
$$\begin{aligned}
 20. \text{ LHS} &= \frac{-2 \sin(\frac{3x+7x}{2}) \sin(\frac{3x-7x}{2})}{2 \sin(\frac{3x+7x}{2}) \cos(\frac{3x-7x}{2})} = \frac{-2 \sin 5x \sin(-2x)}{2 \sin 5x \cos(-2x)} \\
 &= \frac{2 \sin 5x \sin 2x}{2 \sin 5x \cos 2x} = \text{RHS}
 \end{aligned}$$

$$\begin{aligned}
 21. \text{ LHS} &= \frac{2 \sin x \cos x}{\sin x} - \frac{2 \cos^2 x - 1}{\cos x} \\
 &= 2 \cos x - 2 \cos x + \frac{1}{\cos x} = \text{RHS}
 \end{aligned}$$

$$\begin{aligned}
 22. \text{ LHS} &= \cos^2 x + 2 \cos x \cos y + \cos^2 y \\
 &\quad + \sin^2 x - 2 \sin x \sin y + \sin^2 y \\
 &= (\cos^2 x + \sin^2 x) + (\sin^2 y + \cos^2 y) \\
 &\quad + 2(\cos x \cos y - \sin x \sin y) = \text{RHS}
 \end{aligned}$$

$$23. \text{ LHS} = \frac{\tan x + \tan \frac{\pi}{4}}{1 - \tan x \tan \frac{\pi}{4}} = \text{RHS}$$

$$\begin{aligned}
 24. \text{ LHS} &= \frac{\frac{1}{\cos x} - 1}{\sin x \frac{1}{\cos x}} = \left(\frac{1}{\cos x} - 1 \right) \frac{\cos x}{\sin x} \\
 &= \frac{1 - \cos x}{\sin x} = \text{RHS}
 \end{aligned}$$

25. (a)  (b) Yes

26. (a)  (b) No

27. (a)  (b) No

28. (a)  (b) Yes

29. (a)  $2 \sin^2 3x + \cos 6x = 1$

30. (a)  $\sin x \cot \frac{x}{2} = \cos x + 1$

31. $0, \pi$ 32. $0, \frac{\pi}{6}, \frac{5\pi}{6}, \pi$ 33. $\frac{\pi}{6}, \frac{5\pi}{6}$ 34. $0, \frac{\pi}{4}, \frac{5\pi}{4}$

35. $\frac{\pi}{3}, \frac{5\pi}{3}$ 36. $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$ 37. $\frac{2\pi}{3}, \frac{4\pi}{3}$

38. $\frac{\pi}{6}, \frac{3\pi}{2}, \frac{5\pi}{6}$ 39. $\frac{\pi}{3}, \frac{2\pi}{3}, \frac{3\pi}{4}, \frac{4\pi}{3}, \frac{5\pi}{3}, \frac{7\pi}{4}$

40. $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$ 41. $\frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{3\pi}{2}, \frac{11\pi}{6}$

42. $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}, \frac{2\pi}{3}, \frac{4\pi}{3}$ 43. $\frac{\pi}{6}$ 44. $\frac{\pi}{6}, \frac{5\pi}{6}$

45. 1.18 46. 2.22 47. (a) 63.4° (b) No (c) 90°

48. $t = 0.25k, k = 0, 1, 2, \dots$ 49. $\frac{1}{2}\sqrt{2 + \sqrt{3}}$

50. $\frac{\sqrt{2} + \sqrt{6}}{4}$ 51. $\sqrt{2} - 1$ 52. $\frac{1}{2}$ 53. $\frac{\sqrt{2}}{2}$

54. $\sqrt{3}$ 55. $\frac{\sqrt{2}}{2}$ 56. $\frac{\sqrt{2}}{2}$ 57. $\frac{\sqrt{2} + \sqrt{3}}{4}$

58. $\frac{\sqrt{2 + \sqrt{2}}}{2}$ 59. $2 \frac{\sqrt{10} + 1}{9}$ 60. $\frac{1}{9}(4\sqrt{2} + \sqrt{5})$

61. $\frac{2}{3}(\sqrt{2} + \sqrt{5})$ 62. $4\sqrt{5}/9$ 63. $\sqrt{(3 + 2\sqrt{2})/6}$

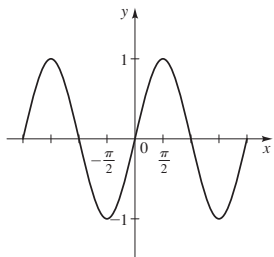
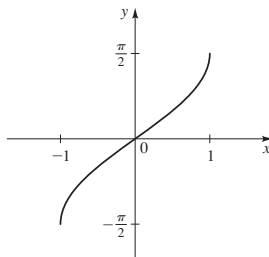
64. $3 - 2\sqrt{2}$ 65. $\pi/3$ 66. $\pi/6$ 67. $\frac{1}{2}$ 68. $\frac{1}{2}$

69. $2/\sqrt{21}$ 70. $\sqrt{55}/8$ 71. $\frac{7}{9}$ 72. $\frac{63}{65}$

73. $x/\sqrt{1+x^2}$ 74. $\frac{1}{\sqrt{1-x^2}}$ 75. $\theta = \cos^{-1}\left(\frac{x}{3}\right)$
 76. $\theta = \tan^{-1}\left(\frac{x}{2}\right)$
 77. (a) $\theta = \tan^{-1}\left(\frac{10}{x}\right)$ (b) 286.4 ft
 78. (a) $\theta = \tan^{-1}\left(\frac{420}{x}\right) - \tan^{-1}\left(\frac{380}{x}\right)$ (b) 400 ft

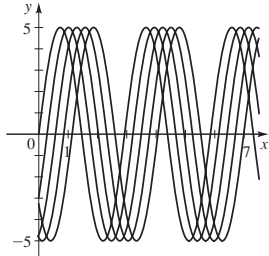
Chapter 7 Test ■ page 574

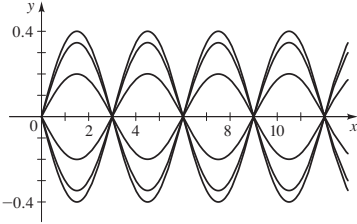
1. (a) LHS = $\frac{\sin \theta}{\cos \theta} \sin \theta + \cos \theta = \frac{\sin^2 \theta + \cos^2 \theta}{\cos \theta} = \text{RHS}$
 (b) LHS = $\frac{\tan x}{1 - \cos x} \cdot \frac{1 + \cos x}{1 + \cos x} = \frac{\tan x(1 + \cos x)}{1 - \cos^2 x}$
 $= \frac{\frac{\sin x}{\cos x}(1 + \cos x)}{\sin^2 x} = \frac{1}{\sin x} \cdot \frac{1 + \cos x}{\cos x} = \text{RHS}$
 (c) LHS = $\frac{2 \tan x}{\sec^2 x} = \frac{2 \sin x}{\cos x} \cdot \cos^2 x = 2 \sin x \cos x = \text{RHS}$
 2. $\tan \theta$
 3. (a) $\frac{1}{2}$ (b) $\frac{\sqrt{2} + \sqrt{6}}{4}$ (c) $\frac{1}{2}\sqrt{2 - \sqrt{3}}$
 4. $(10 - 2\sqrt{5})/15$
 5. (a) $\frac{1}{2}(\sin 8x - \sin 2x)$ (b) $-2 \cos \frac{7}{2}x \sin \frac{3}{2}x$ 6. -2
 7.

Domain \mathbb{R} Domain $[-1, 1]$

8. (a) $\theta = \tan^{-1}\frac{x}{4}$ (b) $\theta = \cos^{-1}\frac{3}{x}$
 9. (a) $\frac{2\pi}{3}, \frac{4\pi}{3}$ (b) $\frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}, \frac{3\pi}{2}$
 10. 0.57964, 2.56195, 3.72123, 5.70355 11. $\frac{40}{41}$

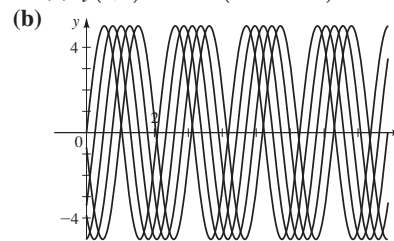
Focus on Modeling ■ page 578

1. (a) $y = -5 \sin\left(\frac{\pi}{2}t\right)$ (b) 
 (c) $v = \pi/4$ Yes, it is a traveling wave.

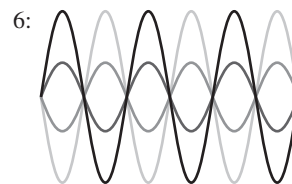
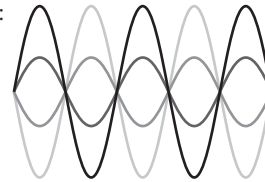
2. (a) $y = 0.4 \sin(1.047x) \cos(0.524t)$; 3, 6, 9, 12, ...
 (b) 

Yes, this is a standing wave.

3. $y(x, t) = 2.7 \sin(0.68x - 4.10t)$
 4. (a) $y(x, t) = 5 \sin(3x - 1.5t)$



5. $y(x, t) = 0.6 \sin(\pi x) \cos(40\pi t)$
 6. $y(x, t) = 7 \sin 2x \cos \frac{1}{2}t$
 7. (a) 1, 2, 3, 4
 (b) 5:

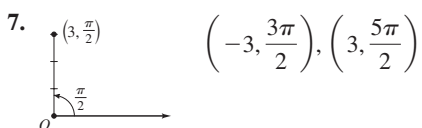
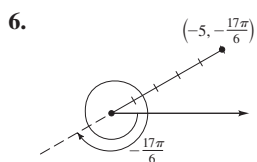
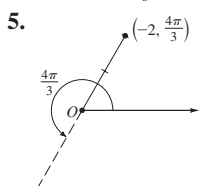
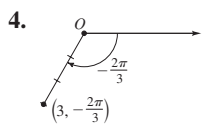
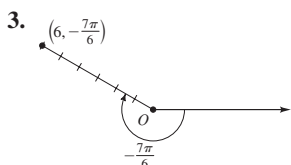


- (c) 880π
 (d) $y(x, t) = \sin t \cos(880\pi t)$;
 $y(x, t) = \sin(2t) \cos(880\pi t)$;
 $y(x, t) = \sin(3t) \cos(880\pi t)$;
 $y(x, t) = \sin(4t) \cos(880\pi t)$
 8. (a) $\pi, 3\pi, 5\pi, 7\pi, 9\pi, 11\pi$; no (b) 25 Hz

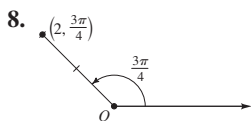
Chapter 8**Section 8.1 ■ page 586**

1. 
 2. 

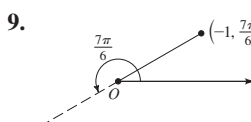
A84 Answers to Exercises and Chapter Tests



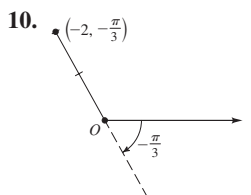
$$\left(-3, \frac{3\pi}{2}\right), \left(3, \frac{5\pi}{2}\right)$$



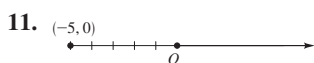
$$\left(-2, \frac{7\pi}{4}\right), \left(2, \frac{11\pi}{4}\right)$$



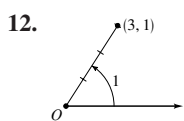
$$\left(-1, -\frac{5\pi}{6}\right), \left(1, \frac{\pi}{6}\right)$$



$$\left(-2, \frac{5\pi}{3}\right), \left(2, \frac{2\pi}{3}\right)$$



$$(-5, 2\pi), (5, \pi)$$



$$(3, 1 + 2\pi), (-3, 1 + \pi)$$

13. Q 14. R 15. Q 16. P 17. P 18. Q 19. P

20. S 21. $(3\sqrt{2}, 3\pi/4)$ 22. $(3, 3\pi/2)$

23. $\left(-\frac{5}{2}, -\frac{5\sqrt{3}}{2}\right)$ 24. $\left(\frac{-3\sqrt{3}}{2}, 1\right)$ 25. $(2\sqrt{3}, 2)$

26. $(-3, 3\sqrt{3})$ 27. $(1, -1)$ 28. $(0, -1)$ 29. $(-5, 0)$

30. $(0, 0)$ 31. $(3\sqrt{6}, -3\sqrt{2})$ 32. $(\sqrt{3}/2, \frac{3}{2})$

33. $(\sqrt{2}, 3\pi/4)$ 34. $(6, 11\pi/6)$ 35. $(4, \pi/4)$

36. $(2\sqrt{2}, 7\pi/6)$ 37. $(5, \tan^{-1} \frac{4}{3})$

38. $(\sqrt{5}, 2\pi + \tan^{-1}(-2))$ 39. $(6, \pi)$ 40. $(\sqrt{3}, 3\pi/2)$

41. $\theta = \pi/4$ 42. $r = 3$ 43. $r = \tan \theta \sec \theta$

44. $r = 5 \csc \theta$ 45. $r = 4 \sec \theta$ 46. $r^2 = \sec 2\theta$

47. $x^2 + y^2 = 49$ 48. $y = 0$ 49. $x = 6$

50. $(x - 3)^2 + y^2 = 9$ 51. $x^2 + y^2 = \frac{y}{x}$

52. $x^4 + 2x^2y^2 + y^4 - 2xy = 0$ 53. $y - x = 1$
 54. $x^2 + 2y - 1 = 0$ 55. $x^2 + y^2 = (x^2 + y^2 - x)^2$
 56. $x^2 - 3y^2 + 16y - 16 = 0$ 57. $x = 2$
 58. $(x^2 + y^2 - x)^2 = 4(x^2 + y^2)$ 59. $y = \pm \sqrt{3}x$
 60. $y = 0$

Section 8.2 ■ page 594

1. VI 2. III 3. II 4. IV 5. I 6. V

7. Symmetric about $\theta = \pi/2$

8. Symmetric about the polar axis

9. Symmetric about the polar axis

10. Symmetric about the pole

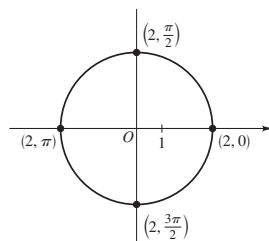
11. Symmetric about $\theta = \pi/2$

12. Symmetric about the polar axis

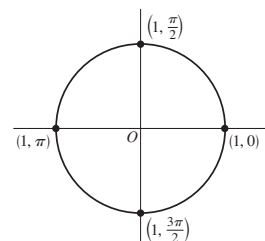
13. All three types of symmetry

14. Symmetric about the pole and about $\theta = \pi/2$

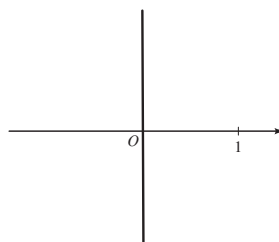
15.



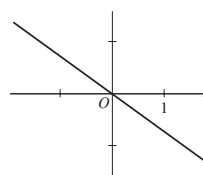
16.



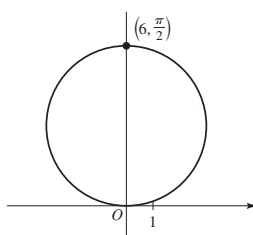
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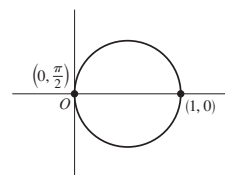
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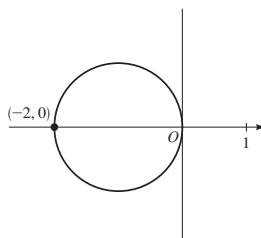
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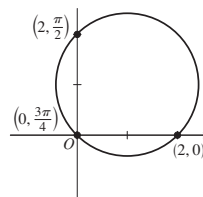
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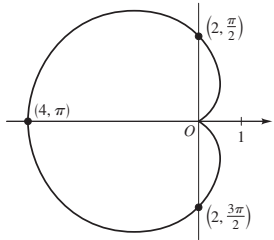
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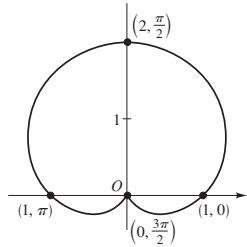
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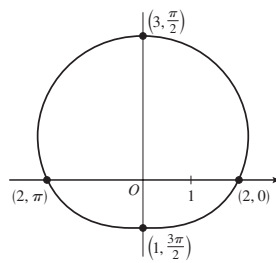
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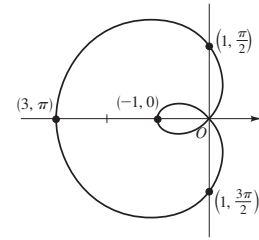
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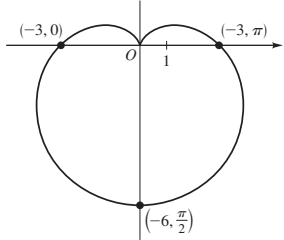
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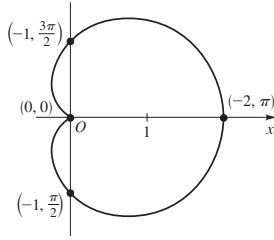
34.



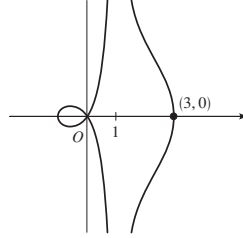
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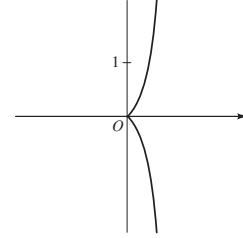
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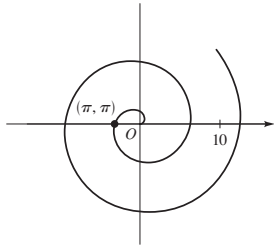
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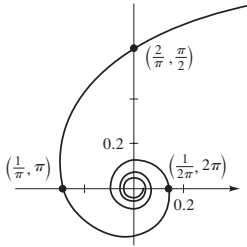
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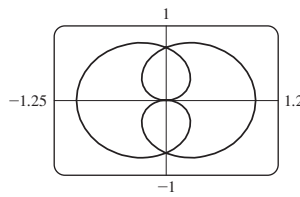
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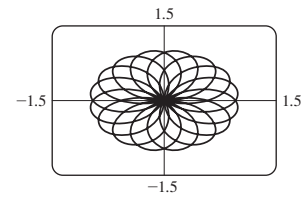
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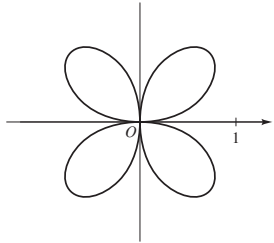
37. $0 \leq \theta \leq 4\pi$



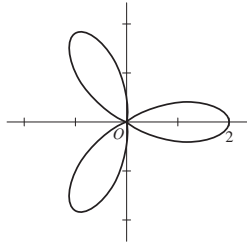
38. $0 \leq \theta \leq 10\pi$



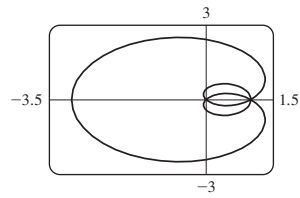
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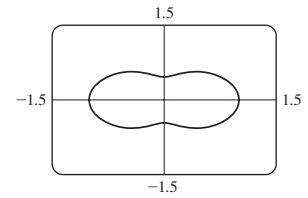
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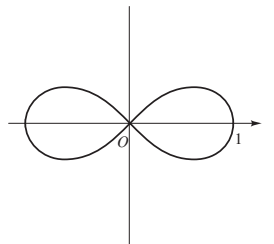
39. $0 \leq \theta \leq 4\pi$



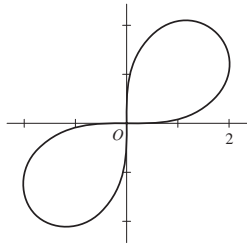
40. $0 \leq \theta \leq 2\pi$



31.



32.



41. The graph of $r = 1 + \sin n\theta$ has n loops.

42. As c increases, the "dimple" of the graph becomes an inner loop.

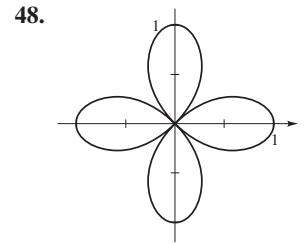
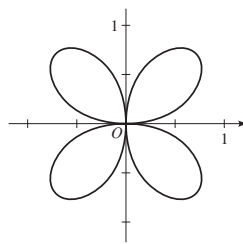
43. IV

44. I

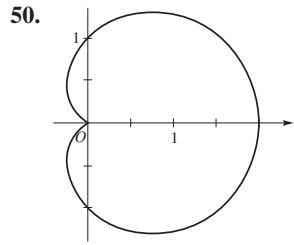
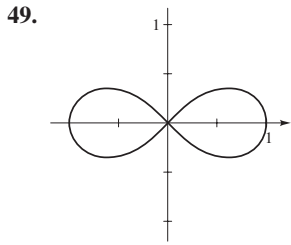
45. III

46. II

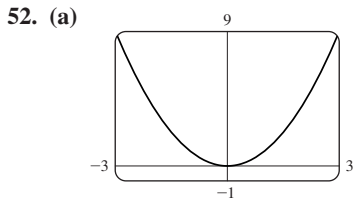
48.



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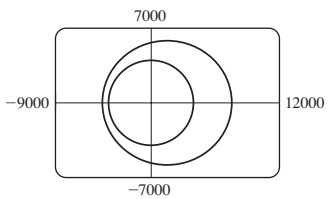


51. $\left(\frac{a}{2}, \frac{b}{2}\right), \frac{\sqrt{a^2 + b^2}}{2}$



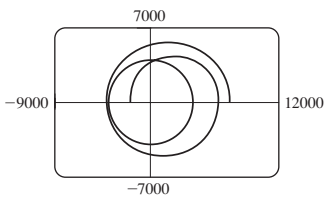
(b) $y = x^2$

53. (a) Elliptical



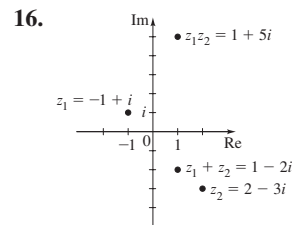
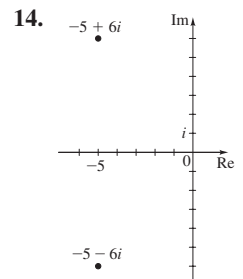
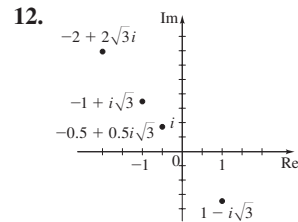
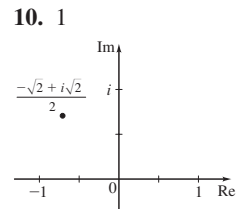
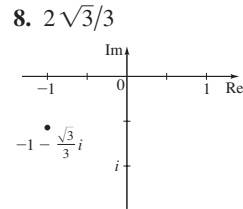
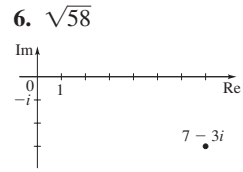
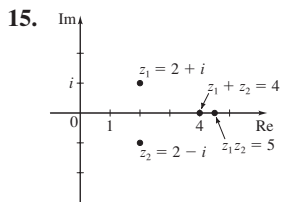
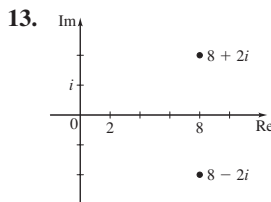
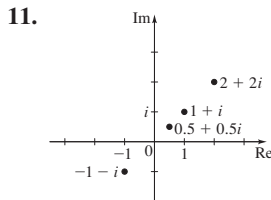
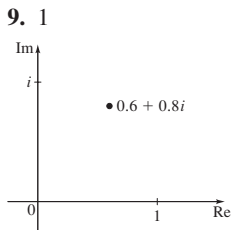
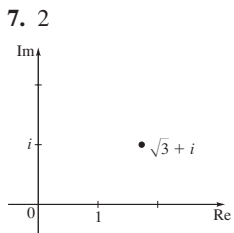
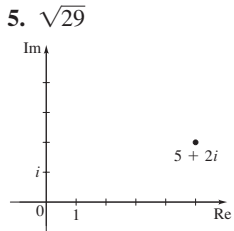
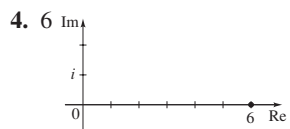
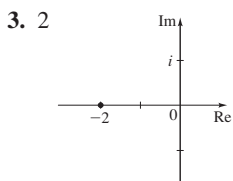
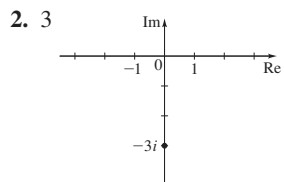
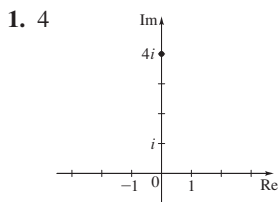
(b) π ; 540 mi

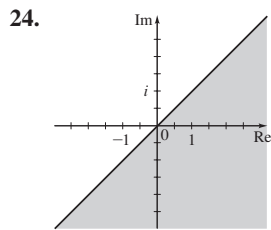
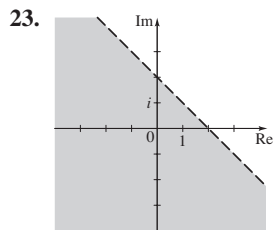
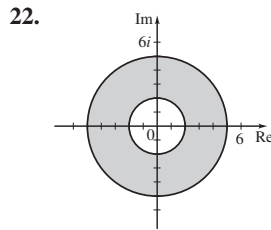
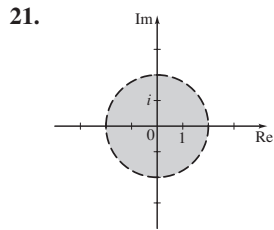
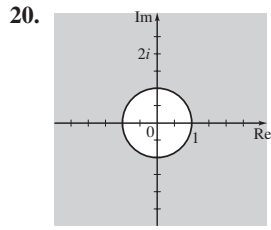
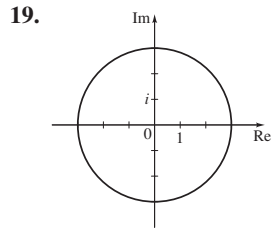
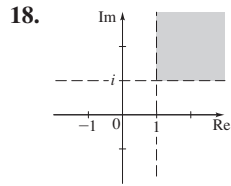
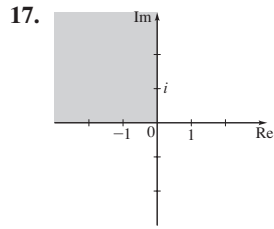
54. (a) Spiral



(b) 2.1 rad

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25. $\sqrt{2}\left(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4}\right)$ 26. $2\left(\cos \frac{\pi}{3} + i \sin \frac{\pi}{3}\right)$
 27. $2\left(\cos \frac{7\pi}{4} + i \sin \frac{7\pi}{4}\right)$ 28. $\sqrt{2}\left(\cos \frac{7\pi}{4} + i \sin \frac{7\pi}{4}\right)$
 29. $4\left(\cos \frac{11\pi}{6} + i \sin \frac{11\pi}{6}\right)$ 30. $\sqrt{2}\left(\cos \frac{3\pi}{4} + i \sin \frac{3\pi}{4}\right)$
 31. $3\left(\cos \frac{3\pi}{2} + i \sin \frac{3\pi}{2}\right)$ 32. $6\left(\cos \frac{4\pi}{3} + i \sin \frac{4\pi}{3}\right)$
 33. $5\sqrt{2}\left(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4}\right)$ 34. $4(\cos 0 + i \sin 0)$
 35. $8\left(\cos \frac{11\pi}{6} + i \sin \frac{11\pi}{6}\right)$ 36. $8\left(\cos \frac{\pi}{2} + i \sin \frac{\pi}{2}\right)$
 37. $20(\cos \pi + i \sin \pi)$ 38. $2\left(\cos \frac{\pi}{6} + i \sin \frac{\pi}{6}\right)$
 39. $5[\cos(\tan^{-1} \frac{4}{3}) + i \sin(\tan^{-1} \frac{4}{3})]$
 40. $2\sqrt{2}\left(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4}\right)$ 41. $3\sqrt{2}\left(\cos \frac{3\pi}{4} + i \sin \frac{3\pi}{4}\right)$
 42. $2\sqrt{2}\left(\cos \frac{7\pi}{4} + i \sin \frac{7\pi}{4}\right)$ 43. $8\left(\cos \frac{\pi}{6} + i \sin \frac{\pi}{6}\right)$

44. $3\sqrt{2}\left(\cos \frac{5\pi}{4} + i \sin \frac{5\pi}{4}\right)$

45. $\sqrt{5}[\cos(\tan^{-1} \frac{1}{2}) + i \sin(\tan^{-1} \frac{1}{2})]$

46. $2\sqrt{3}\left(\cos \frac{\pi}{6} + i \sin \frac{\pi}{6}\right)$ 47. $2\left(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4}\right)$

48. $\pi\left(\cos \frac{3\pi}{2} + i \sin \frac{3\pi}{2}\right)$

49. $z_1 z_2 = \cos \frac{4\pi}{3} + i \sin \frac{4\pi}{3}$ $\frac{z_1}{z_2} = \cos \frac{2\pi}{3} + i \sin \frac{2\pi}{3}$

50. $z_1 z_2 = \cos \pi + i \sin \pi$ $\frac{z_1}{z_2} = \cos \frac{\pi}{2} - i \sin \frac{\pi}{2}$

51. $z_1 z_2 = 15\left(\cos \frac{3\pi}{2} + i \sin \frac{3\pi}{2}\right)$

$\frac{z_1}{z_2} = \frac{3}{5}\left(\cos \frac{7\pi}{6} - i \sin \frac{7\pi}{6}\right)$

52. $z_1 z_2 = 14\left(\cos \frac{5\pi}{4} + i \sin \frac{5\pi}{4}\right)$

$\frac{z_1}{z_2} = \frac{7}{2}(\cos \pi + i \sin \pi)$

53. $z_1 z_2 = 8(\cos 150^\circ + i \sin 150^\circ)$

$\frac{z_1}{z_2} = 2(\cos 90^\circ + i \sin 90^\circ)$

54. $z_1 z_2 = 6(\cos 135^\circ + i \sin 135^\circ)$

$\frac{z_1}{z_2} = \frac{1}{3}(\cos 15^\circ + i \sin 15^\circ)$

55. $z_1 z_2 = 100(\cos 350^\circ + i \sin 350^\circ)$

$\frac{z_1}{z_2} = \frac{4}{25}(\cos 50^\circ + i \sin 50^\circ)$

56. $z_1 z_2 = \frac{4}{25}(\cos 180^\circ + i \sin 180^\circ)$

$\frac{z_1}{z_2} = 4(\cos 130^\circ - i \sin 130^\circ)$

57. $z_1 = 2\left(\cos \frac{\pi}{6} + i \sin \frac{\pi}{6}\right)$

$z_2 = 2\left(\cos \frac{\pi}{3} + i \sin \frac{\pi}{3}\right)$

$z_1 z_2 = 4\left(\cos \frac{\pi}{2} + i \sin \frac{\pi}{2}\right)$

$\frac{z_1}{z_2} = \cos \frac{\pi}{6} - i \sin \frac{\pi}{6}$

$\frac{1}{z_1} = \frac{1}{2}\left(\cos \frac{\pi}{6} - i \sin \frac{\pi}{6}\right)$

58. $z_1 = 2\left(\cos \frac{7\pi}{4} + i \sin \frac{7\pi}{4}\right)$

$z_2 = \sqrt{2}\left(\cos \frac{7\pi}{4} + i \sin \frac{7\pi}{4}\right)$

$z_1 z_2 = 2\sqrt{2}\left(\cos \frac{\pi}{2} - i \sin \frac{\pi}{2}\right)$

$\frac{z_1}{z_2} = \sqrt{2}(\cos 0 + i \sin 0)$

$\frac{1}{z_1} = \frac{1}{2}\left(\cos \frac{7\pi}{4} - i \sin \frac{7\pi}{4}\right)$

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$$59. \quad z_1 = 4 \left(\cos \frac{11\pi}{6} + i \sin \frac{11\pi}{6} \right)$$

$$z_2 = \sqrt{2} \left(\cos \frac{3\pi}{4} + i \sin \frac{3\pi}{4} \right)$$

$$z_1 z_2 = 4\sqrt{2} \left(\cos \frac{7\pi}{12} + i \sin \frac{7\pi}{12} \right)$$

$$\frac{z_1}{z_2} = 2\sqrt{2} \left(\cos \frac{13\pi}{12} + i \sin \frac{13\pi}{12} \right)$$

$$\frac{1}{z_1} = \frac{1}{4} \left(\cos \frac{11\pi}{6} - i \sin \frac{11\pi}{6} \right)$$

$$60. \quad z_1 = \sqrt{2} \left(\cos \frac{3\pi}{2} + i \sin \frac{3\pi}{2} \right)$$

$$z_2 = 6 \left(\cos \frac{4\pi}{3} + i \sin \frac{4\pi}{3} \right)$$

$$z_1 z_2 = 6\sqrt{2} \left(\cos \frac{5\pi}{6} + i \sin \frac{5\pi}{6} \right)$$

$$\frac{z_1}{z_2} = \frac{\sqrt{2}}{6} \left(\cos \frac{\pi}{6} + i \sin \frac{\pi}{6} \right)$$

$$\frac{1}{z_1} = \frac{\sqrt{2}}{2} \left(\cos \frac{3\pi}{2} - i \sin \frac{3\pi}{2} \right)$$

$$61. \quad z_1 = 5\sqrt{2} \left(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4} \right)$$

$$z_2 = 4(\cos 0 + i \sin 0)$$

$$z_1 z_2 = 20\sqrt{2} \left(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4} \right)$$

$$\frac{z_1}{z_2} = \frac{5\sqrt{2}}{4} \left(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4} \right)$$

$$\frac{1}{z_1} = \frac{\sqrt{2}}{10} \left(\cos \frac{\pi}{4} - i \sin \frac{\pi}{4} \right)$$

$$62. \quad z_1 = 8 \left(\cos \frac{11\pi}{6} + i \sin \frac{11\pi}{6} \right)$$

$$z_2 = 8 \left(\cos \frac{\pi}{2} + i \sin \frac{\pi}{2} \right)$$

$$z_1 z_2 = 64 \left(\cos \frac{\pi}{3} + i \sin \frac{\pi}{3} \right)$$

$$\frac{z_1}{z_2} = \cos \frac{4\pi}{3} + i \sin \frac{4\pi}{3}$$

$$\frac{1}{z_1} = \frac{1}{8} \left(\cos \frac{11\pi}{6} - i \sin \frac{11\pi}{6} \right)$$

$$63. \quad z_1 = 20(\cos \pi + i \sin \pi)$$

$$z_2 = 2 \left(\cos \frac{\pi}{6} + i \sin \frac{\pi}{6} \right)$$

$$z_1 z_2 = 40 \left(\cos \frac{7\pi}{6} + i \sin \frac{7\pi}{6} \right)$$

$$\frac{z_1}{z_2} = 10 \left(\cos \frac{5\pi}{6} + i \sin \frac{5\pi}{6} \right)$$

$$\frac{1}{z_1} = \frac{1}{20}(\cos \pi - i \sin \pi)$$

$$64. \quad z_1 = 5[\cos(0.927) + i \sin(0.927)]$$

$$z_2 = 2\sqrt{2} \left(\cos \frac{7\pi}{4} + i \sin \frac{7\pi}{4} \right)$$

$$z_1 z_2 = 10\sqrt{2}[\cos(0.142) + i \sin(0.142)]$$

$$\frac{z_1}{z_2} = \frac{5\sqrt{2}}{4}[\cos(4.57) - i \sin(4.57)]$$

$$\frac{1}{z_1} = \frac{1}{5}[\cos(0.927) - i \sin(0.927)]$$

$$65. -1024 \quad 66. 16 + 16\sqrt{3}i$$

$$67. 512(-\sqrt{3} + i)$$

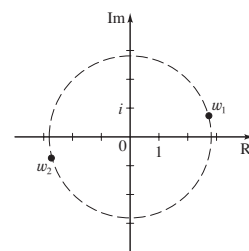
$$68. 16 \quad 69. -1 \quad 70. \frac{1}{2048}(-1 + \sqrt{3}i) \quad 71. 4096$$

$$72. 1 \quad 73. 8(-1 + i) \quad 74. 72(-1 + \sqrt{3}i)$$

$$75. \frac{1}{2048}(-\sqrt{3} - i) \quad 76. \frac{1}{16}$$

$$77. \quad 2\sqrt{2} \left(\cos \frac{\pi}{12} + i \sin \frac{\pi}{12} \right),$$

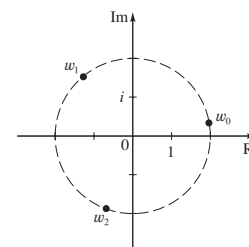
$$2\sqrt{2} \left(\cos \frac{13\pi}{12} + i \sin \frac{13\pi}{12} \right)$$



$$78. \quad 2 \left(\cos \frac{\pi}{18} + i \sin \frac{\pi}{18} \right),$$

$$2 \left(\cos \frac{13\pi}{18} + i \sin \frac{13\pi}{18} \right),$$

$$2 \left(\cos \frac{25\pi}{18} + i \sin \frac{25\pi}{18} \right)$$

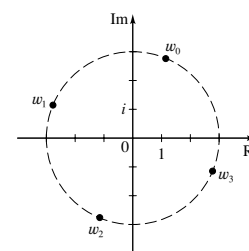


$$79. \quad 3 \left(\cos \frac{3\pi}{8} + i \sin \frac{3\pi}{8} \right),$$

$$3 \left(\cos \frac{7\pi}{8} + i \sin \frac{7\pi}{8} \right),$$

$$3 \left(\cos \frac{11\pi}{8} + i \sin \frac{11\pi}{8} \right),$$

$$3 \left(\cos \frac{15\pi}{8} + i \sin \frac{15\pi}{8} \right)$$

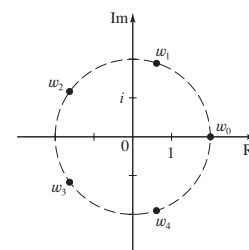


$$80. \quad 2 \left(\cos \frac{2\pi}{5} + i \sin \frac{2\pi}{5} \right),$$

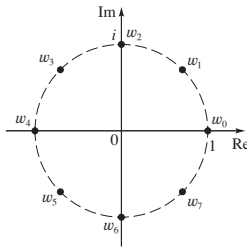
$$2 \left(\cos \frac{4\pi}{5} + i \sin \frac{4\pi}{5} \right),$$

$$2 \left(\cos \frac{6\pi}{5} + i \sin \frac{6\pi}{5} \right),$$

$$2 \left(\cos \frac{8\pi}{5} + i \sin \frac{8\pi}{5} \right)$$



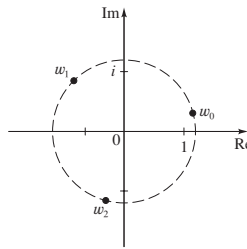
$$81. \pm 1, \pm i, \pm \frac{\sqrt{2}}{2} \pm \frac{\sqrt{2}}{2}i$$



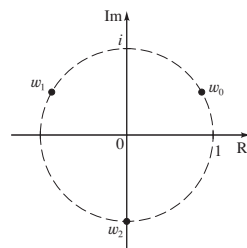
$$82. 2^{1/6} \left(\cos \frac{\pi}{12} + i \sin \frac{\pi}{12} \right),$$

$$2^{1/6} \left(\cos \frac{9\pi}{12} + i \sin \frac{9\pi}{12} \right),$$

$$2^{1/6} \left(\cos \frac{17\pi}{12} + i \sin \frac{17\pi}{12} \right)$$

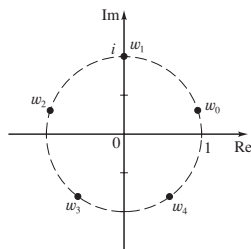


$$83. \frac{\sqrt{3}}{2} + \frac{1}{2}i, -\frac{\sqrt{3}}{2} + \frac{1}{2}i, -i$$

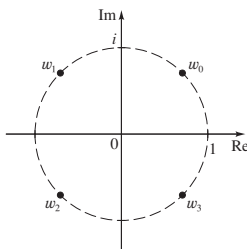


$$84. \cos \frac{\pi}{10} + i \sin \frac{\pi}{10}, \cos \frac{\pi}{2} + i \sin \frac{\pi}{2}, \cos \frac{9\pi}{10} + i \sin \frac{9\pi}{10},$$

$$\cos \frac{13\pi}{10} + i \sin \frac{13\pi}{10}, \cos \frac{17\pi}{10} + i \sin \frac{17\pi}{10}$$



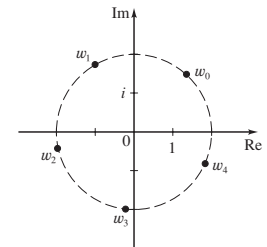
$$85. \pm \frac{\sqrt{2}}{2} \pm \frac{\sqrt{2}}{2}i$$



$$86. 2 \left(\cos \frac{4\pi}{15} + i \sin \frac{4\pi}{15} \right), 2 \left(\cos \frac{2\pi}{3} + i \sin \frac{2\pi}{3} \right),$$

$$2 \left(\cos \frac{16\pi}{15} + i \sin \frac{16\pi}{15} \right), 2 \left(\cos \frac{22\pi}{15} + i \sin \frac{22\pi}{15} \right),$$

$$2 \left(\cos \frac{28\pi}{15} + i \sin \frac{28\pi}{15} \right)$$



$$87. \pm \frac{\sqrt{2}}{2} \pm \frac{\sqrt{2}}{2}i$$

$$88. \cos \frac{\pi}{16} + i \sin \frac{\pi}{16}, \cos \frac{5\pi}{16} + i \sin \frac{5\pi}{16}, \cos \frac{9\pi}{16} + i \sin \frac{9\pi}{16},$$

$$\cos \frac{13\pi}{16} + i \sin \frac{13\pi}{16}, \cos \frac{17\pi}{16} + i \sin \frac{17\pi}{16},$$

$$\cos \frac{21\pi}{16} + i \sin \frac{21\pi}{16}, \cos \frac{25\pi}{16} + i \sin \frac{25\pi}{16},$$

$$\cos \frac{29\pi}{16} + i \sin \frac{29\pi}{16}$$

$$89. 2 \left(\cos \frac{\pi}{18} + i \sin \frac{\pi}{18} \right), 2 \left(\cos \frac{13\pi}{18} + i \sin \frac{13\pi}{18} \right),$$

$$2 \left(\cos \frac{25\pi}{18} + i \sin \frac{25\pi}{18} \right)$$

$$90. \pm 1, \pm \frac{1}{2} \pm \frac{\sqrt{3}}{2}i$$

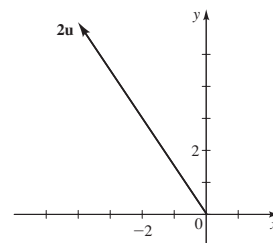
$$91. 2^{1/6} \left(\cos \frac{5\pi}{12} + i \sin \frac{5\pi}{12} \right), 2^{1/6} \left(\cos \frac{13\pi}{12} + i \sin \frac{13\pi}{12} \right),$$

$$2^{1/6} \left(\cos \frac{21\pi}{12} + i \sin \frac{21\pi}{12} \right)$$

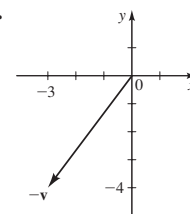
$$92. 1, -\frac{1}{2} \pm \frac{\sqrt{3}}{2}i$$

Section 8.4 ■ page 615

1.

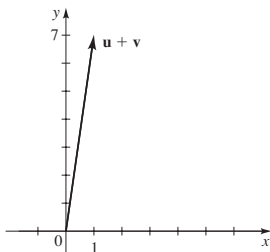


2.

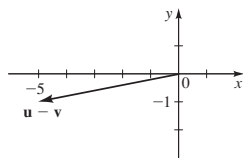


A90 Answers to Exercises and Chapter Tests

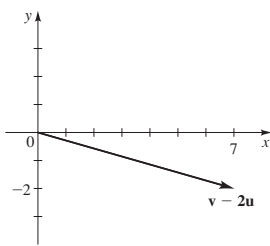
3.



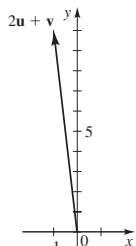
4.



5.



6.



7. $\langle 3, 3 \rangle$ 8. $\langle -5, 3 \rangle$ 9. $\langle 3, -1 \rangle$ 10. $\langle 2, -3 \rangle$ 11. $\langle 5, 7 \rangle$
 12. $\langle 8, 8 \rangle$ 13. $\langle -4, -3 \rangle$ 14. $\langle -5, -4 \rangle$ 15. $\langle 0, 2 \rangle$
 16. $\langle 7, 5 \rangle$ 17. $\langle 4, 14 \rangle, \langle -9, -3 \rangle, \langle 5, 8 \rangle, \langle -6, 17 \rangle$
 18. $\langle -4, 10 \rangle, \langle -6, 24 \rangle, \langle 0, -3 \rangle, \langle -14, 47 \rangle$
 19. $\langle 0, -2 \rangle, \langle 6, 0 \rangle, \langle -2, -1 \rangle, \langle 8, -3 \rangle$
 20. $2\mathbf{i}, 6\mathbf{j}, \mathbf{i} - 2\mathbf{j}, 3\mathbf{i} + 8\mathbf{j}$
 21. $4\mathbf{i}, -9\mathbf{i} + 6\mathbf{j}, 5\mathbf{i} - 2\mathbf{j}, -6\mathbf{i} + 8\mathbf{j}$
 22. $2\mathbf{i} + 2\mathbf{j}, -3\mathbf{i} + 3\mathbf{j}, 2\mathbf{i}, -\mathbf{i} + 7\mathbf{j}$
 23. $\sqrt{5}, \sqrt{13}, 2\sqrt{5}, \frac{1}{2}\sqrt{13}, \sqrt{26}, \sqrt{10}, \sqrt{5} - \sqrt{13}$
 24. $\sqrt{13}, \sqrt{5}, 2\sqrt{13}, \sqrt{5}/2, \sqrt{2}, \sqrt{34}, \sqrt{13} - \sqrt{5}$
 25. $\sqrt{101}, 2\sqrt{2}, 2\sqrt{101}, \sqrt{2}, \sqrt{73}, \sqrt{145}, \sqrt{101} - 2\sqrt{2}$
 26. $6\sqrt{2}, \sqrt{5}, 12\sqrt{2}, \sqrt{5}/2, \sqrt{89}, \sqrt{63}, 6\sqrt{2} - \sqrt{5}$
 27. $20\sqrt{3}\mathbf{i} + 20\mathbf{j}$ 28. $-25\mathbf{i} + 25\sqrt{3}\mathbf{j}$ 29. $-\frac{\sqrt{2}}{2}\mathbf{i} - \frac{\sqrt{2}}{2}\mathbf{j}$
 30. $800 \cos 125^\circ \mathbf{i} + 800 \sin 125^\circ \mathbf{j} \approx -458.86\mathbf{i} + 655.32\mathbf{j}$
 31. $4 \cos 10^\circ \mathbf{i} + 4 \sin 10^\circ \mathbf{j} \approx 3.94\mathbf{i} + 0.69\mathbf{j}$
 32. $\frac{\sqrt{3}}{2}\mathbf{i} - \frac{3}{2}\mathbf{j}$ 33. $5, 53.13^\circ$ 34. $1, 225^\circ$ 35. $13, 157.38^\circ$
 36. $41, 12.68^\circ$ 37. $2, 60^\circ$ 38. $\sqrt{2}, 45^\circ$ 39. $15\sqrt{3}, -15$
 40. $469.85 \text{ mi/h}, 171.01 \text{ mi/h}$ 41. $2\mathbf{i} - 3\mathbf{j}$
 42. $\left(\frac{5\sqrt{2}}{2} + 3\right)\mathbf{i} + \left(\frac{5\sqrt{2}}{2}\right)\mathbf{j}$ 43. (a) $40\mathbf{j}$ (b) $425\mathbf{i}$
 (c) $425\mathbf{i} + 40\mathbf{j}$ (d) $427 \text{ mi/h}, \text{N } 84.6^\circ \text{ E}$
 44. (a) $\left\langle \frac{55}{2}, \frac{55\sqrt{3}}{2} \right\rangle$ (b) $\left\langle \frac{765\sqrt{2}}{2}, \frac{765\sqrt{2}}{2} \right\rangle$
 (c) $\langle 568.44, 588.57 \rangle$ (d) $818 \text{ mi/h}, \text{N } 44^\circ \text{ E}$
 45. $794 \text{ mi/h}, \text{N } 26.6^\circ \text{ W}$ 46. $\text{N } 2.1^\circ \text{ W}$
 47. (a) $10\mathbf{i}$ (b) $10\mathbf{i} + 17.32\mathbf{j}$ (c) $20\mathbf{i} + 17.32\mathbf{j}$
 (d) $26.5 \text{ mi/h}, \text{N } 49.1^\circ \text{ E}$ 48. $\text{N } 30^\circ \text{ W}$
 49. (a) $22.8\mathbf{i} + 7.4\mathbf{j}$ (b) $7.4 \text{ mi/h}, 22.8 \text{ mi/h}$
 50. $25.08 \text{ mi/h}, \text{N } 4.57^\circ \text{ W}$ 51. (a) $\langle 5, -3 \rangle$ (b) $\langle -5, 3 \rangle$
 52. (a) $\langle 0, 0 \rangle$ (b) None 53. (a) $-4\mathbf{j}$ (b) $4\mathbf{j}$

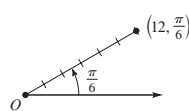
54. (a) \mathbf{j} (b) $-\mathbf{j}$ 55. (a) $\langle -7.57, 10.61 \rangle$
 (b) $\langle 7.57, -10.61 \rangle$ 56. (a) $\langle 2, -4 \rangle$ (b) $\langle -2, 4 \rangle$
 57. $\mathbf{T}_1 \approx -56.5\mathbf{i} + 67.4\mathbf{j}, \mathbf{T}_2 \approx 56.5\mathbf{i} + 32.6\mathbf{j}$
 58. $\mathbf{T}_1 \approx -14,116\mathbf{i} + 5,789\mathbf{j}, \mathbf{T}_2 \approx 14,116\mathbf{i} + 12,488\mathbf{j}$

Section 8.5 ■ page 624

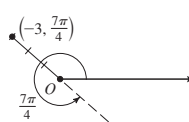
1. (a) 2 (b) 45° 2. (a) 0 (b) 90° 3. (a) 13 (b) 56°
 4. (a) -12 (b) 180° 5. (a) -1 (b) 97°
 6. (a) 4 (b) 60.3° 7. (a) $5\sqrt{3}$ (b) 30°
 8. (a) 0 (b) 90° 9. Yes 10. Yes 11. No 12. Yes
 13. Yes 14. No 15. 9 16. 9 17. -5 18. -10
 19. $-\frac{12}{5}$ 20. $\sqrt{2}$ 21. -24 22. $\frac{28}{5}$
 23. (a) $\langle 1, 1 \rangle$ (b) $\mathbf{u}_1 = \langle 1, 1 \rangle, \mathbf{u}_2 = \langle -3, 3 \rangle$
 24. (a) $\langle 4, 2 \rangle$ (b) $\mathbf{u}_1 = \langle 4, 2 \rangle, \mathbf{u}_2 = \langle 3, -6 \rangle$
 25. (a) $\langle -\frac{1}{2}, \frac{3}{2} \rangle$ (b) $\mathbf{u}_1 = \langle -\frac{1}{2}, \frac{3}{2} \rangle, \mathbf{u}_2 = \langle \frac{3}{2}, \frac{1}{2} \rangle$
 26. (a) $\langle 9, 6 \rangle$ (b) $\mathbf{u}_1 = \langle 9, 6 \rangle, \mathbf{u}_2 = \langle 2, -3 \rangle$
 27. (a) $\langle -\frac{18}{5}, \frac{24}{5} \rangle$ (b) $\mathbf{u}_1 = \langle -\frac{18}{5}, \frac{24}{5} \rangle, \mathbf{u}_2 = \langle \frac{28}{5}, \frac{21}{5} \rangle$
 28. (a) $\langle \frac{2}{5}, -\frac{1}{5} \rangle$ (b) $\mathbf{u}_1 = \langle \frac{2}{5}, -\frac{1}{5} \rangle, \mathbf{u}_2 = \langle \frac{3}{5}, \frac{6}{5} \rangle$
 29. -28 30. $80,400$ 31. 25 32. 280 33. $\mathbf{u} \cdot \mathbf{v}$
 39. $16 \text{ ft}\cdot\text{lb}$ 40. $82 \text{ ft}\cdot\text{lb}$ 41. $8660 \text{ ft}\cdot\text{lb}$ 42. $260,000 \text{ ft}\cdot\text{lb}$
 43. 1164 lb 44. (a) 2822 lb (b) 2779 lb 45. 23.6°
 46. 54.6 lb

Chapter 8 Review ■ page 627

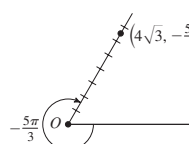
1. (a)

(b) $(6\sqrt{3}, 6)$

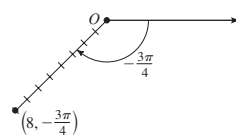
3. (a)

(b) $\left(\frac{-3\sqrt{2}}{2}, \frac{3\sqrt{2}}{2}\right)$

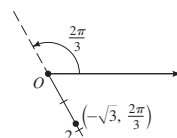
5. (a)

(b) $(2\sqrt{3}, 6)$

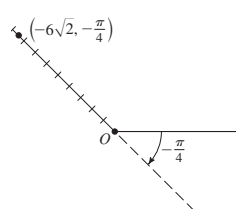
2. (a)

(b) $(-4\sqrt{2}, -4\sqrt{2})$

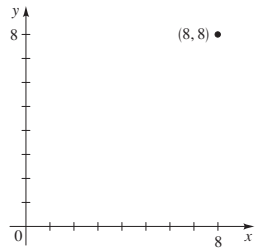
4. (a)

(b) $\left(\frac{\sqrt{3}}{2}, -\frac{3}{2}\right)$

6. (a)

(b) $(-6, 6)$

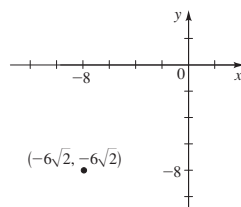
7. (a)



(b) $\left(8\sqrt{2}, \frac{\pi}{4}\right)$

(c) $\left(-8\sqrt{2}, \frac{5\pi}{4}\right)$

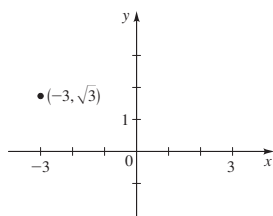
9. (a)



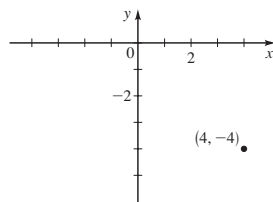
(b) $\left(12, \frac{5\pi}{4}\right)$

(c) $\left(-12, \frac{\pi}{4}\right)$

11. (a)

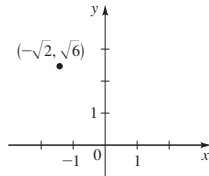


12. (a)



13. (a) $r = \frac{4}{\cos \theta + \sin \theta}$

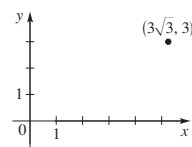
8. (a)



(b) $\left(2\sqrt{2}, \frac{2\pi}{3}\right)$

(c) $\left(-2\sqrt{2}, \frac{5\pi}{3}\right)$

10. (a)



(b) $\left(6, \frac{\pi}{6}\right)$

(c) $\left(-6, \frac{7\pi}{6}\right)$

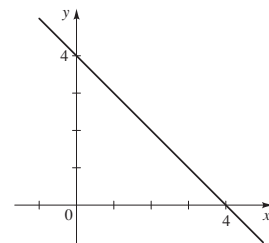
(b) $\left(2\sqrt{3}, \frac{5\pi}{6}\right)$

(c) $\left(-2\sqrt{3}, -\frac{\pi}{6}\right)$

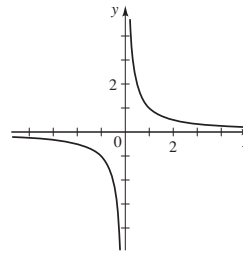
(b) $\left(4\sqrt{2}, \frac{7\pi}{4}\right)$

(c) $\left(-4\sqrt{2}, \frac{3\pi}{4}\right)$

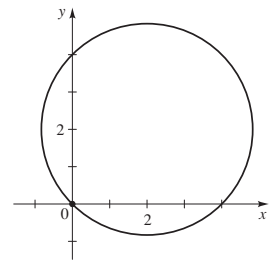
(b)

14. (a) $r^2 = 2 \csc 2\theta$

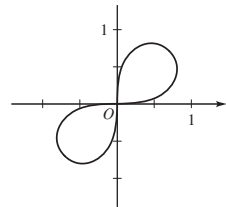
(b)

16. (a) $r^2 = \sin 2\theta$ 15. (a) $r = 4(\cos \theta + \sin \theta)$

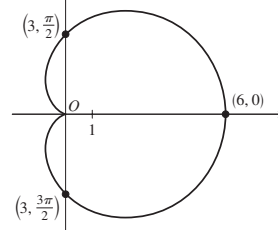
(b)



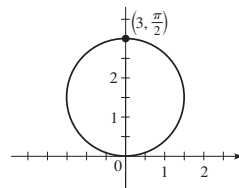
(b)



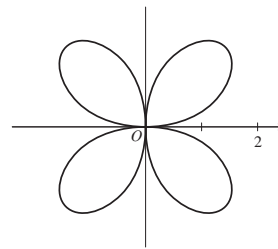
17. (a)

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

18. (a)

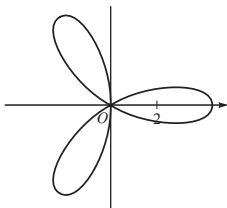
(b) $x^2 + (y - \frac{3}{2})^2 = \frac{9}{4}$

19. (a)

(b) $(x^2 + y^2)^3 = 16x^2y^2$

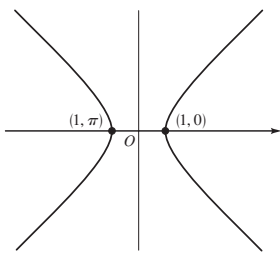
A92 Answers to Exercises and Chapter Tests

20. (a)



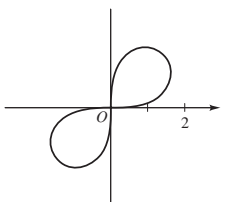
(b) $(x^2 + y^2)^2 = 4x^3 - 12xy^2$

21. (a)



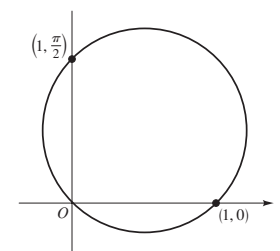
(b) $x^2 - y^2 = 1$

22. (a)



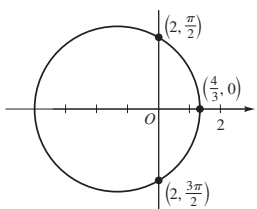
(b) $(x^2 + y^2)^2 = 8xy$

23. (a)

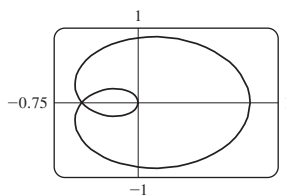
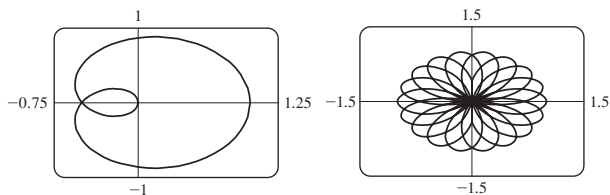
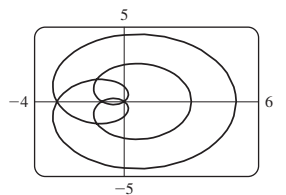
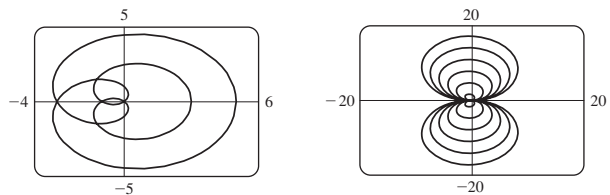


(b) $x^2 + y^2 = x + y$

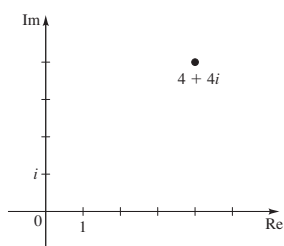
24. (a)



(b) $\frac{(x + \frac{4}{3})^2}{\frac{64}{9}} + \frac{y^2}{\frac{16}{9}} = 1$

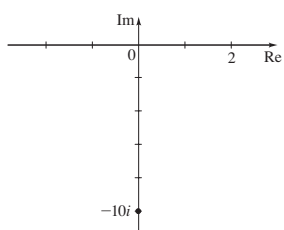
25. $0 \leq \theta \leq 6\pi$ 26. $0 \leq \theta \leq 8\pi$ 27. $0 \leq \theta \leq 6\pi$ 28. $-6\pi \leq \theta \leq 6\pi$ 

29. (a)



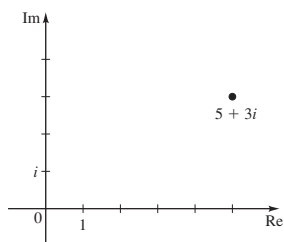
(b) $4\sqrt{2}, \frac{\pi}{4}$ (c) $4\sqrt{2}(\cos \frac{\pi}{4} + i \sin \frac{\pi}{4})$

30. (a)

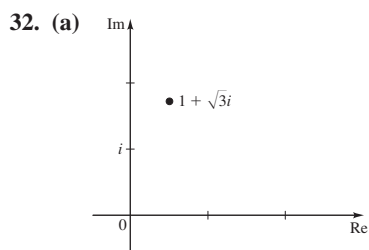


(b) $10, \frac{3\pi}{2}$ (c) $10(\cos \frac{3\pi}{2} + i \sin \frac{3\pi}{2})$

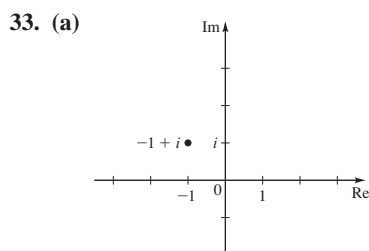
31. (a)



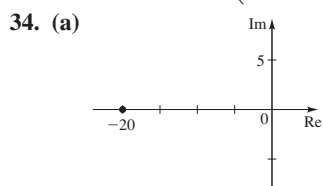
(b) $\sqrt{34}, \tan^{-1}(\frac{3}{5})$ (c) $\sqrt{34}[\cos(\tan^{-1}(\frac{3}{5})) + i \sin(\tan^{-1}(\frac{3}{5}))]$



(b) $2, \frac{\pi}{3}$ (c) $2\left(\cos \frac{\pi}{3} + i \sin \frac{\pi}{3}\right)$



(b) $\sqrt{2}, \frac{3\pi}{4}$ (c) $\sqrt{2}\left(\cos \frac{3\pi}{4} + i \sin \frac{3\pi}{4}\right)$



(b) $20, \pi$ (c) $20(\cos \pi + i \sin \pi)$

35. $8(-1 + i\sqrt{3})$ 36. 16 37. $-\frac{1}{32}(1 + i\sqrt{3})$

38. $\frac{1}{2}(-1 + i\sqrt{3})$ 39. $\pm 2\sqrt{2}(1 - i)$

40. $2\left(\cos \frac{\pi}{9} + i \sin \frac{\pi}{9}\right), 2\left(\cos \frac{7\pi}{9} + i \sin \frac{7\pi}{9}\right),$
 $2\left(\cos \frac{13\pi}{9} + i \sin \frac{13\pi}{9}\right)$

41. $\pm 1, \pm \frac{1}{2} \pm \frac{\sqrt{3}}{2}i$

42. $\cos \frac{\pi}{16} + i \sin \frac{\pi}{16}, \cos \frac{5\pi}{16} + i \sin \frac{5\pi}{16},$
 $\cos \frac{9\pi}{16} + i \sin \frac{9\pi}{16}, \cos \frac{13\pi}{16} + i \sin \frac{13\pi}{16},$
 $\cos \frac{17\pi}{16} + i \sin \frac{17\pi}{16}, \cos \frac{21\pi}{16} + i \sin \frac{21\pi}{16},$
 $\cos \frac{25\pi}{16} + i \sin \frac{25\pi}{16}, \cos \frac{29\pi}{16} + i \sin \frac{29\pi}{16}$

43. $\sqrt{13}, \langle 6, 4 \rangle, \langle -10, 2 \rangle, \langle -4, 6 \rangle, \langle -22, 7 \rangle$

44. $\sqrt{5}, 3\mathbf{i} - \mathbf{j}, \mathbf{i} + 3\mathbf{j}, 4\mathbf{i} + 2\mathbf{j}, 4\mathbf{i} + 7\mathbf{j}$

45. $3\mathbf{i} - 4\mathbf{j}$ 46. $10\mathbf{i} + 10\sqrt{3}\mathbf{j}$ 47. $(10, -2)$ 48. -68.2°

49. (a) $(4.8\mathbf{i} + 0.4\mathbf{j}) \times 10^4$ (b) 4.8×10^4 lb, N 85.2° E

50. (a) $\langle 300\sqrt{3} - 25, 300 + 25\sqrt{3} \rangle$

(b) 602.1 mi/h, N 55.2° E 51. 5, 25, 60 52. 13, 169, 2

53. $2\sqrt{2}, 8, 0$ 54. 10, 100, -30 55. Yes

56. No, 82.2° 57. No, 45° 58. Yes 59. (a) $17\sqrt{37}/37$

(b) $\langle \frac{102}{37}, -\frac{17}{37} \rangle$ (c) $\mathbf{u}_1 = \langle \frac{102}{37}, -\frac{17}{37} \rangle, \mathbf{u}_2 = \langle \frac{9}{37}, \frac{54}{37} \rangle$

60. (a) $-\sqrt{2}$ (b) $\langle -1, -1 \rangle$

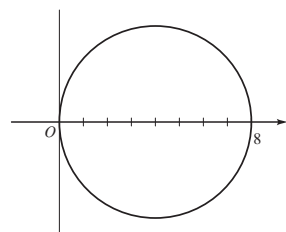
(c) $\mathbf{u}_1 = \langle -1, -1 \rangle, \mathbf{u}_2 = \langle -7, 7 \rangle$

61. -6 62. 40.5°

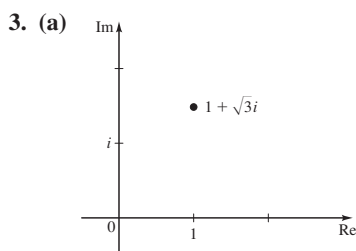
Chapter 8 Test ■ page 629

1. (a) $(-4\sqrt{2}, -4\sqrt{2})$ (b) $(4\sqrt{3}, 5\pi/6), (-4\sqrt{3}, 11\pi/6)$

2. (a)

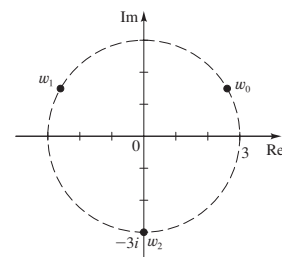


(b) $(x - 4)^2 + y^2 = 16$



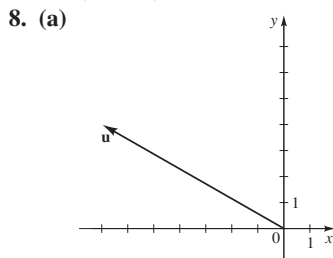
(b) $2\left(\cos \frac{\pi}{3} + i \sin \frac{\pi}{3}\right)$ (c) -512 4. $-8, \sqrt{3} + i$

5. $-3i, 3\left(\pm \frac{\sqrt{3}}{2} + \frac{1}{2}i\right)$



6. (a) $-6\mathbf{i} + 10\mathbf{j}$ (b) $2\sqrt{34}$

7. (a) $\langle 19, -3 \rangle$ (b) $5\sqrt{2}$ (c) 0 (d) Yes



(b) $8, \frac{5\pi}{6}$

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9. (a) $14i + 6\sqrt{3}j$ (b) 17.4 mi/h, N 53.4° E
 10. (a) 45° (b) $\sqrt{26}/2$ (c) $\frac{5}{2}i - \frac{1}{2}j$ 11. 90

Focus on Modeling ■ page 632

1. (a) $R = 18/\pi \approx 5.73$ (b) 691.2 mi 2. 31.48 in.
 3. (a) $x \approx -12.23$, $y \approx 6.27$ (b) $x \approx 3.76$, $y \approx 8.43$
 (c) $x \approx 15.12$, $y \approx -3.85$ (d) $x \approx -4.31$, $y \approx -2.42$
 4. (a) 10 (b) $(10.66, 151.2^\circ)$ 5. (a) 1.14 (b) 1.73
 (c) 36.81 6. (a) 1.06 (b) 1.31 (c) 5.76 7. (a) 1.48
 (b) 1.21 (c) 1.007 8. (a) 1.49 (b) 1.22 (c) 1.01

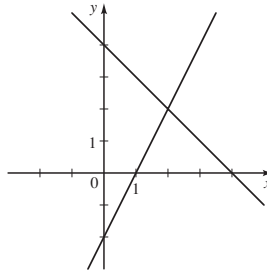
Chapter 9

Section 9.1 ■ page 642

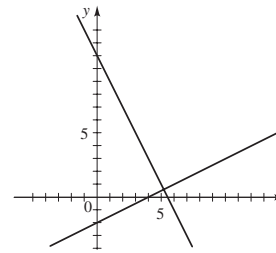
1. (3, 1) 2. (4, -1) 3. (4, 16), (-3, 9)
 4. $(-\sqrt{5}, -2\sqrt{5})$, $(\sqrt{5}, 2\sqrt{5})$ 5. (2, -2), (-2, 2)
 6. (-3, 0), (2, 5) 7. (-25, 5), (-25, -5)
 8. (-2, 3), (2, 3) 9. (1, 2) 10. (2, -1) 11. (-3, 4), (3, 4)
 12. $(-\sqrt{11}, -4)$, $(\sqrt{11}, -4)$
 13. (-2, -1), (-2, 1), (2, -1), (2, 1)
 14. $(\frac{-5\sqrt{2}}{2}, -3)$, $(\frac{5\sqrt{2}}{2}, -3)$, $(\frac{-3\sqrt{2}}{2}, 1)$, $(\frac{3\sqrt{2}}{2}, 1)$
 15. $(-1, \sqrt{2})$, $(-1, -\sqrt{2})$, $(\frac{1}{2}, \sqrt{\frac{7}{2}})$, $(\frac{1}{2}, -\sqrt{\frac{7}{2}})$
 16. (-1, 0), (2, $-\sqrt{3}$), (2, $\sqrt{3}$)
 17. (-2, 3) 18. (3, -1) 19. (2, 4), $(-\frac{5}{2}, \frac{7}{4})$
 20. (0, -2), (5, 3) 21. (0, 0), (1, -1), (-2, -4)
 22. (0, 0), (3, $\sqrt{3}$), (3, $-\sqrt{3}$) 23. (4, 0) 24. (0, 0), (1, 1)
 25. (-2, -2) 26. (-2, 0), (2, 0) 27. (6, 2), (-2, -6)
 28. (4, 6), (-4, -6) 29. No solution 30. $(-\sqrt{6}, 6)$
 31. $(\sqrt{5}, 2)$, $(\sqrt{5}, -2)$, $(-\sqrt{5}, 2)$, $(-\sqrt{5}, -2)$
 32. No solution 33. $(3, -\frac{1}{2})$, $(-3, -\frac{1}{2})$
 34. (-2, 1), (2, 1) 35. $(\frac{1}{5}, \frac{1}{3})$
 36. $(-\sqrt{2}, -\sqrt{2})$, $(-\sqrt{2}, \sqrt{2})$, $(\sqrt{2}, -\sqrt{2})$, $(\sqrt{2}, \sqrt{2})$
 37. (-0.33, 5.33) 38. (3, 6)
 39. (2.00, 20.00), (-8.00, 0)
 40. (0.35, -1.30), (5.65, 9.30)
 41. (-4.51, 2.17), (4.91, -0.97)
 42. (2, -3.61), (2, 3.61)
 43. (1.23, 3.87), (-0.35, -4.21)
 44. (-2.22, 1.40), (-1.88, -0.72), (3.45, -2.99), (4.65, 4.31)
 45. (-2.30, -0.70), (0.48, -1.19)
 46. (-1.19, 3.59), (1.19, 3.59) 47. 12 cm by 15 cm
 48. 7 ft by 24 ft 49. 15, 20 50. $4\sqrt{5}$ in. by $8\sqrt{5}$ in.
 51. (400.50, 200.25), 447.77 m 52. 2π by $600/\pi$
 53. (12, 8)

Section 9.2 ■ page 649

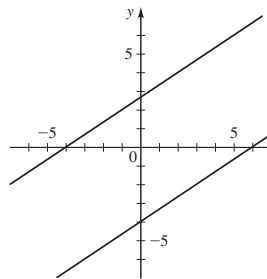
1. (2, 2)



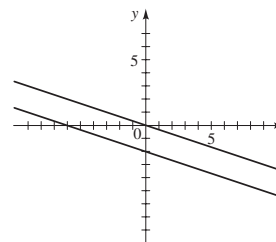
2. (5.2, 0.6)



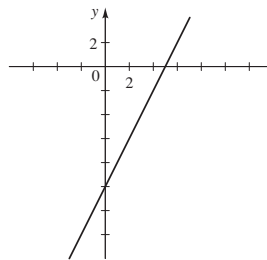
3. No solution



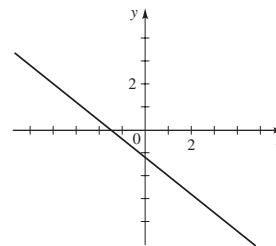
4. No solution



5. Infinitely many solutions



6. Infinitely many solutions



7. (2, 2) 8. (4, 1) 9. (3, -1) 10. (4, -6) 11. (2, 1)
 12. (4, 3) 13. (3, 5) 14. (-2, -12) 15. (1, 3)
 16. (12, 4) 17. (10, -9) 18. (-6, 3) 19. No solution
 20. (10, -12) 21. No solution 22. No solution
 23. $(x, \frac{1}{3}x - \frac{5}{3})$ 24. No solution 25. $(x, 3 - \frac{3}{2}x)$
 26. $(x, \frac{1}{3}x - \frac{4}{3})$ 27. (-3, -7) 28. (25, 1) 29. $(x, 5 - \frac{5}{6}x)$
 30. (5, 21) 31. (5, 10) 32. (1, 3) 33. No solution
 34. $(x, \frac{1}{5}x + 8)$ 35. (3.87, 2.74) 36. (-0.71, -1.72)
 37. (61.00, 20.00) 38. (2.85, 1.36)
 39. $(\frac{1}{a-1}, \frac{1}{a-1})$ 40. $(\frac{b}{b-a}, \frac{a}{a-b})$
 41. $(\frac{1}{a+b}, \frac{1}{a+b})$ 42. $(\frac{1}{a^2-ab}, \frac{1}{b^2-ab})$ 43. 22, 12
 44. 6, 18 45. 5 dimes, 9 quarters 46. 1500 children,
 700 adults 47. Plane's speed 120 mi/h, wind speed 30 mi/h
 48. boat speed 14 mi/h, current 6 mi/h 49. Run 5 mi/h,
 cycle 20 mi/h 50. 400 mL of 5% solution, 600 mL of
 20% solution 51. 200 g of A, 40 g of B 52. 2.5 lb of

Kenyan, 0.5 lb of Sri Lankan **53.** 25%, 10%
54. \$14,000 at 5%, \$6,000 at 8% **55.** \$16,000 at 10%,
 \$32,000 at 6% **56.** John $2\frac{1}{4}$ h, Mary $2\frac{1}{2}$ h **57.** 25 **58.** 6

Section 9.3 ■ page 657

- 1.** Linear **2.** Nonlinear **3.** Nonlinear **4.** Linear
5. (1, 3, 2) **6.** (3, 2, -1) **7.** (4, 0, 3) **8.** (4, 3, 4)
9. $(5, 2, -\frac{1}{2})$ **10.** $(-\frac{7}{2}, 1, 8)$
- 11.**
$$\begin{cases} x - 2y - z = 4 \\ -y - 4z = 4 \\ 2x + y + z = 0 \end{cases}$$
 12.
$$\begin{cases} x + y - 3z = 3 \\ 5y - 5z = 8 \\ x - y + 2z = 0 \end{cases}$$
- 13.**
$$\begin{cases} 2x - y + 3z = 2 \\ x + 2y - z = 4 \\ 3y + 7z = 14 \end{cases}$$
 14.
$$\begin{cases} x - 4y + z = 3 \\ y - 3z = 10 \\ z = -6 \end{cases}$$
- 15.** (1, 2, 1) **16.** (1, -3, 2) **17.** (5, 0, 1) **18.** (-1, 1, 2)
19. (0, 1, 2) **20.** (-1, -2, 4) **21.** $(1 - 3t, 2t, t)$
22. (-2, 0, 3) **23.** No solution **24.** No solution
25. No solution **26.** No solution **27.** $(3 - t, -3 + 2t, t)$
28. $(7t + 1, 4t - 1, t)$ **29.** $(2 - 2t, -\frac{2}{3} + \frac{4}{3}t, t)$
30. $(-2t + 2, t, 1)$ **31.** (1, -1, 1, 2) **32.** (-1, 1, -1, 1)
33. \$30,000 in short-term bonds, \$30,000 in intermediate-term
 bonds, \$40,000 in long-term bonds **34.** \$10,000 in short-term,
 \$45,000 in intermediate-term, \$45,000 in long-term
35. Impossible **36.** $I_1 \approx 0.39, I_2 \approx 0.29, I_3 \approx 0.68$
37. 250 acres corn, 500 acres wheat, 450 acres soybeans

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- 1.** 3×2 **2.** 2×4 **3.** 2×1 **4.** 3×1 **5.** 1×3
6. 2×2

- 7.** (a) Yes (b) Yes (c) $\begin{cases} x = -3 \\ y = 5 \end{cases}$
- 8.** (a) Yes (b) No (c) $\begin{cases} x + 3y = -3 \\ y = 5 \end{cases}$
- 9.** (a) Yes (b) No (c) $\begin{cases} x + 2y + 8z = 0 \\ y + 3z = 2 \\ 0 = 0 \end{cases}$
- 10.** (a) Yes (b) Yes (c) $\begin{cases} x - 7z = 0 \\ y + 3z = 0 \\ 0 = 1 \end{cases}$
- 11.** (a) No (b) No (c) $\begin{cases} x = 0 \\ 0 = 0 \\ y + 5z = 1 \end{cases}$
- 12.** (a) Yes (b) Yes (c) $\begin{cases} x = 1 \\ y = 2 \\ z = 3 \end{cases}$
- 13.** (a) Yes (b) Yes (c) $\begin{cases} x + 3y - w = 0 \\ z + 2w = 0 \\ 0 = 1 \\ 0 = 0 \end{cases}$

$$\mathbf{14.} \text{ (a) No (b) No (c) } \begin{cases} x + 3y + w = 0 \\ y + 4w = 0 \\ w + u = 2 \\ w = 0 \end{cases}$$

- 15.** (1, 1, 2) **16.** (-1, 4, 0) **17.** (1, 0, 1) **18.** (-2, 3, 3)
19. (-1, 0, 1) **20.** (3, 1, 2) **21.** (-1, 5, 0) **22.** (3, 1, 1)
23. (10, 3, -2) **24.** (1, 1, -2) **25.** No solution
26. No solution **27.** $(2 - 3t, 3 - 5t, t)$
28. $(-4t + 10, \frac{1}{2}t + \frac{7}{2}, t)$ **29.** No solution
30. $(3t + 2, t, 4)$ **31.** $(-2t + 5, t - 2, t)$ **32.** $(t, 5, t)$
33. $x = -\frac{1}{2}s + t + 6, y = s, z = t$ **34.** No solution
35. (-2, 1, 3) **36.** (-1, 3, 5) **37.** (-9, 2, 0) **38.** (-2, 1, 3)
39. (0, -3, 0, -3) **40.** (1, 3, 0, -2) **41.** (-1, 0, 0, 1)
42. (-2, 1, 0, 3) **43.** $(\frac{7}{4} - \frac{7}{4}t, -\frac{7}{4} + \frac{3}{4}t, \frac{9}{4} + \frac{3}{4}t, t)$
44. $(-2t + 6, \frac{5}{2}t - 9, \frac{9}{2}t - 9, t)$
45. $x = \frac{1}{3}s - \frac{2}{3}t, y = \frac{1}{3}s + \frac{1}{3}t, z = s, w = t$
46. $(20 - 12t, 31 - 19t, -2 + 2t, t)$
47. 2 VitaMax, 1 Vitron, 2 VitaPlus
48. 40 mL of 10% acid, 50 mL of 20% acid, 10 mL of
 40% acid **49.** 5-mile run, 2-mile swim, 30-mile cycle
50. 20 in room A, 50 in room B, 30 in room C
51. Impossible **52.** $x = t - 50, y = 170 + t, z = 430 - t,$
 $w = t,$ where $50 \leq t \leq 430$

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- 1.** No **2.** Yes **3.** $\begin{bmatrix} 1 & 3 \\ 1 & 5 \end{bmatrix}$ **4.** $\begin{bmatrix} -2 & 0 & 2 \\ 0 & -2 & 2 \end{bmatrix}$
- 5.** $\begin{bmatrix} 3 & 6 \\ 12 & -3 \\ 3 & 0 \end{bmatrix}$ **6.** Impossible **7.** Impossible
- 8.** $\begin{bmatrix} 1 & 2 \\ 7 & 64 \end{bmatrix}$ **9.** $\begin{bmatrix} 5 & 2 & 1 \\ 7 & 10 & -7 \end{bmatrix}$
- 10.** $\begin{bmatrix} 7 \\ 1 \\ 7 \end{bmatrix}$ **11.** $\begin{bmatrix} -1 & -\frac{1}{2} \\ 1 & 2 \end{bmatrix}$ **12.** Impossible
- 13.** No solution **14.** $\begin{bmatrix} 4 & 7 \\ 7 & 4 \\ 2 & 2 \end{bmatrix}$ **15.** $\begin{bmatrix} 0 & -5 \\ -25 & -20 \\ -10 & 10 \end{bmatrix}$
- 16.** $\begin{bmatrix} -2 & -\frac{7}{3} \\ \frac{1}{3} & \frac{1}{3} \end{bmatrix}$ **17.** $\begin{bmatrix} 5 & -2 & 5 \\ 1 & 1 & 0 \end{bmatrix}$ **18.** Impossible
- 19.** $\begin{bmatrix} -1 & -3 & -5 \\ -1 & 3 & -6 \end{bmatrix}$ **20.** $\begin{bmatrix} 10 & -25 \\ 0 & 35 \end{bmatrix}$
- 21.** $\begin{bmatrix} 13 & -\frac{7}{2} & 15 \\ 3 & 1 & 3 \end{bmatrix}$ **22.** Impossible
- 23.** $\begin{bmatrix} -14 & -8 & -30 \\ -6 & 10 & -24 \end{bmatrix}$ **24.** [14 -14]
- 25.** Impossible **26.** Impossible **27.** $\begin{bmatrix} 3 & \frac{1}{2} & 5 \\ 1 & -1 & 3 \end{bmatrix}$

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$$28. \begin{bmatrix} 5 & -3 & 10 \\ 6 & 1 & 0 \\ -5 & 2 & 2 \end{bmatrix} \quad 29. [28 \ 21 \ 28] \quad 30. [28 \ 21 \ 28]$$

$$31. \begin{bmatrix} -1 \\ 8 \\ -1 \end{bmatrix} \quad 32. \begin{bmatrix} 4 & -45 \\ 0 & 49 \end{bmatrix} \quad 33. \begin{bmatrix} 8 & -335 \\ 0 & 343 \end{bmatrix}$$

$$34. [38 \ -11 \ 35] \quad 35. \text{Impossible} \quad 36. \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$37. \text{Impossible} \quad 38. \begin{bmatrix} 13 \\ -7 \end{bmatrix} \quad 39. x = 2, y = -1$$

$$40. x = 2, y = -3 \quad 41. x = 1, y = -2 \quad 42. x = 5, y = 1$$

$$43. \begin{bmatrix} 2 & -5 \\ 3 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 7 \\ 4 \end{bmatrix}$$

$$44. \begin{bmatrix} 6 & -1 & 1 \\ 2 & 0 & 1 \\ 0 & 1 & -2 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 12 \\ 7 \\ 4 \end{bmatrix}$$

$$45. \begin{bmatrix} 3 & 2 & -1 & 1 \\ 1 & 0 & -1 & 0 \\ 0 & 3 & 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \\ 4 \end{bmatrix}$$

$$46. \begin{bmatrix} 1 & -1 & 1 \\ 4 & -2 & -1 \\ 1 & 1 & 5 \\ -1 & -1 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 2 \\ 2 \\ 2 \\ 2 \end{bmatrix}$$

$$47. \text{Only } ACB \text{ is defined. } ACB = \begin{bmatrix} -3 & -21 & 27 & -6 \\ -2 & -14 & 18 & -4 \end{bmatrix}$$

48. (b) No 49. (a) [4,690 1,690 13,210] (b) Total revenue in Santa Monica, Long Beach, and Anaheim, respectively.

$$50. (a) \begin{bmatrix} \$32,000 & \$18,000 \\ \$42,000 & \$26,800 \\ \$44,000 & \$26,800 \end{bmatrix} \quad (b) \$42,000 \quad (c) \$71,600$$

51. (a) [105,000 58,000] (b) The first entry is the total amount (in ounces) of tomato sauce produced, and the second entry is the total amount (in ounces) of tomato paste produced.

$$52. (a) \begin{bmatrix} 97.00 \\ 46.50 \\ 41.00 \end{bmatrix} \begin{array}{l} \text{Amy's stand sold } \$97 \text{ of produce on Saturday.} \\ \text{Beth's stand sold } \$46.50. \\ \text{Chad's stand sold } \$41. \end{array}$$

$$(b) \begin{bmatrix} 70.00 \\ 33.50 \\ 48.50 \end{bmatrix} \begin{array}{l} \text{Amy's stand sold } \$70 \text{ of produce on Sunday.} \\ \text{Beth's stand sold } \$33.50. \\ \text{Chad's stand sold } \$48.50. \end{array}$$

$$(c) \begin{bmatrix} 220 & 110 & 90 \\ 75 & 45 & 50 \\ 120 & 55 & 50 \end{bmatrix} \begin{array}{l} \text{This represents the melons, squash, and} \\ \text{tomatoes they sold during the weekend.} \end{array}$$

$$(d) \begin{bmatrix} 167.00 \\ 80.00 \\ 89.50 \end{bmatrix} \begin{array}{l} \text{During the weekend Amy's stand sold } \$167, \\ \text{Beth's stand sold } \$80, \text{ and Chad's stand sold} \\ \text{\$89.50 of produce.} \end{array}$$

53.

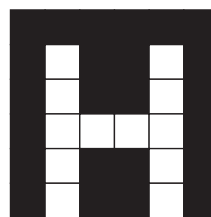
$$(a) \begin{bmatrix} 1 & 0 & 1 & 0 & 1 & 1 \\ 0 & 3 & 0 & 1 & 2 & 1 \\ 1 & 2 & 0 & 0 & 3 & 0 \\ 1 & 3 & 2 & 3 & 2 & 0 \\ 0 & 3 & 0 & 0 & 2 & 1 \\ 1 & 2 & 0 & 1 & 3 & 1 \end{bmatrix}$$

$$(b) \begin{bmatrix} 2 & 1 & 2 & 1 & 2 & 2 \\ 1 & 3 & 1 & 2 & 3 & 2 \\ 2 & 3 & 1 & 1 & 3 & 1 \\ 2 & 3 & 3 & 3 & 3 & 1 \\ 1 & 3 & 1 & 1 & 3 & 2 \\ 2 & 3 & 1 & 2 & 3 & 2 \end{bmatrix}$$

$$(c) \begin{bmatrix} 2 & 3 & 2 & 3 & 2 & 2 \\ 3 & 0 & 3 & 2 & 1 & 2 \\ 2 & 1 & 3 & 3 & 0 & 3 \\ 2 & 0 & 1 & 0 & 1 & 3 \\ 3 & 0 & 3 & 3 & 1 & 2 \\ 2 & 1 & 3 & 2 & 0 & 2 \end{bmatrix}$$

$$(d) \begin{bmatrix} 3 & 3 & 3 & 3 & 3 & 3 \\ 3 & 0 & 3 & 3 & 0 & 3 \\ 3 & 0 & 3 & 3 & 0 & 3 \\ 3 & 0 & 0 & 0 & 0 & 3 \\ 3 & 0 & 3 & 3 & 0 & 3 \\ 3 & 0 & 3 & 3 & 0 & 3 \end{bmatrix}$$

(e) The letter E



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$$5. \begin{bmatrix} 1 & -2 \\ -\frac{3}{2} & \frac{7}{2} \end{bmatrix} \quad 6. \begin{bmatrix} -1 & 1 & -1 \\ 2 & -2 & 1 \\ -2 & \frac{5}{2} & -1 \end{bmatrix} \quad 7. \begin{bmatrix} 2 & -3 \\ -3 & 5 \end{bmatrix}$$

$$8. \begin{bmatrix} -9 & 4 \\ 7 & -3 \end{bmatrix} \quad 9. \begin{bmatrix} 13 & 5 \\ -5 & -2 \end{bmatrix} \quad 10. \begin{bmatrix} -\frac{5}{3} & -\frac{4}{3} \\ -\frac{8}{3} & -\frac{7}{3} \end{bmatrix}$$

$$11. \text{No inverse} \quad 12. \begin{bmatrix} 12 & -1 \\ -15 & \frac{3}{2} \end{bmatrix} \quad 13. \begin{bmatrix} 1 & 2 \\ -\frac{1}{2} & \frac{2}{3} \end{bmatrix}$$

$$14. \begin{bmatrix} 3 & -2 & -5 \\ -1 & 1 & 1 \\ -3 & 2 & 6 \end{bmatrix} \quad 15. \begin{bmatrix} -4 & -4 & 5 \\ 1 & 1 & -1 \\ 5 & 4 & -6 \end{bmatrix}$$

$$16. \begin{bmatrix} 26 & 7 & -25 \\ -3 & -1 & 3 \\ -27 & -7 & 26 \end{bmatrix} \quad 17. \text{No inverse}$$

$$18. \begin{bmatrix} -1 & -1 & 2 \\ 3 & 2 & -4 \\ -\frac{1}{2} & 0 & \frac{1}{2} \end{bmatrix} \quad 19. \begin{bmatrix} -\frac{9}{2} & -1 & 4 \\ 3 & 1 & -3 \\ \frac{7}{2} & 1 & -3 \end{bmatrix}$$

$$20. \begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -\frac{3}{2} \\ -6 & 1 & \frac{13}{2} \end{bmatrix} \quad 21. \begin{bmatrix} 0 & 0 & -2 & 1 \\ -1 & 0 & 1 & 1 \\ 0 & 1 & -1 & 0 \\ 1 & 0 & 0 & -1 \end{bmatrix}$$

22. No inverse 23. $x = 8, y = -12$ 24. $x = -10, y = 10$
 25. $x = 126, y = -50$ 26. $x = -\frac{400}{3}, y = -\frac{700}{3}$
 27. $x = -38, y = 9, z = 47$ 28. $x = 8, y = -1, z = -8$
 29. $x = -20, y = 10, z = 16$ 30. $x = -1, y = 5, z = -1, w = -3$
 31. $x = 3, y = 2, z = 1$ 32. $x = -1, y = 2, z = 3$
 33. $x = 3, y = -2, z = 2$ 34. $x = 6, y = 12, z = 24$
 35. $x = 8, y = 1, z = 0, w = 3$
 36. $x = 8, y = 4, z = 2, w = 1$

$$37. \begin{bmatrix} 7 & 2 & 3 \\ 10 & 3 & 5 \end{bmatrix} \quad 38. \begin{bmatrix} -\frac{39}{2} & -39 \\ 15 & 30 \\ \frac{33}{2} & 33 \end{bmatrix} \quad 39. \frac{1}{2a} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$$

$$40. \begin{bmatrix} \frac{1}{a} & 0 & 0 & 0 \\ 0 & \frac{1}{b} & 0 & 0 \\ 0 & 0 & \frac{1}{c} & 0 \\ 0 & 0 & 0 & \frac{1}{d} \end{bmatrix}$$

$$41. \begin{bmatrix} 1 & -\frac{1}{x} \\ -\frac{1}{x} & \frac{2}{x^2} \end{bmatrix}; \text{ inverse does not exist for } x = 0$$

$$42. \frac{1}{2} \begin{bmatrix} e^{-x} & e^{-2x} \\ -e^{-2x} & e^{-3x} \end{bmatrix}; \text{ inverse exists for all } x$$

$$43. \frac{1}{2} \begin{bmatrix} 1 & e^{-x} & 0 \\ e^{-x} & -e^{-2x} & 0 \\ 0 & 0 & 1 \end{bmatrix}; \text{ inverse exists for all } x$$

$$44. \begin{bmatrix} \frac{1}{x^2} & -\frac{x-1}{x^2} \\ \frac{x-1}{x} & \frac{x-1}{x} \end{bmatrix}; \text{ inverse does not exist for } x = 0, x = 1$$

$$45. \begin{bmatrix} \cos x & -\sin x \\ \sin x & \cos x \end{bmatrix}; \text{ inverse exists for all } x$$

$$46. \begin{bmatrix} \sec x & -\tan x \\ -\tan x & \sec x \end{bmatrix}; \text{ inverse does not exist for } x = \frac{(2n+1)\pi}{2}$$

$$47. \text{(a)} \begin{bmatrix} 0 & 1 & -1 \\ -2 & \frac{3}{2} & 0 \\ 1 & -\frac{3}{2} & 1 \end{bmatrix} \quad \text{(b)} \text{ 1 oz A, 1 oz B, 2 oz C}$$

(c) 2 oz A, 0 oz B, 1 oz C (d) No

48. No, since the inverse does not exist in this case.

$$49. \text{(a)} \begin{cases} x + y + 2z = 675 \\ 2x + y + z = 600 \\ x + 2y + z = 625 \end{cases}$$

$$\text{(b)} \begin{bmatrix} 1 & 1 & 2 \\ 2 & 1 & 1 \\ 1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 675 \\ 600 \\ 625 \end{bmatrix}$$

$$\text{(c)} A^{-1} = \begin{bmatrix} -\frac{1}{4} & \frac{3}{4} & -\frac{1}{4} \\ -\frac{1}{4} & -\frac{1}{4} & \frac{3}{4} \\ \frac{3}{4} & -\frac{1}{4} & -\frac{1}{4} \end{bmatrix}$$

He earns \$125 on a standard set, \$150 on a deluxe set, and \$200 on a leather-bound set.

Section 9.7 ■ page 713

1. 6 2. 2 3. -4 4. 1 5. Does not exist
 6. Does not exist 7. $\frac{1}{8}$ 8. 2.9 9. 20, 20 10. 5, 5
 11. -12, 12 12. 0, 0 13. 0, 0 14. $\frac{7}{2}, -\frac{7}{2}$
 15. 4, has an inverse 16. 2, has an inverse
 17. -6, has an inverse 18. -4, has an inverse
 19. 5000, has an inverse 20. 0, does not have an inverse
 21. -4, has an inverse 22. 92, has an inverse
 23. -18 24. -1183 25. 120 26. 32 27. (a) -2
 (b) -2 (c) Yes 28. (b) -46 (c) No other solutions
 (d) Yes, since $|M| \neq 0$ 29. $(-2, 5)$ 30. $(\frac{3}{2}, 2)$
 31. $(0.6, -0.4)$ 32. $(-2, 6)$ 33. $(4, -1)$ 34. $(\frac{2}{5}, -1)$
 35. $(4, 2, -1)$ 36. $(1, -2, -5)$ 37. $(1, 3, 2)$ 38. $(-1, 5, 0)$
 39. $(0, -1, 1)$ 40. $(2, -1, 3)$ 41. $(\frac{189}{29}, -\frac{108}{29}, \frac{88}{29})$
 42. $(\frac{22}{5}, \frac{24}{25}, -\frac{66}{25})$ 43. $(\frac{1}{2}, \frac{1}{4}, \frac{1}{4}, -1)$ 44. $(-1, 2, 0, 3)$
 45. abcde 46. a^5 47. 0, 1, 2 48. 1 49. 1, -1
 50. a, b 51. 21 52. $\frac{19}{2}$ 53. $\frac{63}{2}$ 54. 33

$$56. \text{(a)} \begin{cases} x + y + z = 18 \\ 75x + 90y + 60z = 1380 \\ -75x + 90y + 60z = 180 \end{cases}$$

(b) 8 apples, 6 peaches, 4 pears

$$57. \text{(a)} \begin{cases} 100a + 10b + c = 25 \\ 225a + 15b + c = 33\frac{3}{4} \\ 1600a + 40b + c = 40 \end{cases}$$

(b) $y = -0.05x^2 + 3x$

58. 7 million ft²

Section 9.8 ■ page 720

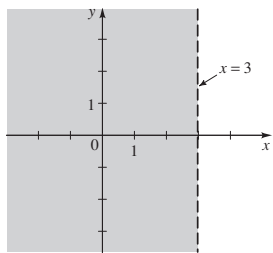
1. $\frac{A}{x-1} + \frac{B}{x+2}$ 2. $\frac{A}{x-1} + \frac{B}{x+4}$
 3. $\frac{A}{x-2} + \frac{B}{(x-2)^2} + \frac{C}{x+4}$ 4. $\frac{A}{x} + \frac{B}{x^2} + \frac{C}{x^3} + \frac{D}{x-1}$
 5. $\frac{A}{x-3} + \frac{Bx+C}{x^2+4}$ 6. $\frac{A}{x-1} + \frac{B}{x+1} + \frac{Cx+D}{x^2+1}$
 7. $\frac{Ax+B}{x^2+1} + \frac{Cx+D}{x^2+2}$ 8. $\frac{A}{x} + \frac{B}{x^2} + \frac{Cx+D}{x^2+4} + \frac{Ex+F}{(x^2+4)^2}$
 9. $\frac{A}{x} + \frac{B}{2x-5} + \frac{C}{(2x-5)^2} + \frac{D}{(2x-5)^3}$
 $+ \frac{Ex+F}{x^2+2x+5} + \frac{Gx+H}{(x^2+2x+5)^2}$
 10. $\frac{A}{x-1} + \frac{B}{(x-1)^2} + \frac{C}{x+1} + \frac{Dx+E}{x^2+x+1}$
 11. $\frac{1}{x-1} - \frac{1}{x+1}$ 12. $\frac{1}{x-1} + \frac{1}{x+1}$

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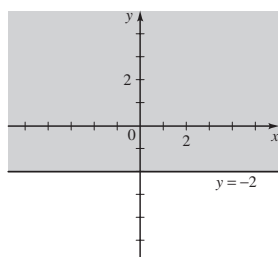
13. $\frac{1}{x-1} - \frac{1}{x+4}$ 14. $\frac{2}{x} - \frac{1}{x+3}$
 15. $\frac{2}{x-3} - \frac{2}{x+3}$ 16. $\frac{3}{x} - \frac{2}{x-4}$
 17. $\frac{1}{x-2} - \frac{1}{x+2}$ 18. $\frac{1}{x+2} + \frac{1}{x-1}$
 19. $\frac{3}{x-4} - \frac{2}{x+2}$ 20. $\frac{3}{x} + \frac{2}{2x-1}$
 21. $\frac{-\frac{1}{2}}{2x-1} + \frac{\frac{3}{2}}{4x-3}$ 22. $\frac{1}{x} - \frac{2}{x+3} + \frac{1}{x-1}$
 23. $\frac{2}{x-2} + \frac{3}{x+2} - \frac{1}{2x-1}$
 24. $\frac{-3}{x+2} + \frac{1}{2x-3} + \frac{1}{x+3}$ 25. $\frac{2}{x+1} - \frac{1}{x} + \frac{1}{x^2}$
 26. $\frac{-\frac{135}{64}}{3x+2} + \frac{\frac{109}{64}}{x-2} + \frac{\frac{9}{8}}{(x-2)^2}$
 27. $\frac{1}{2x+3} - \frac{3}{(2x+3)^2}$ 28. $\frac{\frac{1}{2}}{2x-5} - \frac{\frac{3}{2}}{(2x-5)^2}$
 29. $\frac{2}{x} - \frac{1}{x^3} - \frac{2}{x+2}$ 30. $\frac{1}{x} - \frac{2}{x^2} - \frac{4}{x^3} + \frac{3}{x^4}$
 31. $\frac{4}{x+2} - \frac{4}{x-1} + \frac{2}{(x-1)^2} + \frac{1}{(x-1)^3}$
 32. $\frac{1}{x+1} - \frac{1}{x-1} + \frac{1}{(x-1)^3}$
 33. $\frac{3}{x+2} - \frac{1}{(x+2)^2} - \frac{1}{(x+3)^2}$
 34. $-\frac{1}{x+2} - \frac{2}{(x+2)^2} + \frac{1}{x-2} + \frac{1}{(x-2)^2}$
 35. $\frac{x+1}{x^2+3} - \frac{1}{x}$ 36. $-\frac{2}{x^2+2} + \frac{3}{x-1}$
 37. $\frac{2x-5}{x^2+x+2} + \frac{5}{x^2+1}$ 38. $\frac{2x+1}{2x^2+1} - \frac{x}{x^2+1}$
 39. $\frac{1}{x^2+1} - \frac{x+2}{(x^2+1)^2} + \frac{1}{x}$ 40. $\frac{2}{x^2+4} - \frac{1}{(x^2+4)^2}$
 41. $x^2 + \frac{3}{x-2} - \frac{x+1}{x^2+1}$ 42. $x+1 + \frac{2}{(x-2)^2} + \frac{x}{x^2+2}$
 43. $A = \frac{a+b}{2}, B = \frac{a-b}{2}$
 44. $A = a, B = b, C = -a, D = -b$

Section 9.9 ■ page 726

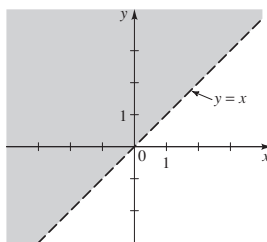
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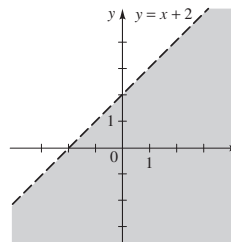
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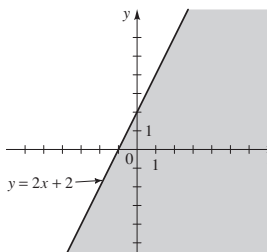
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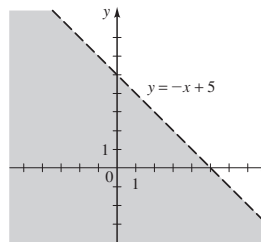
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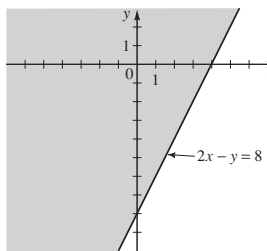
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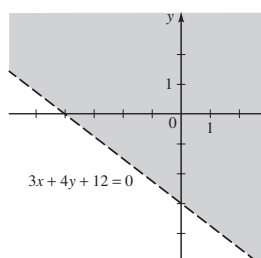
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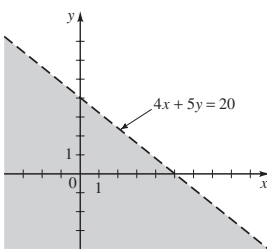
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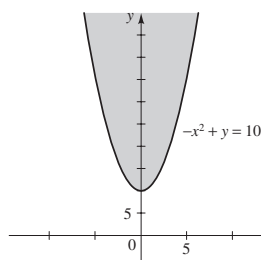
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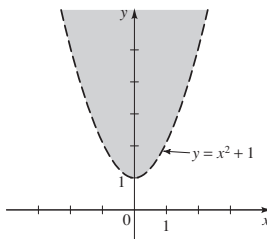
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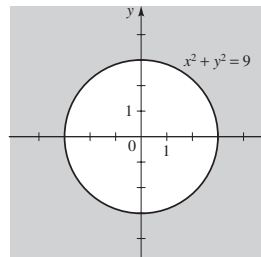
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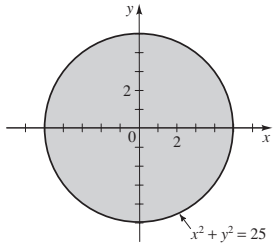
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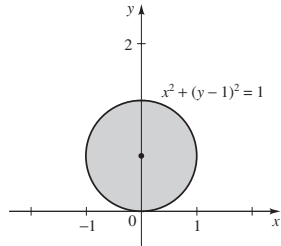
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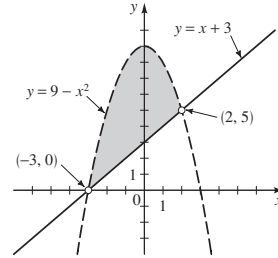
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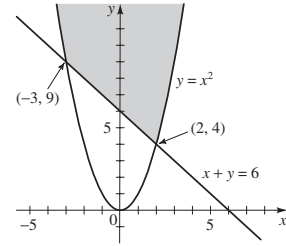
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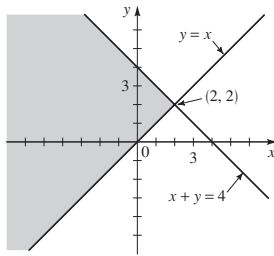
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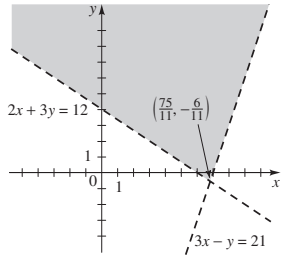
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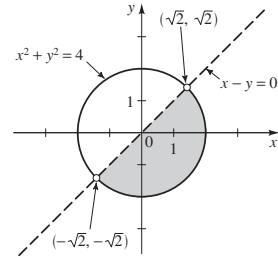
15. $y \leq \frac{1}{2}x - 1$ 16. $y \leq x^2 + 2$
 17. $x^2 + y^2 > 4$
 18. $y \geq x^3 - 4x$
 19.



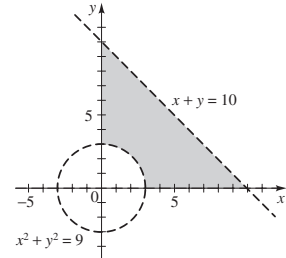
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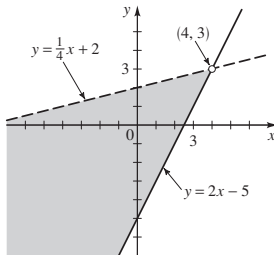
bounded
27.



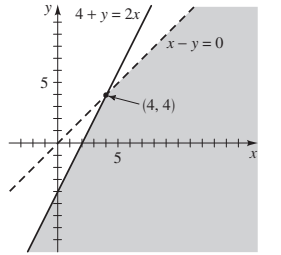
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28.



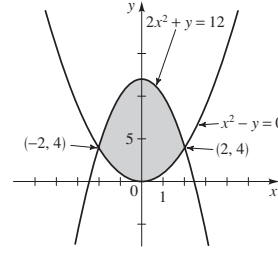
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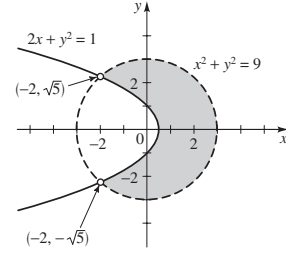
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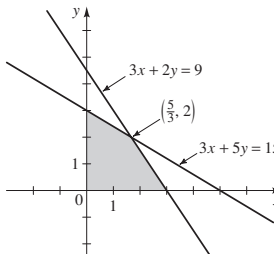
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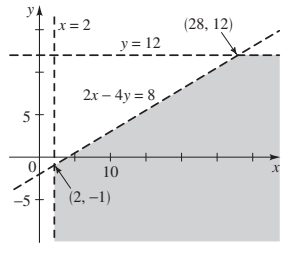
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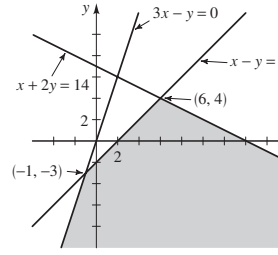
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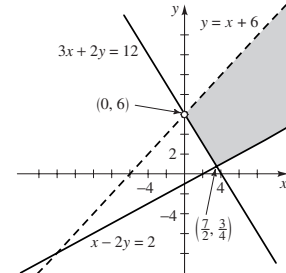
not bounded
24.



bounded
31.



bounded
32.



bounded

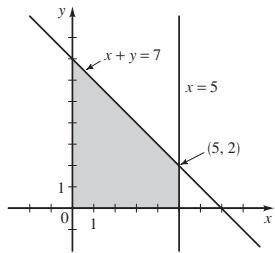
not bounded

not bounded

not bounded

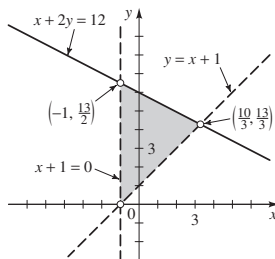
A100 Answers to Exercises and Chapter Tests

33.



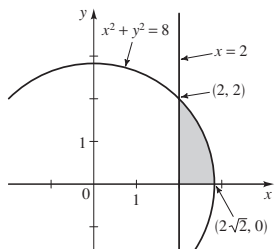
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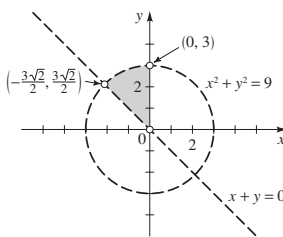
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37.



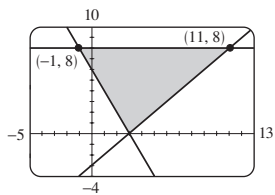
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39.

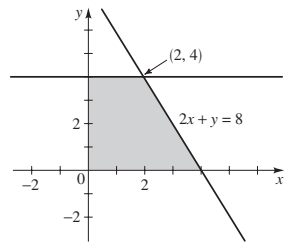


bounded

41.



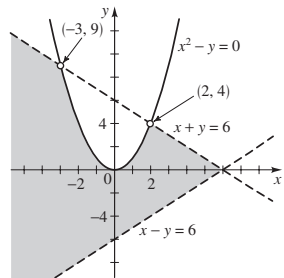
34.



bounded

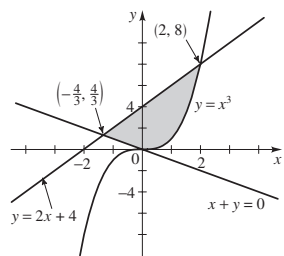
36. No solution

38.



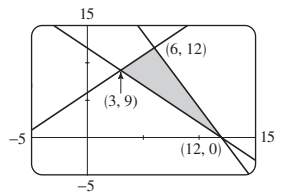
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40.

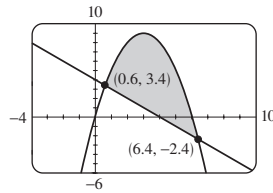


bounded

42.



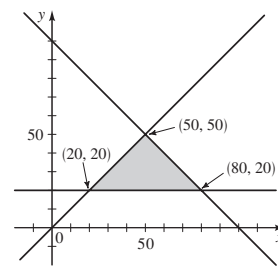
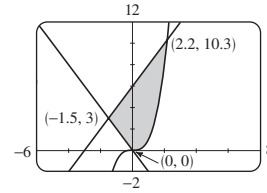
43.



45. x = number of fiction books
 y = number of nonfiction books

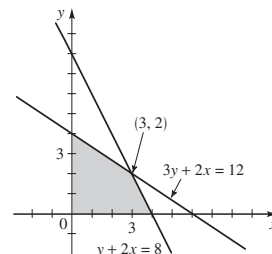
$$\begin{cases} x + y \leq 100 \\ 20 \leq y, x \geq y \\ x \geq 0, y \geq 0 \end{cases}$$

44.



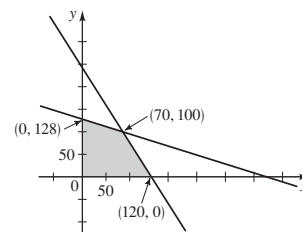
46. x = number of chairs
 y = number of tables

$$\begin{cases} 3y + 2x \leq 12 \\ y + 2x \leq 8 \\ x \geq 0, y \geq 0 \end{cases}$$



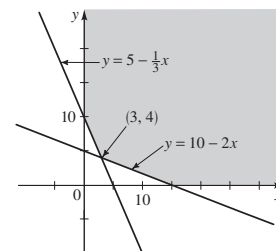
47. x = number of standard packages
 y = number of deluxe packages

$$\begin{cases} \frac{1}{4}x + \frac{5}{8}y \leq 80 \\ \frac{3}{4}x + \frac{3}{8}y \leq 90 \\ x \geq 0, y \geq 0 \end{cases}$$



48. x = oz of fish
 y = oz of beef

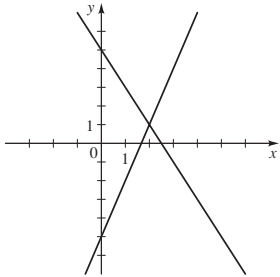
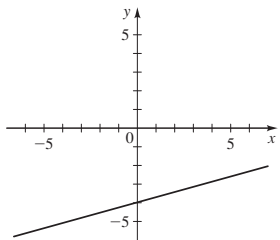
$$\begin{cases} 12x + 6y \geq 60 \\ 3x + 9y \geq 45 \\ x \geq 0, y \geq 0 \end{cases}$$



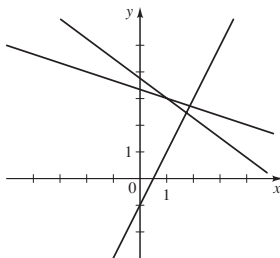
Chapter 9 Review ■ page 728

- (2, 1)
- (-2, 14), (4, -4)
- $(-\frac{1}{2}, \frac{7}{4})$, (2, -2)
- (-2, 0), (2, 4)

5. (2, 1)

7. $x = \text{any number}$
 $y = \frac{2}{7}x - 4$ 

9. No solution



11. (-3, 3), (2, 8)

12. $(-1 - \sqrt{3}, 1 - \sqrt{3}), (-1 + \sqrt{3}, 1 + \sqrt{3})$ 13. $(\frac{16}{7}, -\frac{14}{3})$ 14. $(-\sqrt{6}, 2), (\sqrt{6}, 2)$

15. (21.41, -15.93) 16. (61.04, -105.73)

17. (11.94, -1.39), (12.07, 1.44)

18. (-1.45, -1.35), (1, 6), (1.51, 12.93)

19. (a) 2×3 (b) Yes (c) No

(d)
$$\begin{cases} x + 2y = -5 \\ y = 3 \end{cases}$$

20. (a) 2×3 (b) Yes (c) Yes

(d)
$$\begin{cases} x = 6 \\ y = 0 \end{cases}$$

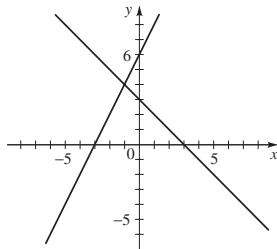
21. (a) 3×4 (b) Yes (c) Yes

(d)
$$\begin{cases} x + 8z = 0 \\ y + 5z = -1 \\ 0 = 0 \end{cases}$$

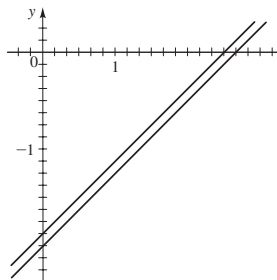
22. (a) 3×4 (b) No (c) No

(d)
$$\begin{cases} x + 3y + 6z = 2 \\ 2x + y = 5 \\ z = 0 \end{cases}$$

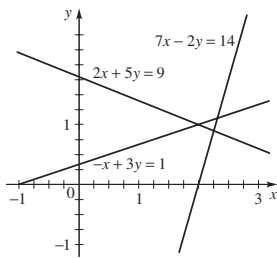
6. (-1, 4)



8. No solution



10. No solution

23. (a) 3×4 (b) No (c) No

(d)
$$\begin{cases} y - 3z = 4 \\ x + y = 7 \\ x + 2y + z = 2 \end{cases}$$

24. (a) 4×4 (b) No (c) No

(d)
$$\begin{cases} x + 8y + 6z = -4 \\ y - 3z = 5 \\ 2z = -7 \\ x + y + z = 0 \end{cases}$$

25. (1, 1, 2) 26. (3, 1, 0)

27. No solution 28. (1, 0, -1, 2)

29. (-8, -7, 10) 30. (2, 1, 1) 31. No solution

32. $(-2t + 4, -t + 2, t)$ 33. (1, 0, 1, -2)

34. (2, 1, -1, -1)

35. $x = -4t + 1, y = -t - 1, z = t$ 36. No solution37. $x = 6 - 5t, y = \frac{1}{2}(7 - 3t), z = t$ 38. $(\frac{2}{11}, \frac{48}{11}, -\frac{60}{11}, -\frac{40}{11})$ 39. $(-\frac{4}{3}t + \frac{4}{3}, \frac{5}{3}t - \frac{2}{3}, t)$ 40. $(2 - t, 1 - t, t)$ 41. $(s + 1, 2s - t + 1, s, t)$ 42. No solution 43. No solution44. No solution 45. $(1, t + 1, t, 0)$ 46. No solution

47. \$3000 at 6%, \$6000 at 7%

48. 12 nickels, 30 dimes, 8 quarters

49. \$11,250 in bank A, \$22,500 in bank B, \$26,250 in bank C

50. 160 haddock, 340 sea bass, 60 red snapper

51. Impossible

52.
$$\begin{bmatrix} -\frac{1}{2} & -1 \\ 2 & \frac{5}{2} \\ -4 & 1 \end{bmatrix}$$

53.
$$\begin{bmatrix} 4 & 18 \\ 4 & 0 \\ 2 & 2 \end{bmatrix}$$
 54. Impossible

55. $[10 \ 0 \ -5]$ 56. Impossible 57. $\begin{bmatrix} -\frac{7}{2} & 10 \\ 1 & -\frac{9}{2} \end{bmatrix}$

58.
$$\begin{bmatrix} -\frac{11}{2} & 4 & 2 \\ -1 & \frac{11}{2} & 8 \\ -4 & -3 & -8 \end{bmatrix}$$
 59.
$$\begin{bmatrix} 30 & 22 & 2 \\ -9 & 1 & -4 \end{bmatrix}$$

60.
$$\begin{bmatrix} -2 & 14 \\ \frac{3}{2} & -\frac{3}{2} \\ \frac{27}{2} & \frac{57}{2} \end{bmatrix}$$
 61.
$$\begin{bmatrix} -\frac{1}{2} & \frac{11}{2} \\ \frac{15}{4} & -\frac{3}{2} \\ -\frac{1}{2} & 1 \end{bmatrix}$$
 62.
$$\begin{bmatrix} -12 & 12 \\ 4 & 2 \\ 20 & 34 \end{bmatrix}$$

65. $\frac{1}{3} \begin{bmatrix} -1 & -3 \\ -5 & 2 \end{bmatrix}$ 66.
$$\begin{bmatrix} 6 & -2 \\ 2 & 12 \end{bmatrix}$$
 67.
$$\begin{bmatrix} \frac{7}{2} & -2 \\ 0 & 8 \end{bmatrix}$$

68. Impossible 69.
$$\begin{bmatrix} 2 & -2 & 6 \\ -4 & 5 & -9 \end{bmatrix}$$
 70.
$$\begin{bmatrix} 4 & -8 \\ -7 & 14 \end{bmatrix}$$

71. $1, \begin{bmatrix} 9 & -4 \\ -2 & 1 \end{bmatrix}$ 72. $-8, \begin{bmatrix} \frac{3}{8} & \frac{1}{4} \\ \frac{1}{8} & -\frac{1}{4} \end{bmatrix}$ 73. 0, no inverse

74. 0, no inverse 75. $-1, \begin{bmatrix} 3 & 2 & -3 \\ 2 & 1 & -2 \\ -8 & -6 & 9 \end{bmatrix}$

76. $1, \begin{bmatrix} -1 & 3 & -2 \\ -2 & 0 & 1 \\ 2 & -1 & 0 \end{bmatrix}$ 77. $24, \begin{bmatrix} 1 & 0 & 0 & -\frac{1}{4} \\ 0 & \frac{1}{2} & 0 & -\frac{1}{4} \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$

78. 0, no inverse 79. (65, 154) 80. (6, 7) 81. $(-\frac{1}{12}, \frac{1}{12}, \frac{1}{12})$ 82. (10, 20, -5) 83. $(\frac{1}{5}, \frac{9}{5})$ 84. (8, -4) 85. $(-\frac{87}{26}, \frac{21}{26}, \frac{3}{2})$

A102 Answers to Exercises and Chapter Tests

86. $(\frac{860}{41}, -\frac{540}{41}, \frac{10}{41})$ 87. 11 88. $\frac{51}{2}$

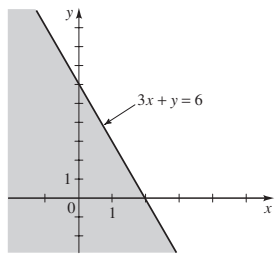
89. $\frac{2}{x-5} + \frac{1}{x+3}$ 90. $\frac{-2}{x} + \frac{1}{x-2} + \frac{1}{x+2}$

91. $\frac{-4}{x} + \frac{4}{x-1} + \frac{-2}{(x-1)^2}$ 92. $\frac{x+1}{x^2+4} + \frac{1}{x-2}$

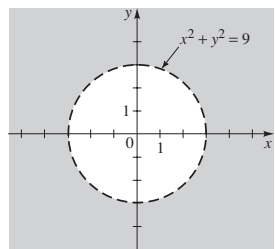
93. $\frac{-1}{x} + \frac{x+2}{x^2+1}$ 94. $\frac{2}{x-1} - \frac{3}{x+1} + \frac{x}{x^2+2}$

95. $x + y^2 \leq 4$ 96. $x^2 + y^2 \geq 8$

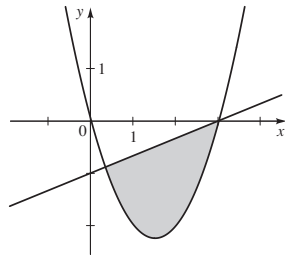
97.



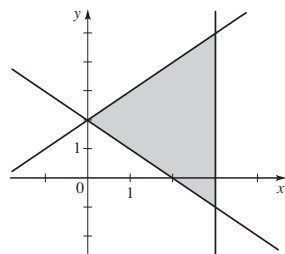
99.



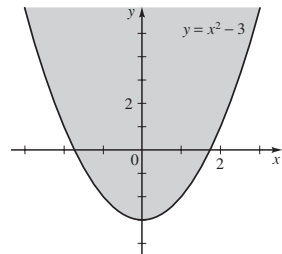
101.



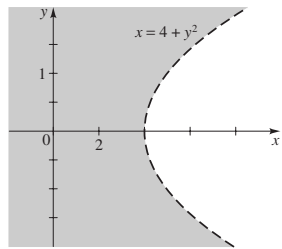
103.



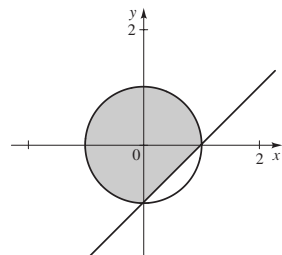
98.



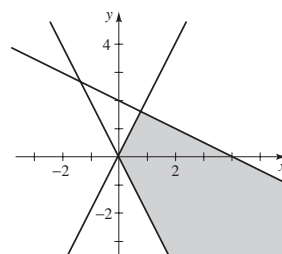
100.



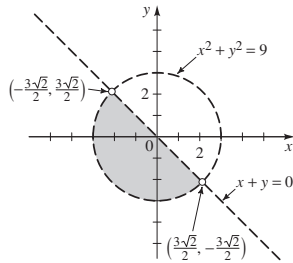
102.



104.

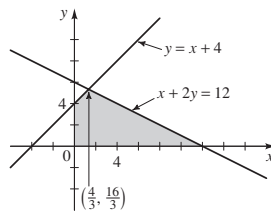


105.



bounded

107.

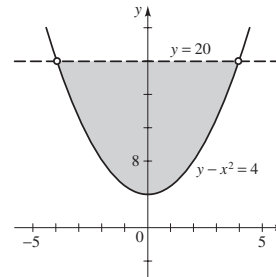


bounded

109. $x = \frac{b+c}{2}, y = \frac{a+c}{2}, z = \frac{a+b}{2}$ 110. (1, -1, 1)

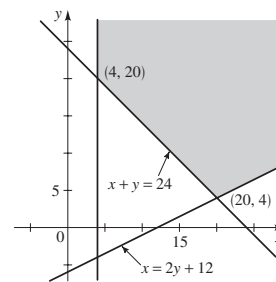
111. 2, 3 112. $\frac{1}{5}$

106.



bounded

108.



not bounded

Chapter 9 Test ■ page 733

1. (a) Linear (b) (-2, 3) 2. (a) Nonlinear

(b) (1, -2), ($\frac{5}{3}, 0$)

3. (-0.55, -0.78), (0.43, -0.29), (2.12, 0.56)

4. Wind 60 km/h, airplane 300 km/h

5. (a) Row-echelon form (b) Reduced row-echelon form

(c) Neither 6. (a) ($\frac{5}{2}, \frac{5}{2}, 0$) (b) No solution

7. ($-\frac{3}{5} + \frac{2}{5}t, \frac{1}{5} + \frac{1}{5}t, t$)

8. Coffee \$1.50, juice \$1.75, donut \$0.75

9. (a) Incompatible dimensions

(b) Incompatible dimensions

(c) $\begin{bmatrix} 6 & 10 \\ 3 & -2 \\ -3 & 9 \end{bmatrix}$ (d) $\begin{bmatrix} 36 & 58 \\ 0 & -3 \\ 18 & 28 \end{bmatrix}$ (e) $\begin{bmatrix} 2 & -\frac{3}{2} \\ -1 & 1 \end{bmatrix}$

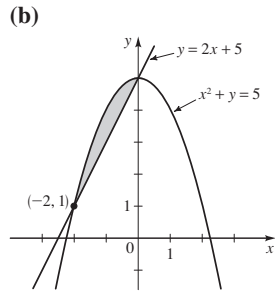
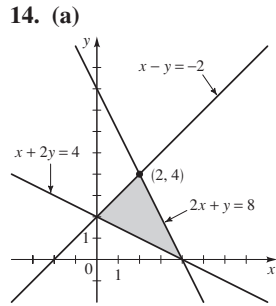
(f) B is not square (g) B is not square (h) -3

10. (a) $\begin{bmatrix} 4 & -3 \\ 3 & -2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 10 \\ 30 \end{bmatrix}$ (b) (70, 90)

11. $|A| = 0, |B| = 2, B^{-1} = \begin{bmatrix} 1 & -2 & 0 \\ 0 & \frac{1}{2} & 0 \\ 3 & -6 & 1 \end{bmatrix}$

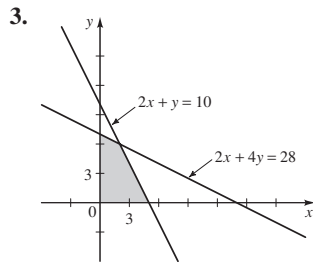
12. (5, -5, -4)

13. (a) $\frac{1}{x-1} + \frac{1}{(x-1)^2} - \frac{1}{x+2}$ (b) $-\frac{1}{x} + \frac{x+2}{x^2+3}$

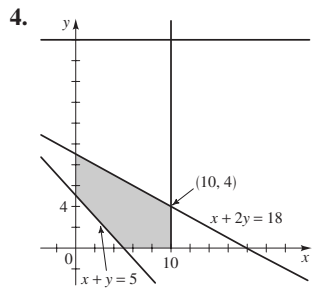


Focus on Modeling ■ page 739

1. 198, 195 2. 42, 40.375

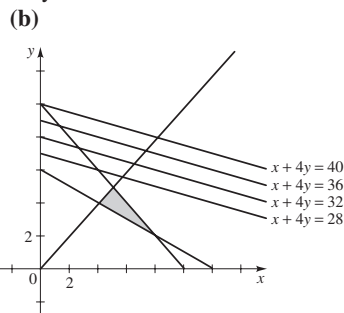
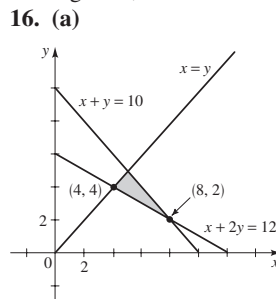


maximum 161
minimum 135



maximum 1028
minimum 350

5. 3 tables, 34 chairs 6. 0 colonial, 90 ranch; 10 lots vacant
7. 30 grapefruit crates, 30 orange crates 8. (a) 120 standard, 80 scientific (b) 100 standard, 170 scientific 9. 15 Pasadena to Santa Monica, 3 Pasadena to El Toro, 0 Long Beach to Santa Monica, 16 Long Beach to El Toro 10. 5 sheets from east-side to customer A, 70 sheets from east-side to customer B, 45 sheets from west-side to customer A, 0 sheets from west-side to customer B 11. 90 standard, 40 deluxe 12. 3 oz type I, 0 type II 13. \$7500 in municipal bonds, \$2500 in bank certificates, \$2000 in high-risk bonds 14. \$47.50
15. 4 games, 32 educational, 0 utility



(c) (4, 4)

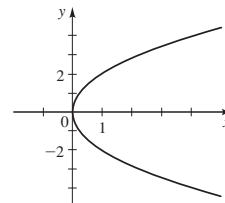
Chapter 10

Section 10.1 ■ page 751

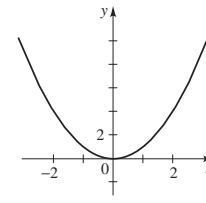
1. III 2. V 3. II 4. I 5. VI 6. IV

Order of answers: focus; directrix; focal diameter

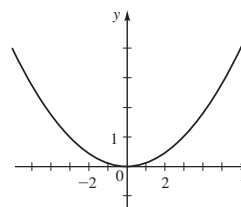
7. $F(1, 0)$; $x = -1$; 4



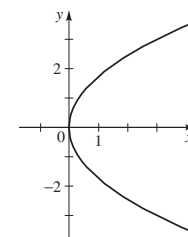
8. $F(0, \frac{1}{4})$; $y = -\frac{1}{4}$; 1



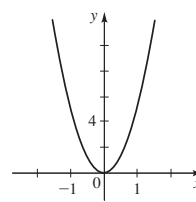
9. $F(0, \frac{9}{4})$; $y = -\frac{9}{4}$; 9



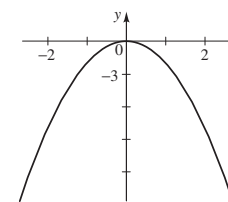
10. $F(\frac{3}{4}, 0)$; $x = -\frac{3}{4}$; 3



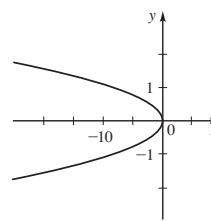
11. $F(0, \frac{1}{20})$; $y = -\frac{1}{20}$; $\frac{1}{5}$



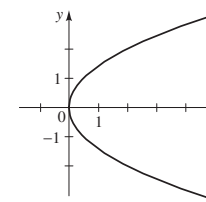
12. $F(0, -\frac{1}{8})$; $y = \frac{1}{8}$; $\frac{1}{2}$



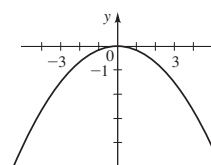
13. $F(-\frac{1}{32}, 0)$; $x = \frac{1}{32}$; $\frac{1}{8}$



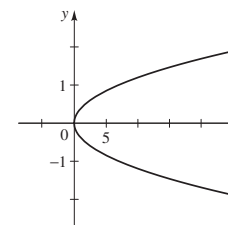
14. $F(\frac{1}{2}, 0)$; $x = -\frac{1}{2}$; 2



15. $F(0, -\frac{3}{2})$; $y = \frac{3}{2}$; 6

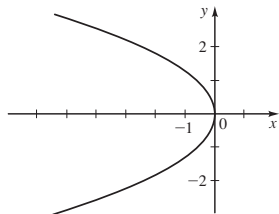


16. $F(\frac{1}{28}, 0)$; $x = -\frac{1}{28}$; $\frac{1}{7}$

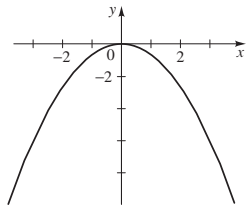


A104 Answers to Exercises and Chapter Tests

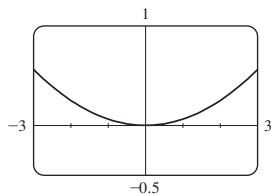
17. $F(-\frac{5}{12}, 0); x = \frac{5}{12}, \frac{5}{3}$



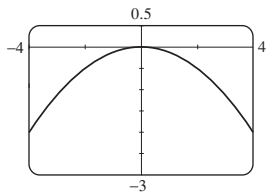
18. $F(0, -\frac{3}{8}); y = \frac{3}{8}, \frac{3}{2}$



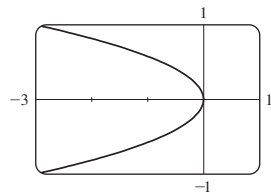
19.



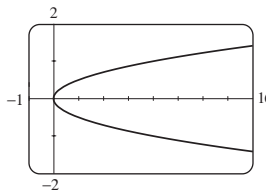
20.



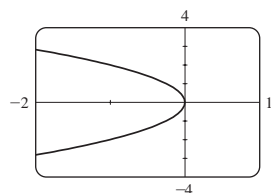
21.



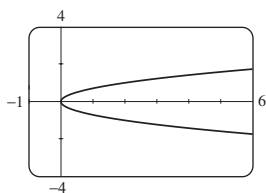
22.



23.

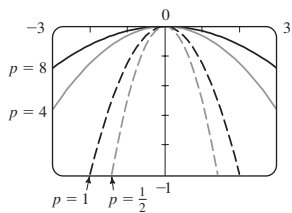


24.

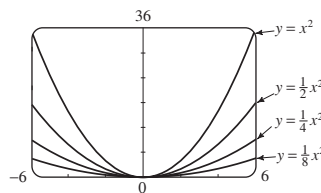


25. $x^2 = 8y$ 26. $x^2 = -2y$ 27. $y^2 = -32x$ 28. $y^2 = 20x$
 29. $y^2 = -8x$ 30. $x^2 = -24y$ 31. $x^2 = 40y$ 32. $y^2 = \frac{1}{2}x$
 33. $y^2 = 4x$ 34. $x^2 = -24y$ 35. $x^2 = 20y$ 36. $x^2 = -8y$
 37. $x^2 = 8y$ 38. $y^2 = 8x$ 39. $y^2 = -16x$ 40. $x^2 = -12y$
 41. $y^2 = -3x$ 42. $x^2 = 10y$ 43. $x = y^2$ 44. $y^2 = 16x$
 45. $x^2 = -4\sqrt{2}y$ 46. $x^2 = 2(\sqrt{5} - 1)y$
 47. (a) $x^2 = -4py, p = \frac{1}{2}, 1, 4,$ and 8

(b) The closer the directrix to the vertex, the steeper the parabola.



48. (a)



(b) The larger the focal diameter, the wider the parabola.

49. (a) $y^2 = 12x$ (b) $8\sqrt{15} \approx 31$ cm 50. 25 ft

51. $x^2 = 600y$ 52. 659.63 in.

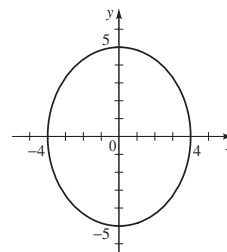
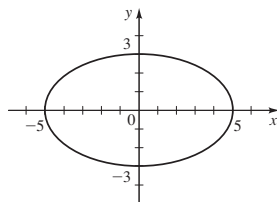
Section 10.2 ■ page 759

1. II 2. IV 3. I 4. III

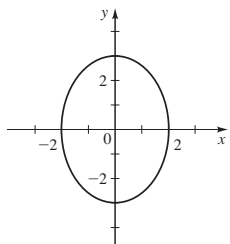
Order of answers: vertices; foci; eccentricity; major axis and minor axis

5. $V(\pm 5, 0); F(\pm 4, 0); \frac{4}{5}; 10, 6$

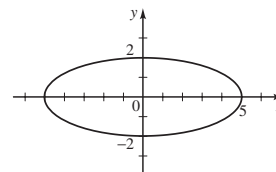
6. $V(\pm 5, 0); F(0, \pm 3); 0.6; 10, 8$



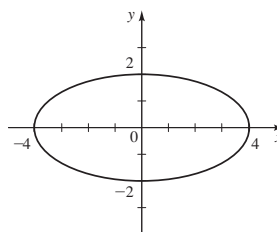
7. $V(0, \pm 3); F(0, \pm \sqrt{5}); \sqrt{5}/3; 6, 4$



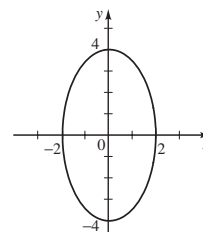
8. $V(\pm 5, 0); F(\pm \sqrt{21}, 0); \sqrt{21}/5; 10, 4$



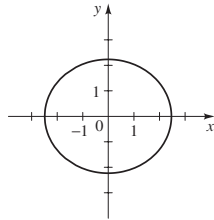
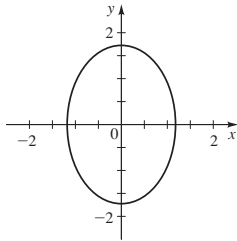
9. $V(\pm 4, 0); F(\pm 2\sqrt{3}, 0); \sqrt{3}/2; 8, 4$



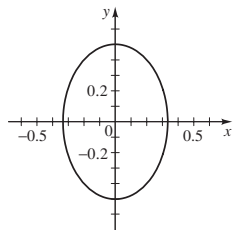
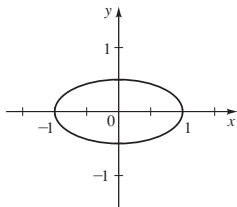
10. $V(0, \pm 4); F(0, \pm 2\sqrt{3}); \sqrt{3}/2; 8, 4$



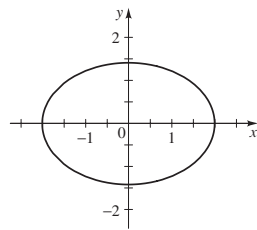
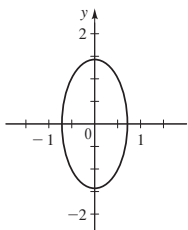
- 11.** $V(0, \pm\sqrt{3}); F(0, \pm\sqrt{3}/2)$; **12.** $V(\pm\sqrt{6}, 0); F(\pm 1, 0)$;
 $1/\sqrt{2}; 2\sqrt{3}, \sqrt{6}$ $\sqrt{6}/6; 2\sqrt{6}, 2\sqrt{5}$



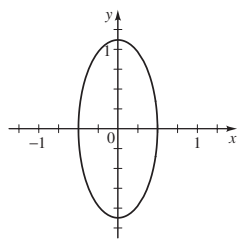
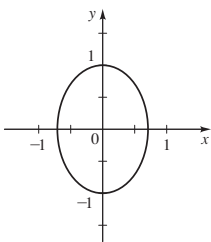
- 13.** $V(\pm 1, 0); F(\pm\sqrt{3}/2, 0)$; **14.** $V(0, \pm\frac{1}{2}); F(0, \pm\sqrt{5}/6)$;
 $\sqrt{3}/2; 2, 1$ $\sqrt{5}/3; 1, \frac{2}{3}$



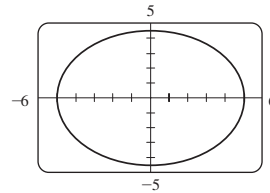
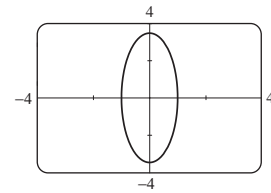
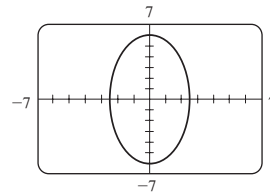
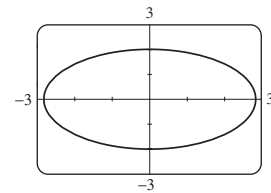
- 15.** $V(0, \pm\sqrt{2}); F(0, \pm\sqrt{3}/2)$; **16.** $V(\pm 2, 0); F(\pm\sqrt{2}, 0)$;
 $\sqrt{3}/2; 2\sqrt{2}, \sqrt{2}$ $\sqrt{2}/2; 4, 2\sqrt{2}$



- 17.** $V(0, \pm 1); F(0, \pm 1/\sqrt{2})$; **18.** $V(0, \pm\sqrt{5}/2); F(0, \pm 1)$;
 $1/\sqrt{2}; 2, \sqrt{2}$ $2\sqrt{5}/5; \sqrt{5}, 1$



- 19.** $\frac{x^2}{25} + \frac{y^2}{16} = 1$ **20.** $\frac{x^2}{4} + \frac{y^2}{25} = 1$ **21.** $\frac{x^2}{4} + \frac{y^2}{8} = 1$
22. $\frac{x^2}{7} + \frac{y^2}{16} = 1$ **23.** $\frac{x^2}{256} + \frac{y^2}{48} = 1$ **24.** $\frac{x^2}{4} + \frac{3y^2}{16} = 1$

25.**26.****27.****28.**

29. $\frac{x^2}{25} + \frac{y^2}{9} = 1$ **30.** $\frac{x^2}{16} + \frac{y^2}{25} = 1$ **31.** $x^2 + \frac{y^2}{4} = 1$

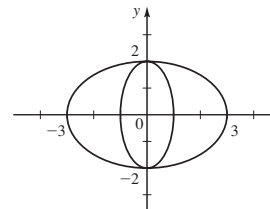
32. $\frac{x^2}{9} + \frac{y^2}{4} = 1$ **33.** $\frac{x^2}{9} + \frac{y^2}{13} = 1$ **34.** $\frac{x^2}{36} + \frac{y^2}{11} = 1$

35. $\frac{x^2}{100} + \frac{y^2}{91} = 1$ **36.** $\frac{x^2}{25} + \frac{y^2}{9} = 1$ **37.** $\frac{x^2}{25} + \frac{y^2}{5} = 1$

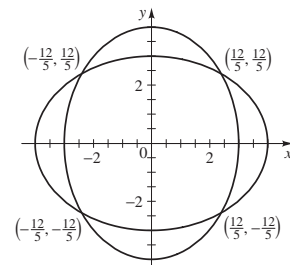
38. $\frac{x^2}{320} + \frac{y^2}{324} = 1$ **39.** $\frac{64x^2}{225} + \frac{64y^2}{81} = 1$

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

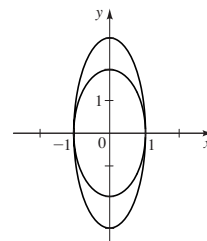
41. $(0, \pm 2)$



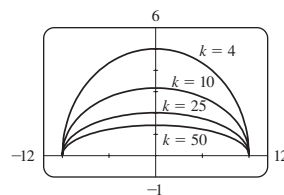
42. $(\pm\frac{12}{5}, \pm\frac{12}{5})$



43. $(\pm 1, 0)$



44. (a) $x^2 + y^2 = 4$

45. (a)

(b) Common major axes and vertices; eccentricity increases as k increases.

A106 Answers to Exercises and Chapter Tests

47. $\frac{x^2}{2.2500 \times 10^{16}} + \frac{y^2}{2.2491 \times 10^{16}} = 1$

48. Perihelion 3.87×10^9 km; aphelion 6.45×10^9 km

49. $\frac{x^2}{1,455,642} + \frac{y^2}{1,451,610} = 1$ 50. 8 ft; 6.92 ft apart

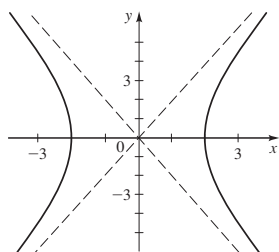
51. $5\sqrt{39}/2 \approx 15.6$ in.

Section 10.3 ■ page 768

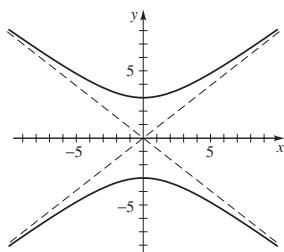
1. III 2. IV 3. II 4. I

Order of answers: vertices; foci; asymptotes

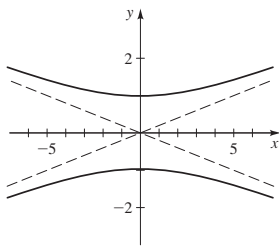
5. $V(\pm 2, 0); F(\pm 2\sqrt{5}, 0);$
 $y = \pm 2x$



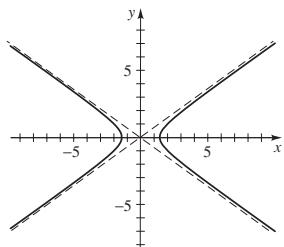
6. $V(0, \pm 3); F(0, \pm 5);$
 $y = \pm \frac{3}{4}x$



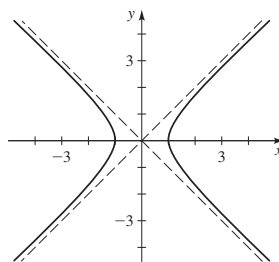
7. $V(0, \pm 1); F(0, \pm \sqrt{26});$
 $y = \pm \frac{1}{5}x$



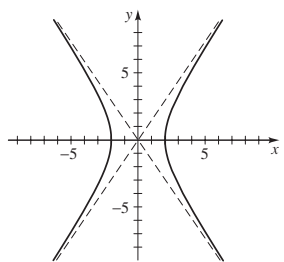
8. $V(\pm \sqrt{2}, 0); F(\pm \sqrt{3}, 0);$
 $y = \pm \frac{1}{\sqrt{2}}x$



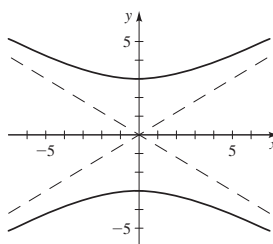
9. $V(\pm 1, 0); F(\pm \sqrt{2}, 0);$
 $y = \pm x$



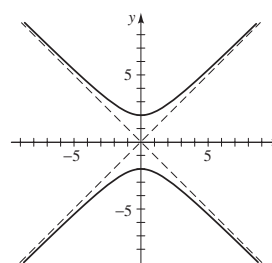
10. $V(\pm 2, 0); F(\pm \sqrt{13}, 0);$
 $y = \pm \frac{3}{2}x$



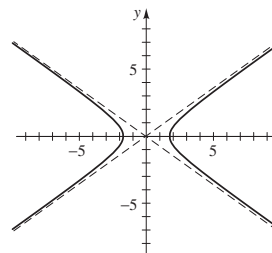
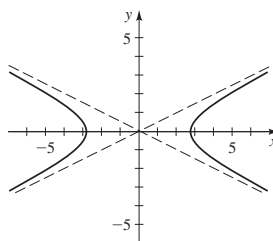
11. $V(0, \pm 3); F(0, \pm \sqrt{34});$
 $y = \pm \frac{3}{5}x$



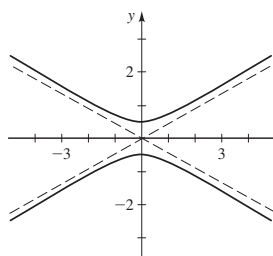
12. $V(0, \pm 2); F(0, \pm 2\sqrt{2});$
 $y = \pm x$



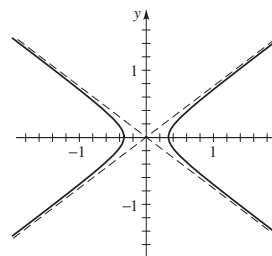
13. $V(\pm 2\sqrt{2}, 0); F(\pm \sqrt{10}, 0);$ 14. $V(\pm \sqrt{3}, 0); F(\pm \sqrt{\frac{3}{2}}, 0);$
 $y = \pm \frac{1}{2}x$ $y = \pm \frac{\sqrt{2}}{2}x$



15. $V(0, \pm \frac{1}{2}); F(0, \pm \sqrt{5}/2);$
 $y = \pm \frac{1}{2}x$



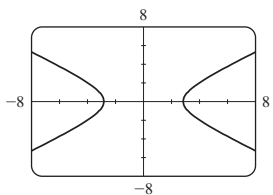
16. $V(\pm \frac{1}{3}, 0); F(\pm \frac{5}{12}, 0);$
 $y = \pm \frac{3}{4}x$



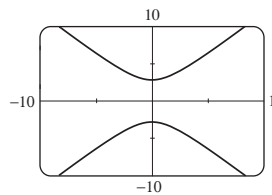
17. $\frac{x^2}{4} - \frac{y^2}{12} = 1$ 18. $\frac{y^2}{144} - \frac{x^2}{25} = 1$ 19. $\frac{y^2}{16} - \frac{x^2}{16} = 1$

20. $\frac{x^2}{12} - \frac{y^2}{48} = 1$ 21. $\frac{x^2}{9} - \frac{4y^2}{9} = 1$ 22. $\frac{y^2}{9} - x^2 = 1$

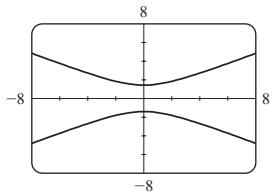
23.



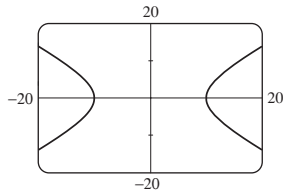
24.



25.



26.



27. $\frac{x^2}{9} - \frac{y^2}{16} = 1$ 28. $\frac{y^2}{64} - \frac{x^2}{36} = 1$

29. $y^2 - \frac{x^2}{3} = 1$ 30. $\frac{x^2}{4} - \frac{y^2}{32} = 1$

31. $x^2 - \frac{y^2}{25} = 1$ 32. $\frac{y^2}{36} - \frac{x^2}{324} = 1$

33. $\frac{5y^2}{64} - \frac{5x^2}{256} = 1$ 34. $\frac{y^2}{36} - \frac{x^2}{20} = 1$

35. $\frac{x^2}{16} - \frac{y^2}{16} = 1$ 36. $\frac{x^2}{8} - y^2 = 1$

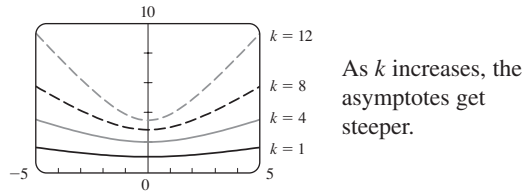
37. $\frac{x^2}{9} - \frac{y^2}{16} = 1$ 38. $4y^2 - \frac{4x^2}{3} = 1$

39. (b) $x^2 - y^2 = c^2/2$ 40. (b) They both have asymptotes $y = \pm \frac{1}{2}x$.

42. (a) $a = 3, b = 4, c = 5; F_1(5, 0), F_2(-5, 0)$

(c) $d(P, F_1) = \frac{16}{3}, d(P, F_2) = \frac{34}{3}$

43. (b)

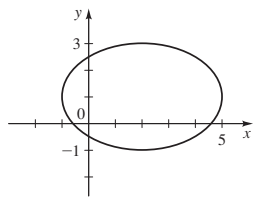


44. (a) 490 mi (b) $\frac{y^2}{60,025} - \frac{x^2}{2475} = 1$ (c) 10.1 mi

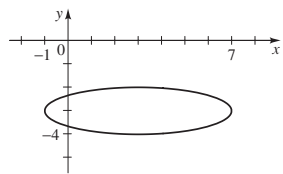
45. $x^2 - y^2 = 2.3 \times 10^{19}$

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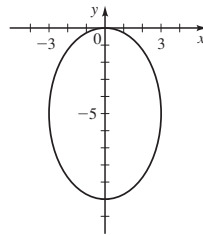
1. Center $C(2, 1)$;
foci $F(2 \pm \sqrt{5}, 1)$;
vertices $V_1(-1, 1), V_2(5, 1)$;
major axis 6, minor axis 4



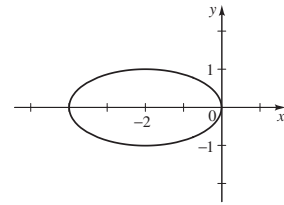
2. Center $C(3, -3)$;
foci $F(3 \pm \sqrt{15}, -3)$;
vertices $V_1(-1, -3), V_2(7, -3)$;
major axis 8, minor axis 2



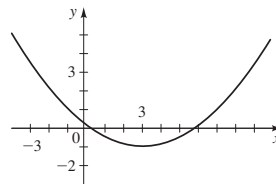
3. Center $C(0, -5)$;
foci $F_1(0, -1), F_2(0, -9)$;
vertices $V_1(0, 0), V_2(0, -10)$;
major axis 10, minor axis 6



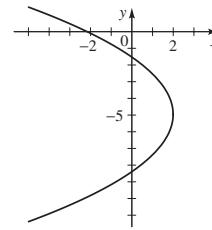
4. Center $C(-2, 0)$;
foci $F(-2 \pm \sqrt{3}, 0)$;
vertices $V_1(-4, 0), V_2(0, 0)$;
major axis 4, minor axis 2



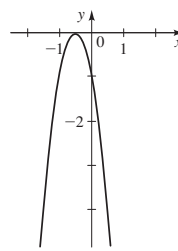
5. Vertex $V(3, -1)$;
focus $F(3, 1)$;
directrix $y = -3$



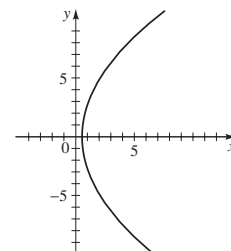
6. Vertex $V(2, -5)$;
focus $F(\frac{1}{2}, -5)$;
directrix $x = \frac{7}{2}$



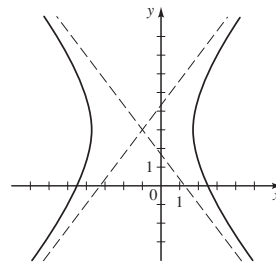
7. Vertex $V(-\frac{1}{2}, 0)$;
focus $F(-\frac{1}{2}, -\frac{1}{16})$;
directrix $y = \frac{1}{16}$



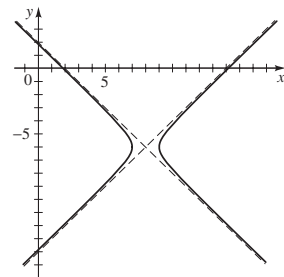
8. Vertex $V(\frac{1}{2}, 0)$;
focus $F(\frac{9}{2}, 0)$;
directrix $x = -\frac{7}{2}$



9. Center $C(-1, 3)$;
foci $F_1(-6, 3), F_2(4, 3)$;
vertices $V_1(-4, 3), V_2(2, 3)$;
asymptotes
 $y = \pm \frac{4}{3}(x + 1) + 3$

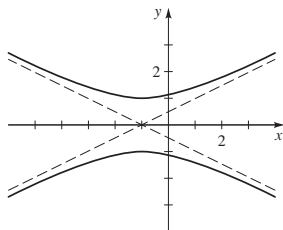


10. Center $C(8, -6)$;
foci $F(8 \pm \sqrt{2}, -6)$;
vertices $V_1(7, -6), V_2(9, -6)$;
asymptotes $y = -x + 2,$
 $y = x - 14$

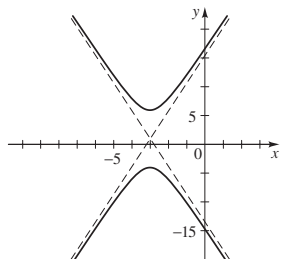


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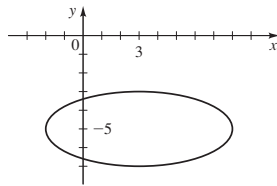
11. Center $C(-1, 0)$;
foci $F(-1, \pm\sqrt{5})$;
vertices $V(-1, \pm 1)$;
asymptotes
 $y = \pm\frac{1}{2}(x + 1)$



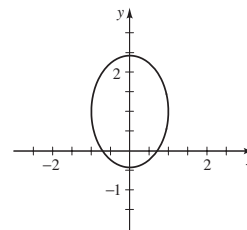
12. Center $C(-3, 1)$;
foci $F(-3, 1 \pm \sqrt{26})$;
vertices $V_1(-3, -4)$, $V_2(-3, 6)$;
asymptotes $y = -5x - 14$,
 $y = 5x + 16$



23. Ellipse; $C(3, -5)$;
 $F(3 \pm \sqrt{21}, -5)$;
 $V_1(-2, -5)$, $V_2(8, -5)$;
major axis 10,
minor axis 4



24. Ellipse;
 $C(0, 1)$; $F_1(0, 0)$, $F_2(0, 2)$;
 $V(0, 1 \pm \sqrt{2})$;
major axis $2\sqrt{2}$,
minor axis 2



13. $x^2 = -\frac{1}{4}(y - 4)$

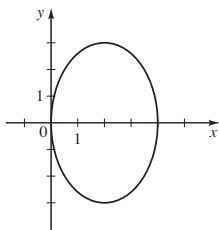
15. $\frac{(x - 5)^2}{25} + \frac{y^2}{16} = 1$

16. $\frac{(x - 2)^2}{4} + \frac{(y + 3)^2}{9} = 1$

17. $(y - 1)^2 - x^2 = 1$

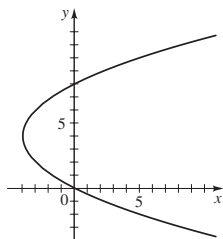
18. $\frac{(x - 4)^2}{4} - \frac{3y^2}{16} = 1$

19. Ellipse; $C(2, 0)$;
 $F(2, \pm\sqrt{5})$; $V(2, \pm 3)$;
major axis 6,
minor axis 4

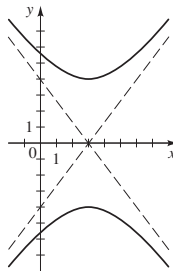


14. $y^2 = 24(x + 6)$

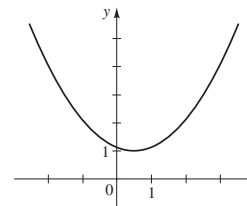
20. Parabola;
 $V(-4, 4)$;
 $F(-3, 4)$;
 $x = -5$



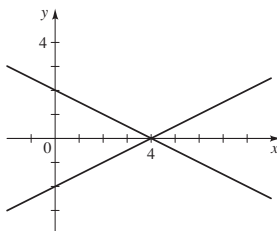
25. Hyperbola; $C(3, 0)$;
 $F(3, \pm 5)$; $V(3, \pm 4)$;
asymptotes $y = \pm\frac{4}{3}(x - 3)$



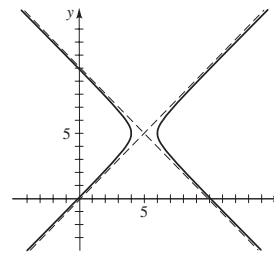
26. Parabola;
 $V(\frac{1}{2}, 1)$; $F(\frac{1}{2}, \frac{3}{2})$; $y = \frac{1}{2}$



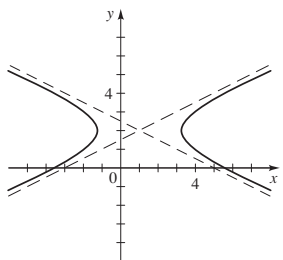
27. Degenerate conic
(pair of lines),
 $y = \pm\frac{1}{2}(x - 4)$



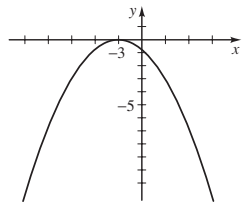
28. Hyperbola;
 $C(5, 5)$; $F(5 \pm \sqrt{2}, 5)$;
 $V_1(4, 5)$, $V_2(6, 5)$;
asymptotes $y = x$,
 $y = -x + 10$



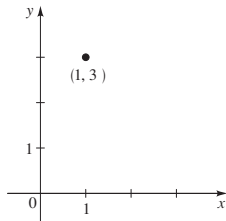
21. Hyperbola;
 $C(1, 2)$; $F_1(-\frac{3}{2}, 2)$, $F_2(\frac{7}{2}, 2)$;
 $V(1 \pm \sqrt{5}, 2)$; asymptotes
 $y = \pm\frac{1}{2}(x - 1) + 2$



22. Parabola;
 $V(-3, 0)$;
 $F(-3, -3)$;
 $y = 3$

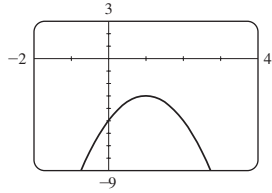


29. Point (1, 3)

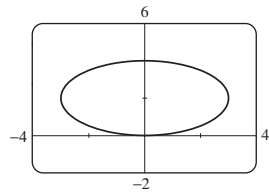


30. No graph

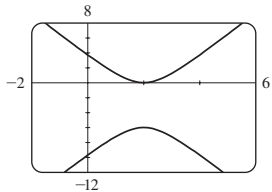
31.



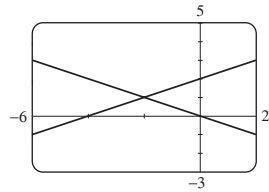
32.



33.



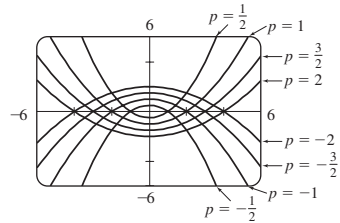
34.



35. (a) $F < 17$ (b) $F = 17$ (c) $F > 17$

36. $\frac{x^2}{25} + \frac{(8y - 399)^2}{160,801} = 1$

37. (a)



(c) The parabolas become narrower.

38. $(x - 800)^2 = -200(y - 3200)$

39. $\frac{(x + 150)^2}{18,062,500} + \frac{y^2}{18,040,000} = 1$

Section 10.5 ■ page 790

1. $(\sqrt{2}, 0)$ 2. $\left(1 - \frac{\sqrt{3}}{2}, 1 + \frac{\sqrt{3}}{2}\right)$ 3. $(0, -2\sqrt{3})$

4. $(1.9319, -0.5176)$ 5. $(1.6383, 1.1472)$ 6. $(5, 3)$

7. $X^2 + \sqrt{3}XY + 2 = 0$

8. $X^2 + Y^2 - 2XY - 3\sqrt{2}X + \sqrt{2}Y + 2 = 0$

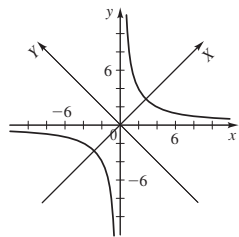
9. $7Y^2 - 48XY - 7X^2 - 40X - 30Y = 0$

10. $34X^2 + 41Y^2 + 24XY = 400$ 11. $X^2 - Y^2 = 2$

12. $\frac{(X - \sqrt{2})^2}{2} - \frac{Y^2}{2} = 1$

13. (a) Hyperbola (b) $X^2 - Y^2 = 16$

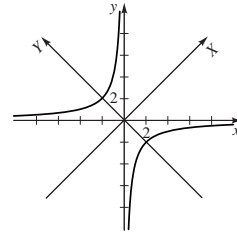
(c) $\phi = 45^\circ$



14. (a) Hyperbola

(b) $\frac{Y^2}{8} - \frac{X^2}{8} = 1$

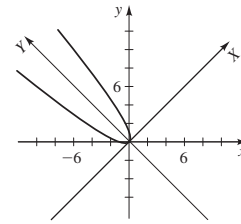
(c) $\phi = 45^\circ$



15. (a) Parabola

(b) $Y = \sqrt{2}X^2$

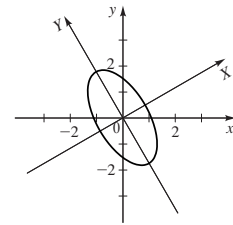
(c) $\phi = 45^\circ$



16. (a) Ellipse

(b) $X^2 + \frac{Y^2}{4} = 1$

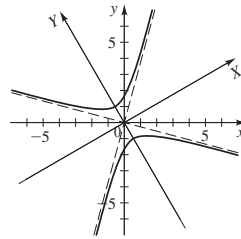
(c) $\phi = 30^\circ$



17. (a) Hyperbola

(b) $Y^2 - X^2 = 1$

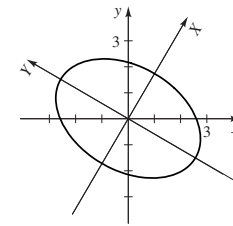
(c) $\phi = 30^\circ$



18. (a) Ellipse

(b) $\frac{X^2}{4} + \frac{Y^2}{9} = 1$

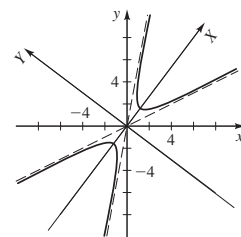
(c) $\phi = 60^\circ$



19. (a) Hyperbola

(b) $\frac{X^2}{4} - Y^2 = 1$

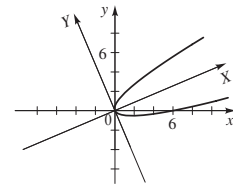
(c) $\phi \approx 53^\circ$



20. (a) Parabola

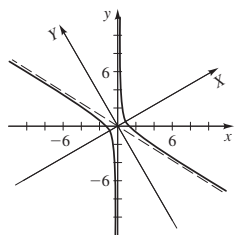
(b) $X = Y^2$

(c) $\phi \approx 23^\circ$

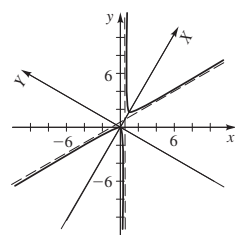


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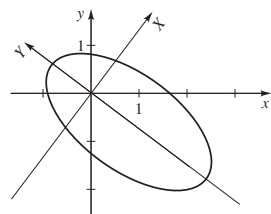
21. (a) Hyperbola
 (b) $3X^2 - Y^2 = 2\sqrt{3}$
 (c) $\phi = 30^\circ$



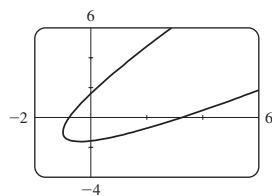
23. (a) Hyperbola
 (b) $(X - 1)^2 - 3Y^2 = 1$
 (c) $\phi = 60^\circ$



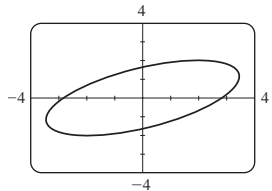
25. (a) Ellipse
 (b) $X^2 + \frac{(Y + 1)^2}{4} = 1$
 (c) $\phi \approx 53^\circ$



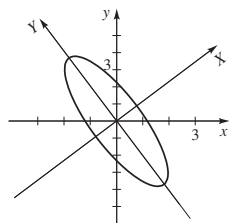
27. (a) Parabola
 (b)



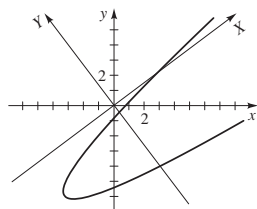
28. (a) Ellipse
 (b)



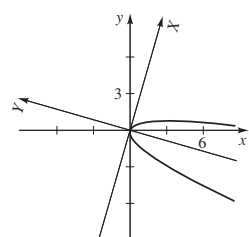
22. (a) Ellipse
 (b) $X^2 + \frac{Y^2}{9} = 1$
 (c) $\phi \approx 37^\circ$



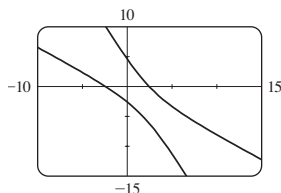
24. (a) Parabola
 (b) $\frac{4}{5}(X + \frac{24}{5}) = (Y + \frac{14}{5})^2$
 (c) $\phi \approx 37^\circ$



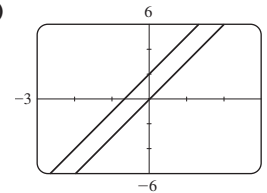
26. (a) Parabola
 (b) $X^2 = -(Y - \frac{1}{25})$
 (c) $\phi \approx 74^\circ$



29. (a) Hyperbola
 (b)



30. (a) Parabola
 (b)



31. (a) $(X - 5)^2 - Y^2 = 1$
 (b) XY -coordinates:
 $C(5, 0)$; $V_1(6, 0)$, $V_2(4, 0)$; $F(5 \pm \sqrt{2}, 0)$;
 xy -coordinates:
 $C(4, 3)$; $V_1(\frac{24}{5}, \frac{18}{5})$, $V_2(\frac{16}{5}, \frac{12}{5})$; $F_1(4 + \frac{4}{5}\sqrt{2}, 3 + \frac{3}{5}\sqrt{2})$,
 $F_2(4 - \frac{4}{5}\sqrt{2}, 3 - \frac{3}{5}\sqrt{2})$

- (c) $Y = \pm(X - 5)$; $7x - y - 25 = 0$, $x + 7y - 25 = 0$

32. (a) $4(X + 1)^2 = Y + 4$

- (b) XY -coordinates: $V(-1, -4)$, $F(-1, -\frac{63}{16})$; xy -coordinates:

$$V\left(\frac{3\sqrt{2}}{2}, -\frac{5\sqrt{2}}{2}\right), F\left(\frac{47\sqrt{2}}{32}, -\frac{79\sqrt{2}}{32}\right)$$

- (c) $Y = -\frac{65}{16}$; $y = x - \frac{65\sqrt{2}}{16}$

33. $X = x \cos \phi + y \sin \phi$; $Y = -x \sin \phi + y \cos \phi$

34. $Y^2 = \sqrt{2}\left(X - \frac{\sqrt{2}}{4}\right)$

Section 10.6 ■ page 799

1. $r = 6/(3 + 2 \cos \theta)$

2. $r = 12/(3 - 4 \cos \theta)$

3. $r = 2/(1 + \sin \theta)$

4. $r = 4/(2 - \sin \theta)$

5. $r = 20/(1 + 4 \cos \theta)$

6. $r = 1.2/(1 + 0.6 \sin \theta)$

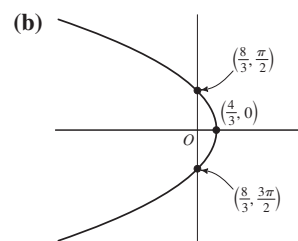
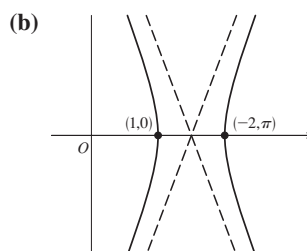
7. $r = 10/(1 + \sin \theta)$

8. $r = 2.8/(1 + 0.4 \cos \theta)$

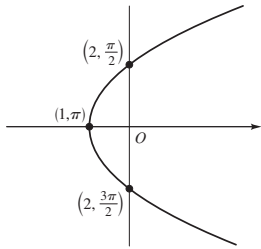
9. II 10. III 11. VI 12. I 13. IV 14. V

15. (a) 3, hyperbola

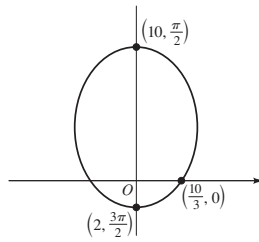
16. (a) 1, parabola



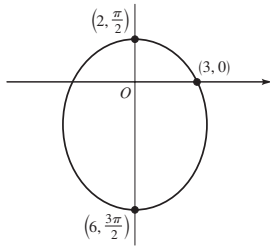
17. (a) 1, parabola
(b)



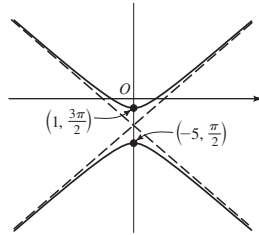
18. (a) $\frac{2}{3}$, ellipse
(b)



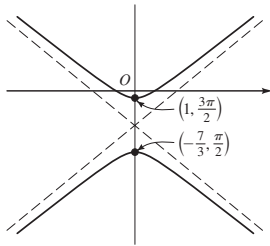
19. (a) $\frac{1}{2}$, ellipse
(b)



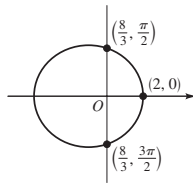
20. (a) $\frac{3}{2}$, hyperbola
(b)



21. (a) $\frac{5}{2}$, hyperbola
(b)

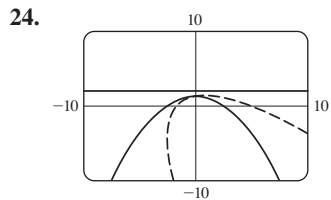
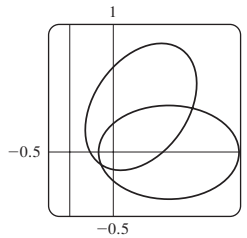


22. (a) $\frac{1}{3}$, ellipse
(b)

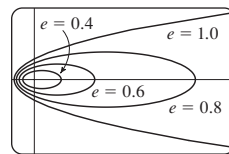


23. (a) $e = \frac{3}{4}$, directrix $x = -\frac{1}{3}$

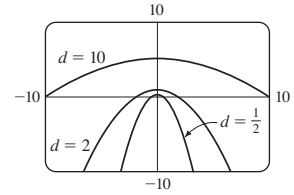
(b) $r = \frac{1}{4 - 3 \cos\left(\theta - \frac{\pi}{3}\right)}$



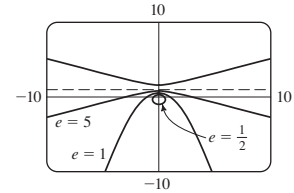
25. The ellipse is nearly circular when e is close to 0 and becomes more elongated as $e \rightarrow 1^-$. At $e = 1$, the curve becomes a parabola.



26. (a) As d increases, the parabolas get flatter while the vertex moves farther from the focus at the origin.



(b) As e increases, the conics change from ellipses to a parabola, and finally to hyperbolas, with the vertices getting closer to the directrix (shown as dashed line).

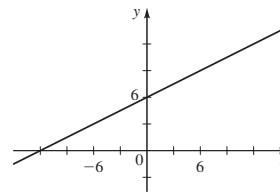


27. (b) $r = (1.49 \times 10^8)/(1 - 0.017 \cos \theta)$

28. (b) 1.468×10^8 km, 1.520×10^8 km 29. 0.25

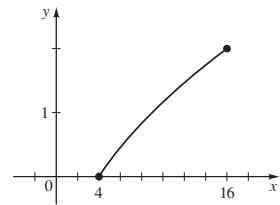
Section 10.7 ■ page 807

1. (a)



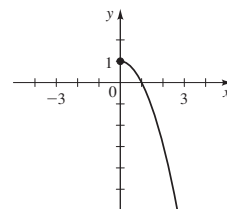
(b) $x - 2y + 12 = 0$

3. (a)



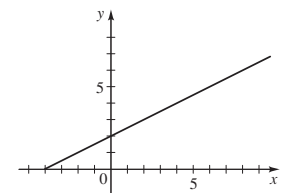
(b) $x = (y + 2)^2$

5. (a)



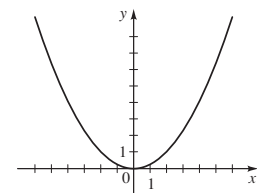
(b) $x = \sqrt{1 - y}$

2. (a)



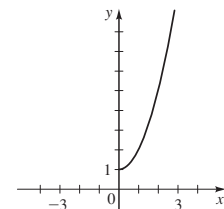
(b) $2y = x + 4, y \geq 0$

4. (a)



(b) $y = \frac{1}{4}x^2$

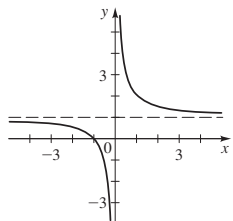
6. (a)



(b) $y = x^2 + 1, x \geq 0$

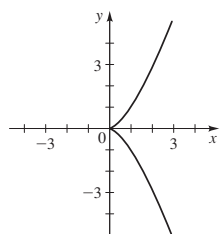
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7. (a)



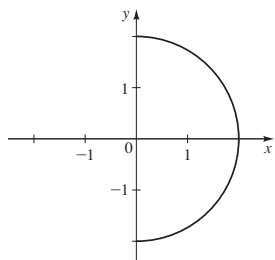
(b) $y = \frac{1}{x} + 1$

9. (a)



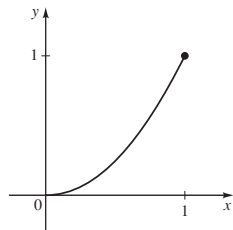
(b) $x^3 = y^2$

11. (a)



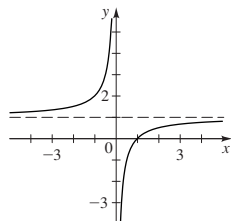
(b) $x^2 + y^2 = 4, x \geq 0$

13. (a)



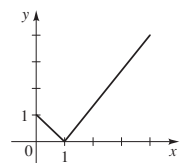
(b) $y = x^2, 0 \leq x \leq 1$

8. (a)



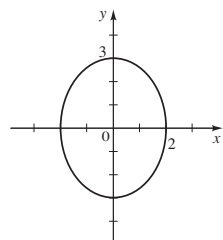
(b) $y = \frac{x-1}{x}$

10. (a)



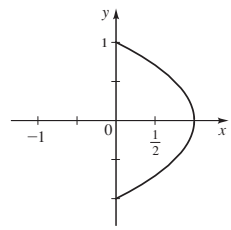
(b) $y = |1-x|, x \geq 0$

12. (a)



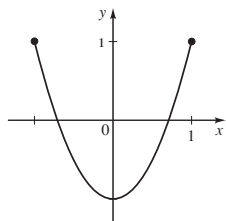
(b) $\frac{x^2}{4} + \frac{y^2}{9} = 1$

14. (a)



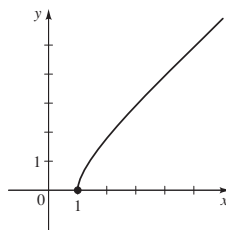
(b) $x = 1 - y^2, -1 \leq y \leq 1$

15. (a)



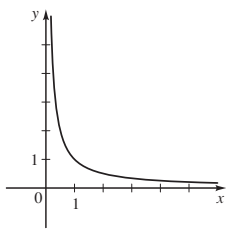
(b) $y = 2x^2 - 1, -1 \leq x \leq 1$

17. (a)



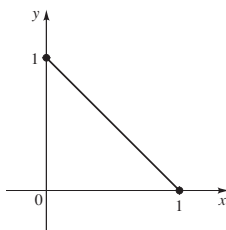
(b) $x^2 - y^2 = 1, x \geq 1, y \geq 0$

19. (a)



(b) $xy = 1, x \geq 0$

21. (a)



(b) $x + y = 1, 0 \leq x \leq 1$

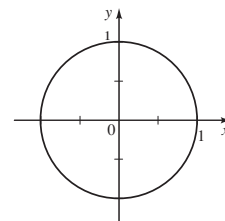
23. $x = 4 + t, y = -1 + \frac{1}{2}t$

24. $x = -10 + t, y = -20 - 2t$

25. $x = 6 + t, y = 7 + t$ 26. $x = t, y = \frac{7}{12}t$

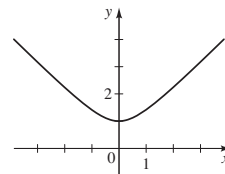
27. $x = a \cos t, y = a \sin t$ 28. $x = a \cos t, y = b \sin t$

16. (a)



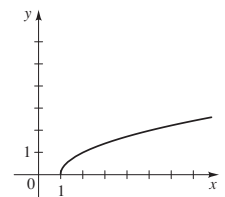
(b) $x^2 + y^2 = 1$

18. (a)



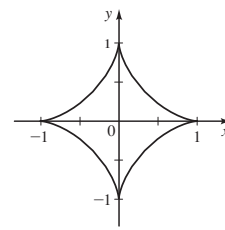
(b) $y^2 - x^2 = 1, y \geq 1$

20. (a)



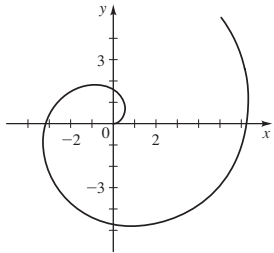
(b) $x = y^2 + 1, y \geq 0$

22. (a)

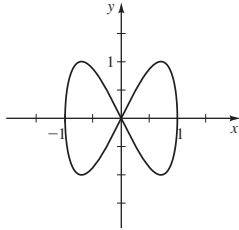


(b) $x^{2/3} + y^{2/3} = 1$

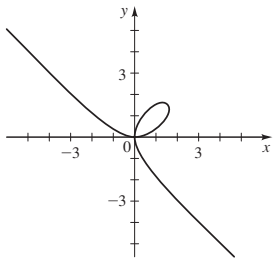
31.



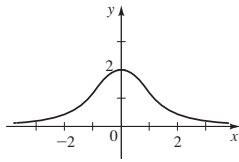
32.



33.

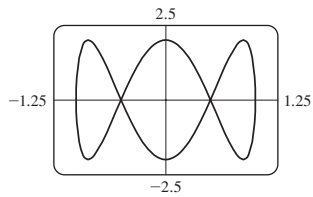


34.

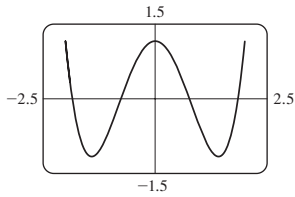


36. (a) 64 s (b) 21.5 mi
(c) 16,384 ft \approx 3.1 mi

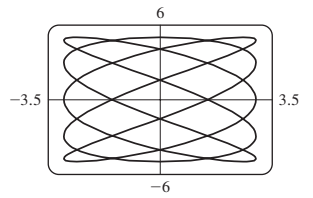
37.



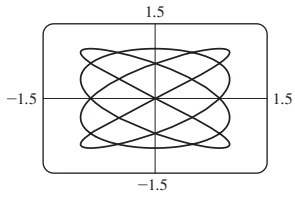
38.



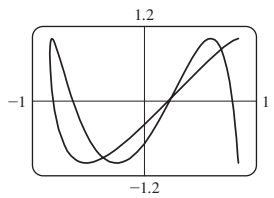
39.



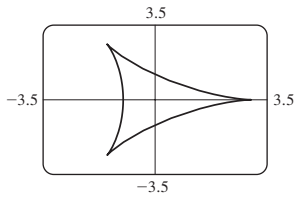
40.



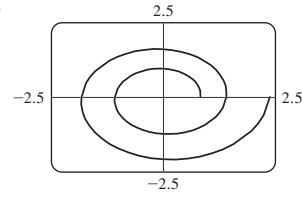
41.



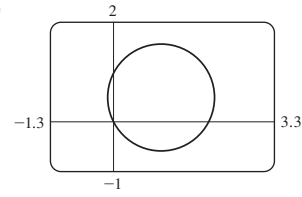
42.



43. (a) $x = 2^{t/12} \cos t, y = 2^{t/12} \sin t$
(b)

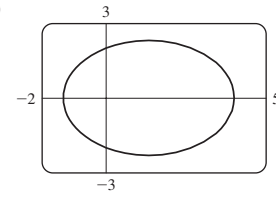


44. (a) $x = (\sin t + 2 \cos t) \cos t, y = (\sin t + 2 \cos t) \sin t$
(b)

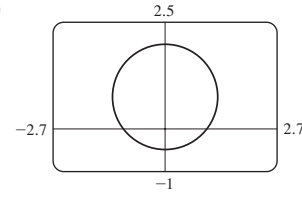


45. (a) $x = \frac{4 \cos t}{2 - \cos t}, y = \frac{4 \sin t}{2 - \cos t}$

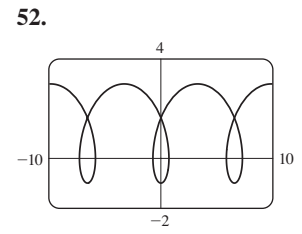
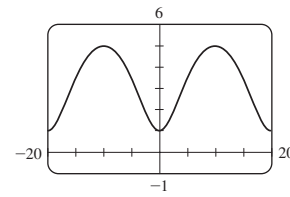
(b)



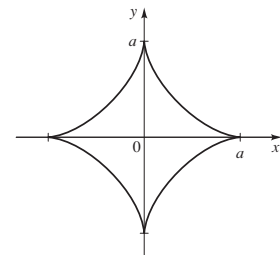
46. (a) $x = 2^{\sin t} \cos t, y = 2^{\sin t} \sin t$
(b)



47. III 48. IV 49. II 50. I
51.



53. (b) $x^{2/3} + y^{2/3} = a^{2/3}$



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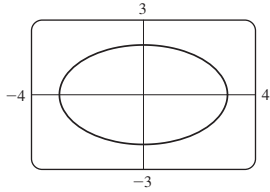
54. $x = (a + b)\cos t - b \cos\left(\frac{a + b}{b}t\right)$,

$y = (a + b)\sin t - b \sin\left(\frac{a + b}{b}t\right)$

55. $x = a(\sin \theta \cos \theta + \cot \theta)$, $y = a(1 + \sin^2 \theta)$

56. (a) $x = a \cos \theta$, $y = b \sin \theta$

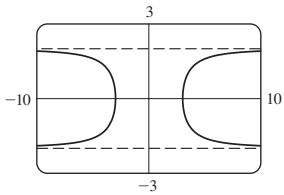
(b)



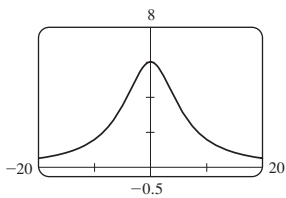
(c) $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

57. (a) $x = a \sec \theta$, $y = b \sin \theta$

(b)

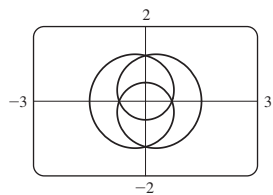


58. (b)

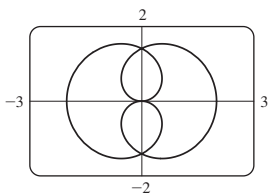


59. $y = a - a \cos\left(\frac{x + \sqrt{2ay - y^2}}{a}\right)$

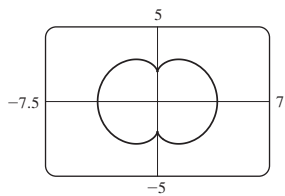
60. (a)



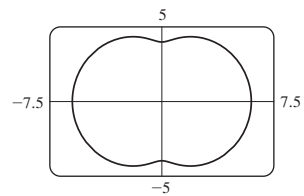
$R = 0.5$



$R = 1$



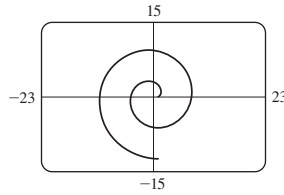
$R = 3$



$R = 5$

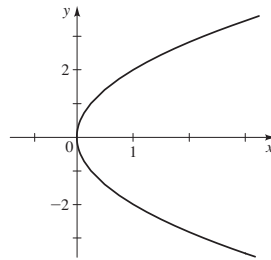
(b) $R = 5$

61. (b)

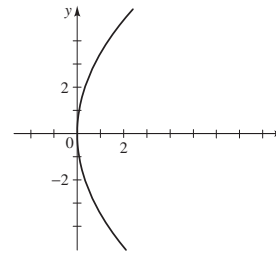


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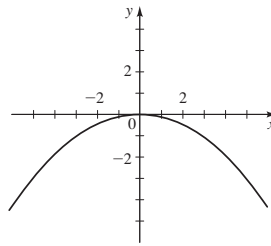
1. $V(0, 0)$; $F(1, 0)$; $x = -1$



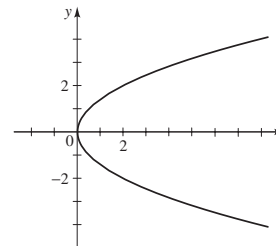
2. $V(0, 0)$; $F(3, 0)$; $x = -3$



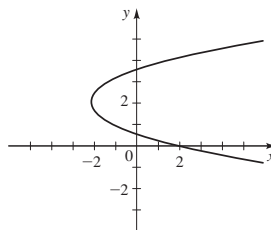
3. $V(0, 0)$; $F(0, -2)$; $y = 2$



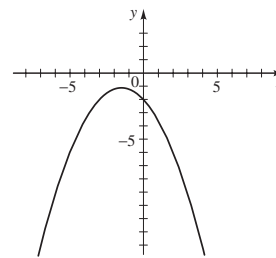
4. $V(0, 0)$; $F(\frac{1}{2}, 0)$; $x = -\frac{1}{2}$



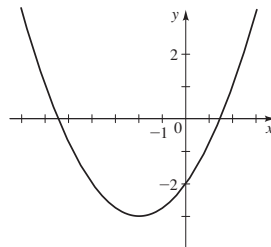
5. $V(-2, 2)$; $F(-\frac{7}{4}, 2)$; $x = -\frac{9}{4}$



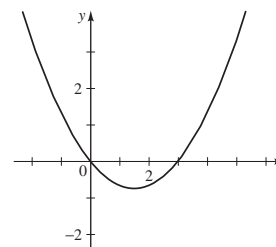
6. $V(-\frac{3}{2}, -\frac{11}{10})$; $F(-\frac{3}{2}, -\frac{69}{20})$; $y = -\frac{19}{40}$



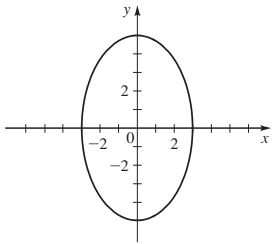
7. $V(-2, -3)$; $F(-2, -2)$; $y = -4$



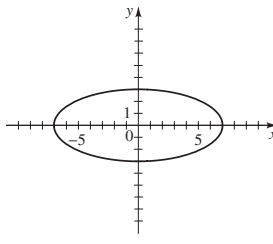
8. $V(\frac{3}{2}, -\frac{3}{4})$; $F(\frac{3}{2}, 0)$; $y = -\frac{3}{2}$



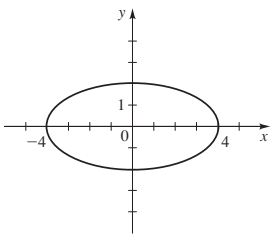
9. $C(0, 0)$; $V(0, \pm 5)$; $F(0, \pm 4)$; axes 10, 6



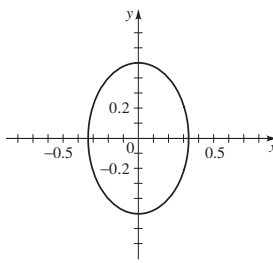
10. $C(0, 0)$; $V(\pm 7, 0)$; $F(\pm 2\sqrt{10}, 0)$; axes 14, 6



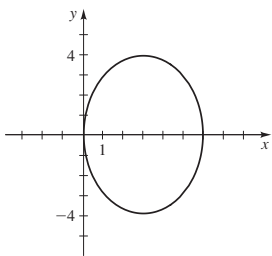
11. $C(0, 0)$; $V(\pm 4, 0)$; $F(\pm 2\sqrt{3}, 0)$; axes 8, 4



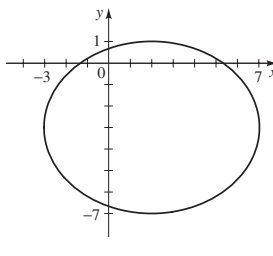
12. $C(0, 0)$; $V(0, \pm \frac{1}{2})$; $F(0, \pm \frac{1}{6}\sqrt{5})$; axes $1, \frac{2}{3}$



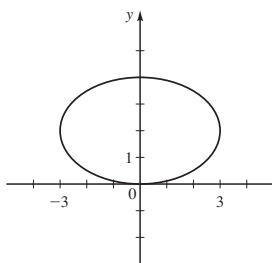
13. $C(3, 0)$; $V(3, \pm 4)$; $F(3, \pm \sqrt{7})$; axes 8, 6



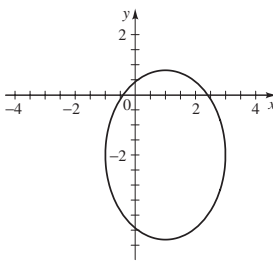
14. $C(2, -3)$; $V_1(-3, -3)$, $V_2(7, -3)$; $F_1(-1, -3)$, $F_2(5, -3)$; axes 10, 8



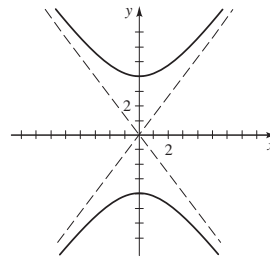
15. $C(0, 2)$; $V(\pm 3, 2)$; $F(\pm \sqrt{5}, 2)$; axes 6, 4



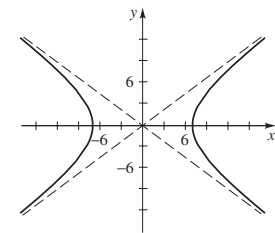
16. $C(1, -2)$; $V(1, -2 \pm 2\sqrt{2})$; $F_1(1, 0)$, $F_2(1, -4)$; axes $4\sqrt{2}, 4$



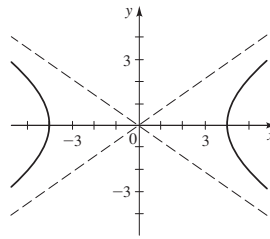
17. $C(0, 0)$; $V(0, \pm 4)$; $F(0, \pm 5)$; asymptotes $y = \pm \frac{4}{3}x$



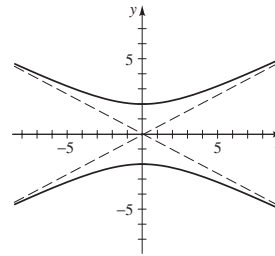
18. $C(0, 0)$; $V(\pm 7, 0)$; $F(\pm 9, 0)$; asymptotes $y = \pm \frac{4\sqrt{2}}{7}x$



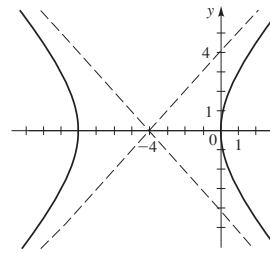
19. $C(0, 0)$; $V(\pm 4, 0)$; $F(\pm 2\sqrt{6}, 0)$; asymptotes $y = \pm \frac{1}{\sqrt{2}}x$



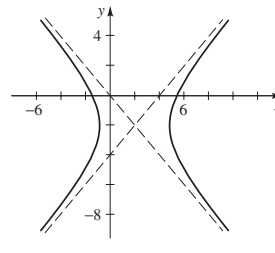
20. $C(0, 0)$; $V(0, \pm 2)$; $F(0, \pm 2\sqrt{5})$; asymptotes $y = \pm \frac{1}{2}x$



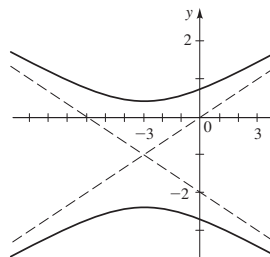
21. $C(-4, 0)$; $V_1(-8, 0)$, $V_2(0, 0)$; $F(-4 \pm 4\sqrt{2}, 0)$; asymptotes $y = \pm(x + 4)$



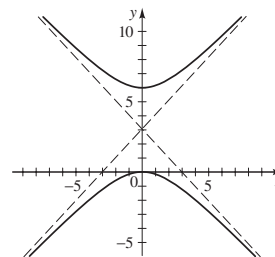
22. $C(2, -2)$; $V(2 \pm 2\sqrt{2}, -2)$; $F_1(-2, -2)$, $F_2(6, -2)$; asymptotes $y = -x$, $y = x - 4$



23. $C(-3, -1)$; $V(-3, -1 \pm \sqrt{2})$; $F(-3, -1 \pm 2\sqrt{5})$; asymptotes $y = \frac{1}{3}x$, $y = -\frac{1}{3}x - 2$



24. $C(0, 3)$; $V_1(0, 0)$, $V_2(0, 6)$; $F(0, 3 \pm 3\sqrt{2})$; asymptotes $y = x + 3$, $y = -x + 3$



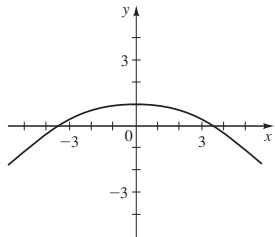
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25. $y^2 = 8x$ 26. $\frac{x^2}{144} + \frac{y^2}{25} = 1$ 27. $\frac{y^2}{16} - \frac{x^2}{9} = 1$

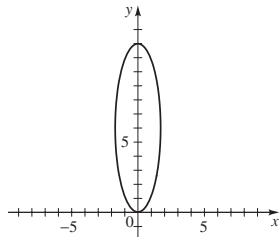
28. $(y - 4)^2 = -4(x - 4)$ 29. $\frac{(x - 4)^2}{16} + \frac{(y - 2)^2}{4} = 1$

30. $(x - 1)^2 - y^2 = 1$

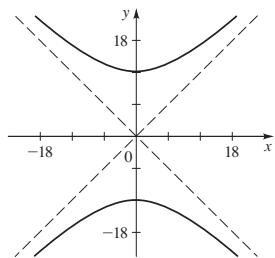
31. Parabola;
 $F(0, -2); V(0, 1)$



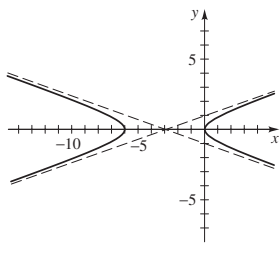
32. Ellipse; $F(0, 6 \pm \sqrt{33}); V_1(0, 0), V_2(0, 12)$



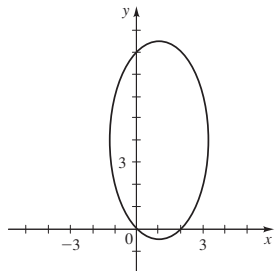
33. Hyperbola;
 $F(0, \pm 12\sqrt{2}); V(0, \pm 12)$



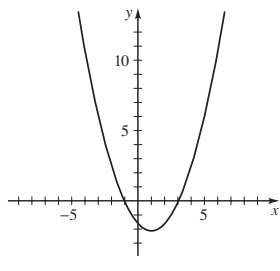
34. Hyperbola;
 $F(-3 \pm \sqrt{10}, 0); V_1(-6, 0), V_2(0, 0)$



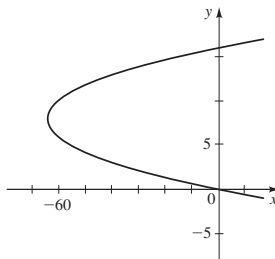
35. Ellipse; $F(1, 4 \pm \sqrt{15}); V(1, 4 \pm 2\sqrt{5})$



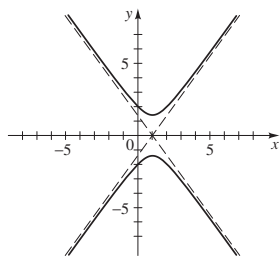
36. Parabola;
 $F(1, -\frac{5}{3}); V(1, -\frac{13}{6})$



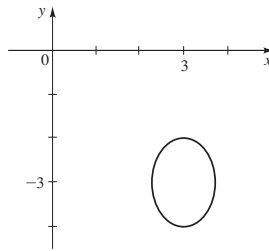
37. Parabola;
 $F(-\frac{255}{4}, 8); V(-64, 8)$



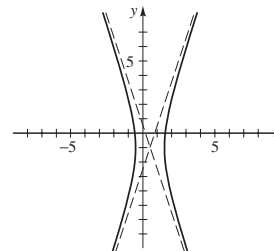
38. Hyperbola;
 $F(1, \pm \sqrt{3}); V(1, \pm \sqrt{2})$



39. Ellipse;
 $F(3, -3 \pm 1/\sqrt{2}); V_1(3, -4), V_2(3, -2)$

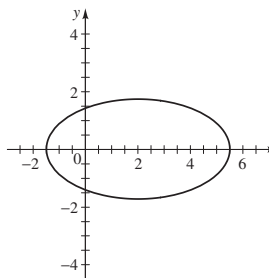


40. Hyperbola;
 $F(\frac{1}{2} \pm \sqrt{10}, -1); V_1(-\frac{1}{2}, -1), V_2(\frac{3}{2}, -1)$



41. Has no graph

42. Ellipse; $F_1(-1, 0), F_2(5, 0); V(2 \pm 2\sqrt{3}, 0)$



43. $x^2 = 4y$ 44. $\frac{x^2}{9} + \frac{(y - 4)^2}{25} = 1$ 45. $\frac{y^2}{4} - \frac{x^2}{16} = 1$

46. $\frac{(y - 4)^2}{4} - \frac{(x - 2)^2}{5} = 1$ 47. $\frac{(x - 1)^2}{3} + \frac{(y - 2)^2}{4} = 1$

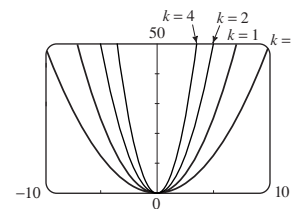
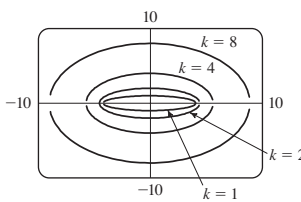
48. $(y - 5)^2 = 20(x - 5)$ 49. $\frac{4(x - 7)^2}{225} + \frac{(y - 2)^2}{100} = 1$

50. $y^2 = 4(x + 1)$ 51. (a) 91,419,000 mi

(b) 94,581,000 mi 52. (40, 41.5)

53. (a)

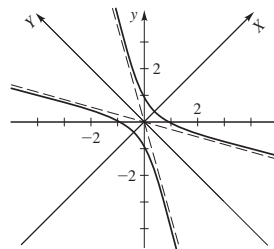
54. (a)



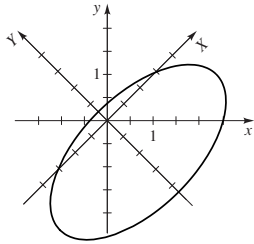
(b) $F(0, \frac{1}{4}k)$ (c) As k increases, the focus gets closer to the vertex.

55. (a) Hyperbola (b) $3X^2 - Y^2 = 1$

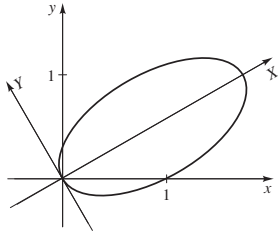
(c) $\phi = 45^\circ$



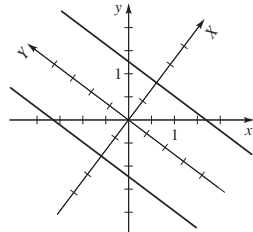
56. (a) Ellipse (b) $\frac{X^2}{6} + \frac{(Y+1)^2}{\frac{3}{2}} = 1$
 (c) $\phi = 45^\circ$



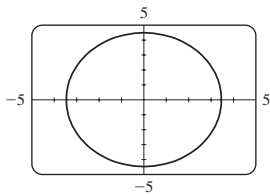
57. (a) Ellipse
 (b) $(X-1)^2 + 4Y^2 = 1$
 (c) $\phi = 30^\circ$



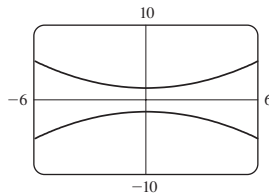
58. (a) Parabola
 (b) $X = \pm 1$
 (c) $\phi \approx 53^\circ$



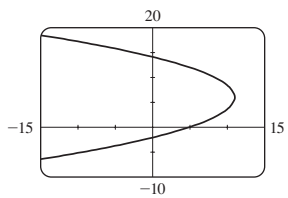
59. Ellipse



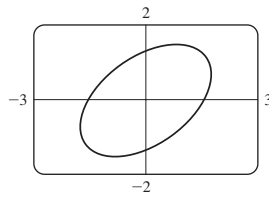
60. Hyperbola



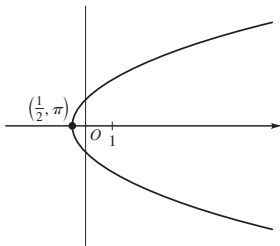
61. Parabola



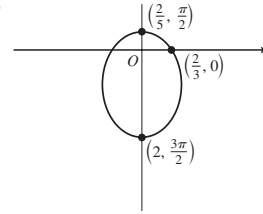
62. Ellipse



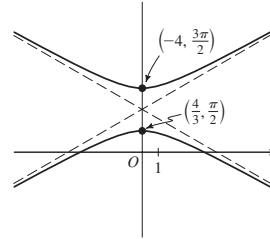
63. (a) $e = 1$, parabola
 (b)



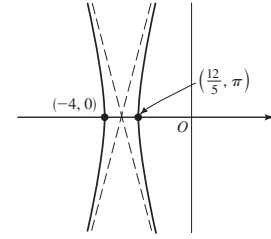
64. (a) $e = \frac{2}{3}$, ellipse
 (b)



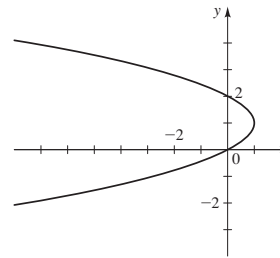
65. (a) $e = 2$, hyperbola



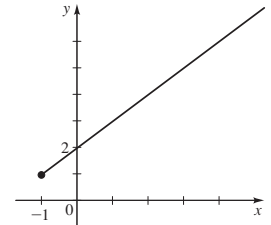
66. (a) $e = 4$, hyperbola



67. (a)



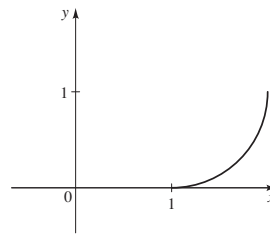
68. (a)



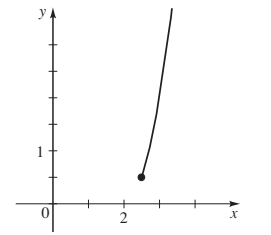
- (b) $x = 2y - y^2$

- (b) $y = x + 2, x \geq -1$

69. (a)

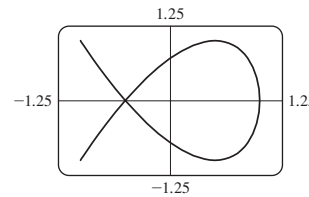


70. (a)

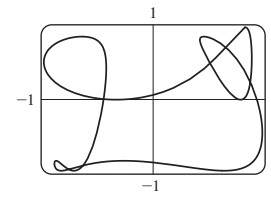


- (b) $(x-1)^2 + (y-1)^2 = 1, 1 \leq x \leq 2, 0 \leq y \leq 1$

- 71.



- 72.

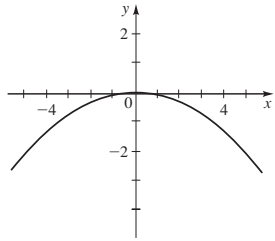


73. $x = \frac{1}{2}(1 + \cos \theta), y = \frac{1}{2}(\sin \theta + \tan \theta)$

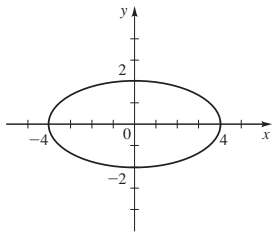
A118 Answers to Exercises and Chapter Tests

Chapter 10 Test ■ page 814

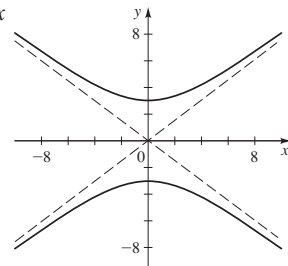
1. $F(0, -3), y = 3$



2. $V(\pm 4, 0); F(\pm 2\sqrt{3}, 0); 8, 4$

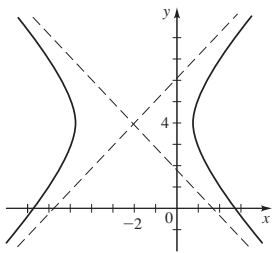
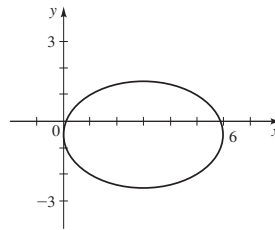


3. $V(0, \pm 3); F(0, \pm 5); y = \pm \frac{3}{4}x$

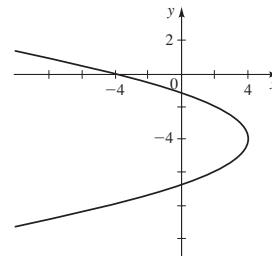


4. $y^2 = -x$ 5. $\frac{x^2}{16} + \frac{(y-3)^2}{9} = 1$ 6. $(x-2)^2 - \frac{y^2}{3} = 1$

7. $\frac{(x-3)^2}{9} + \frac{(y+\frac{1}{2})^2}{4} = 1$ 8. $\frac{(x+2)^2}{8} - \frac{(y-4)^2}{9} = 1$



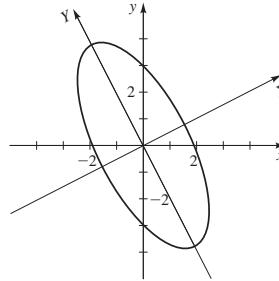
9. $(y+4)^2 = -2(x-4)$



10. $\frac{y^2}{9} - \frac{x^2}{16} = 1$ 11. $x^2 - 4x - 8y + 20 = 0$

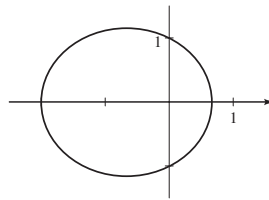
12. $\frac{3}{4}$ in. 13. (a) Ellipse (b) $\frac{X^2}{3} + \frac{Y^2}{18} = 1$

(c) $\phi \approx 27^\circ$

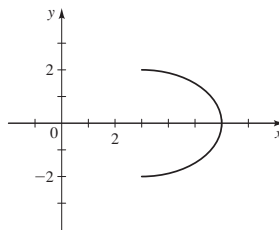


(d) $(-3\sqrt{2/5}, 6\sqrt{2/5}), (3\sqrt{2/5}, -6\sqrt{2/5})$

14. (a) $r = \frac{1}{1 + 0.5 \cos \theta}$ (b) Ellipse



15. (a)

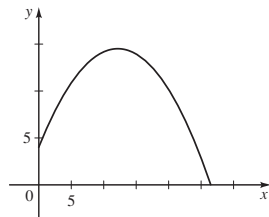


(b) $\frac{(x-3)^2}{9} + \frac{y^2}{4} = 1, x \geq 3$

Focus on Modeling ■ page 818

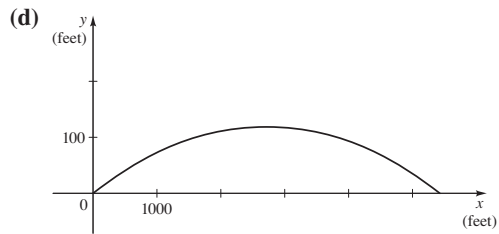
1. $y = -\left(\frac{g}{2v_0^2 \cos^2 \theta}\right)x^2 + (\tan \theta)x$

2. (a) $x = 15t, y = 4 + 15\sqrt{3}t - 16t^2$

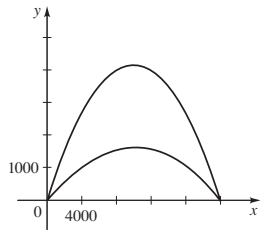


(b) 26.5 ft, 1.77 s

3. (a) 5.45 s (b) 118.7 ft (c) 5426.5 ft



4. (a) 32.08° or 115.85°



- (b) 32.08°

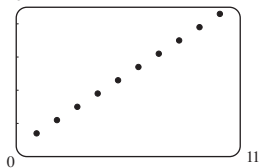
5. $\frac{v_0^2 \sin^2 \theta}{2g}$ 6. $x = (v_0 \cos \theta - w)t, y = (v_0 \sin \theta)t - \frac{1}{2}gt^2$

7. No, $\theta \approx 23^\circ$ 8. (b) Same spot; the projectile fired with $\theta = 30^\circ$ lands first. (c) Increases the maximum height by a factor of 4.

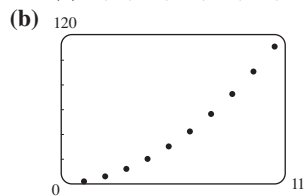
Chapter 11

Section 11.1 ■ page 830

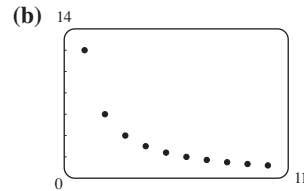
1. 2, 3, 4, 5; 101 2. 5, 7, 9, 11; 203 3. $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}; \frac{1}{101}$
 4. 2, 5, 10, 17; 10,001 5. $-1, \frac{1}{4}, -\frac{1}{9}, \frac{1}{16}; \frac{1}{10,000}$
 6. $1, \frac{1}{4}, \frac{1}{9}, \frac{1}{16}, \frac{1}{10,000}$ 7. 0, 2, 0, 2; 2 8. $\frac{1}{2}, -\frac{2}{3}, \frac{3}{4}, -\frac{4}{5}, -\frac{100}{101}$
 9. 1, 4, 27, 256; 100^{100} 10. 3, 3, 3, 3, 3
 11. 3, 2, 0, -4, -12 12. -8, -4, -2, -1, $-\frac{1}{2}$
 13. 1, 3, 7, 15, 31 14. $1, \frac{1}{2}, \frac{2}{3}, \frac{3}{5}, \frac{5}{8}$ 15. 1, 2, 3, 5, 8
 16. 1, 1, 1, 3, 5
 17. (a) 7, 11, 15, 19, 23, 27, 31, 35, 39, 43
 (b) 45



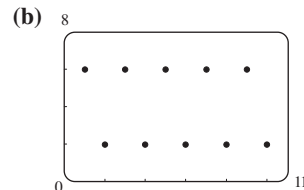
18. (a) 2, 6, 12, 20, 30, 42, 56, 72, 90, 110



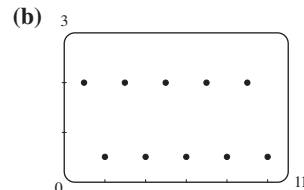
19. (a) 12, 6, 4, 3, $\frac{12}{5}, 2, \frac{12}{7}, \frac{3}{2}, \frac{4}{3}, \frac{6}{5}$



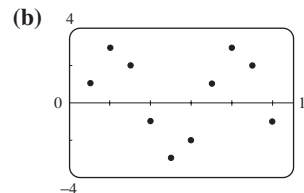
20. (a) 6, 2, 6, 2, 6, 2, 6, 2, 6, 2



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



22. (a) 1, 3, 2, -1, -3, -2, 1, 3, 2, -1



23. 2^n 24. $a_n = \frac{(-1)^n}{3^n}$ 25. $3n - 2$ 26. $a_n = (-1)^{n+1}5^n$

27. $(2n - 1)/n^2$ 28. $a_n = \frac{n + 2}{n + 3}$ 29. $1 + (-1)^n$

30. $a_n = n^{(-1)^{n+1}}$ 31. 1, 4, 9, 16, 25, 36

32. 1, 5, 14, 30, 55, 91 33. $\frac{1}{3}, \frac{4}{9}, \frac{13}{27}, \frac{40}{81}, \frac{121}{243}, \frac{364}{729}$

34. -1, 0, -1, 0, -1, 0 35. $\frac{2}{3}, \frac{8}{9}, \frac{26}{27}, \frac{80}{81}, S_n = 1 - \frac{1}{3^n}$

36. $\frac{1}{6}, \frac{1}{4}, \frac{3}{10}, \frac{1}{3}; S_n = \frac{1}{2} - \frac{1}{n + 2}$

37. $1 - \sqrt{2}, 1 - \sqrt{3}, -1, 1 - \sqrt{5}; S_n = 1 - \sqrt{n + 1}$

38. $-\log 2, -\log 3, -\log 4, -\log 5; S_n = -\log(n + 1)$

39. 10 40. 30 41. $\frac{11}{6}$ 42. 0 43. 8 44. 90 45. 31

46. 34 47. 385 48. 15,550 49. 46,438 50. 0.153146

51. 22 52. -0.688172 53. $\sqrt{1} + \sqrt{2} + \sqrt{3} + \sqrt{4} + \sqrt{5}$

54. $-1 + \frac{1}{3} + \frac{3}{5} + \frac{5}{7} + \frac{7}{9}$

55. $\sqrt{4} + \sqrt{5} + \sqrt{6} + \sqrt{7} + \sqrt{8} + \sqrt{9} + \sqrt{10}$

56. $6 \cdot 9 + 7 \cdot 10 + 8 \cdot 11 + 9 \cdot 12$

57. $x^3 + x^4 + \dots + x^{100}$

58. $x - x^2 + x^3 - \dots + (-1)^{n+1}x^n$

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59. $\sum_{k=1}^{100} k$ 60. $\sum_{k=1}^{10} 2k$ 61. $\sum_{k=1}^{10} k^2$ 62. $\sum_{k=2}^{100} \frac{(-1)^k}{k \ln k}$

63. $\sum_{k=1}^{999} \frac{1}{k(k+1)}$ 64. $\sum_{k=1}^n \frac{\sqrt{k}}{k^2}$ 65. $\sum_{k=0}^{100} x^k$

66. $\sum_{k=1}^{100} (-1)^{k+1} kx^{k-1}$ 67. $2^{(2^n-1)/2^n}$

68.

n	G_n
1	1
2	1
3	2
4	3
5	5
6	8
7	13
8	21
9	34
10	55

69. (a) 2004.00, 2008.01, 2012.02, 2016.05, 2020.08, 2024.12

(b) \$2149.16 70. (a) 0, 0.50, 1.50, 3.01, 5.03, 7.55

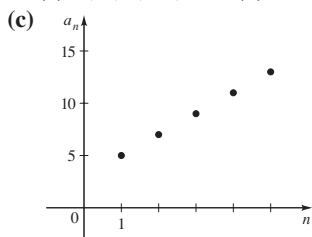
(b) \$977.00 71. (a) 35,700, 36,414, 37,142, 37,885, 38,643

(b) 42,665 72. (b) \$9088.67 73. (b) 6898

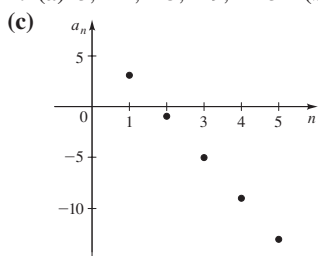
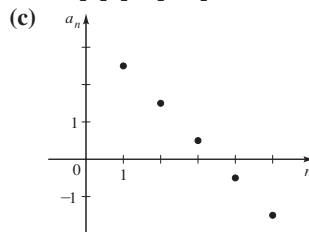
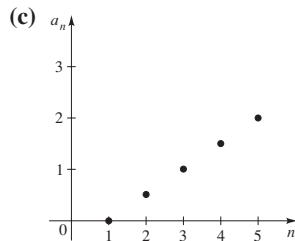
74. (a) $P_n = 240,000(1.06)^n$ (b) \$382,52475. (a) $S_n = S_{n-1} + 2000$ (b) \$38,00076. (a) $C_n = 1.1C_{n-1}$, $C_0 = 4$ (b) 8.6 g/L

Section 11.2 ■ page 837

1. (a) 5, 7, 9, 11, 13 (b) 2



2. (a) 3, -1, -5, -9, -13 (b) -4

3. (a) $\frac{5}{2}, \frac{3}{2}, \frac{1}{2}, -\frac{1}{2}, -\frac{3}{2}$ (b) -14. (a) $0, \frac{1}{2}, 1, \frac{3}{2}, 2$ (b) $\frac{1}{2}$ 5. $a_n = 3 + 5(n-1)$, $a_{10} = 48$ 6. $a_n = -6 + 3(n-1)$, $a_{10} = 21$ 7. $a_n = \frac{5}{2} - \frac{1}{2}(n-1)$, $a_{10} = -2$ 8. $a_n = \sqrt{3} + \sqrt{3}(n-1)$, $a_{10} = 10\sqrt{3}$

9. Arithmetic, 3 10. Not arithmetic 11. Not arithmetic

12. Arithmetic, 2 13. Arithmetic, $-\frac{3}{2}$ 14. Arithmetic, $\ln 2$ 15. Arithmetic, 1.7

16. Not arithmetic

17. 11, 18, 25, 32, 39; 7; $a_n = 11 + 7(n-1)$

18. 6, 8, 12, 20, 36; not arithmetic

19. $\frac{1}{3}, \frac{1}{5}, \frac{1}{7}, \frac{1}{9}, \frac{1}{11}$; not arithmetic20. $\frac{3}{2}, 2, \frac{5}{2}, 3, \frac{7}{2}, \frac{1}{2}$; $a_n = \frac{3}{2} + \frac{1}{2}(n-1)$ 21. -4, 2, 8, 14, 20; 6; $a_n = -4 + 6(n-1)$

22. 2, 5, 0, 7, -2; not arithmetic

23. 3, $a_5 = 14$, $a_n = 2 + 3(n-1)$, $a_{100} = 299$ 24. 4, $a_5 = 17$, $a_n = 1 + 4(n-1)$, $a_{100} = 397$ 25. 5, $a_5 = 24$, $a_n = 4 + 5(n-1)$, $a_{100} = 499$ 26. -3, $a_5 = -1$, $a_n = 11 - 3(n-1)$, $a_{100} = -286$ 27. 4, $a_5 = 4$, $a_n = -12 + 4(n-1)$, $a_{100} = 384$ 28. $\frac{1}{2}$, $a_5 = \frac{19}{6}$, $a_n = \frac{7}{6} + \frac{1}{2}(n-1)$, $a_{100} = \frac{152}{3}$ 29. 1.5, $a_5 = 31$, $a_n = 25 + 1.5(n-1)$, $a_{100} = 173.5$ 30. -2.7, $a_5 = 4.2$, $a_n = 15 - 2.7(n-1)$, $a_{100} = -252.3$ 31. s , $a_5 = 2 + 4s$, $a_n = 2 + (n-1)s$, $a_{100} = 2 + 99s$ 32. 3, $a_5 = -t + 12$, $a_n = -t + 3(n-1)$, $a_{100} = -t + 297$ 33. $\frac{1}{2}$ 34. 48 35. -100, -98, -9636. $a_n = 44 + 3(n-1)$ 37. 30th

38. Yes, the 2985th term

39. 100 40. 168 41. 460 42. 660 43. 1090 44. 165

45. 20,301 46. 310.5 47. 832.3 48. -505 49. 46.75

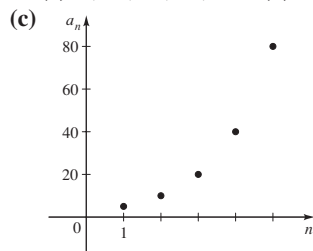
50. -399 52. 10^{19} 53. Yes 54. $\frac{15}{4}$ 55. 50 56. 31

57. \$1250 58. 234 59. \$403,500 60. 840 61. 20

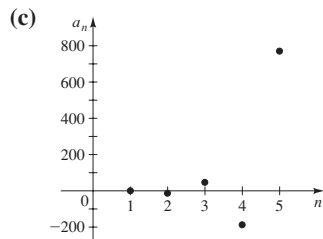
62. (a) 576 ft (b) $16n^2$ ft 63. 78

Section 11.3 ■ page 844

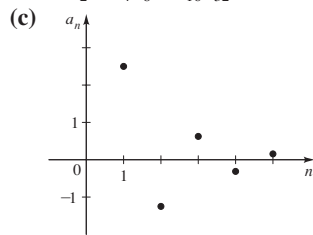
1. (a) 5, 10, 20, 40, 80 (b) 2



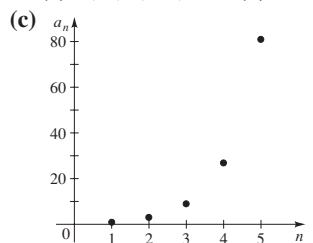
2. (a) 3, -12, 48, -192, 768 (b) -4



3. (a)
- $\frac{5}{2}, -\frac{5}{4}, \frac{5}{8}, -\frac{5}{16}, \frac{5}{32}$
- (b)
- $-\frac{1}{2}$



4. (a) 1, 3, 9, 27, 81 (b) 3



5. $a_n = 3 \cdot 5^{n-1}$, $a_4 = 375$ 6. $a_n = -6 \cdot 3^{n-1}$, $a_4 = -162$
 7. $a_n = \frac{5}{2}(-\frac{1}{2})^{n-1}$, $a_4 = -\frac{5}{16}$ 8. $a_n = \sqrt{3}(\sqrt{3})^{n-1}$, $a_4 = 9$
 9. Geometric, 2 10. Not geometric 11. Geometric, $\frac{1}{2}$
 12. Geometric, $-\frac{1}{3}$ 13. Not geometric 14. Geometric, e^2
 15. Geometric, 1.1 16. Not geometric 17. 6, 18, 54, 162, 486; geometric, common ratio 3; $a_n = 6 \cdot 3^{n-1}$
 18. 7, 13, 31, 85, 247; not geometric
 19. $\frac{1}{4}, \frac{1}{16}, \frac{1}{64}, \frac{1}{256}, \frac{1}{1024}$; geometric, common ratio $\frac{1}{4}$; $a_n = \frac{1}{4}(\frac{1}{4})^{n-1}$
 20. -2, 4, -8, 16, -32; geometric, common ratio -2, $a_n = -2 \cdot (-2)^{n-1}$ 21. 0, $\ln 5$, $2 \ln 5$, $3 \ln 5$, $4 \ln 5$; not geometric 22. 1, 4, 54, 256, 3125; not geometric
 23. 3, $a_5 = 162$, $a_n = 2 \cdot 3^{n-1}$ 24. $\frac{2}{3}, a_5 = \frac{112}{81}$, $a_n = 7(\frac{2}{3})^{n-1}$

25. -0.3, $a_5 = 0.00243$, $a_n = (0.3)(-0.3)^{n-1}$
 26. $\sqrt{2}$, $a_5 = 4$, $a_n = (\sqrt{2})^{n-1}$
 27. $-\frac{1}{12}$, $a_5 = \frac{1}{144}$, $a_n = 144(-\frac{1}{12})^{n-1}$
 28. $\frac{1}{4}$, $a_5 = -\frac{1}{32}$, $a_n = -8(\frac{1}{4})^{n-1}$
 29. $3^{2/3}$, $a_5 = 3^{11/3}$, $a_n = 3^{(2n+1)/3}$
 30. $t/2$, $a_5 = t^5/16$, $a_n = t(t/2)^{n-1}$
 31. $s^{2/7}$, $a_5 = s^{8/7}$, $a_n = s^{2(n-1)/7}$
 32. 5^c , $a_5 = 5^{4c+1}$, $a_n = 5 \cdot (5^c)^{n-1}$ 33. $\frac{1}{2}$ 34. $\frac{16}{27}$ 35. $\frac{25}{4}$
 36. $\frac{16}{81}, \frac{8}{27}, \frac{4}{9}$ 37. 11th 38. Yes, the 7th term 39. 315
 40. $\frac{80}{81}$ 41. 441 42. 0.7488 43. 3280 44. $\frac{341}{512}$ 45. $\frac{6141}{1024}$
 46. $\frac{4655}{32}$ 47. $\frac{3}{2}$ 48. $\frac{2}{3}$ 49. $\frac{3}{4}$ 50. $\frac{2}{3}$ 51. $\frac{1}{648}$ 52. 2
 53. $-\frac{1000}{117}$ 54. $\sqrt{2} + 1$ 55. $\frac{7}{9}$ 56. $\frac{251}{990}$ 57. $\frac{1}{33}$ 58. $\frac{10,457}{4950}$
 59. $\frac{112}{999}$ 60. $\frac{123}{999}$ 61. 10, 20, 40 62. $a \cdot \frac{1 - a^9}{1 - a} + 55b$
 63. (a) $V_n = 160,000(0.80)^{n-1}$ (b) 4th year
 64. 32,768 65. 19 ft, $80(\frac{3}{4})^n$ 66. 7347, $a_n = 5000 \cdot (1.08)^n$
 67. $\frac{64}{25}, \frac{1024}{625}, 5(\frac{4}{5})^n$ 68. 64 69. (a) $17\frac{8}{9}$ ft (b) $18 - (\frac{1}{3})^{n-3}$
 70. \$10,737,418.23, 37 days 71. 2801 72. (a) 99.90 mg (b) 100 mg
 73. 3 m 74. $2 + \sqrt{2} \approx 3.41$ s
 75. (a) 2 (b) $8 + 4\sqrt{2}$ 76. $2\pi R^2$ 77. 1

Section 11.4 ■ page 853

1. \$13,180.79 2. \$12,966.59 3. \$360,262.21
 4. \$13,435.19 5. \$5,591.79 6. \$572.34 7. \$245.66
 8. \$13,007.94 9. \$2,601.59 10. \$3,679.09 11. \$307.24
 12. \$643.70, \$811.41 13. \$733.76, \$264,153.60
 14. \$80,783.21 15. (a) \$859.15 (b) \$309,294.00
 (c) \$1,841,519.29 16. \$9020.60 17. \$341.24 18. 12.80%
 19. 18.16% 20. 15.84% 21. 11.68%

Section 11.5 ■ page 859

1. Let
- $P(n)$
- denote the statement

$$2 + 4 + \cdots + 2n = n(n + 1).$$

Step 1 $P(1)$ is true since $2 = 1(1 + 1)$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 2 + 4 + \cdots + 2k + 2(k + 1) &= k(k + 1) + 2(k + 1) && \text{Induction hypothesis} \\ &= (k + 1)(k + 2) \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

2. Let
- $P(n)$
- denote the statement

$$1 + 4 + 7 + \cdots + (3n - 2) = \frac{n(3n - 1)}{2}.$$

Step 1 $P(1)$ is true since $1 = \frac{1(3 \cdot 1 - 1)}{2}$.

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Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & 1 + 4 + 7 + \cdots + (3k - 2) + [3(k + 1) - 2] \\ &= \frac{k(3k - 1)}{2} + [3(k + 1) - 2] \quad \text{Induction hypothesis} \\ &= \frac{3k^2 + 5k + 2}{2} = \frac{(k + 1)[3(k + 1) - 1]}{2} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

3. Let $P(n)$ denote the statement

$$5 + 8 + \cdots + (3n + 2) = \frac{n(3n + 7)}{2}.$$

Step 1 $P(1)$ is true since $5 = \frac{1(3 \cdot 1 + 7)}{2}$

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & 5 + 8 + \cdots + (3k + 2) + [3(k + 1) + 2] \\ &= \frac{k(3k + 7)}{2} + (3k + 5) \quad \text{Induction hypothesis} \\ &= \frac{3k^2 + 13k + 10}{2} \\ &= \frac{(k + 1)[3(k + 1) + 7]}{2} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

4. Let $P(n)$ denote the statement

$$1^2 + 2^2 + \cdots + n^2 = \frac{n(n + 1)(2n + 1)}{6}.$$

Step 1 $P(1)$ is true since $1^2 = \frac{1(1 + 1)(2 \cdot 1 + 1)}{6}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & 1^2 + 2^2 + \cdots + k^2 + (k + 1)^2 \\ &= \frac{k(k + 1)(2k + 1)}{6} + (k + 1)^2 \quad \text{Induction hypothesis} \\ &= \frac{(k + 1)[2k^2 + 7k + 6]}{6} \\ &= \frac{(k + 1)[(k + 1) + 1][2(k + 1) + 1]}{6} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

5. Let $P(n)$ denote the statement

$$1 \cdot 2 + 2 \cdot 3 + \cdots + n(n + 1) = \frac{n(n + 1)(n + 2)}{3}.$$

Step 1 $P(1)$ is true since $1 \cdot 2 = \frac{1 \cdot (1 + 1) \cdot (1 + 2)}{3}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & 1 \cdot 2 + 2 \cdot 3 + \cdots + k(k + 1) + (k + 1)(k + 2) \\ &= \frac{k(k + 1)(k + 2)}{3} + (k + 1)(k + 2) \quad \text{Induction hypothesis} \\ &= \frac{(k + 1)(k + 2)(k + 3)}{3} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

6. Let $P(n)$ denote the statement

$$1 \cdot 3 + 2 \cdot 4 + \cdots + n(n + 2) = \frac{n(n + 1)(2n + 7)}{6}.$$

Step 1 $P(1)$ is true since $1 \cdot 3 = \frac{1(1 + 1)(2 \cdot 1 + 7)}{6}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & 1 \cdot 3 + 2 \cdot 4 + \cdots + k(k + 2) + (k + 1)[(k + 1) + 2] \\ &= \frac{k(k + 1)(2k + 7)}{6} + (k + 1)[(k + 1) + 2] \quad \text{Induction hypothesis} \\ &= \frac{(k + 1)(2k^2 + 13k + 18)}{6} \\ &= \frac{(k + 1)[(k + 1) + 1][2(k + 1) + 7]}{6} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

7. Let $P(n)$ denote the statement

$$1^3 + 2^3 + \cdots + n^3 = \frac{n^2(n + 1)^2}{4}.$$

Step 1 $P(1)$ is true since $1^3 = \frac{1^2 \cdot (1 + 1)^2}{4}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & 1^3 + 2^3 + \cdots + k^3 + (k + 1)^3 \\ &= \frac{k^2(k + 1)^2}{4} + (k + 1)^3 \quad \text{Induction hypothesis} \\ &= \frac{(k + 1)^2[k^2 + 4(k + 1)]}{4} \\ &= \frac{(k + 1)^2(k + 2)^2}{4} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

8. Let $P(n)$ denote the statement
 $1^3 + 3^3 + \cdots + (2n - 1)^3 = n^2(2n^2 - 1)$.

Step 1 $P(1)$ is true since $1^3 = 1^2(2 \cdot 1^2 - 1)$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 1^3 + 2^3 + \cdots + (2k - 1)^3 + (2k + 1)^3 & \\ &= k^2(2k^2 - 1) + (2k + 1)^3 && \text{Induction hypothesis} \\ &= 2k^4 + 8k^3 + 11k^2 + 6k + 1 \\ &= (k + 1)(k + 1)(2k^2 + 4k + 1) && \text{Factor (see Sec. 3.3)} \\ &= (k + 1)^2[2(k + 1)^2 - 1] \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

9. Let $P(n)$ denote the statement
 $2^3 + 4^3 + \cdots + (2n)^3 = 2n^2(n + 1)^2$.

Step 1 $P(1)$ is true since $2^3 = 2 \cdot 1^2(1 + 1)^2$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 2^3 + 4^3 + \cdots + (2k)^3 + [2(k + 1)]^3 & \\ &= 2k^2(k + 1)^2 + [2(k + 1)]^3 && \text{Induction hypothesis} \\ &= (k + 1)^2(2k^2 + 8k + 8) \\ &= 2(k + 1)^2(k + 2)^2 \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

10. Let $P(n)$ denote the statement
 $\frac{1}{1 \cdot 2} + \frac{1}{2 \cdot 3} + \cdots + \frac{1}{n(n + 1)} = \frac{n}{n + 1}$.

Step 1 $P(1)$ is true since $\frac{1}{1 \cdot 2} = \frac{1}{1 + 1}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} \frac{1}{1 \cdot 2} + \frac{1}{2 \cdot 3} + \cdots + \frac{1}{k(k + 1)} + \frac{1}{(k + 1)[(k + 1) + 1]} & \\ &= \frac{k}{k + 1} + \frac{1}{(k + 1)[(k + 1) + 1]} && \text{Induction hypothesis} \\ &= \frac{k^2 + 2k + 1}{(k + 1)(k + 2)} = \frac{k + 1}{k + 2} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

11. Let $P(n)$ denote the statement
 $1 \cdot 2 + 2 \cdot 2^2 + \cdots + n \cdot 2^n = 2[1 + (n - 1)2^n]$.

Step 1 $P(1)$ is true since $1 \cdot 2 = 2[1 + 0]$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 1 \cdot 2 + 2 \cdot 2^2 + \cdots + k \cdot 2^k + (k + 1) \cdot 2^{k+1} & \\ &= 2[1 + (k - 1)2^k] + (k + 1) \cdot 2^{k+1} && \text{Induction hypothesis} \\ &= 2 + (k - 1)2^{k+1} + (k + 1) \cdot 2^{k+1} \\ &= 2 + 2k2^{k+1} = 2(1 + k2^{k+1}) \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

12. Let $P(n)$ denote the statement
 $1 + 2 + 2^2 + \cdots + 2^{n-1} = 2^n - 1$.

Step 1 $P(1)$ is true since $1 = 2^1 - 1$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 1 + 2 + 2^2 + \cdots + 2^{k-1} + 2^k & \\ &= (2^k - 1) + 2^k && \text{Induction hypothesis} \\ &= 2 \cdot 2^k - 1 = 2^{k+1} - 1 \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

13. Let $P(n)$ denote the statement $n^2 + n$ is divisible by 2.

Step 1 $P(1)$ is true since $1^2 + 1$ is divisible by 2.

Step 2 Suppose $P(k)$ is true. Now

$$\begin{aligned} (k + 1)^2 + (k + 1) &= k^2 + 2k + 1 + k + 1 \\ &= (k^2 + k) + 2(k + 1) \end{aligned}$$

But $k^2 + k$ is divisible by 2 (by the induction hypothesis) and $2(k + 1)$ is clearly divisible by 2, so $(k + 1)^2 + (k + 1)$ is divisible by 2. So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

14. Let $P(n)$ denote the statement that $5^n - 1$ is divisible by 4.

Step 1 $P(1)$ is true since $5^1 - 1 = 4$.

Step 2 Suppose $P(k)$ is true. We have

$$5^{k+1} - 1 = 5(5^k - 1) + 4$$

Now $5^k - 1$ is divisible by 4 (induction hypothesis), and so is 4, and hence $5(5^k - 1) + 4$ is also divisible by 4. So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

15. Let $P(n)$ denote the statement $n^2 - n + 41$ is odd.

Step 1 $P(1)$ is true since $1^2 - 1 + 41$ is odd.

Step 2 Suppose $P(k)$ is true. Now

$$(k + 1)^2 - (k + 1) + 41 = (k^2 - k + 41) + 2k$$

But $k^2 - k + 41$ is odd (by the induction hypothesis) and $2k$ is clearly even, so their sum is odd. So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

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16. Let $P(n)$ denote the statement that $n^3 - n + 3$ is divisible by 3.

Step 1 $P(1)$ is true since $1^3 - 1 + 3 = 3$.

Step 2 Suppose $P(k)$ is true. We have

$$(k+1)^3 - (k+1) + 3 = k^3 - k + 3 + 3(k^2 + k)$$

Now $k^3 - k + 3$ is divisible by 3 (induction hypothesis), and so is $3(k^2 + k)$. So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

17. Let $P(n)$ denote the statement $8^n - 3^n$ is divisible by 5.

Step 1 $P(1)$ is true since $8^1 - 3^1$ is divisible by 5.

Step 2 Suppose $P(k)$ is true. Now

$$\begin{aligned} 8^{k+1} - 3^{k+1} &= 8 \cdot 8^k - 3 \cdot 3^k \\ &= 8 \cdot 8^k - (8 - 5) \cdot 3^k = 8 \cdot (8^k - 3^k) + 5 \cdot 3^k \end{aligned}$$

which is divisible by 5 because $8^k - 3^k$ is divisible by 5 (by the induction hypothesis) and $5 \cdot 3^k$ is clearly divisible by 5. So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

18. Let $P(n)$ denote the statement that $3^{2n} - 1$ is divisible by 8.

Step 1 $P(1)$ is true since $3^{2 \cdot 1} - 1 = 8$.

Step 2 Suppose $P(k)$ is true. We have

$$3^{2(k+1)} - 1 = 9(3^{2k} - 1) + 8$$

Now $3^{2k} - 1$ is divisible by 8 (induction hypothesis), and so is 8, and hence $9(3^{2k} - 1) + 8$ is also divisible by 8. So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

19. Let $P(n)$ denote the statement $n < 2^n$.

Step 1 $P(1)$ is true since $1 < 2^1$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} k+1 &< 2^k + 1 && \text{Induction hypothesis} \\ &< 2^k + 2^k && \text{Because } 1 < 2^k \\ &= 2 \cdot 2^k = 2^{k+1} \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

20. Let $P(n)$ denote the statement that $(n+1)^2 < 2n^2$ for all $n \geq 3$.

Step 1 $P(3)$ is true since $(3+1)^2 < 2 \cdot 3^2$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} [(k+1)+1]^2 &= (k+1)^2 + 2(k+1) + 1 \\ &< 2k^2 + 2(k+1) + 1 && \text{Induction hypothesis} \\ &< 2k^2 + 4k + 2 && \text{Because } 2k-1 > 0 \text{ for } k \geq 3 \\ &= 2(k+1)^2 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

21. Let $P(n)$ denote the statement $(1+x)^n \geq 1+nx$ for $x > -1$.

Step 1 $P(1)$ is true since $(1+x)^1 \geq 1+1 \cdot x$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} (1+x)^{k+1} &= (1+x)(1+x)^k \\ &\geq (1+x)(1+kx) && \text{Induction hypothesis} \\ &= 1 + (k+1)x + kx^2 \\ &\geq 1 + (k+1)x \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

22. Let $P(n)$ denote the statement that $100n \leq n^2$ for all $n \geq 100$.

Step 1 $P(100)$ is true since $100(100) \leq (100)^2$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 100(k+1) &= 100k + 100 \\ &\leq k^2 + 100 && \text{Induction hypothesis} \\ &\leq k^2 + 2k + 1 && \text{Because } 100 \leq 2k + 1 \text{ for } k \geq 100 \\ &= (k+1)^2 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

23. Let $P(n)$ denote the statement $a_n = 5 \cdot 3^{n-1}$.

Step 1 $P(1)$ is true since $a_1 = 5 \cdot 3^0 = 5$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} a_{k+1} &= 3 \cdot a_k && \text{Definition of } a_{k+1} \\ &= 3 \cdot 5 \cdot 3^{k-1} && \text{Induction hypothesis} \\ &= 5 \cdot 3^k \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

24. $a_n = 4$ for all n .

Let $P(n)$ denote the statement $a_n = 4$.

Step 1 $P(1)$ is true since $a_1 = 4$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} a_{k+1} &= 3a_k - 8 && \text{Definition of } a_k \\ &= 3 \cdot 4 - 8 && \text{Induction hypothesis} \\ &= 4 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

25. Let $P(n)$ denote the statement $x - y$ is a factor of $x^n - y^n$.

Step 1 $P(1)$ is true since $x - y$ is a factor of $x^1 - y^1$.

Step 2 Suppose $P(k)$ is true. Now

$$\begin{aligned} x^{k+1} - y^{k+1} &= x^{k+1} - x^k y + x^k y - y^{k+1} \\ &= x^k(x - y) + (x^k - y^k)y \end{aligned}$$

But $x^k(x - y)$ is clearly divisible by $x - y$ and $(x^k - y^k)y$ is divisible by $x - y$ (by the induction hypothesis), so their sum is divisible by $x - y$. So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

26. Let $P(n)$ denote the statement that $x + y$ is a factor of $x^{2n-1} + y^{2n-1}$.

Step 1 $P(1)$ is obviously true.

Step 2 Suppose $P(k)$ is true. Then

$$x^{2(k+1)-1} + y^{2(k+1)-1} = x^{2k-1}(x^2 - y^2) + (x^{2k-1} + y^{2k-1})y^2$$

The first term in this sum is obviously divisible by $x + y$ and the second term is divisible by $x + y$ by the induction hypothesis, so the sum is also divisible by $x + y$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

27. Let $P(n)$ denote the statement F_{3n} is even.

Step 1 $P(1)$ is true since $F_{3 \cdot 1} = 2$, which is even.

Step 2 Suppose $P(k)$ is true. Now, by the definition of the Fibonacci sequence

$$\begin{aligned} F_{3(k+1)} &= F_{3k+3} = F_{3k+2} + F_{3k+1} \\ &= F_{3k+1} + F_{3k} + F_{3k+1} \\ &= F_{3k} + 2 \cdot F_{3k+1} \end{aligned}$$

But F_{3k} is even (by the induction hypothesis) and $2 \cdot F_{3k+1}$ is clearly even, so $F_{3(k+1)}$ is even. So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

28. Let $P(n)$ denote the statement

$$F_1 + F_2 + \cdots + F_n = F_{n+2} - 1.$$

Step 1 $P(1)$ is true since $F_1 = 1$ and $F_{1+2} = 2$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} F_1 + F_2 + \cdots + F_k + F_{k+1} & \quad \text{Induction hypothesis} \\ &= (F_{k+2} - 1) + F_{k+1} \\ &= (F_{k+2} + F_{k+1}) - 1 = F_{k+3} - 1 \quad \text{Definition of the Fibonacci sequence} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

29. Let $P(n)$ denote the statement

$$F_1^2 + F_2^2 + \cdots + F_n^2 = F_n \cdot F_{n+1}.$$

Step 1 $P(1)$ is true since $F_1^2 = F_1 \cdot F_2$ (because $F_1 = F_2 = 1$).

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} F_1^2 + F_2^2 + \cdots + F_k^2 + F_{k+1}^2 & \\ &= F_k \cdot F_{k+1} + F_{k+1}^2 \quad \text{Induction hypothesis} \\ &= F_{k+1}(F_k + F_{k+1}) \quad \text{Definition of the Fibonacci sequence} \\ &= F_{k+1} \cdot F_{k+2} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

30. Let $P(n)$ denote the statement

$$F_1 + F_3 + \cdots + F_{2n-1} = F_{2n}$$

Step 1 $P(1)$ is true since $F_1 = F_{2 \cdot 1}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} F_1 + F_3 + \cdots + F_{2k-1} + F_{2k+1} &= F_{2k} + F_{2k+1} \quad \text{Induction hypothesis} \\ &= F_{2k+2} \quad \text{Definition of Fibonacci sequence} \\ &= F_{2(k+1)} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

31. Let $P(n)$ denote the statement $\begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}^n = \begin{bmatrix} F_{n+1} & F_n \\ F_n & F_{n-1} \end{bmatrix}$.

Step 1 $P(2)$ is true since $\begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}^2 = \begin{bmatrix} 2 & 1 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} F_3 & F_2 \\ F_2 & F_1 \end{bmatrix}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}^{k+1} &= \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}^k \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix} \\ &= \begin{bmatrix} F_{k+1} & F_k \\ F_k & F_{k-1} \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix} \quad \text{Induction hypothesis} \\ &= \begin{bmatrix} F_{k+1} + F_k & F_{k+1} \\ F_k + F_{k-1} & F_k \end{bmatrix} \\ &= \begin{bmatrix} F_{k+2} & F_{k+1} \\ F_{k+1} & F_k \end{bmatrix} \quad \text{Definition of the Fibonacci sequence} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all $n \geq 2$.

32. $a_n = \frac{F_n}{F_{n+1}}$ for all n .

Let $P(n)$ denote the statement $a_n = \frac{F_n}{F_{n+1}}$.

Step 1 $P(1)$ is true since $\frac{F_1}{F_{1+1}} = \frac{1}{1} = 1 = a_1$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} a_{k+1} &= \frac{1}{1 + a_k} \quad \text{Definition of } a_k \\ &= \frac{1}{1 + \frac{F_k}{F_{k+1}}} \quad \text{Induction hypothesis} \\ &= \frac{F_{k+1}}{F_{k+1} + F_k} \quad \text{Multiply numerator and denominator by } F_{k+1} \\ &= \frac{F_{k+1}}{F_{k+2}} \quad \text{Definition of Fibonacci sequence} \end{aligned}$$

So $P(k + 1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

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33. Let $P(n)$ denote the statement $F_n \geq n$.

Step 1 $P(5)$ is true since $F_5 \geq 5$ (because $F_5 = 5$).

Step 2 Suppose $P(k)$ is true. Now

$$\begin{aligned} F_{k+1} &= F_k + F_{k-1} && \text{Definition of the Fibonacci sequence} \\ &\geq k + F_{k-1} && \text{Induction hypothesis} \\ &\geq k + 1 && \text{Because } F_{k-1} \geq 1 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all $n \geq 5$.

34. $100n \leq n^3$ for $n \geq 10$.

Let $P(n)$ denote the statement that $100n \leq n^3$.

Step 1 $P(10)$ is true since $100(10) \leq 10^3$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 100(k+1) &= 100k + 100 \\ &\leq k^3 + 100 && \text{Induction hypothesis} \\ &\leq k^3 + 3k^2 + 3k + 1 && \text{Because } 100 \leq 3k^2 + 3k + 1 \\ & && \text{for } k \geq 10 \\ &= (k+1)^3 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all $n \geq 10$.

Section 11.6 ■ page 868

1. $x^6 + 6x^5y + 15x^4y^2 + 20x^3y^3 + 15x^2y^4 + 6xy^5 + y^6$

2. $16x^4 + 32x^3 + 24x^2 + 8x + 1$

3. $x^4 + 4x^2 + 6 + \frac{4}{x^2} + \frac{1}{x^4}$

4. $x^5 - 5x^4y + 10x^3y^2 - 10x^2y^3 + 5xy^4 - y^5$

5. $x^5 - 5x^4 + 10x^3 - 10x^2 + 5x - 1$

6. $a^3 + 6a^{5/2}b^{1/2} + 15a^2b + 20a^{3/2}b^{3/2} + 15ab^2 + 6a^{1/2}b^{5/2} + b^3$

7. $x^{10}y^5 - 5x^8y^4 + 10x^6y^3 - 10x^4y^2 + 5x^2y - 1$

8. $99 + 70\sqrt{2}$ 9. $8x^3 - 36x^2y + 54xy^2 - 27y^3$

10. $1 + 3x^3 + 3x^6 + x^9$

11. $\frac{1}{x^5} - \frac{5}{x^{7/2}} + \frac{10}{x^2} + \frac{10}{x^{1/2}} + 5x - x^{5/2}$

12. $32 + 40x + 20x^2 + 5x^3 + \frac{5}{8}x^4 + \frac{1}{32}x^5$

13. 15 14. 56 15. 4950 16. 252 17. 18 18. 100

19. 32 20. 0 21. $x^4 + 8x^3y + 24x^2y^2 + 32xy^3 + 16y^4$

22. $1 - 5x + 10x^2 - 10x^3 + 5x^4 - x^5$

23. $1 + \frac{6}{x} + \frac{15}{x^2} + \frac{20}{x^3} + \frac{15}{x^4} + \frac{6}{x^5} + \frac{1}{x^6}$

24. $16A^4 + 32A^3B^2 + 24A^2B^4 + 8AB^6 + B^8$

25. $x^{20} + 40x^{19}y + 760x^{18}y^2$

26. $x^{15} + 30x^{29/2} + 435x^{14} + 4060x^{27/2}$ 27. $25a^{26/3} + a^{25/3}$

28. $x^{40} + 40x^{38} + 780x^{36}$ 29. $48,620x^{18}$ 30. $4845a^{16}b^{16}$

31. $300a^2b^{23}$ 32. $-4060A^3B^{27}$ 33. $100y^{99}$ 34. $-25x^{47}$

35. $13,440x^4y^6$ 36. $3520\sqrt{2}y^3$ 37. $495a^8b^8$ 38. 17,920

39. $(x+y)^4$ 40. $[(x-1)+1]^5 = x^5$ 41. $(2a+b)^3$

42. $(x^2 + y)^4$ 43. $3x^2 + 3xh + h^2$

44. $4x^3 + 6x^2h + 4xh^2 + h^3$

Chapter 11 Review ■ page 870

1. $\frac{1}{2}, \frac{4}{3}, \frac{9}{4}, \frac{16}{5}, \frac{100}{11}$ 2. $-2, 2, -\frac{8}{3}, 4, \frac{512}{5}$ 3. $0, \frac{1}{4}, 0, \frac{1}{32}, \frac{1}{500}$

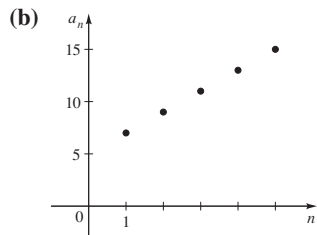
4. 1, 3, 6, 10; 55 5. 1, 3, 15, 105; 654,729,075

6. 1, 3, 6, 10; 55 7. 1, 4, 9, 16, 25, 36, 49

8. $1, \frac{1}{2}, \frac{1}{6}, \frac{1}{24}, \frac{1}{120}, \frac{1}{720}, \frac{1}{5040}$ 9. 1, 3, 5, 11, 21, 43, 85

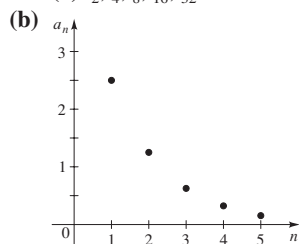
10. $3^{1/2}, 3^{3/4}, 3^{7/8}, 3^{15/16}, 3^{31/32}, 3^{63/64}, 3^{127/128}$

11. (a) 7, 9, 11, 13, 15



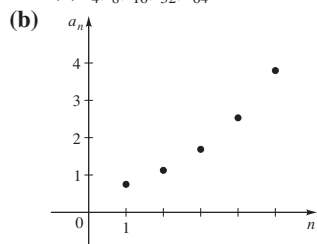
(c) Arithmetic, common difference 2

12. (a) $\frac{5}{2}, \frac{5}{4}, \frac{5}{8}, \frac{5}{16}, \frac{5}{32}$



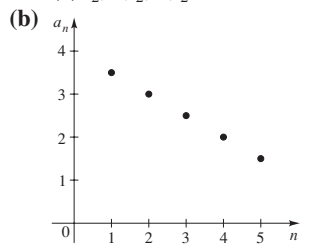
(c) Geometric, common ratio $\frac{1}{2}$

13. (a) $\frac{3}{4}, \frac{9}{8}, \frac{27}{16}, \frac{81}{32}, \frac{243}{64}$



(c) Geometric, common ratio $\frac{3}{2}$

14. (a) $\frac{7}{2}, 3, \frac{5}{2}, 2, \frac{3}{2}$



(c) Arithmetic, common difference 2

15. Arithmetic, 7 16. Neither 17. Arithmetic, $5\sqrt{2}$

18. Geometric, $4\sqrt{2}$ 19. Arithmetic, $t+1$

20. Geometric, $\frac{1}{t}$ 21. Geometric, $\frac{4}{27}$ 22. Geometric, $\frac{1}{a^3}$
 23. $2i$ 24. $a_n = 2(1+i)^{n-1}$ 25. 5
 26. $a_n = 1 + 5(n-1)$ 27. $\frac{81}{4}$ 28. $a_n = 6(\frac{5}{3})^{n-1}$
 29. (a) $A_n = 32,000(1.05)^{n-1}$
 (b) \$32,000, \$33,600, \$35,280, \$37,044, \$38,896.20,
 \$40,841.01, \$42,883.06, \$45,027.21
 30. (a) $A_n = 35,000 + 1200(n-1)$ (b) \$43,400
 31. 12,288 34. (a) Yes (b) Yes 35. (a) 9 (b) $\pm 6\sqrt{2}$
 36. (a) 7, 12 (b) $2^{2/3}17^{1/3}$, $2^{1/3}17^{2/3}$
 37. 126 38. $\frac{596}{105}$ 39. 384 40. $\frac{121}{3}$
 41. $0^2 + 1^2 + 2^2 + \cdots + 9^2$ 42. $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{99}$
 43. $\frac{3}{2^2} + \frac{3^2}{2^3} + \frac{3^3}{2^4} + \cdots + \frac{3^{50}}{2^{51}}$
 44. $1^2 \cdot 2^1 + 2^2 \cdot 2^2 + 3^2 \cdot 2^3 + 4^2 \cdot 2^4 + \cdots + 10^2 \cdot 2^{10}$
 45. $\sum_{k=1}^{33} 3k$ 46. $\sum_{k=1}^{100} k^2$ 47. $\sum_{k=1}^{100} k2^{k+2}$ 48. $\sum_{k=1}^{999} \frac{1}{k(k+1)}$
 49. Geometric; 4.68559 50. Arithmetic; 71.5
 51. Arithmetic; $5050\sqrt{5}$ 52. Arithmetic; 1650
 53. Geometric; 9831
 54. Geometric; $5467 + 1092\sqrt{5} \approx 7908.8$
 55. 13 56. 4 57. 65,534 58. \$30,324.28 59. \$2390.27
 60. (a) \$482.77 (b) \$608.56 61. $\frac{5}{7}$ 62. $\frac{1}{9}$
 63. $\frac{1}{2}(3 + \sqrt{3})$ 64. $\frac{a}{1-b^2}$

65. Let $P(n)$ denote the statement
 $1 + 4 + 7 + \cdots + (3n-2) = \frac{n(3n-1)}{2}$.

Step 1 $P(1)$ is true since $1 = \frac{1(3 \cdot 1 - 1)}{2}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & 1 + 4 + 7 + \cdots + (3k-2) + [3(k+1) - 2] \\ &= \frac{k(3k-1)}{2} + [3k+1] \quad \text{Induction hypothesis} \\ &= \frac{3k^2 - k + 6k + 2}{2} \\ &= \frac{(k+1)(3k+2)}{2} \\ &= \frac{(k+1)[3(k+1) - 1]}{2} \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

66. Let $P(n)$ denote the statement
 $\frac{1}{1 \cdot 3} + \frac{1}{3 \cdot 5} + \cdots + \frac{1}{(2n-1)(2n+1)} = \frac{n}{2n+1}$.

Step 1 $P(1)$ is true since $\frac{1}{1 \cdot 3} = \frac{1}{2 \cdot 1 + 1}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & \frac{1}{1 \cdot 3} + \frac{1}{3 \cdot 5} + \cdots + \frac{1}{(2k-1)(2k+1)} + \frac{1}{(2k+1)(2k+3)} \\ &= \frac{k}{2k+1} + \frac{1}{(2k+1)(2k+3)} \quad \text{Induction hypothesis} \\ &= \frac{2k^2 + 3k + 1}{(2k+1)(2k+3)} = \frac{k+1}{2k+3} \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

67. Let $P(n)$ denote the statement
 $(1 + \frac{1}{1})(1 + \frac{1}{2}) \cdots (1 + \frac{1}{n}) = n + 1$.

Step 1 $P(1)$ is true since $(1 + \frac{1}{1}) = 1 + 1$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} & \left(1 + \frac{1}{1}\right) \left(1 + \frac{1}{2}\right) \cdots \left(1 + \frac{1}{k}\right) \left(1 + \frac{1}{k+1}\right) \\ &= (k+1) \left(1 + \frac{1}{k+1}\right) \quad \text{Induction hypothesis} \\ &= (k+1) + 1 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

68. Let $P(n)$ denote the statement that $7^n - 1$ is divisible by 6.

Step 1 $P(1)$ is true since $7^1 - 1 = 6$.

Step 2 Suppose $P(k)$ is true. We have

$$7^{k+1} - 1 = 7(7^k - 1) + 6$$

Now $7^k - 1$ is divisible by 6 (induction hypothesis), and so is 6, and hence $7(7^k - 1) + 6$ is also divisible by 6. So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

69. Let $P(n)$ denote the statement $a_n = 2 \cdot 3^n - 2$.

Step 1 $P(1)$ is true since $a_1 = 2 \cdot 3^1 - 2 = 4$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} a_{k+1} &= 3a_k + 4 \\ &= 3(2 \cdot 3^k - 2) + 4 \quad \text{Induction hypothesis} \\ &= 2 \cdot 3^{k+1} - 2 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

70. Let $P(n)$ denote the statement that F_{4n} is divisible by 3.

Step 1 $P(1)$ is true since $F_4 = 3$.

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Step 2 Suppose $P(k)$ is true. Then F_{4k} is divisible by 3. Using the definition of the Fibonacci sequence repeatedly, we get

$$\begin{aligned} F_{4(k+1)} &= F_{4k+4} = F_{4k+3} + F_{4k+2} \\ &= (F_{4k+2} + F_{4k+1}) + (F_{4k+1} + F_{4k}) \\ &= [(F_{4k+1} + F_{4k}) + F_{4k+1}] + (F_{4k+1} + F_{4k}) \\ &= 3F_{4k+1} + 2F_{4k} \end{aligned}$$

The first term is clearly divisible by 3, and so is the second by the induction hypothesis. So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

71. Let $P(n)$ denote the statement $n! > 2^n$ for $n \geq 4$.

Step 1 $P(4)$ is true since $4! > 2^4$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} (k+1)! &= k!(k+1) \\ &> 2^k(k+1) && \text{Induction hypothesis} \\ &> 2^{k+1} && \text{Because } k+1 > 2 \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all $n \geq 4$.

72. 100 **73.** 255 **74.** 32 **75.** 12,870

76. $1 - 6x^2 + 15x^4 - 20x^6 + 15x^8 - 6x^{10} + x^{12}$

77. $16x^4 + 32x^3y + 24x^2y^2 + 8xy^3 + y^4$ **78.** $1540a^3b^{19}$

79. $b^{-40/3} + 20b^{-37/3} + 190b^{-34/3}$ **80.** $17,010A^6B^4$

Chapter 11 Test ■ page 873

1. 0, 3, 8, 15; 99 **2.** -1 **3.** (a) 3

(b) $a_n = 2 + (n-1)3$ (c) 104

4. (a) $\frac{1}{4}$ (b) $a_n = 12\left(\frac{1}{4}\right)^{n-1}$ (c) $3/4^8$

5. (a) $\frac{1}{5}, \frac{1}{25}$ (b) $\frac{5^8 - 1}{12,500}$

6. (a) $-\frac{8}{9}, -78$ (b) 60

8. (a) $(1-1^2) + (1-2^2) + (1-3^2) + (1-4^2) + (1-5^2) = -50$

(b) $(-1)^{3 \cdot 2^1} + (-1)^{4 \cdot 2^2} + (-1)^{5 \cdot 2^3} + (-1)^{6 \cdot 2^4} = 10$

9. (a) $\frac{58,025}{59,049}$ (b) $2 + \sqrt{2}$

10. Let $P(n)$ denote the statement

$$1^2 + 2^2 + \cdots + n^2 = \frac{n(n+1)(2n+1)}{6}.$$

Step 1 $P(1)$ is true since $1^2 = \frac{1(1+1)(2 \cdot 1 + 1)}{6}$.

Step 2 Suppose $P(k)$ is true. Then

$$\begin{aligned} 1^2 + 2^2 + \cdots + k^2 + (k+1)^2 &= \frac{k(k+1)(2k+1)}{6} + (k+1)^2 && \text{Induction hypothesis} \\ &= \frac{k(k+1)(2k+1) + 6(k+1)^2}{6} \\ &= \frac{(k+1)[k(2k+1) + 6(k+1)]}{6} \\ &= \frac{(k+1)(2k^2 + 7k + 6)}{6} \\ &= \frac{(k+1)[(k+1) + 1][2(k+1) + 1]}{6} \end{aligned}$$

So $P(k+1)$ follows from $P(k)$. Thus, by the Principle of Mathematical Induction, $P(n)$ holds for all n .

11. $32x^5 + 80x^4y^2 + 80x^3y^4 + 40x^2y^6 + 10xy^8 + y^{10}$

12. $\binom{10}{3}(3x)^3(-2)^7 = -414,720x^3$

13. (a) $a_n = (0.85)(1.24)^n$ (b) 3.09 lb (c) Geometric

Focus on Modeling ■ page 877

1. (a) $A_n = 1.0001A_{n-1}, A_0 = 275,000$ (b) $A_0 = 275,000,$

$A_1 = 275,027.50, A_2 = 275,055.00, A_3 = 275,082.51,$

$A_4 = 275,110.02, A_5 = 275,137.53, A_6 = 275,165.04,$

$A_7 = 275,192.56$ (c) $A_n = 1.0001^n(275,000)$

2. (a) $T_n = T_{n-1} + 1.5, T_1 = 5$ (b) $T_1 = 5, T_2 = 6.5,$

$T_3 = 8, T_4 = 9.5, T_5 = 11, T_6 = 12.5$

(c) $T_n = 5 + 1.5(n-1)$, arithmetic (d) On the 41st day

(e) 802.5 min = 13 h 22.5 min

3. (a) $A_n = 1.0025A_{n-1} + 100, A_0 = 100$ (b) $A_0 = 100,$

$A_1 = 200.25, A_2 = 300.75, A_3 = 401.50, A_4 = 502.51$

(c) $A_n = 100[(1.0025^{n+1} - 1)/0.0025]$ (d) \$603.76

4. In each part $P_0 = 4000$. (a) $P_n = 1.2P_{n-1}, P_5 = 9953$

(b) $P_n = 1.2P_{n-1} - 600, P_5 = 5488$ (c) $P_n = 1.2P_{n-1} + 250,$

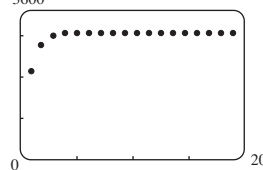
$P_5 = 11,814$ (d) $P_n = 1.2P_{n-1} - 0.1P_{n-1} + 300, P_5 = 8274$

5. (b) $A_0 = 2400, A_1 = 3120, A_2 = 3336, A_3 = 3400.8,$

$A_4 = 3420.2$ (c) $A_n = 3428.6(1 - 0.3^{n+1})$

(d) 3427.8 tons, 3428.6 tons

(e) 3600



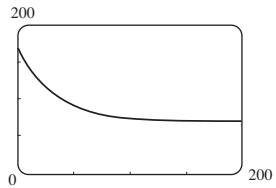
6. (a) $U_n = U_{n-1} + 0.05U_{n-1} + 0.1(U_{n-1} + 0.05U_{n-1}) =$

$1.155U_{n-1}, U_0 = 5000$ (b) $U_0 = 5000, U_1 = 5775,$

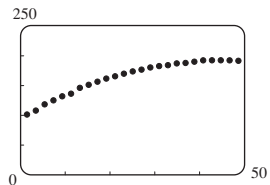
$U_2 = 6670.13, U_3 = 7703.99, U_4 = 8898.11$

(c) $U_n = 5000(1.155)^n$ (d) \$21,124.67

7. (b) In the 35th year
 8. (a) $T_n = T_{n-1} - 0.03(T_{n-1} - 70)$, $T_0 = 170$
 (b) $T_0 = 170$, $T_{10} = 143.7$, $T_{20} = 124.4$, $T_{30} = 110.1$,
 $T_{40} = 99.6$, $T_{50} = 91.8$, $T_{60} = 86.1$
 (c) It approaches 70°F .



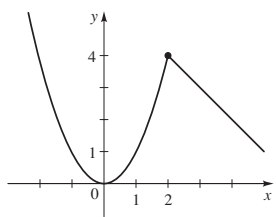
9. (a) $R_1 = 104$, $R_2 = 108$, $R_3 = 112$, $R_4 = 116$, $R_5 = 120$,
 $R_6 = 124$, $R_7 = 127$ (b) It approaches 200.



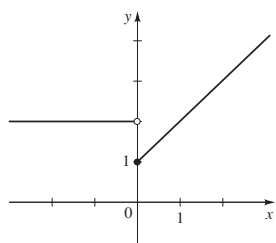
Chapter 12

Section 12.1 ■ page 889

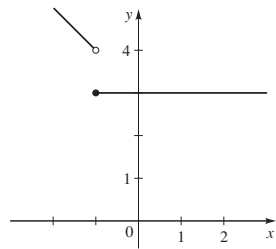
1. $\frac{1}{4}$ 2. 0.2 3. $\frac{1}{3}$ 4. 1 5. 1 6. 0 7. -1 8. 1.5
 9. 0.51 10. 0.1667 11. $\frac{1}{2}$ 12. 0.6667 13. (a) 2 (b) 3
 (c) Does not exist (d) 4 (e) Not defined 14. (a) 3
 (b) 4 (c) 2 (d) Does not exist (e) 3
 15. (a) -1 (b) -2 (c) Does not exist (d) 2 (e) 0
 (f) Does not exist (g) 1 (h) 3 16. (a) 2 (b) -1 (c) 1
 (d) 1 (e) 2 (f) Does not exist 17. -8 18. Does not exist
 19. Does not exist 20. -0.22 21. Does not exist
 22. Does not exist
 23. (a) 4 (b) 4 (c) 4



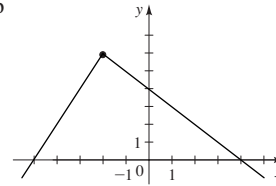
24. (a) 2 (b) 1 (c) Does not exist



25. (a) 4 (b) 3 (c) Does not exist

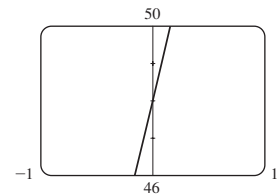
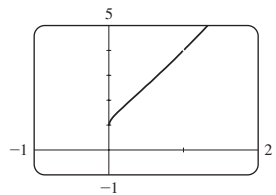


26. (a) 6 (b) 6 (c) 6

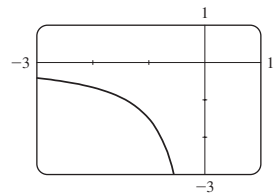


Section 12.2 ■ page 897

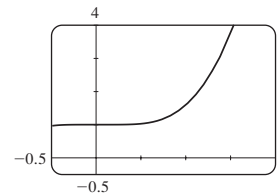
1. (a) 5 (b) 9 (c) 2 (d) $-\frac{1}{3}$ (e) $-\frac{3}{8}$ (f) 0 (g) Does not exist (h) $-\frac{6}{11}$ 2. (a) 2 (b) Does not exist (c) 0
 (d) Does not exist (e) 16 (f) 2 3. 75 4. -174 5. $\frac{1}{2}$
 6. $\frac{4}{9}$ 7. -3 8. 4 9. 5 10. $\frac{3}{5}$ 11. 2 12. $\frac{3}{2}$ 13. $\frac{6}{5}$
 14. $\frac{1}{2}$ 15. 12 16. 32 17. $\frac{1}{6}$ 18. $\frac{1}{9}$ 19. $-\frac{1}{16}$ 20. 1
 21. 4 22. 48



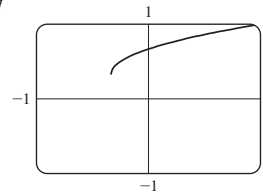
23. $-\frac{3}{2}$



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



25. (a) 0.667



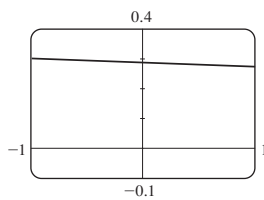
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(b) 0.667

x	$f(x)$	x	$f(x)$
0.1	0.71339	-0.1	0.61222
0.01	0.67163	-0.01	0.66163
0.001	0.66717	-0.001	0.66617
0.0001	0.66672	-0.0001	0.66662

(c) $\frac{2}{3}$

26. (a) 0.29



(b) 0.2887

x	$f(x)$	x	$f(x)$
-0.1	0.29112	0.1	0.28631
-0.01	0.28892	0.01	0.28843
-0.001	0.28870	0.001	0.28865
-0.0001	0.28868	0.0001	0.28867

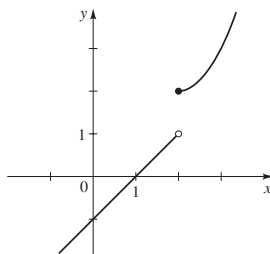
(c) $1/(2\sqrt{3})$

27. 0 28. Does not exist 29. Does not exist

30. Does not exist 31. Does not exist 32. 0

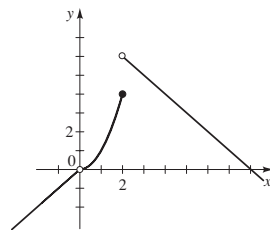
33. (a) 1, 2 (b) Does not exist

(c)



34. (a) 0, 0, 1, 4, 6, does not exist

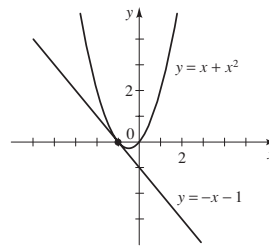
(b)



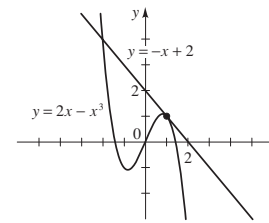
Section 12.3 ■ page 906

1. 3 2. -2 3. -11 4. -4 5. 24 6. $-\frac{2}{3}$

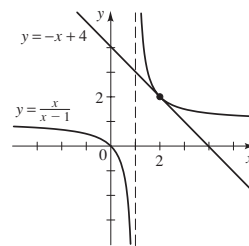
7. $y = -x - 1$



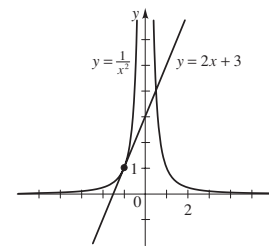
8. $y = -x + 2$



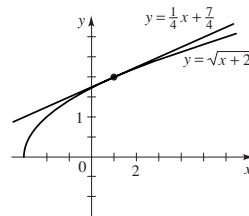
9. $y = -x + 4$



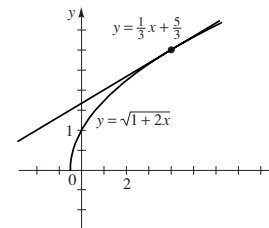
10. $y = 2x + 3$



11. $y = \frac{1}{4}x + \frac{7}{4}$



12. $y = \frac{1}{3}x + \frac{5}{3}$



13. $f'(2) = -12$ 14. $f'(-1) = -5$ 15. $g'(1) = 4$

16. $g'(1) = 7$ 17. $F'(4) = -\frac{1}{16}$ 18. $G'(4) = \frac{1}{2}$

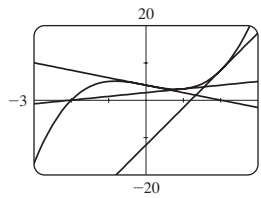
19. $f'(a) = 2a + 2$ 20. $f'(a) = \frac{2}{a^3}$

21. $f'(a) = \frac{1}{(a+1)^2}$ 22. $f'(a) = 1/(2\sqrt{a-2})$

23. (a) $f'(a) = 3a^2 - 2$

(b) $y = -2x + 4, y = x + 2, y = 10x - 12$

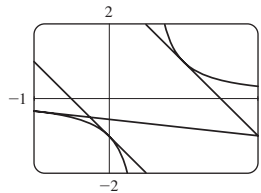
(c)



24. (a) $g'(a) = \frac{-2}{(2a-1)^2}$ (b) $y = -\frac{2}{9}x - \frac{5}{9}$

$y = -2x - 1, y = -2x + 3$

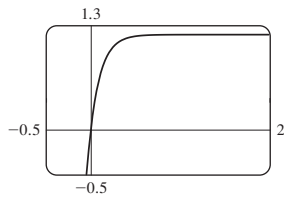
(c)



25. -24 ft/s 26. (a) 56.34 m/s (b) $58 - 1.66a$ m/s
 (c) 69.88 s (d) -58 m/s 27. $12a^2 + 6$ m/s, 18 m/s,
 54 m/s, 114 m/s 28. 16π ft/s 29. $0.75^\circ/\text{min}$
 30. (a) 71 heartbeats/min, 66 heartbeats/min
 (b) 68.5 heartbeats/min 31. (a) -38.3 gal/min,
 -27.8 gal/min (b) -33.3 gal/min 32. 16 million/yr

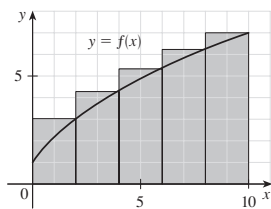
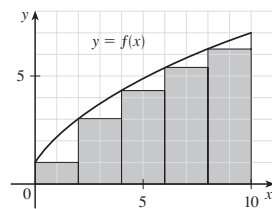
Section 12.4 ■ page 915

1. (a) $-1, 2$ (b) $y = -1, y = 2$ 2. (a) $3, -2$ (b) $y = 3,$
 $y = -2$ 3. 0 4. 0 5. $\frac{2}{5}$ 6. $-\frac{3}{4}$ 7. $\frac{4}{3}$ 8. 0 9. 2 10. 4
 11. Does not exist 12. -2 13. 7 14. Does not exist
 15. $-\frac{1}{4}$ 16. 0.1667 17. 0 18. 403.4288 19. 0 20. 5
 21. Divergent 22. 0 23. 0 24. 0 25. Divergent
 26. Divergent 27. $\frac{3}{2}$ 28. 15 29. 8 30. 3
 31. (b) 30 g/L
 32. (a) 1.2 (b) 0.56 s



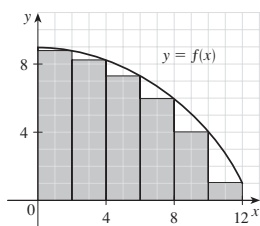
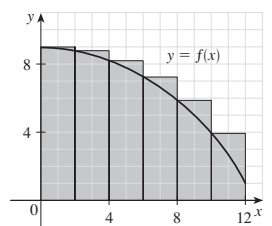
Section 12.5 ■ page 924

1. (a) $40, 52$



- (b) $43.2, 49.2$

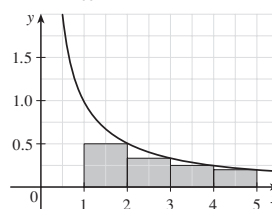
2. (a) $86.6, 70.6$



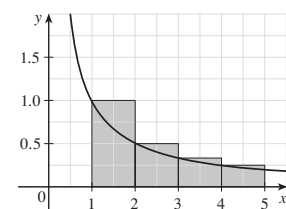
- (b) Overestimate (c) Underestimate

3. 5.25 4. $\frac{29}{4}$ 5. $\frac{223}{35}$ 6. 15.1875

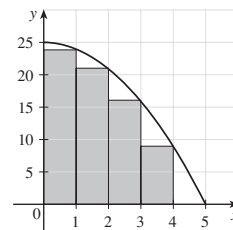
7. (a) $\frac{77}{60}$, underestimate



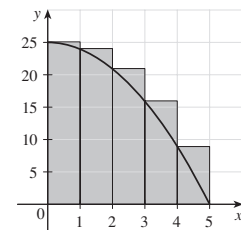
- (b) $\frac{25}{12}$, overestimate



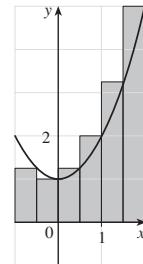
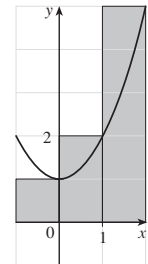
8. (a) 70 , underestimate



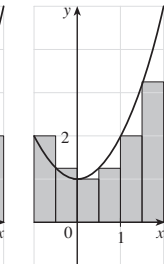
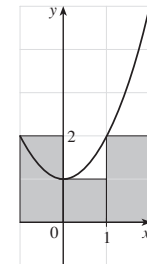
- (b) 95 , overestimate



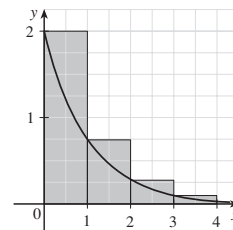
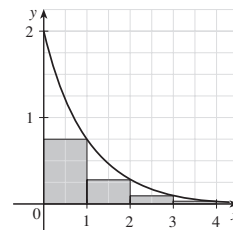
9. (a) $8, 6.875$



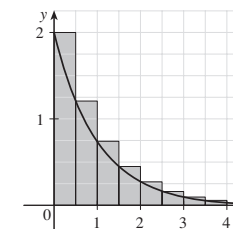
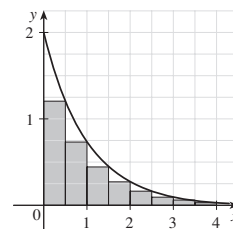
- (b) $5, 5.375$



10. (a) $0.5712, 1.5529$



- (b) $0.75655, 1.25655$



11. 37.5 12. 10 13. 8 14. $\frac{5}{6}$ 15. 166.25 16. 609
 17. 133.5 18. $\frac{22}{3}$

Chapter 12 Review ■ page 925

1. 1 2. 0.5 3. 0.69 4. 2 5. Does not exist 6. -1
 7. (a) Does not exist (b) 2.4 (c) 2.4 (d) 2.4 (e) 0.5
 (f) 1 (g) 2 (h) 0 8. (a) 2 (b) 1 (c) Does not exist
 (d) 4 (e) 4 (f) 4 (g) 0 (h) 25 9. -3 10. 4 11. 7
 12. $\frac{4}{3}$ 13. 2 14. $\frac{1}{6}$ 15. -1 16. $-\frac{1}{2}$ 17. 2 18. 0
 19. Does not exist 20. Does not exist
 21. $f'(4) = 3$ 22. $g'(-1) = -4$ 23. $f'(16) = \frac{1}{8}$
 24. $f'(1) = \frac{1}{4}$ 25. (a) $f'(a) = -2$ (b) $-2, -2$

A132 Answers to Exercises and Chapter Tests

26. (a) $f'(a) = 2a - 3$ (b) 1, -7

27. (a) $f'(a) = 1/(2\sqrt{a+6})$ (b) $1/(4\sqrt{2}), 1/4$

28. (a) $f'(a) = -\frac{4}{a^2}$ (b) -1, -1 29. $y = 2x + 1$

30. $y = \frac{1}{2}x + \frac{1}{2}$ 31. $y = 2x$ 32. $y = 4x - 7$

33. $y = -\frac{1}{4}x + 1$ 34. $y = \frac{1}{4}x + \frac{5}{4}$ 35. (a) -64 ft/s

(b) $-32a$ ft/s (c) $\sqrt{40} \approx 6.32$ s (d) -202.4 ft/s

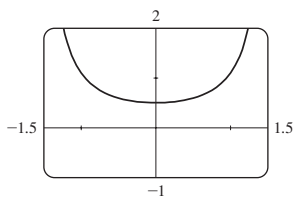
36. (a) $P = 100/T$ (b) $-\frac{1}{900}$ 37. $\frac{1}{5}$ 38. 1 39. $\frac{1}{2}$

40. Divergent 41. Divergent 42. 0 43. 3.83 44. 7.25

45. 10 46. 12 47. $\frac{5}{6}$ 48. 3.75

Chapter 12 Test ■ page 928

1. (a) $\frac{1}{2}$ (b)



2. (a) 1 (b) 1 (c) 1 (d) 0 (e) 0 (f) 0 (g) 4 (h) 2

(i) Does not exist 3. (a) 6 (b) -2 (c) Does not exist

(d) Does not exist (e) $\frac{1}{4}$ (f) 2 4. (a) $f'(x) = 2x - 2$

(b) -4, 0, 2 5. $y = \frac{1}{6}x + \frac{3}{2}$ 6. (a) 0 (b) Does not exist

7. (a) $\frac{89}{25}$ (b) $\frac{11}{3}$

Focus on Modeling ■ page 931

1. $57,333\frac{1}{3}$ ft-lb 2. 40 ft-lb 3. (b) Area under the graph of $p(x) = 375x$ between $x = 0$ and $x = 4$ (c) 3000 lb

(d) 1500 lb 4. (b) 90.625 ft 5. (a) 1625.28 heating-degree hours (b) 70°F (c) 1488 heating-degree hours (d) 75°F

(e) The day in part (a)