Some Solutions to Chapter 1.

Exercise 1.1

1. $\angle DEB$ and $\angle BEA$; $\angle EAD$ and $\angle DAB$
3. (a) 60° (b) 30° (c) 45° (d) 72° (e) 1°
5. 128° 7. 64° 9. $x = 20$
11. $x = 4$
13. $\angle 1 = 145°, \angle 2 = 35°, \angle 3 = 145°$
15. $\angle 1 = 65°, \angle 2 = 115°, \angle 3 = 65°$
17. $\angle 1 = \angle 3 = \angle 6 = \angle 8 = 55°$; $\angle 2 = \angle 5 = \angle 7 = 125°$
19. $x = 56$
21. $\angle 1 = \angle 4 = \angle 5 = \angle 7 = \angle 9 = \angle 11 = \angle 14 = \angle 16 = 140°$; $\angle 3 = \angle 6 = \angle 8 = \angle 10 = \angle 12 = \angle 13 = \angle 15 = 40°$
23. $\angle 1 = 50°; \angle 2 = 130°; \angle 3 = 50°; \angle 4 = 130°$

Exercises 1.2

1. 123° 3. 70°, 70° 5. $x = 28$
7. $x = 28$ 9. $x = 67$ 11. $x = 26$
13. $|\overline{AB}| = 5$ 15. $|\overline{AC}| = \sqrt{65}$
17. $|\overline{AC}| = |\overline{BC}| = 4\sqrt{2}$
19. $|\overline{AC}| = 4\sqrt{5}$
21. $20\sqrt{2} \approx 28.28$ feet
23. 240.8 miles
25. 113.2 nautical miles
27. No 29. $x = 27$ 31. $x = 115$
33. $x = 70$ 35. $x = 40$

Exercises 1.3

1. SSS 3. ASA 5. ASA 7. SAS
9. SAS 11. SAS 13. ASA

Exercises 1.4

1. The corresponding pairs of angles are A and D, B and E, C and F
3. The corresponding pairs of angles are A and EDB, ACB and DEB, ABC and DBE
5. The corresponding pairs of angles are A and D, B and E, C and F
7. $|\overline{DE}| = 24, |\overline{EF}| = 12$
9. $|\overline{DE}| = 7.5, |\overline{DF}| = 12.5$
11. $|\overline{AC}| = 20$ 13. $|\overline{EA}| = 10.8$
15. $|\overline{DE}| = 12$
17. $|\overline{AB}| = \sqrt{61}, |\overline{CD}| = 8\frac{1}{3}, |\overline{DE}| = \frac{5\sqrt{61}}{3}$
19. 27 ft 21. 10.2 cm 23. 2.9 ft
25. 0.3 cm; 0.1 cm
27. $|\overline{AC}| = 6, |\overline{BC}| = 6\sqrt{2}$
29. $|\overline{AB}| = 12\sqrt{3}, |\overline{BC}| = 24$
31. $|\overline{AB}| = |\overline{BC}| = \frac{20}{\sqrt{2}} = 10\sqrt{2}$
33. $|\overline{AB}| = 4\sqrt{3}; |\overline{BC}| = 8\sqrt{3}$

Exercises 1.5

1. 80°
3. $B = 120°, C = 60°, D = 120°$
5. $x = 5$ 7. $x = 18$
9. $\sqrt{89}$ cm 11. $4\sqrt{2}$ in.
13. $\frac{5\sqrt{2}}{2}$ cm 21. $\sqrt{117} = 3\sqrt{13}$
23. $x = 5$ 25. $x = \sqrt{89}$
27. $x = \sqrt{85}$ 29. $x = \sqrt{37}$

Exercises 1.6

1. $P = 26$ ft, $A = 40$ sq ft
3. $P = 36$ in., $A = 72$ sq in.
5. $P = 12$ in., $A = 9$ sq in.
7. $A = 48$ 9. $A = 60$
11. $A = 24$ 13. $A = 24$
15. $A = 12$ 17. $A = 51$
19. $P = 56, A = 180$
21. $P = 13 + \sqrt{89}, A = 20$
23. $P = 16 + 4\sqrt{2}, A = 14\sqrt{2}$
25. $P = 16 + 8\sqrt{5}$ cm, $A = 32\sqrt{5}$ sq cm
27. $P = 20\sqrt{2}$ mm, $A = 50$ sq mm
29. $P = 22, A = 26$
31. $P = 56, A = 108$
33. $A = 54\sqrt{2} - 18$ 35. $A = 37$
37. $A = 132$ 39. $A = 30$
41. $P = 147$ in.; $A = 945$ sq in.
43. $P = 128$ in.; $A = 5120$ sq in.
45. 1050 sq ft

Exercises 1.7

1. 35° 3. 130° 5. 6π in.
7. 8π ft 9. $\frac{3\pi}{2}$ in.
11. $P = \frac{13\pi}{6} + 12; A = \frac{13\pi}{2}$
13. $P = \frac{5\pi}{18} + 10; A = \frac{25}{36}\pi$
15. 9π sq in. 17. 36π sq in.
19. $P = 20 + 10\pi$ in., $A = 50\pi$ sq in.
21. $\frac{50\pi}{9}$ sq in.
23. $P = 22 + 3\pi, A = 48 + \frac{9\pi}{2}$
25. $64 - 16\pi$ cm 27. 80π
29. $14 + 5\pi$
31. $P = 70 + 5\pi$ cm; $A = 300 + 12.5\pi$ sq cm
33. One 12-in. pie; they are both the same value.

Exercises 1.8

1. $A = 396$ cm^2; $V = 504$ cm^3
3. $A = 40\pi$ ft^2; $V = 32\pi$ ft^3
5. $A = 24\pi$ m^2; $V = 12\pi$ m^3
7. $A = 275.6\pi$ ft^2; $V = 762.4\pi$ ft^3
9. $A = 113.1$ ft^2; $V = 113.1$ ft^3
11. $A = 226.2$ cm^2; $V = 251.3$ cm^3
13. $A = 134.6$ m^2; $V = 64.8$ m^3
15. $A = 502.7$ ft^2; $V = 599.5$ ft^3
17. $A = 4{,}712.4$ mm^2; $V = 29{,}452.4$ mm^3

Chapter 1 - Review

1. $\angle 1 = \angle 4 = 40°$;
   $\angle 2 = \angle 3 = 50°$
2. $x = 20, y = 110$ 3. $x = 65$
4. $x = 93$ 5. $x = 40$ 6. $x = 80$
7. $x = 115$ 8. $x = 20$
9. $|\overline{AC}| = 12$
10. $|\overline{AC}| = |\overline{BC}| = \frac{10}{\sqrt{2}} = 5\sqrt{2}$
11. $|\overline{AB}| = 5, |\overline{BD}| = 8, |\overline{BE}| = 10$
12. $|\overline{AB}| = 7.5, |\overline{EC}| = 6$
13. $x = 36$ 14. $x = 8, y = 4\sqrt{3}$
15. $a = 8, b = 8\sqrt{2}$
16. $a = \frac{10}{\sqrt{3}} = \frac{10\sqrt{3}}{3}, b = \frac{20}{\sqrt{3}} = \frac{20\sqrt{3}}{3}$
17. $x = 5$ 18. $x = 13$
19. $P = 24\sqrt{2}$ in.; $A = 72$ sq in.
20. $P = 28$ cm; $A = 48$ sq cm
21. $P = 14 + 2\sqrt{14}$ cm;
    $A = 5\sqrt{14}$ sq cm
22. $P = 30$ in.; $A = 36$ sq in.
23. $P = 32$; $A = 50$
24. $P = 56$; $A = 84$
25. $P = 44$; $A = 104$
26. $P = 20 + 10\sqrt{2}$; $A = 50$
27. $P = 36$; $A = 36\sqrt{3}$
28. 102 29. 160 30. 345 31. 132
32. (a) 40 (b) 30 (c) trapezoid
    (d) 110
33. (a) 15 (b) 49 (c) 72 (d) 56
34. (a) 22.5 (b) 24.5 (c) 24
    (d) 150 (e) 79
35. (a) 24 (b) 67.5 (c) 127.5
    (d) 300 (e) 81
36. (a) 64 (b) 48 (c) 112 (d) 96
37. (a) 48 (b) 108 (c) 12 (d) 120
38. $C = 20\pi$ in.; $A = 100\pi$ sq in.
39. $C = 32\pi$ in.; $A = 256\pi$ sq in.
40. 6π 41. 48π 42. $36 + 6\pi$
43. $16\pi - 32$ 44. $64 - 16\pi$
45. $68 + 12\pi$
46. $P = 60 + 10\pi$; $A = 400 - 50\pi$
47. $144 - 36\pi$ 48. $216 + 8\pi$
49. 10π 50. $216 + 18\pi$
51. $S = 158$ cm^2; $V = 120$ cm^3
52. $S = 256\pi$ in.^{2}; $V = \frac{2048}{3}\pi$ in.^{3}
53. $S = 78\pi$ ft^2; $V = 90\pi$ ft^3
54. $S = 24\pi$ m^2; $V = 12\pi$ m^3

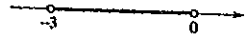
Some Solutions to Chapter 2

Chapter 2

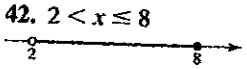
Section 2.1 ■ page 10

1. (a) 50 (b) 0, −10, 50 (c) 0, −10, 50, $\frac{22}{7}$, 0.538, $1.2\overline{3}$, $-\frac{1}{3}$ (d) $\sqrt{7}$, $\sqrt[3]{2}$ 2. (a) 11, $\sqrt{16}$ (b) −11, 11, $\sqrt{16}$ (c) 1.001, $0.3\overline{3}$, −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) ∅
39. (a) $\{x \mid x \leq 5\}$ (b) $\{x \mid -1 < x < 4\}$
40. (a) $\{x \mid -1 < x \leq 5\}$ (b) $\{x \mid -2 \leq x < 4\}$

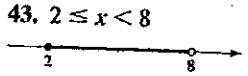
41. $-3 < x < 0$



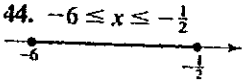
42. $2 < x \leq 8$



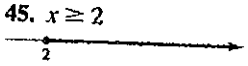
43. $2 \leq x < 8$



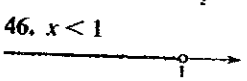
44. $-6 \leq x \leq -\frac{1}{2}$



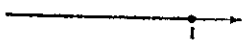
45. $x \geq 2$



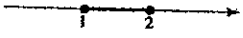
46. $x < 1$



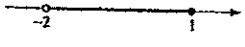
47. $(-\infty, 1]$



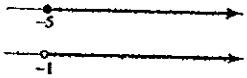
48. $[1, 2]$



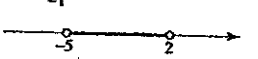
49. $(-2, 1]$



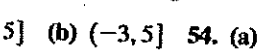
50. $[-5, \infty)$



51. $(-1, \infty)$



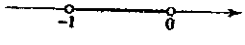
52. $(-5, 2)$



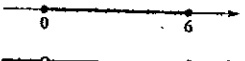
53. (a) $[-3, 5]$ (b) $(-3, 5]$ 54. (a) $[0, 2)$ (b) $(-2, 0]$

55.

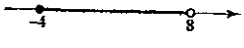
56.



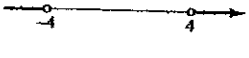
57.



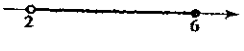
58.



59.



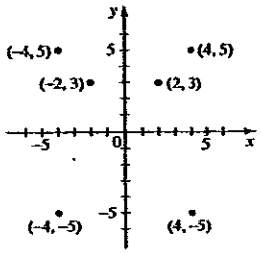
60.



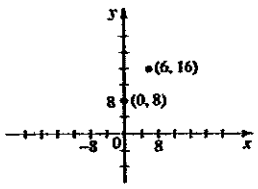
61. (a) 100 (b) 73 62. (a) $5 - \sqrt{5}$ (b) $10 - \pi$
63. (a) 2 (b) −1 64. (a) 10 (b) −1 65. (a) 12
(b) 5 66. (a) $\frac{1}{4}$ (b) 1 67. 5 68. 4 69. (a) 15 (b) 24
(c) $\frac{67}{40}$ 70. (a) $\frac{18}{35}$ (b) 19 (c) 0.8 71. (a) $\frac{7}{9}$ (b) $\frac{13}{45}$
(c) $\frac{19}{33}$ 72. (a) $\frac{518}{99}$ (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 2.2 ■ page 97

1.

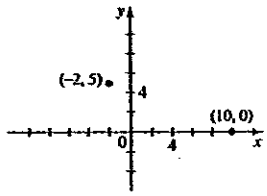


2. $A(5, 1)$, $B(1, 2)$, $C(-2, 6)$, $D(-6, 2)$, $E(-4, -1)$, $F(-2, 0)$, $G(-1, -3)$, $H(2, -2)$ 3. (a) $\sqrt{13}$ (b) $\left(\frac{3}{2}, 1\right)$ 4. (a) 5
(b) $\left(0, \frac{1}{2}\right)$ 5. (a) 10 (b) (1, 0) 6. (a) $2\sqrt{10}$ (b) (1, −2)
7. (a)



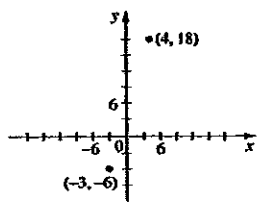
(b) 10 (c) (3, 12)

8. (a)



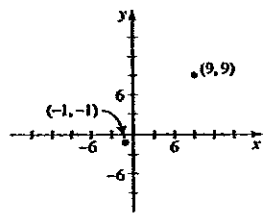
(b) 13 (c) $\left(4, \frac{5}{2}\right)$

9. (a)



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

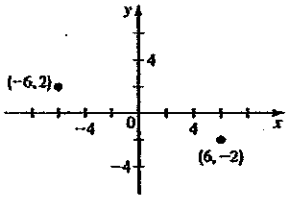
10. (a)



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

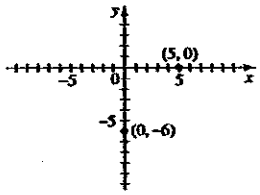
More Solutions to 2.8

11. (a)



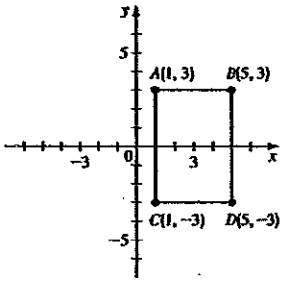
(b) $4\sqrt{10}$ (c) (0, 0)

12. (a)

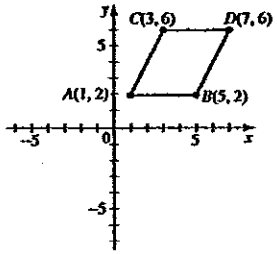


(b) $\sqrt{61}$ (c) $\left(\frac{5}{2}, -3\right)$

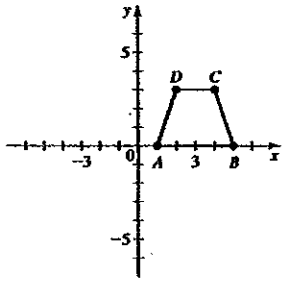
13. 24



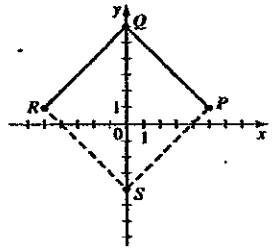
14. 16



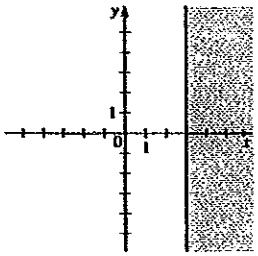
15. Trapezoid, area = 9



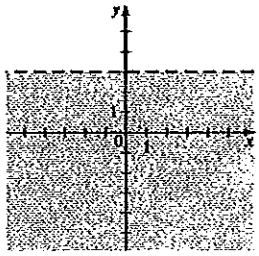
16. 50



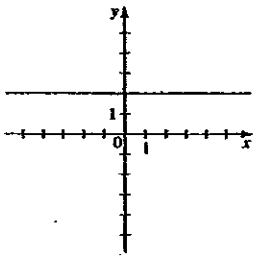
17.



18.



19.



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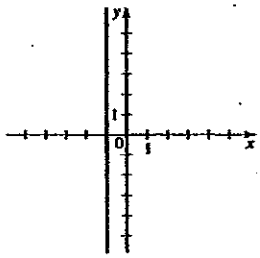

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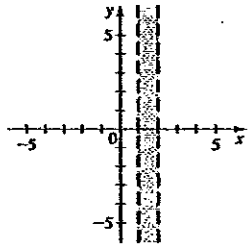

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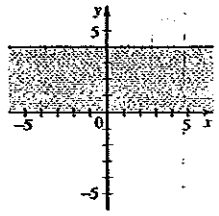

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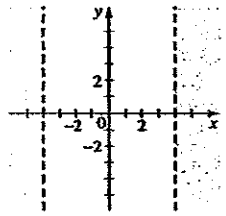
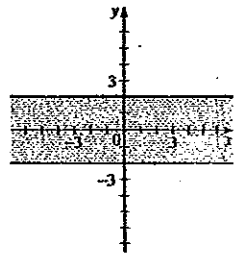
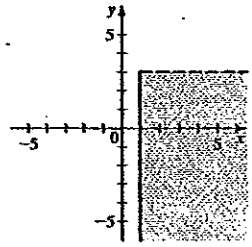


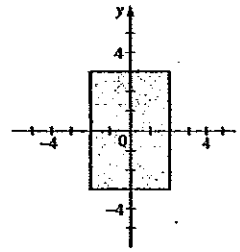
24.



25.



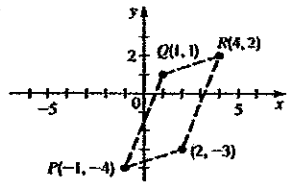
26.



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

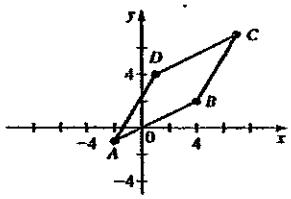
33. (b) 10 **37.** $(0, -4)$ **38.** $\sqrt{37}, \frac{\sqrt{109}}{2}, \frac{\sqrt{145}}{2}$

39. $(2, -3)$



40. (10, 13)

41. (a)

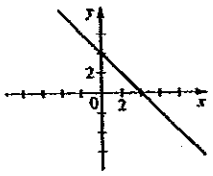


(b) $\left(\frac{5}{2}, 3\right), \left(\frac{3}{2}, 3\right)$

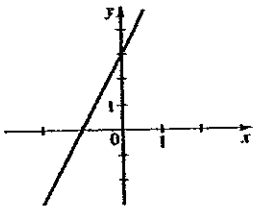
43. No, yes, yes **44.** No, yes, yes **45.** Yes, no, yes
46. Yes, yes, yes **47.** x-intercepts 0, 4; y-intercept 0
48. x-intercepts -3, 3; y-intercepts -2, 2
49. x-intercepts -2, 2; y-intercepts -4, 4
50. x-intercepts -8, 8; y-intercept 4

More Solutions to 2.8

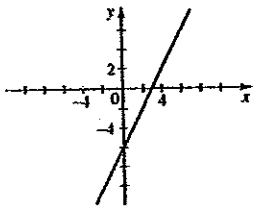
51. x-intercept 4,
y-intercept 4,
no symmetry



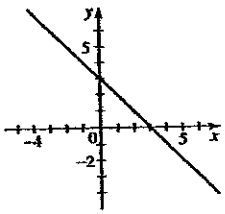
52. x-intercept -1,
y-intercept 3,
no symmetry



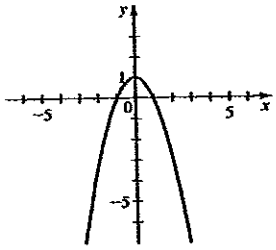
53. x-intercept 3,
y-intercept -6,
no symmetry



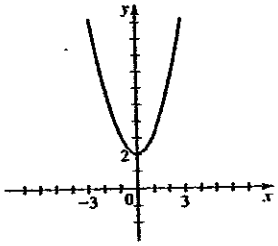
54. x-intercept 3,
y-intercept 3,
no symmetry



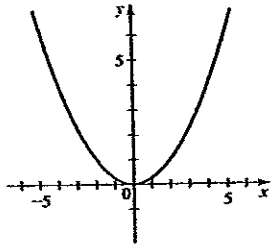
55. x-intercepts ± 1,
y-intercept 1,
symmetry about y-axis



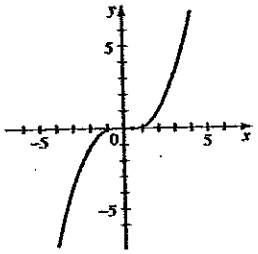
56. No x-intercepts,
y-intercept 2,
symmetry about y-axis



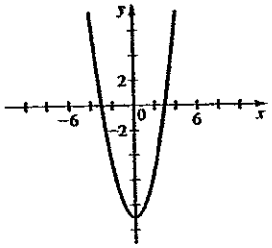
57. x-intercept 0,
y-intercept 0,
symmetry about y-axis



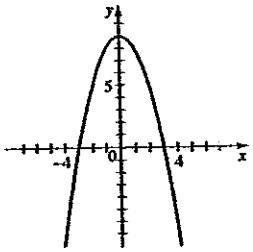
58. x-intercept 0,
y-intercept 0,
symmetry about origin



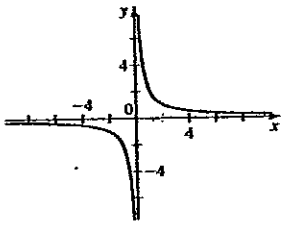
59. x-intercepts ± 3,
y-intercept -9,
symmetry about y-axis



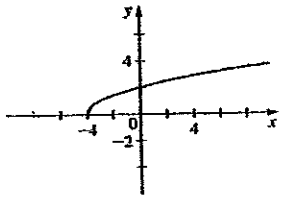
60. x-intercepts -3, 3,
y-intercept 9,
symmetry about y-axis



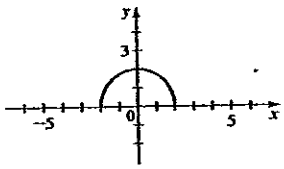
61. No intercepts,
symmetry about origin



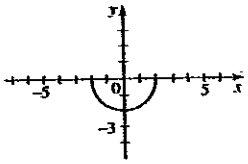
62. x-intercept -4,
y-intercept 2,
no symmetry



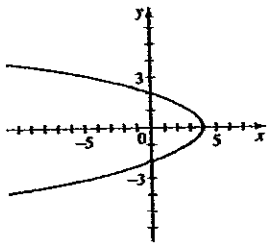
63. x-intercepts ± 2,
y-intercept 2,
symmetry about y-axis



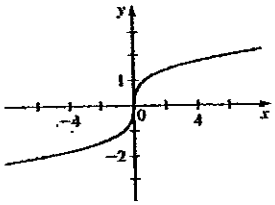
64. x-intercepts -2, 2,
y-intercept -2,
symmetry about y-axis



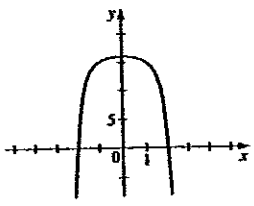
65. x-intercept 4,
y-intercepts -2, 2,
symmetry about x-axis



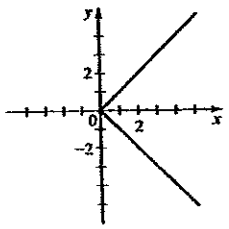
66. x-intercept 0,
y-intercept 0,
symmetry about origin



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

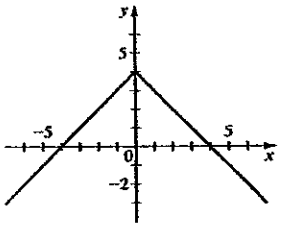


68. x-intercept 0,
y-intercept 0,
symmetry about x-axis

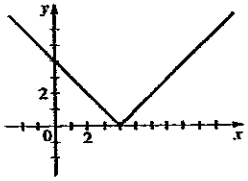


More solutions to 2.8

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

72. Symmetry about x-axis

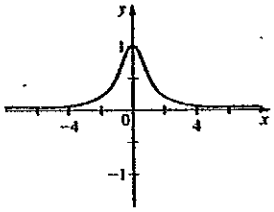
73. Symmetry about origin

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

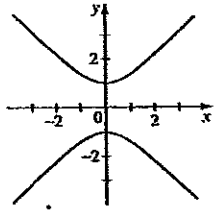
75. Symmetry about origin

76. Symmetry about y-axis

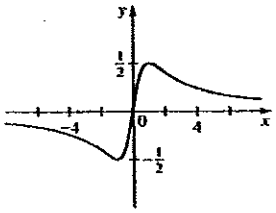
77.



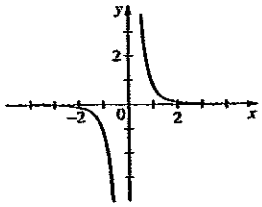
78.



79.



80.



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

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

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

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

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

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

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

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

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

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

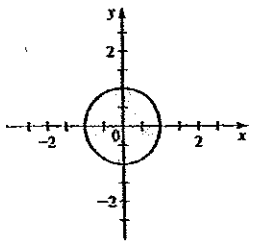
91. $\left(\frac{1}{4},-\frac{1}{4}\right),\frac{1}{2}$

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

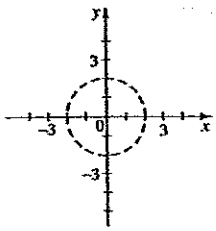
93. $\left(\frac{3}{4},0\right),\frac{3}{4}$

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

95.

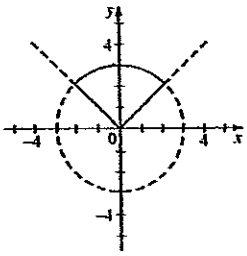


96.



97. 12π

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

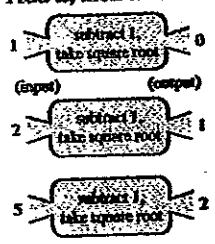


99. (a) 5 (b) 31; 25 (c) Points P and Q must either be on the same street or the same avenue. **100.** (a) 15th Street and 12th Avenue (b) 17 blocks **101.** (a) 2 Mm, 8 Mm (b) -1.33, 7.33; 2.40 Mm, 7.60 Mm

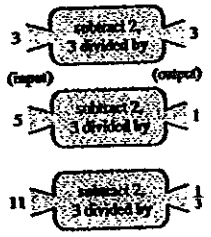
Chapter 3 Solutions

Sec 3.1

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
9.



10.



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

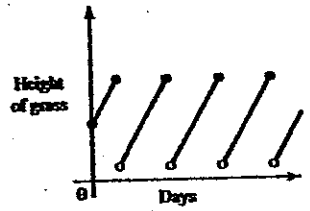
13. $3, -3, 2, 2a+1, -2a+1, 2a+2b+1$
14. $0, 15, 3, a^2+2a, x^2-2x, \frac{1}{a^2}+\frac{2}{a}$
15. $-\frac{1}{3}, -3, \frac{1}{3}, \frac{1-a}{1+a}, \frac{2-a}{a}$, undefined
16. $2, -2, \frac{5}{2}, \frac{5}{2}, x+\frac{1}{x}, \frac{1}{x}+x$
17. $-4, 10, -2, 3\sqrt{2}, 2x^2+7x+1, 2x^2-3x-4$
18. $0, -3, -5, -\frac{45}{8}, \frac{x^3}{8}-x^2, x^6-4x^4$
19. $6, 2, 1, 2, 2|x|, 2(x^2+1)$
20. $-1, -1$, 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. $\{x \mid x \neq 3\}$ 42. $\{x \mid x \neq 2\}$ 43. $\{x \mid x \neq \pm 1\}$
44. $\{x \mid x \neq -3, x \neq 2\}$ 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. $(\frac{1}{3}, \infty)$ 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

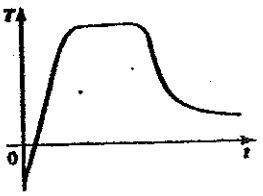
63. (a) $v(0.1) = 4440$, $v(0.4) = 1665$
(b) Flow is faster near central axis.
(c)

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

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) $T(x) = \begin{cases} 75x & \text{if } 0 \le x \le 2 \\ 150 + 50(x-2) & \text{if } x > 2 \end{cases}$
(b) \$150, \$200, \$300 (c) Total cost of staying at the hotel
69. (a) $F(x) = \begin{cases} 15(40-x) & \text{if } 0 < x < 40 \\ 0 & \text{if } 40 \le x \le 65 \\ 15(x-65) & \text{if } x > 65 \end{cases}$
(b) \$150, \$0, \$150 (c) Fines for violating the speed limits
70.



71.



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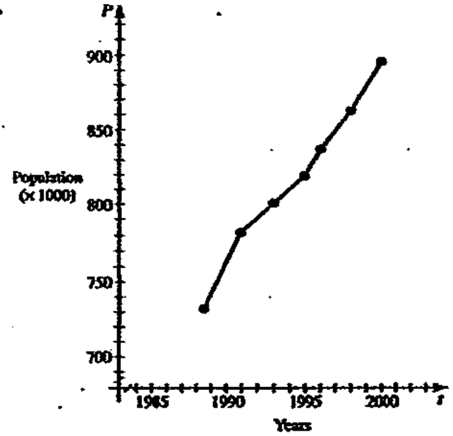
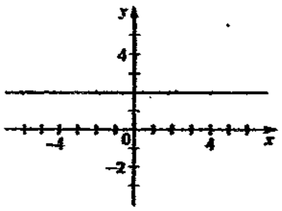


3.2

Section

1.



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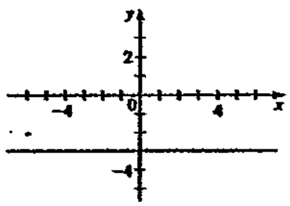

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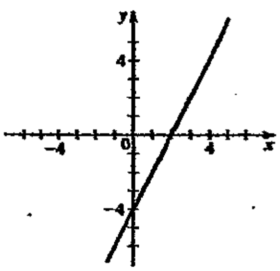

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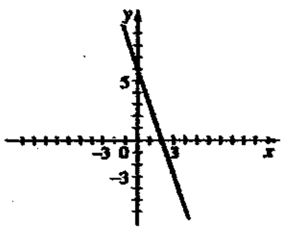

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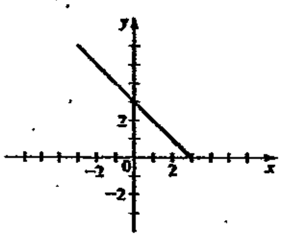

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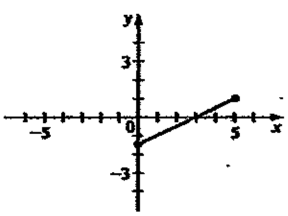

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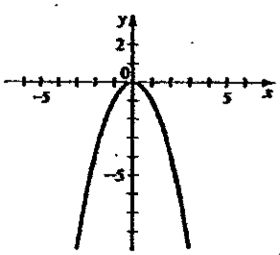

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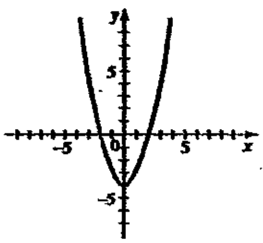

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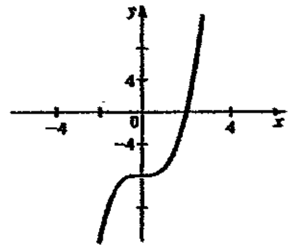

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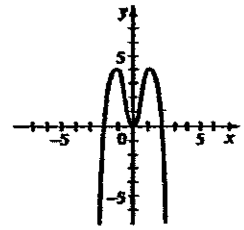

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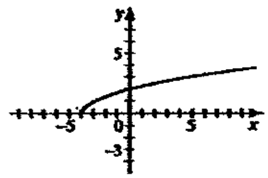

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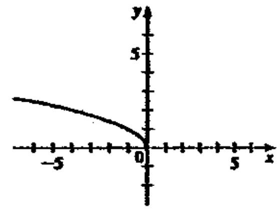

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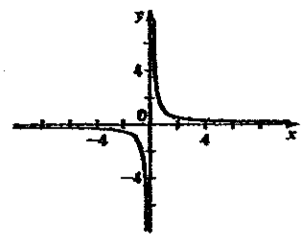

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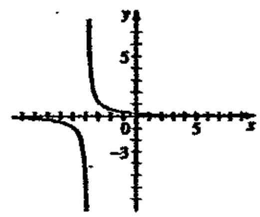

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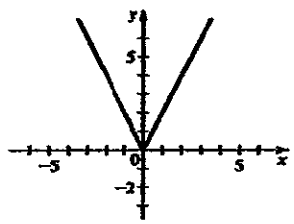

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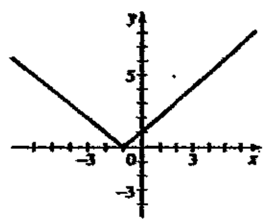

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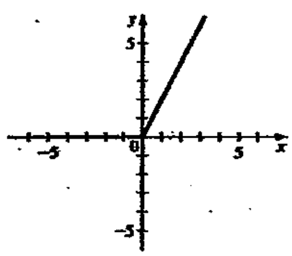

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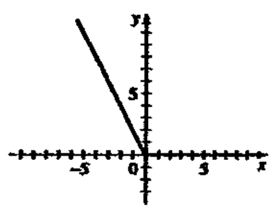

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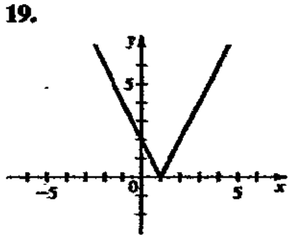

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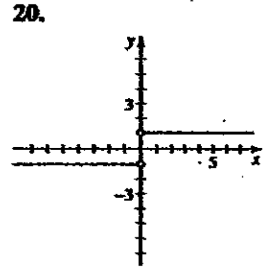

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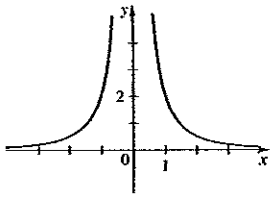

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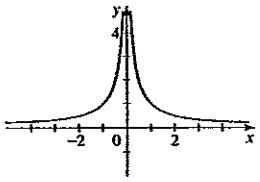


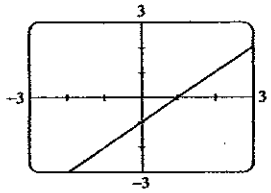
23. (a) 1, −1, 3, 4 (b) Domain $[-3, 4]$, range $[-1, 4]$

24. (a) 3, 2, −2, 1, 0 (b) Domain $[-4, 4]$, range $[-2, 3]$

25. (a) $f(0)$ (b) $g(-3)$ (c) $-2, 2$

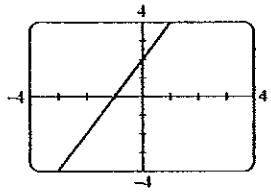
26. (a) 1.2 (b) 2.1 (c) 0.4, 3.6

27. (a)



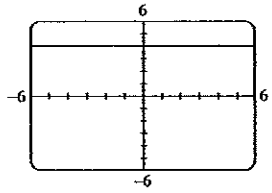
(b) Domain $(-\infty, \infty)$, range $(-\infty, \infty)$

28. (a)



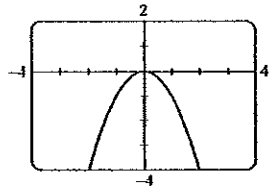
(b) Domain $(-\infty, \infty)$, range $(-\infty, \infty)$

29. (a)



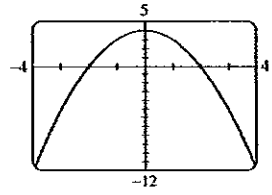
(b) Domain $(-\infty, \infty)$, range $\{4\}$

30. (a)



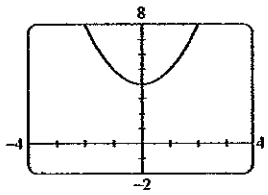
(b) Domain $(-\infty, \infty)$, range $(-\infty, 0]$

31. (a)



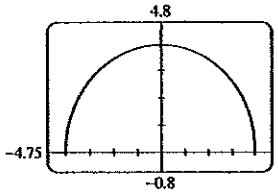
(b) Domain $(-\infty, \infty)$, range $(-\infty, 4]$

32. (a)



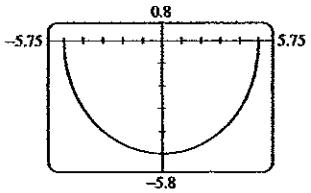
(b) Domain $(-\infty, \infty)$, range $[4, \infty)$

33. (a)



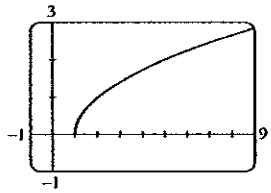
(b) Domain $[-4, 4]$, range $[0, 4]$

34. (a)



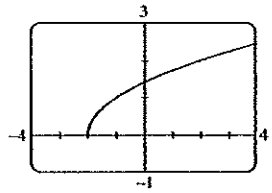
(b) Domain $[-5, 5]$, range $[-5, 0]$

35. (a)



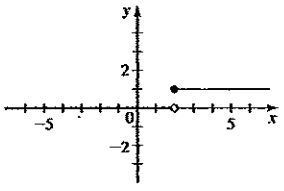
(b) Domain $[1, \infty)$, range $[0, \infty)$

36. (a)



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

37.



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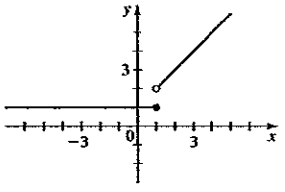

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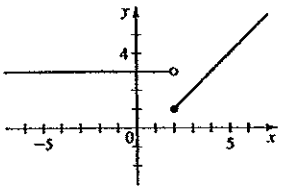

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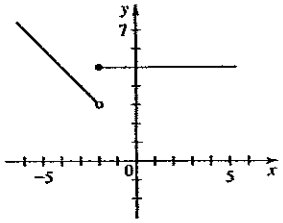

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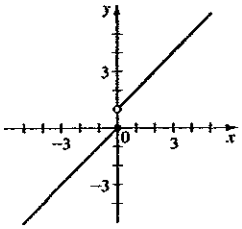

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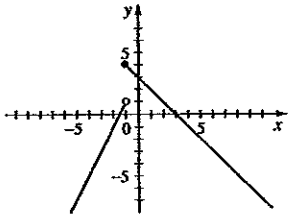

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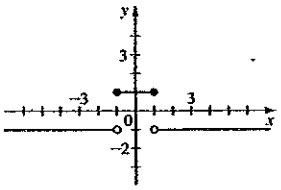

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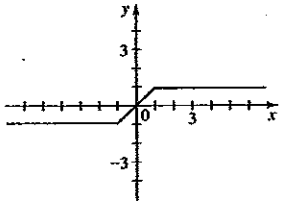

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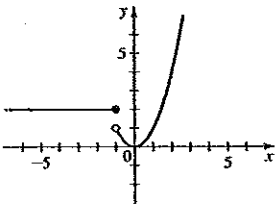

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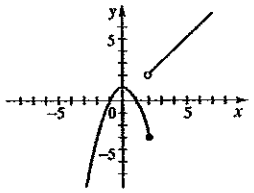

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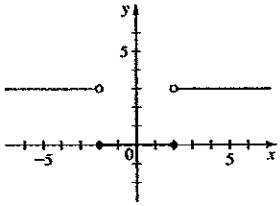

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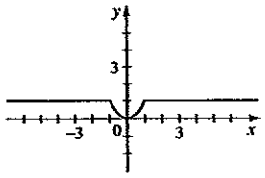

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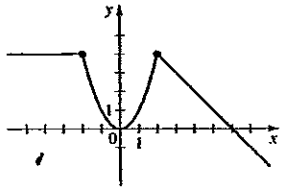

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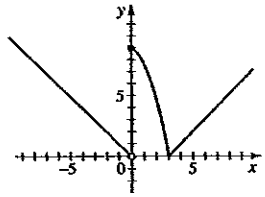

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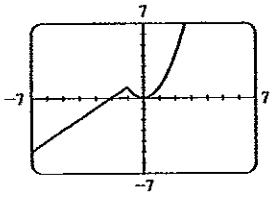

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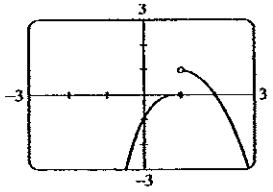
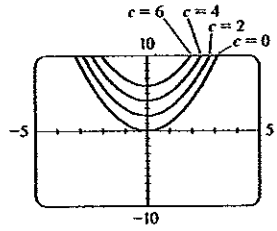


53. $f(x) = \begin{cases} -2 & \text{if } x < -2 \\ x & \text{if } -2 \le x \le 2 \\ 2 & \text{if } x > 2 \end{cases}$

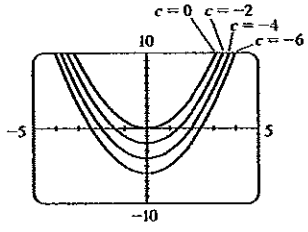
54. $f(x) = \begin{cases} 1 & \text{if } x \le -1 \\ 1 - x & \text{if } -1 < x \le 2 \\ -2 & \text{if } x > 2 \end{cases}$

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)

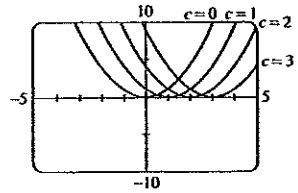


(b)

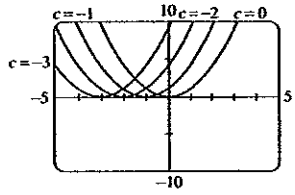


(c) If $c > 0$, then the graph of $f(x) = x^2 + c$ is the same as the graph of $y = x^2$ shifted upward c units. If $c < 0$, then the graph of $f(x) = x^2 + c$ is the same as the graph of $y = x^2$ shifted downward c units.

74. (a)

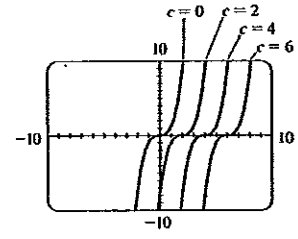


(b)

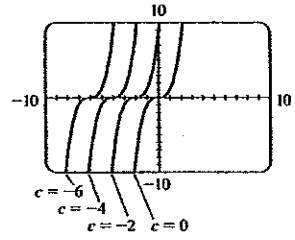


(c) The graphs in part (a) are obtained by shifting the graph of $y = x^2$ to the right 1, 2, and 3 units, while the graphs in part (b) are obtained by shifting the graph of $y = x^2$ to the left, 1, 2, and 3 units.

75. (a)

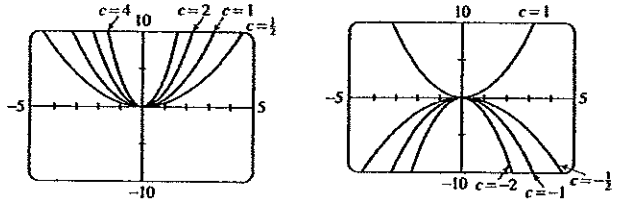


(b)



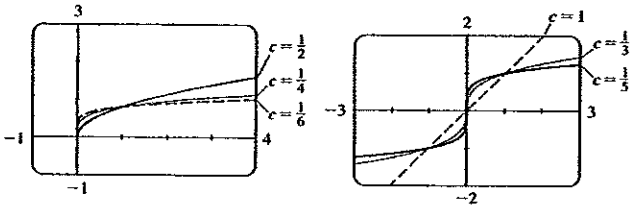
(c) If $c > 0$, then the graph of $f(x) = (x - c)^3$ is the same as the graph of $y = x^3$ shifted right c units. If $c < 0$, then the graph of $f(x) = (x - c)^3$ is the same as the graph of $y = x^3$ shifted left c units.

76. (a) (b)



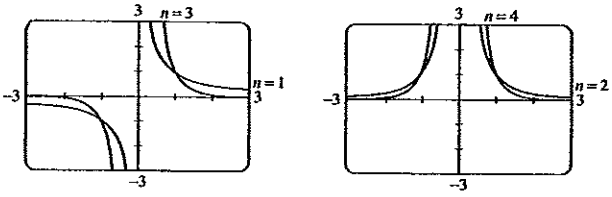
(c) As $|c|$ increases, the graph of $f(x) = cx^2$ is stretched vertically. As $|c|$ decreases, the graph of f is flattened. When $c < 0$, the graph is reflected about the x-axis.

77. (a) (b)



(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 $x > 1$.

78. (a) (b)



(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.** $f(x) = -\frac{7}{6}x - \frac{4}{3}$, $-2 \le x \le 4$

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

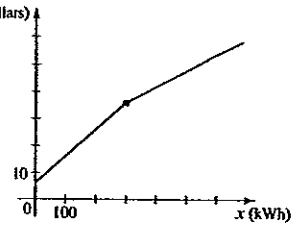
81. $f(x) = \sqrt{9 - x^2}$, $-3 \le x \le 3$

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

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

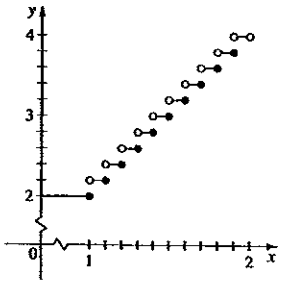
88. (a) $E(x) = \begin{cases} 6 + 0.10x & 0 \le x \le 300 \\ 36 + 0.06(x - 300), & x > 300 \end{cases}$

(b)

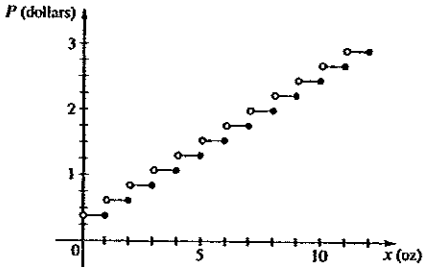


89.

$$C(x) = \begin{cases} 2 & 0 < x \le 1 \\ 2.2 & 1 < x \le 1.1 \\ 2.4 & 1.1 < x \le 1.2 \\ \vdots & \\ 4.0 & 1.9 < x < 2.0 \end{cases}$$



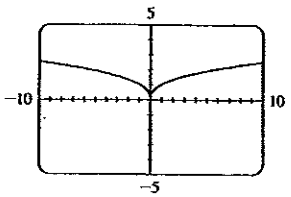
90. $P(x) = \begin{cases} 0.37 & \text{if } 0 < x \le 1 \\ 0.60 & \text{if } 1 < x \le 2 \\ 0.83 & \text{if } 2 < x \le 3 \\ \vdots & \\ 2.90 & \text{if } 11 < x \le 12 \end{cases}$



Section 3.3 ■ page 278

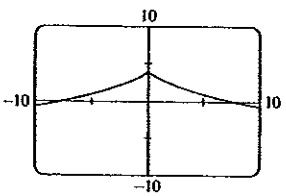
1. (a) $[-1, 1], [2, 4]$ (b) $[1, 2]$ **2.** (a) $[0, 1]$ (b) $[-2, 0], [1, 3]$ **3.** (a) $[-2, -1], [1, 2]$ (b) $[-3, -2], [-1, 1], [2, 3]$ **4.** (a) $[-1, 1]$ (b) $[-2, -1], [1, 2]$

5. (a)



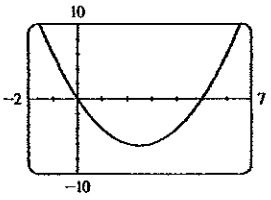
(b) Increasing on $[0, \infty)$; decreasing on $(-\infty, 0]$

6. (a)



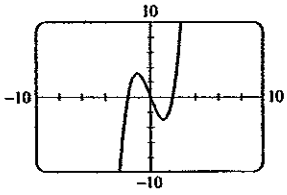
(b) Increasing on $(-\infty, 0]$; decreasing on $[0, \infty)$

7. (a)



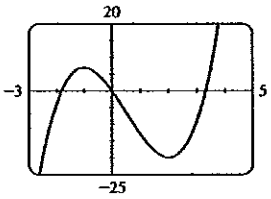
(b) Increasing on $[2.5, \infty)$; decreasing on $(-\infty, 2.5]$

8. (a)



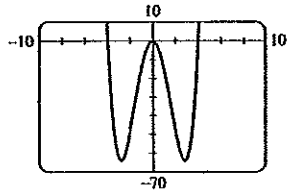
(b) Increasing on $(\infty, -1.15]$, $[1.15, \infty)$; decreasing on $[-1.15, 1.15]$

9. (a)



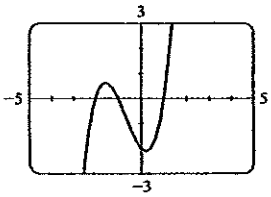
(b) Increasing on $(-\infty, -1]$, $[2, \infty)$; decreasing on $[-1, 2]$

10. (a)



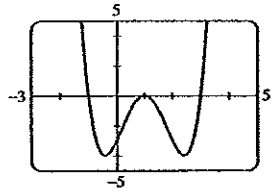
(b) Increasing on $[-2.83, 0]$, $[2.83, \infty)$; decreasing on $[-\infty, -2.83]$, $[0, 2.83]$

11. (a)



(b) Increasing on $(-\infty, -1.55]$, $[0.22, \infty)$; decreasing on $[-1.55, 0.22]$

12. (a)



(b) Increasing on $[-0.4, 1]$, $[2.4, \infty)$; decreasing on $(-\infty, -0.4]$, $[1, 2.4]$

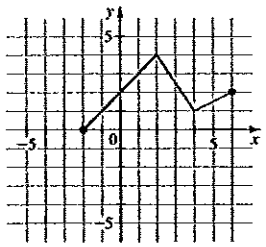
13. $\frac{2}{3}$ **14.** $-\frac{1}{2}$ **15.** $-\frac{4}{5}$ **16.** $\frac{2}{3}$ **17.** 3 **18.** $\frac{1}{2}$ **19.** 5
20. 6 **21.** 60 **22.** 21 **23.** $12 + 3h$ **24.** $-2 - h$
25. $-\dfrac{1}{a}$ **26.** $-\dfrac{2}{h+1}$ **27.** $\dfrac{-2}{a(a+h)}$
28. $\dfrac{1}{\sqrt{a+h}+\sqrt{a}}$
29. (a) $\frac{1}{2}$ **30.** (a) -4 **31.** (a) Increasing on $[0, 150]$, $[300, 365]$; decreasing on $[150, 300]$ (b) -0.25 ft/day
32. (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

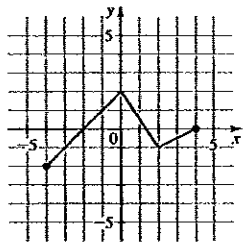
36.

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

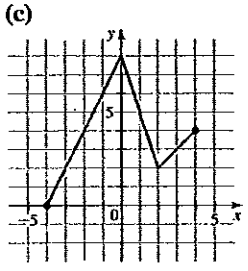
Section 3.4

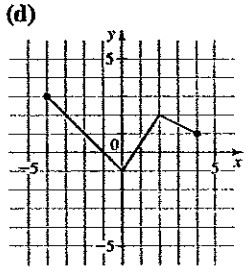
1. (a) Shift downward 5 units (b) Shift right 5 units
2. (a) Shift left 7 units (b) Shift up 7 units **3.** (a) Shift left $\frac{1}{2}$ unit (b) Shift up $\frac{1}{2}$ unit **4.** (a) Reflect in the x-axis (b) Reflect in the y-axis **5.** (a) Reflect in the x-axis and stretch vertically by a factor 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 units **7.** (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 4 **10.** (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 unit **11.** $g(x) = (x-2)^2$
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)



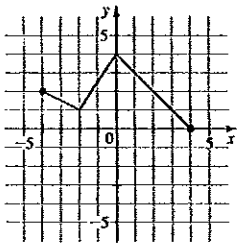


(c) (d)

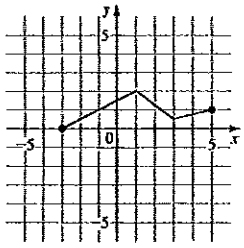




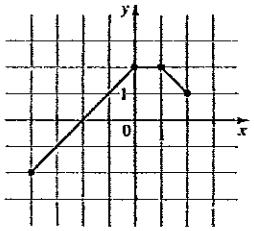
(e)



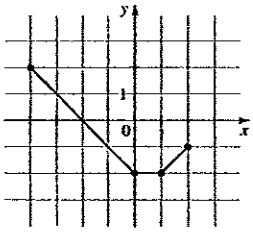
(f)



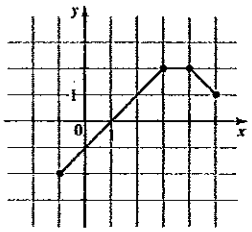
20. (a)



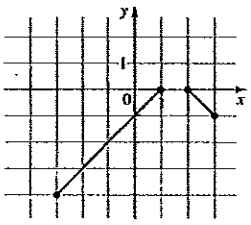
(b)



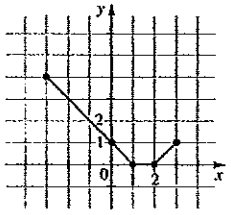
(c)



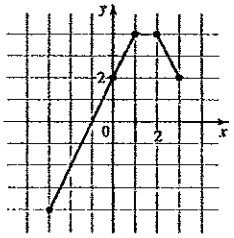
(d)



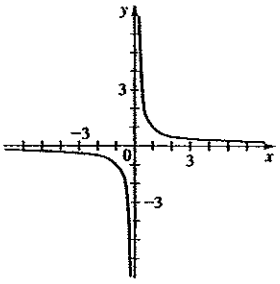
(e)



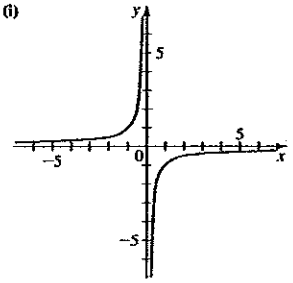
(f)



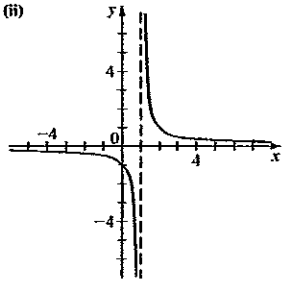
21. (a)



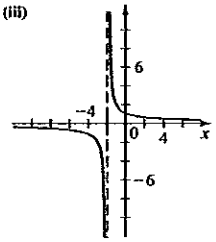
(b) (i)



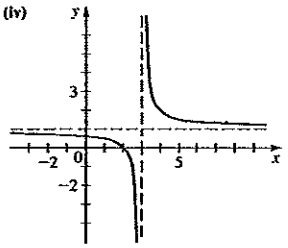
(ii)



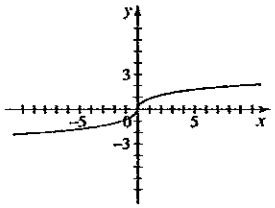
(iii)



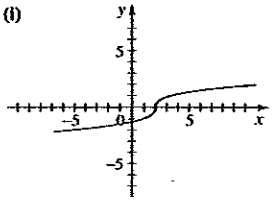
(iv)



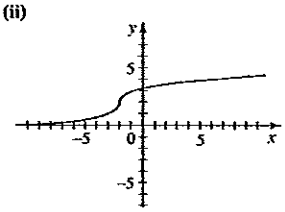
22. (a)



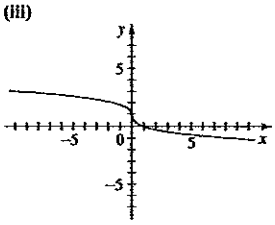
(b) (i)



(ii)



(iii)



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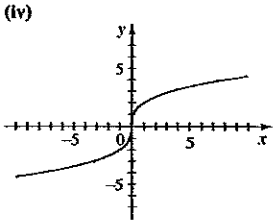


23. (a) Shift left 2 units (b) Shift up 2 units

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

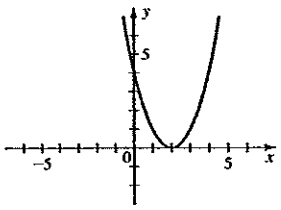
27. $g(x) = (x - 2)^2 + 3$ **28.** $g(x) = (x + 4)^3 - 1$

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

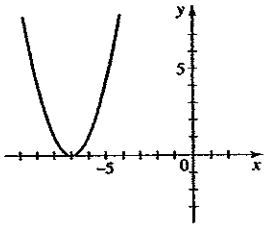
31. $g(x) = 0.1|x - \frac{1}{2}| - 2$

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

33.



34.



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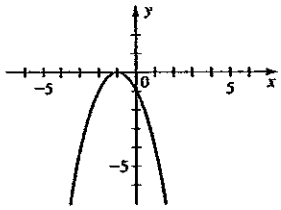

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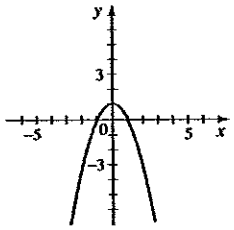

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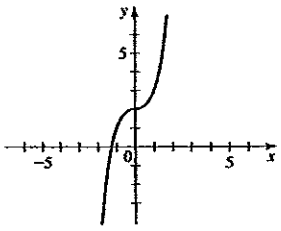
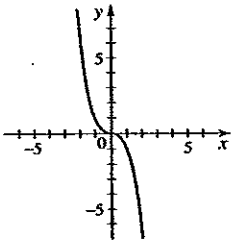


38.



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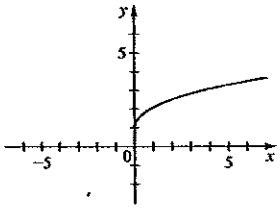
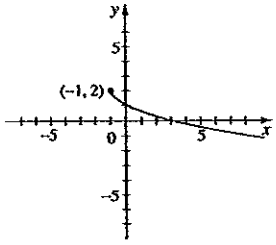
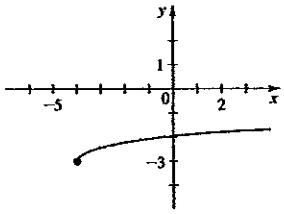


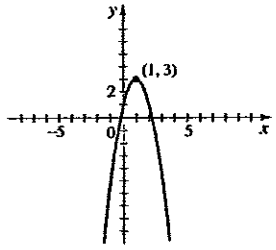
40.



41.



42.



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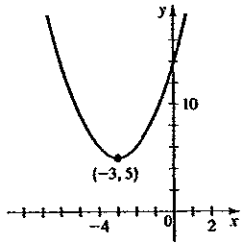
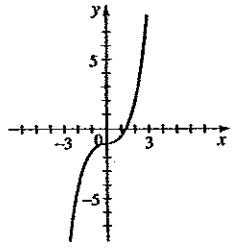
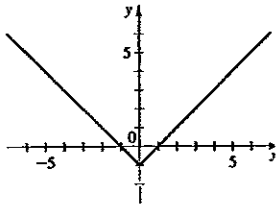


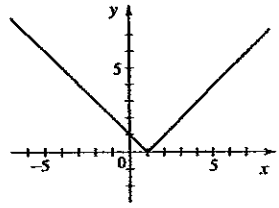
44.



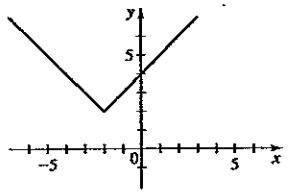
45.



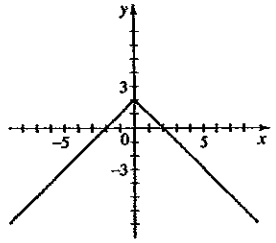
46.



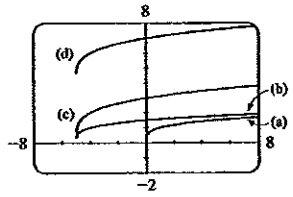
47.



48.

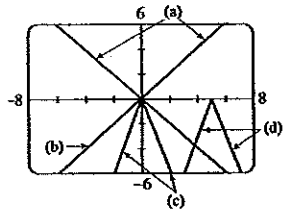


49.



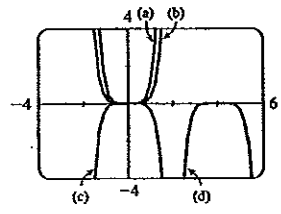
For part (b) shift the graph in (a) left 5 units; for part (c) shift the graph in (a) left 5 units and stretch vertically by a factor of 2; for part (d) shift the graph in (a) left 5 units, stretch vertically by a factor of 2, and then shift upward 4 units.

50.



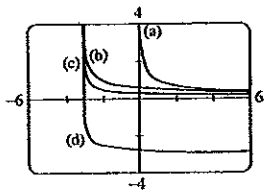
For (b), reflect in the x-axis; for (c), stretch vertically by a factor of 3 and reflect in the x-axis; for (d), shift right 5 units, stretch vertically by a factor of 3, and reflect in the x-axis.

51.



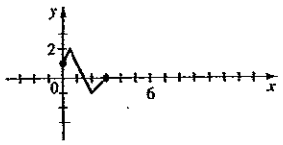
For part (b) shrink the graph in (a) vertically by a factor of $\frac{1}{3}$; for part (c) shrink the graph in (a) vertically by a factor of $\frac{1}{3}$ and reflect in the x-axis; for part (d) shift the graph in (a) right 4 units, shrink vertically by a factor of $\frac{1}{3}$, and then reflect in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

52.

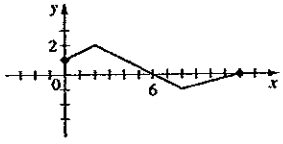


For (b), shift left 3 units; for (c), shift left 3 units and shrink vertically by a factor of $\frac{1}{2}$; for (d), shift left 3 units, shrink vertically by factor of $\frac{1}{2}$, and then shift down 3 units.

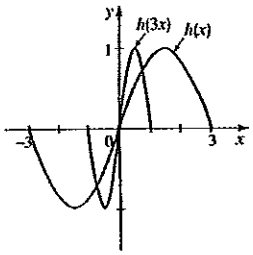
53. (a)



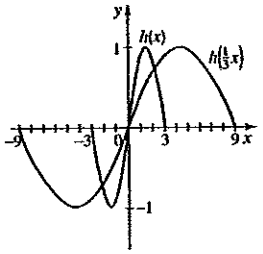
(b)



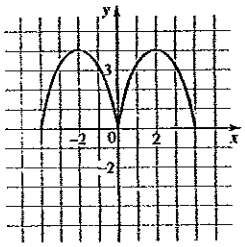
54. (a)



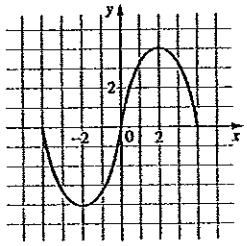
(b)



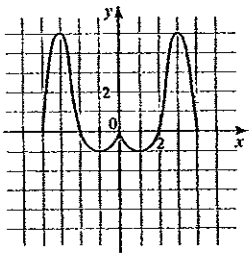
55. (a)



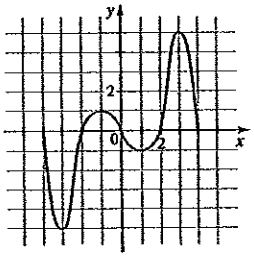
(b)



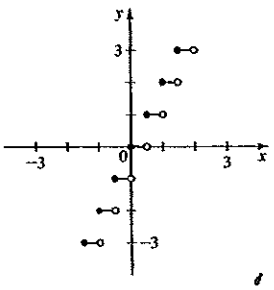
56. (a)



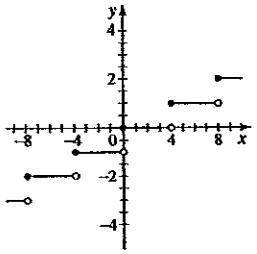
(b)



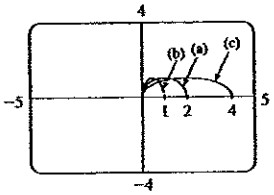
57.



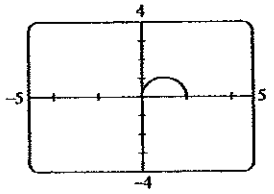
58.



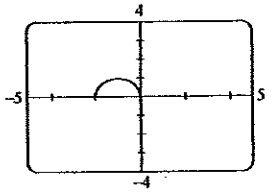
59.



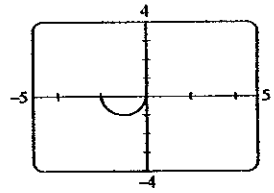
60. (a)



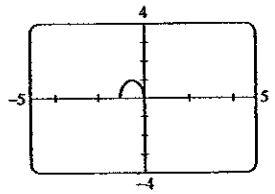
(b) Reflect in y-axis



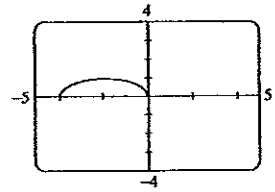
(c) Reflect in origin



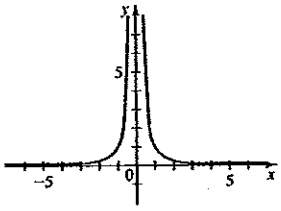
(d) Reflect in y-axis, then horizontally shrink by a factor of 2



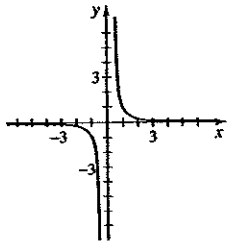
(e) Reflect in y-axis, then horizontally stretch by a factor of 2



61. Even

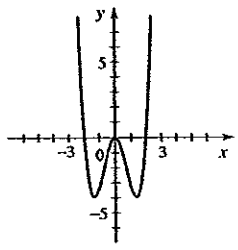


62. Odd

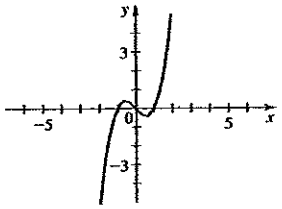


63. Neither

64. Even



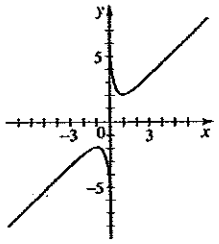
65. Odd



66. Neither

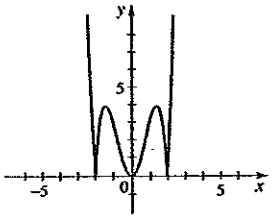
67. Neither

68. Odd

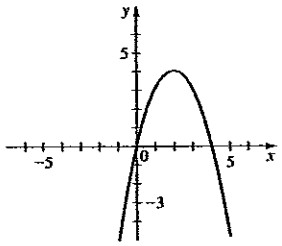


69. To obtain the graph of g, reflect in the x-axis the part of the graph of f that is below the x-axis.

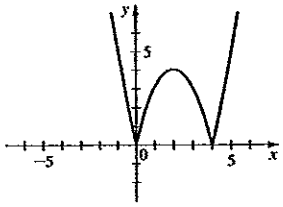
70.



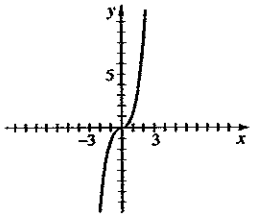
71. (a)



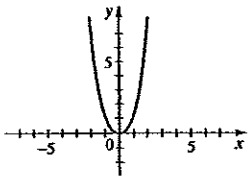
(b)



72. (a)



(b)



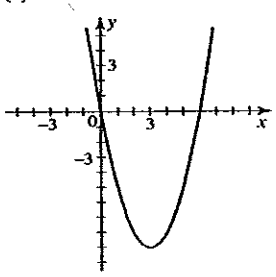
73. (a) Shift up 4 units, shrink vertically by a factor of 0.01
(b) Shift right 10 units; $g(t) = 4 + 0.01(t - 10)^2$

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

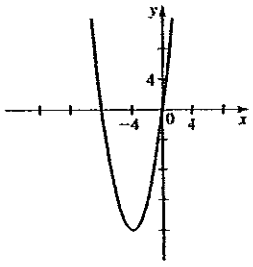
Section 3.5

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

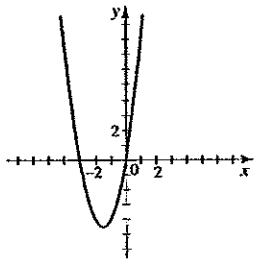
5. (a) $f(x) = (x - 3)^2 - 9$
(b) Vertex $(3, -9)$
x-intercepts 0, 6
y-intercept 0
(c)



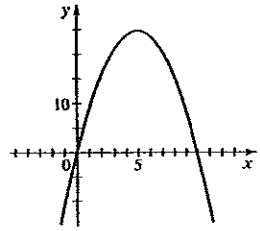
6. (a) $f(x) = (x + 4)^2 - 16$
(b) Vertex $(-4, -16)$
x-intercepts 0, -8
y-intercept 0
(c)



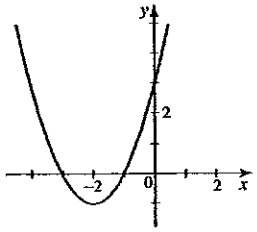
7. (a) $f(x) = 2(x + \frac{3}{2})^2 - \frac{9}{2}$
(b) Vertex $(-\frac{3}{2}, -\frac{9}{2})$
x-intercepts 0, -3,
y-intercept 0
(c)



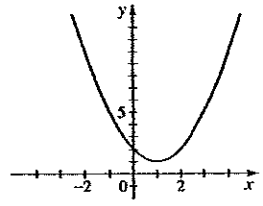
8. (a) $f(x) = -(x - 5)^2 + 25$
(b) Vertex $(5, 25)$
x-intercepts 0, 10
y-intercept 0
(c)



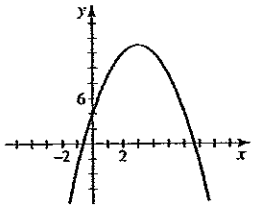
9. (a) $f(x) = (x + 2)^2 - 1$
(b) Vertex $(-2, -1)$
x-intercepts -1, -3
y-intercept 3
(c)



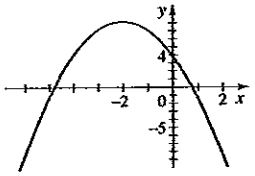
10. (a) $f(x) = (x - 1)^2 + 1$
(b) Vertex $(1, 1)$
no x-intercepts
y-intercept 2
(c)



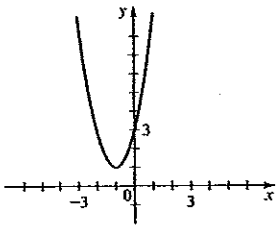
11. (a) $f(x) = -(x-3)^2 + 13$ (b) Vertex $(3, 13)$; x-intercepts $3 \pm \sqrt{13}$; y-intercept 4
(c)



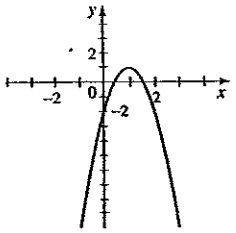
12. (a) $f(x) = -(x+2)^2 + 8$ (b) Vertex $(-2, 8)$; x-intercepts $-2 \pm 2\sqrt{2}$; y-intercept 4
(c)



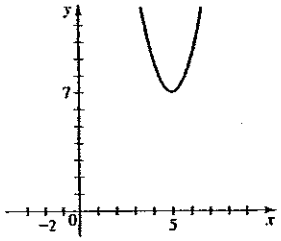
13. (a) $f(x) = 2(x+1)^2 + 1$ (b) Vertex $(-1, 1)$; no x-intercept; y-intercept 3
(c)



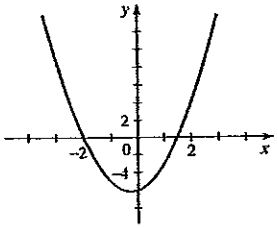
14. (a) $f(x) = -3(x-1)^2 + 1$ (b) Vertex $(1, 1)$; x-intercepts $1 \pm \sqrt{\frac{1}{3}}$; y-intercept -2
)



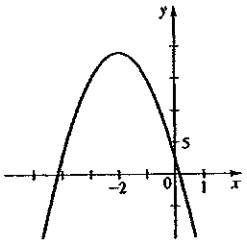
15. (a) $f(x) = 2(x-5)^2 + 7$ (b) Vertex $(5, 7)$; no x-intercept; y-intercept 57
(c)



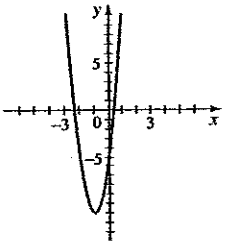
16. (a) $f(x) = 2(x+\frac{1}{4})^2 - \frac{49}{8}$ (b) Vertex $(-\frac{1}{4}, -\frac{49}{8})$; x-intercepts $-2, \frac{3}{2}$; y-intercept -6
(c)



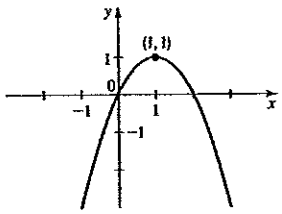
17. (a) $f(x) = -4(x+2)^2 + 19$ (b) Vertex $(-2, 19)$; x-intercepts $-2 \pm \frac{1}{2}\sqrt{19}$; y-intercept 3
(c)



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

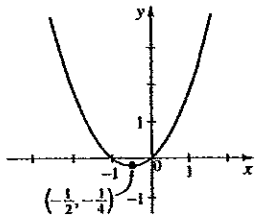


19. (a) $f(x) = -(x-1)^2 + 1$
(b)



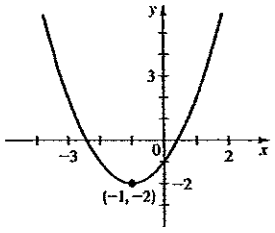
(c) Maximum $f(1) = 1$

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



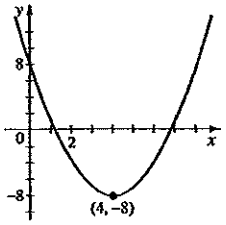
(c) Minimum $f(-\frac{1}{2}) = -\frac{1}{4}$

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



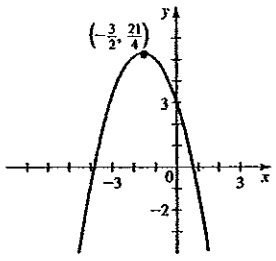
(c) Minimum $f(-1) = -2$

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



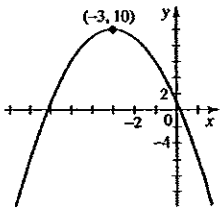
(c) Minimum $f(4) = -8$

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



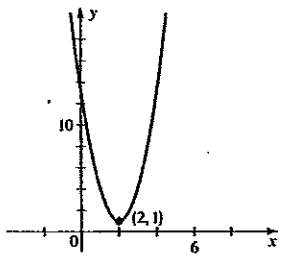
(c) Maximum $f\left(-\frac{3}{2}\right) = \frac{21}{4}$

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



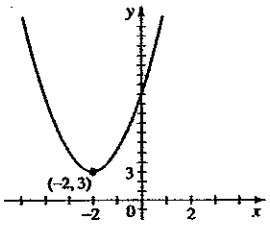
(c) Maximum $f(-3) = 10$

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



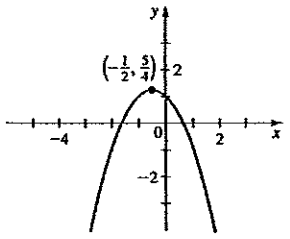
(c) Minimum $g(2) = 1$

26. (a) $g(x) = 2(x + 2)^2 + 3$
(b)



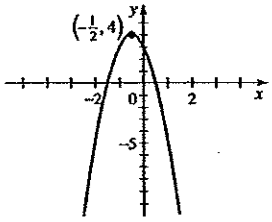
(c) Minimum $g(-2) = 3$

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



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

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



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

29. Minimum $f\left(-\frac{1}{2}\right) = \frac{3}{4}$ **30.** Maximum $f\left(\frac{3}{2}\right) = \frac{13}{4}$
31. Maximum $f(-3.5) = 185.75$ **32.** Minimum $f(-2) = 73$
33. Minimum $f(0.6) = 15.64$ **34.** Minimum $g\left(\frac{15}{2}\right) = -5625$
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. $(-\infty, \infty)$, $\left(-\frac{23}{2}, \infty\right)$ **44.** $(-\infty, \infty)$, $(-\infty, 7)$
45. (a) -4.01 (b) -4.011025
46. (a) 1.18 (b) $\dfrac{8 + \sqrt{2}}{8} \approx 1.176777$
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 $x \approx -0.5$
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

3.6

Section 3.6 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.** $P(x) = 2x + \dfrac{32}{x}, x > 0$
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 ft^2
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) $1.174 \le x \le 3.898$ (c) 262.682 in^3
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) $T(x) = \frac{1}{2}\sqrt{x^2 - 14x + 53} + \frac{1}{5}x$ (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 3.7 ■ 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. $(f + g)(x) = 4x^2 + 2x - 1, (-\infty, \infty)$;
$(f - g)(x) = -2x^2 + 2x + 1, (-\infty, \infty)$;
$(fg)(x) = 3x^4 + 6x^3 - x^2 - 2x, (-\infty, \infty)$;
$\left(\frac{f}{g}\right)(x) = \frac{x^2 + 2x}{3x^2 - 1}, x \ne \pm\frac{1}{\sqrt{3}}$

3. $(f + g)(x) = \sqrt{4 - x^2} + \sqrt{1 + x}, [-1, 2]$;
$(f - g)(x) = \sqrt{4 - x^2} - \sqrt{1 + x}, [-1, 2]$;
$(fg)(x) = \sqrt{-x^3 - x^2 + 4x + 4}, [-1, 2]$;
$\left(\frac{f}{g}\right)(x) = \sqrt{\frac{4 - x^2}{1 + x}}, (-1, 2]$

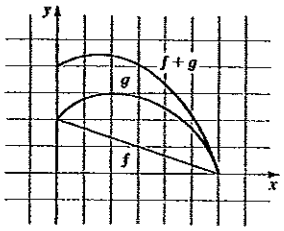
4. $(f + g)(x) = \sqrt{9 - x^2} + \sqrt{x^2 - 4}, [-3, -2] \cup [2, 3]$;
$(f - g)(x) = \sqrt{9 - x^2} - \sqrt{x^2 - 4}, [-3, -2] \cup [2, 3]$;
$(fg)(x) = \sqrt{-x^4 + 13x^2 - 36}, [-3, -2] \cup [2, 3]$;
$\left(\frac{f}{g}\right)(x) = \sqrt{\frac{9 - x^2}{x^2 - 4}}, [-3, -2) \cup (2, 3]$

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

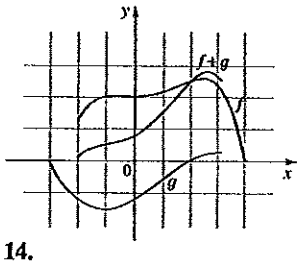
6. $(f + g)(x) = \frac{2 + x}{x + 1}, x \ne -1$;
$(f - g)(x) = \frac{2 - x}{x + 1}, x \ne -1$;
$(fg)(x) = \frac{2x}{(x + 1)^2}, x \ne -1$; $\left(\frac{f}{g}\right)(x) = \frac{2}{x}, x \ne -1, x \ne 0$

7. $[0,1]$ **8.** $[-1, 0) \cup (0, \infty)$ **9.** $(3, \infty)$
10. $[-3, 1) \cup (1, \infty)$

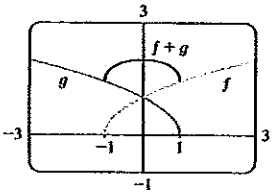
11.



12.



13.



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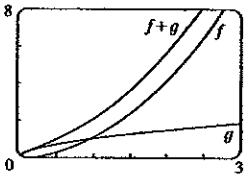

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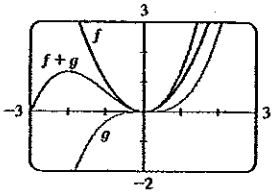
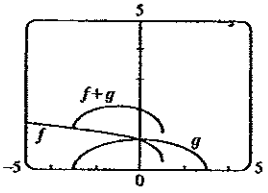


16.



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. $(f \circ g)(x) = 3x - 5, (-\infty, \infty)$;
$(g \circ f)(x) = 3x - \frac{5}{2}, (-\infty, \infty)$;
$(f \circ f)(x) = 36x - 35, (-\infty, \infty)$; $(g \circ g)(x) = \frac{x}{4}, (-\infty, \infty)$

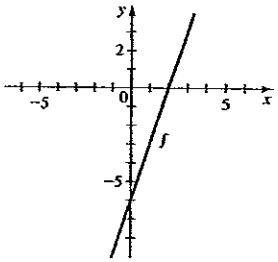
31. $(f \circ g)(x) = (x+1)^2, (-\infty, \infty)$;
$(g \circ f)(x) = x^2 + 1, (-\infty, \infty)$; $(f \circ f)(x) = x^4, (-\infty, \infty)$;
$(g \circ g)(x) = x + 2, (-\infty, \infty)$
32. $(f \circ g)(x) = x + 2, (-\infty, \infty)$;
$(g \circ f)(x) = \sqrt[3]{x^3 + 2}, (-\infty, \infty)$;
$(f \circ f)(x) = x^9 + 6x^6 + 12x^3 + 10, (-\infty, \infty)$;
$(g \circ g)(x) = x^{1/9}, (-\infty, \infty)$
33. $(f \circ g)(x) = \dfrac{1}{2x+4}, x \neq -2$; $(g \circ f)(x) = \dfrac{2}{x} + 4, x \neq 0$;
$(f \circ f)(x) = x, x \neq 0$, $(g \circ g)(x) = 4x + 12, (-\infty, \infty)$
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. $(f \circ g)(x) = \dfrac{2x-1}{2x}, x \neq 0$;
$(g \circ f)(x) = \dfrac{2x}{x+1} - 1, x \neq -1$;
$(f \circ f)(x) = \dfrac{x}{2x+1}, x \neq -1, x \neq -\frac{1}{2}$;
$(g \circ g)(x) = 4x - 3, (-\infty, \infty)$
38. $(f \circ g)(x) = \dfrac{1}{\sqrt{x^2 - 4x}}, (-\infty, 0) \cup (4, \infty)$;
$(g \circ f)(x) = \dfrac{1}{x} - \dfrac{4}{\sqrt{x}}, (0, \infty)$; $(f \circ f)(x) = x^{1/4}, (0, \infty)$;
$(g \circ g)(x) = x^4 - 8x^3 + 12x^2 + 16x, (-\infty, \infty)$
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. $(f \circ g)(x) = \dfrac{2x+4}{x}, x \neq -2, x \neq 0$;
$(g \circ f)(x) = \dfrac{1}{1+x}, x \neq -1, x \neq 0$; $(f \circ f)(x) = x, x \neq 0$;
$(g \circ g)(x) = \dfrac{x}{3x+4}, x \neq -2, x \neq -\frac{4}{3}$
41. $(f \circ g \circ h)(x) = \sqrt{x-1} - 1$
42. $(f \circ g \circ h)(x) = \dfrac{1}{x^6 + 6x^4 + 12x^2 + 8}$
43. $(f \circ g \circ h)(x) = (\sqrt{x} - 5)^4 + 1$
44. $(f \circ g \circ h)(x) = \sqrt{\dfrac{\sqrt[3]{x}}{\sqrt[3]{x} - 1}}$ **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) $s(t) = \sqrt{1 + 122{,}500t^2}$

3.8

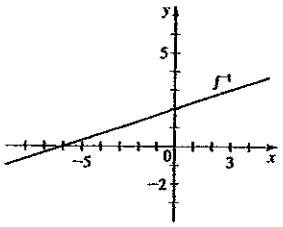
Section 3.8 ■ page 239

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. $f^{-1}(x) = \dfrac{-2(x+1)}{x-1}$
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)

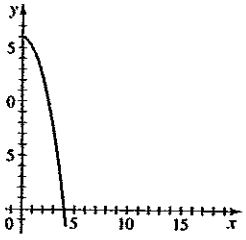


(b)

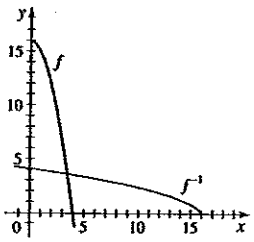


c) $f^{-1}(x) = \frac{1}{3}(x + 6)$

52. (a)

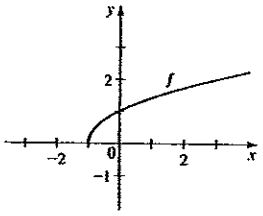


(b)

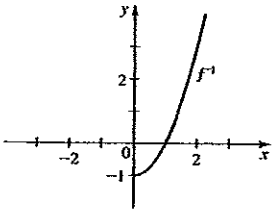


c) $f^{-1}(x) = \sqrt{16 - x}, x \leq 16$

53. (a)

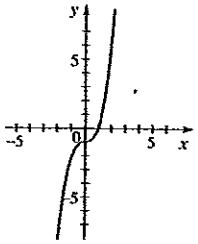


(b)

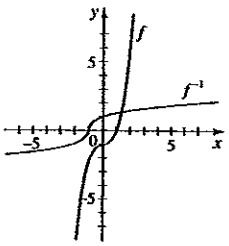


:) $f^{-1}(x) = x^2 - 1, x \geq 0$

54. (a)

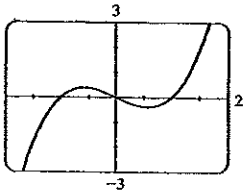


(b)

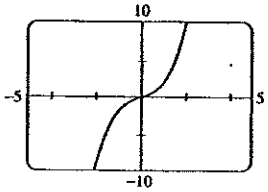


) $f^{-1}(x) = \sqrt[3]{x + 1}$

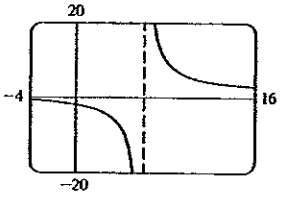
55. Not one-to-one



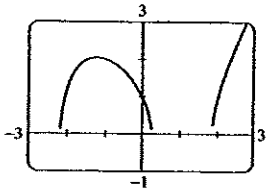
56. One-to-one



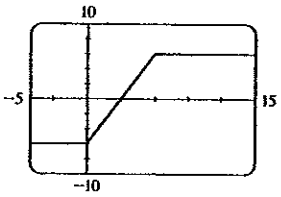
57. One-to-one



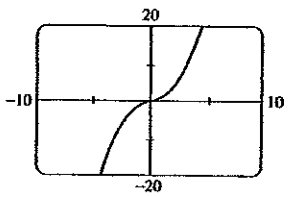
58. Not one-to-one



59. Not one-to-one

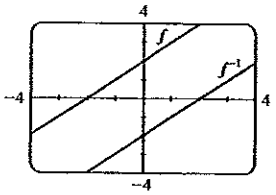


60. One-to-one

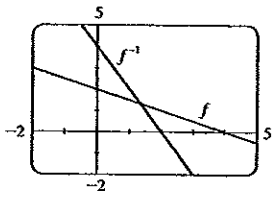


61. (a) $f^{-1}(x) = x - 2$

(b)

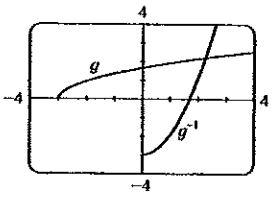


62. (a) $f^{-1}(x) = 4 - 2x$

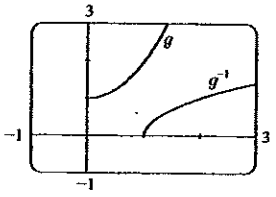


63. (a) $g^{-1}(x) = x^2 - 3, x \geq 0$

(b)



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

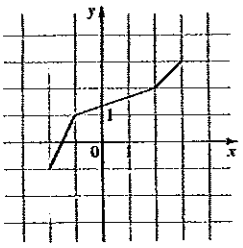


65. $x \geq 0, f^{-1}(x) = \sqrt{4 - x}$

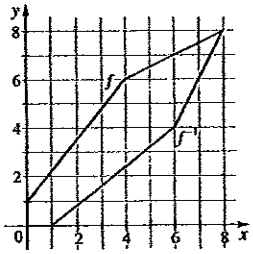
66. $x \geq 1, g^{-1}(x) = 1 + \sqrt{x}$

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

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) $v^{-1}(t) = \sqrt{0.25 - \dfrac{t}{18{,}500}}$ (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) $f(x) = \begin{cases} 0.1x & \text{if } 0 \le x \le 20{,}000 \\ 2000 + 0.2(x - 20{,}000) & \text{if } x > 20{,}000 \end{cases}$

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

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

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

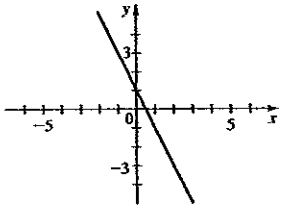
(b) $g(x) = x - 1000$ (c) $H = 0.85x - 850$

(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.

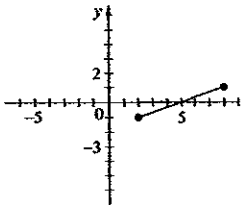
Chapter 3 Review ■ page 204

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.



16.



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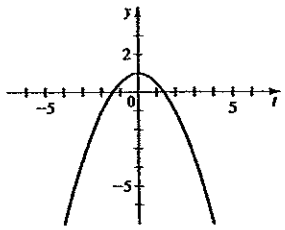

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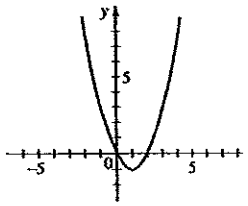

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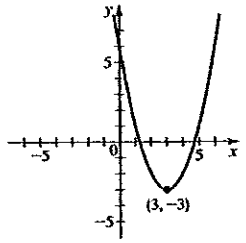

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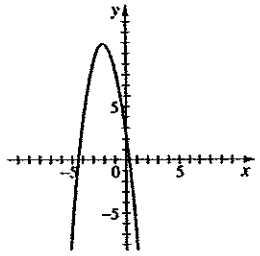

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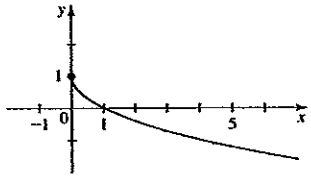

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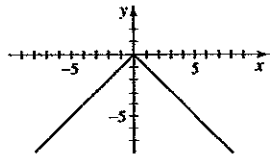

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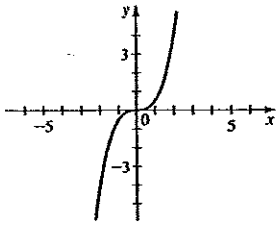

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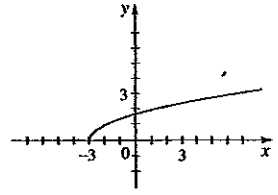

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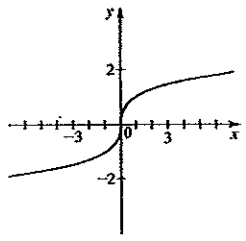

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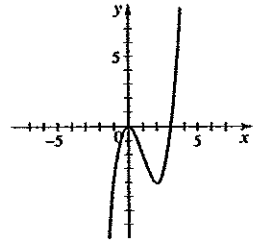
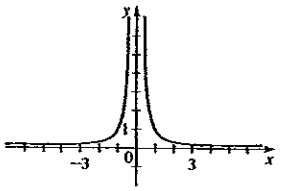


27.



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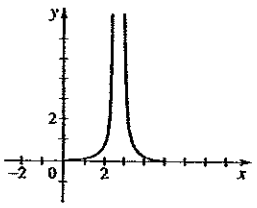

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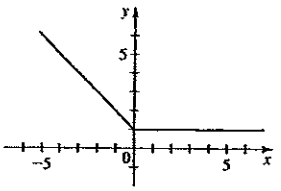

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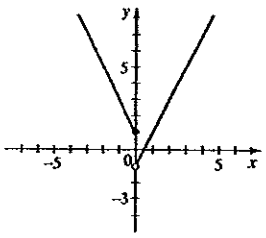

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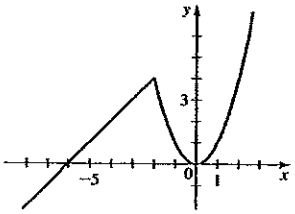

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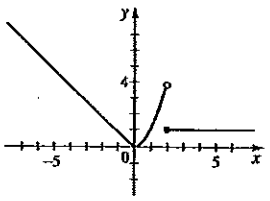
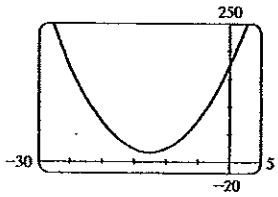


33. (iii)

34. (iii)

35.



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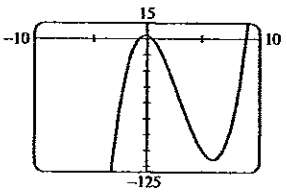

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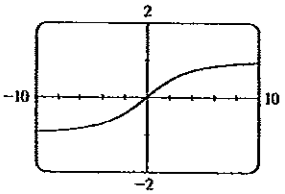

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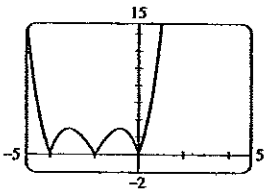
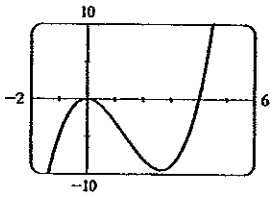


39. $[-2.1, 0.2] \cup [1.9, \infty)$ **40.** $[-7.10, \infty)$ **41.** 5

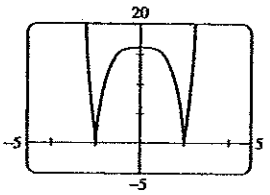
42. $-\frac{1}{12}$ **43.** $\dfrac{-1}{3(3+h)}$ **44.** $2a + h + 2$

45.



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

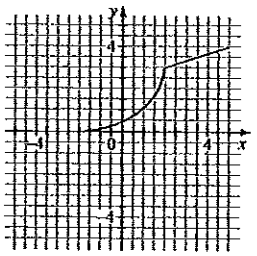
46.



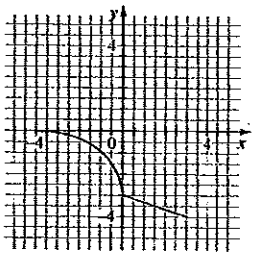
Increasing on $[-2, 0]$, $[2, \infty)$; decreasing on $(-\infty, -2]$, $[0, 2]$

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 $y = x$

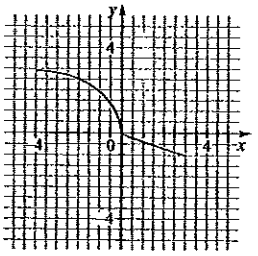
48. (a)



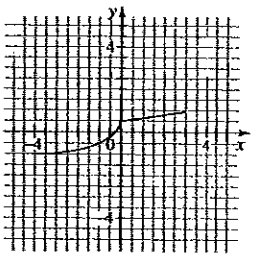
(b)



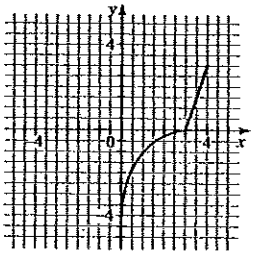
(c)



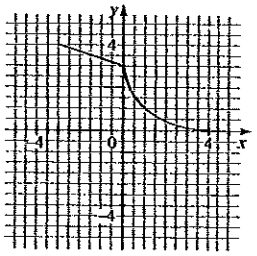
(d)



(e)



(f)

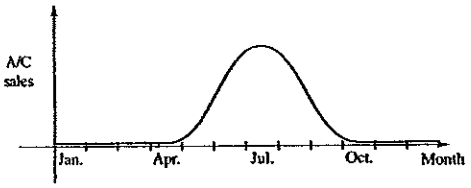


49. (a) Neither (b) Odd (c) Even (d) Neither

50. (a) Odd (b) Neither (c) Even (d) Neither

51. $f(x) = (x + 2)^2 - 3$ **52.** $f(x) = -2(x - 3)^2 + 30$

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.

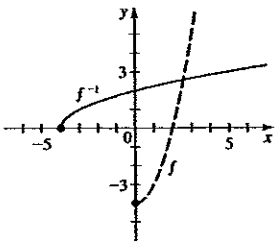


60. $A = b\sqrt{4 - b}$
61. (a) $A(x) = 5\sqrt{3}x - \frac{\sqrt{3}}{2}x^2$ (b) 5 cm by $\frac{5\sqrt{3}}{2}$ cm

62. (a) $A(x) = \frac{x^2}{16} + \frac{\sqrt{3}(10 - x)^2}{36}$, $0 \le x \le 10$
(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. $(f \circ g)(x) = -3x^2 + 6x - 1, (-\infty, \infty)$;
$(g \circ f)(x) = -9x^2 + 12x - 3, (-\infty, \infty)$; $(f \circ f)(x) = 9x - 4$, $(-\infty, \infty)$; $(g \circ g)(x) = -x^4 + 4x^3 - 6x^2 + 4x, (-\infty, \infty)$

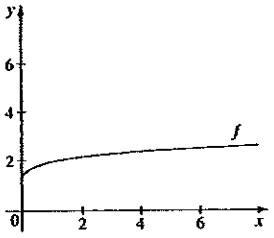
66. $(f \circ g)(x) = \sqrt{\frac{2}{x - 4}}, (4, \infty)$; $(g \circ f)(x) = \frac{2}{\sqrt{x} - 4}$, $[0, 16) \cup (16, \infty)$; $(f \circ f)(x) = x^{1/4}, [0, \infty)$;
$(g \circ g)(x) = \frac{x - 4}{9 - 2x}, x \ne 4, x \ne \frac{9}{2}$

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)

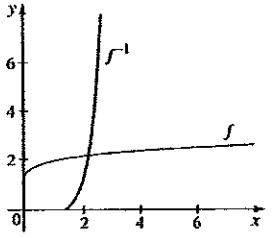


(c) $f^{-1}(x) = \sqrt{x + 4}$

80. (b)



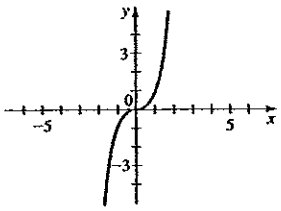
(c)



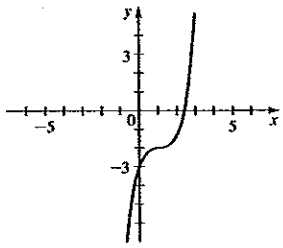
(d) $f^{-1}(x) = (x - 1)^4, x \ge 1$

Chapter 3 Test

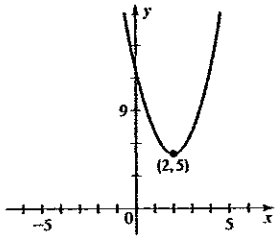
1. (a) and (b) are graphs of functions, (a) is one-to-one
2. (a) $2/3, \sqrt{6}/5, \sqrt{a}/(a - 1)$ (b) $[-1, 0) \cup (0, \infty)$
3. 5
4. (a)



(b)

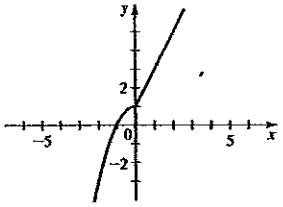


5. (a) Shift right 3 units, then shift upward 2 units
(b) Reflect in y-axis **6.** (a) $f(x) = 2(x - 2)^2 + 5$
(b)



(c) $f(2) = 5$

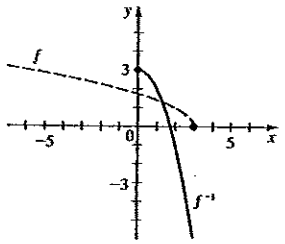
7. (a) $-3, 3$ (b)



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

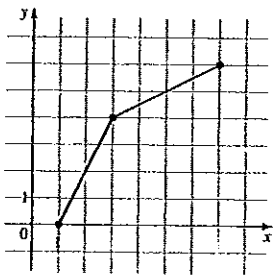
. (a) $f^{-1}(x) = 3 - x^2, x \geq 0$

)



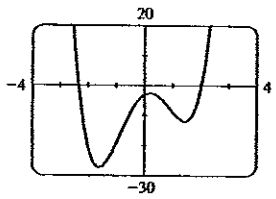
11. (a) Domain $[0, 6]$, range $[1, 7]$

(b)



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

12. (a)

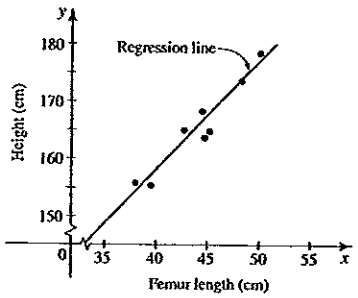


(b) No

(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 $(-\infty, -1.61] \cup [0.18, 1.43]$

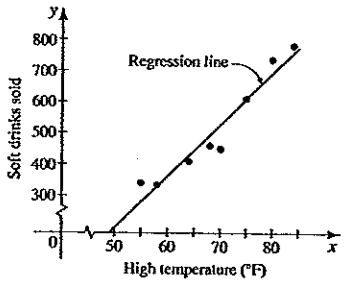
Focus on Modeling ■ page 243

1. (a)



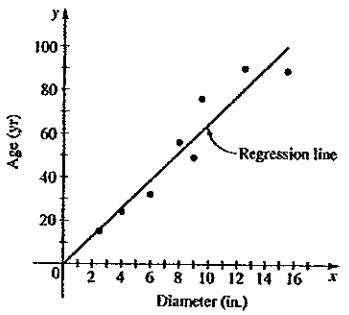
(b) $y = 1.8807x + 82.65$ (c) 191.7 cm

2. (a)



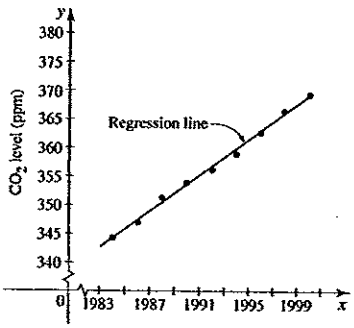
(b) $y = 16.4163x - 621.83$ (c) 938 cans

3. (a)



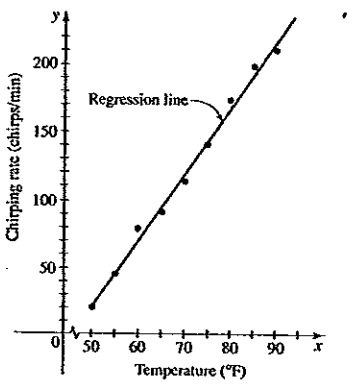
(b) $y = 6.451x - 0.1523$ (c) 116 years

4. (a)



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

5. (a)



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

(c) The power function
(d) $y = ax^b$, where $a = 0.893421326$ and $b = 1.50983$
11. (a) $y = \dfrac{c}{1 + ae^{-bx}}$, where $a = 49.10976596$, $b = 0.4981144989$, and $c = 500.855793$ (b) 10.58 days
12. (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 4 Solutions

Section 4.1 ■ 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 4.2 ■ 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 undefined
27. $\frac{4}{5}, \frac{3}{5}, \frac{4}{3}$ **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.** $\tan t = -\dfrac{\sqrt{1 - \cos^2 t}}{\cos t}$

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

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

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

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

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

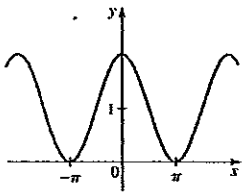
79. $y(0) = 4$, $y(0.25) = -2.828$, $y(0.50) = 0$, $y(0.75) = 2.828$, $y(1.00) = -4$, $y(1.25) = 2.828$

80. (a) 87 mmHg (b) 82.7 mmHg (c) 80 mmHg (d) 73.9 mmHg **81.** (a) 0.49870 amp (b) −0.17117 amp

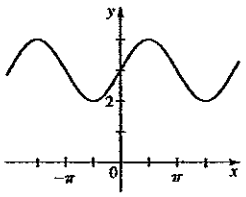
82. $H(0) = 175$ m, $H(1) = 150.4$ m, $H(2) = 100$ m, $H(4) = 38.6$ m, $H(6) = 100$ m, $H(8) = 150.3$ m, $H(12) = 58.8$ m

Section 4.3 ■ page 328

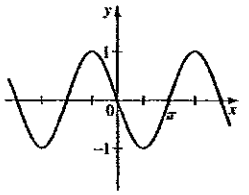
1.



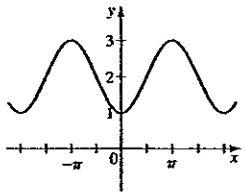
2.



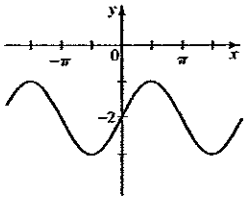
3.



4.



5.



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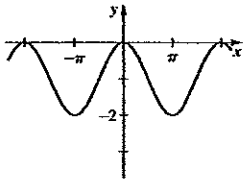

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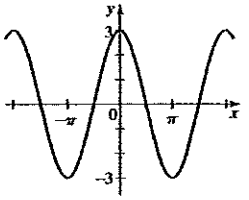

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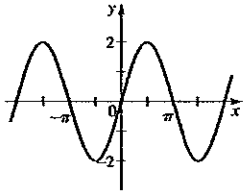

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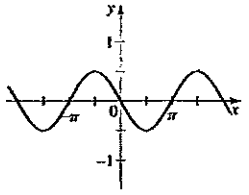

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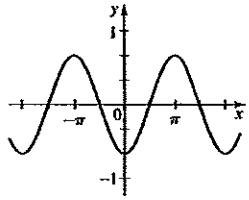

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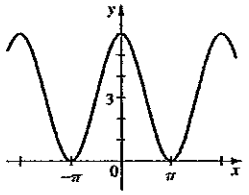

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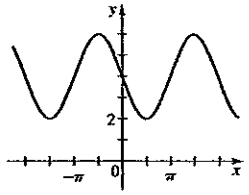

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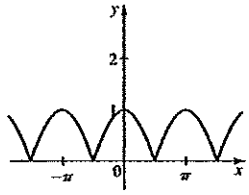

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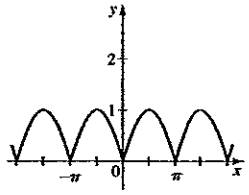
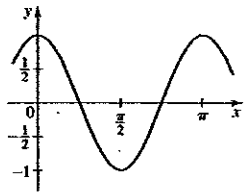
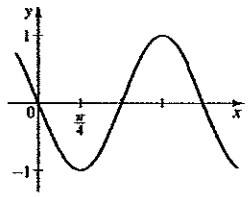


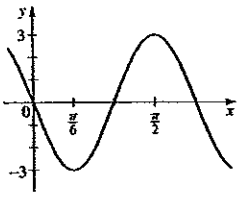
15. 1, π



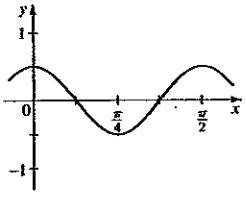
16. 1, π



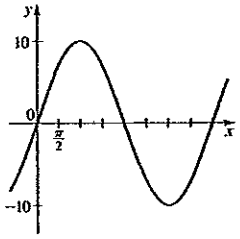
17. 3, $2\pi/3$



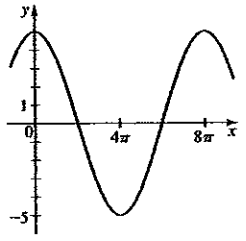
18. $\frac{1}{2}$, $\pi/2$



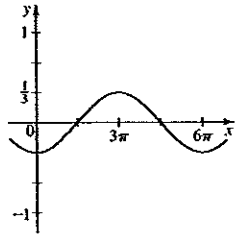
19. 10, 4π



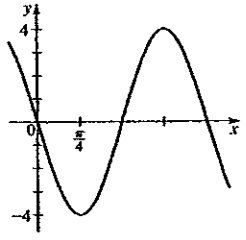
20. 5, 8π



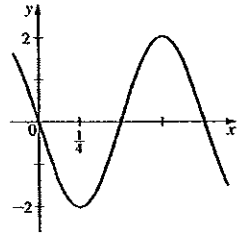
21. $\frac{1}{3}$, 6π



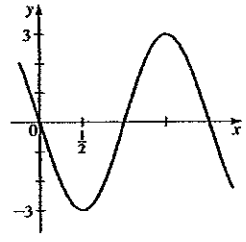
22. 4, π



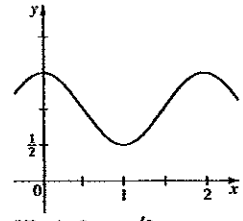
23. 2, 1



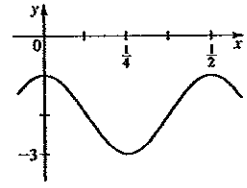
24. 3, 2



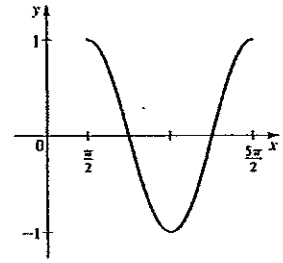
25. $\frac{1}{2}$, 2



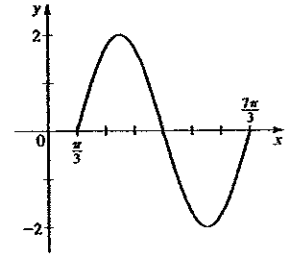
26. 1, $\frac{1}{2}$



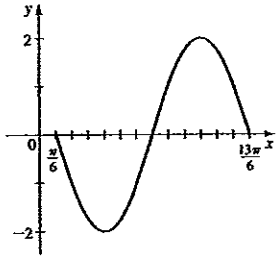
27. 1, 2π, $\pi/2$



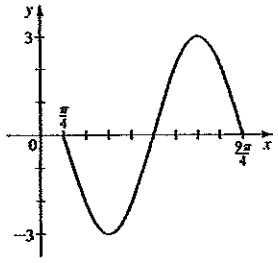
28. 2, 2π, $\pi/3$



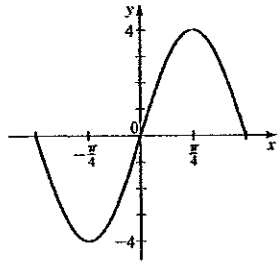
29. 2, 2π, $\pi/6$



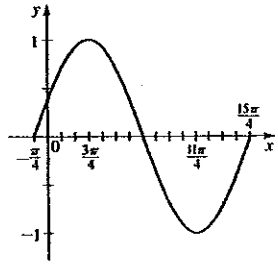
30. 3, 2π, $-\pi/4$



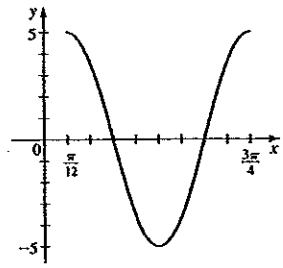
31. 4, π, $-\pi/2$



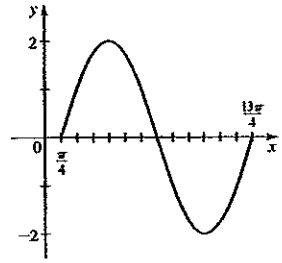
32. 1, 4π, $-\pi/4$



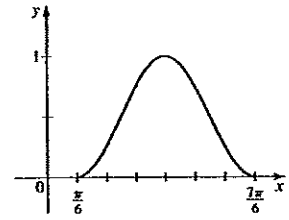
33. 5, $2\pi/3$, $\pi/12$



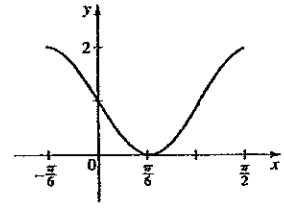
34. 2, 3π, $\pi/4$



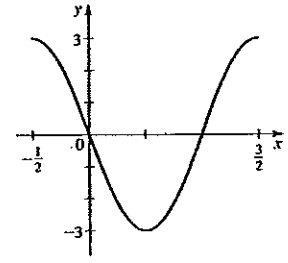
35. $\frac{1}{2}$, π, $\pi/6$



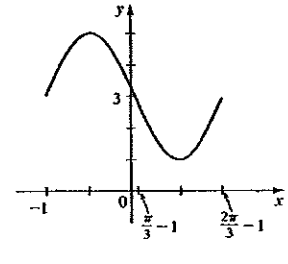
36. 1, $2\pi/3$, $-\pi/6$



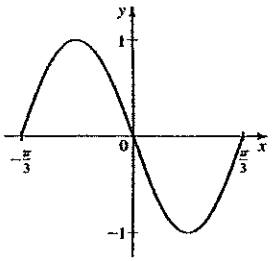
37. 3, 2, $-\frac{1}{2}$



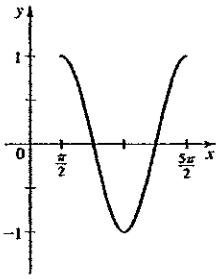
38. 2, $2\pi/3$, -1



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) $y = 3 \sin \frac{1}{2}x$

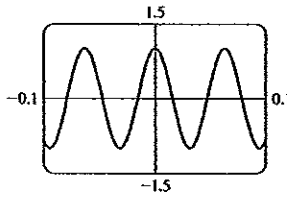
45. (a) $\frac{1}{2}, \pi, -\frac{\pi}{3}$ (b) $y = -\frac{1}{2} \cos 2(x + \pi/3)$

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

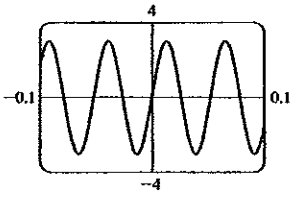
47. (a) $4, \frac{3}{2}, -\frac{1}{2}$ (b) $y = 4 \sin \frac{4\pi}{3}\left(x + \frac{1}{2}\right)$

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

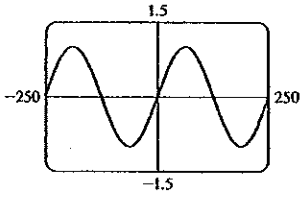
49.



50.



51.



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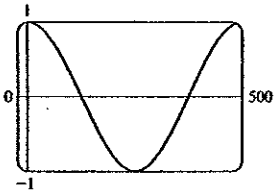
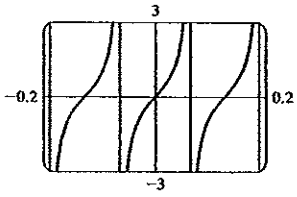


53.



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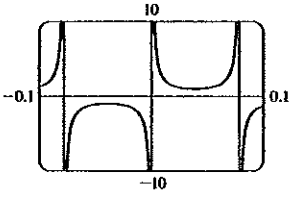

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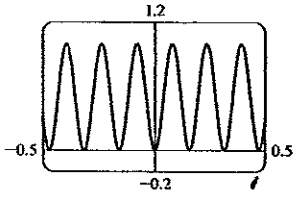

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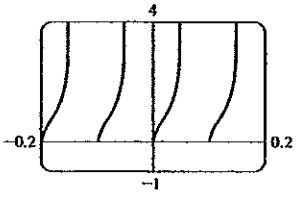

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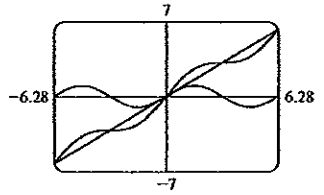
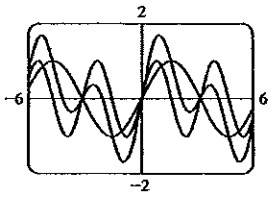


58.



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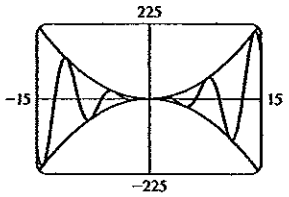
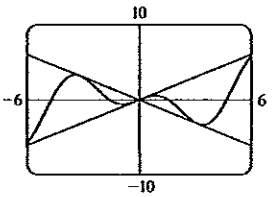


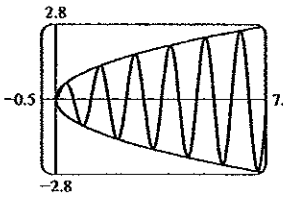
$y = x^2 \sin x$ is a sine curve that lies between the graphs of $y = x^2$ and $y = -x^2$

60.



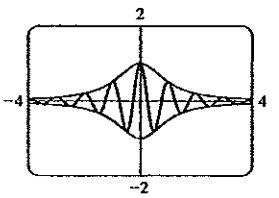
$y = x \cos x$ is a cosine curve that lies between the graphs of $y = x$ and $y = -x$

61.



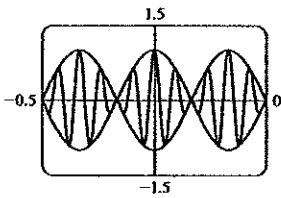
$y = \sqrt{x} \sin 5\pi x$ is a sine curve that lies between the graphs of $y = \sqrt{x}$ and $y = -\sqrt{x}$

62.



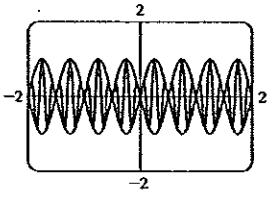
$y = \dfrac{\cos 2\pi x}{1 + x^2}$ is a cosine curve that lies between the graphs of $y = \dfrac{1}{1 + x^2}$ and $y = -\dfrac{1}{1 + x^2}$

63.



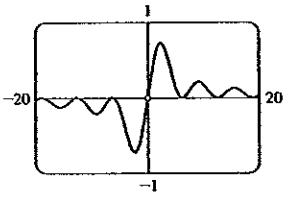
$y = \cos 3\pi x \cos 21\pi x$ is a cosine curve that lies between the graphs of $y = \cos 3\pi x$ and $y = -\cos 3\pi x$

64.



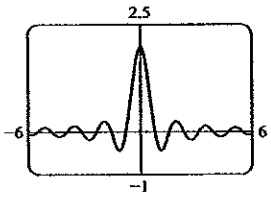
$y = \sin 2\pi x \sin 10\pi x$ is a sine curve that lies between the graphs of $y = \sin 2\pi x$ and $y = -\sin 2\pi x$

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) $0, \pm 2\pi, \pm 4\pi, \pm 6\pi, \ldots$
(c)



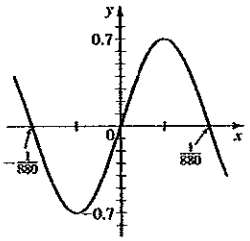
(d) $f(x)$ approaches 0
(e) $f(x)$ approaches 0

74. (a) Even
(b) $0, \pm\pi/4, \pm 2\pi/4, \pm 3\pi/4, \ldots$
(c)

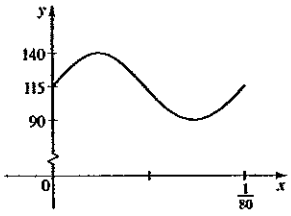


(d) $f(x)$ approaches 0
(e) $f(x)$ approaches 2

75. (a) 20 s (b) 6 ft
76. (a) $\frac{1}{440}$ s (b) 440 (c)

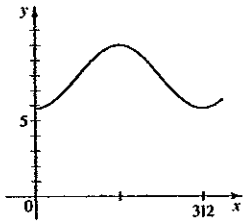


77. (a) $\frac{1}{80}$ min (b) 80
(c)



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

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



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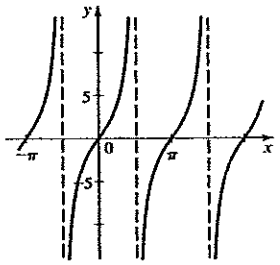
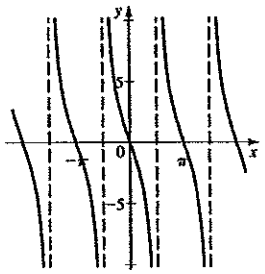
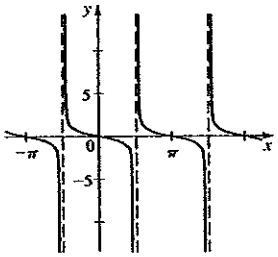
1. II **2.** III **3.** VI **4.** I **5.** IV **6.** V
7. π



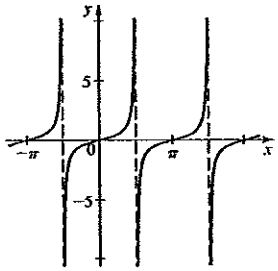
8. π



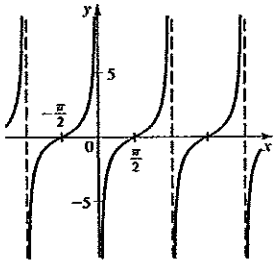
9. π



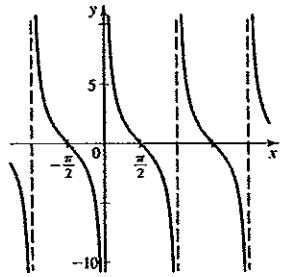
10. π



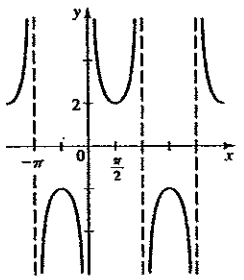
11. π



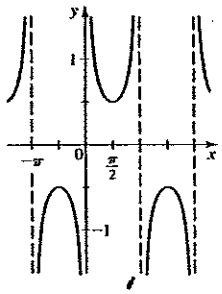
12. π



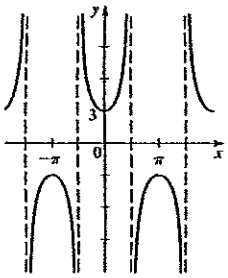
13. 2π



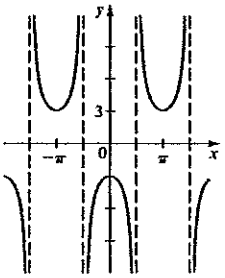
14. 2π



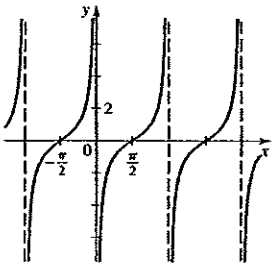
15. 2π



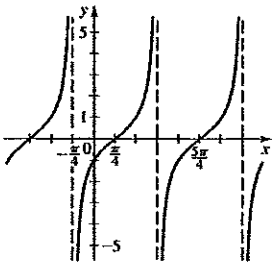
16. 2π



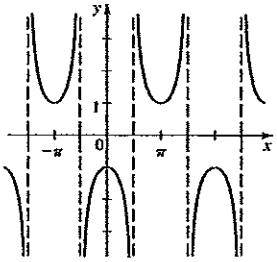
17. π



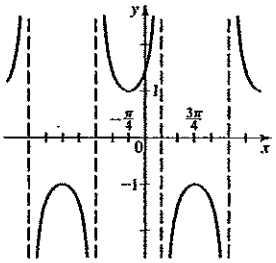
18. π



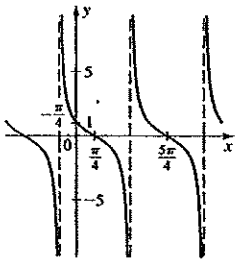
19. 2π



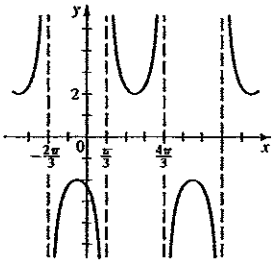
20. 2π



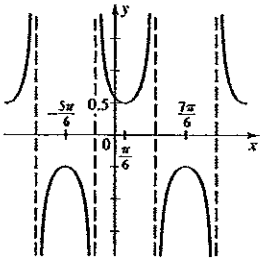
21. π



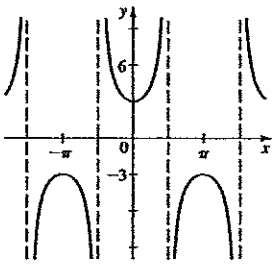
22. 2π



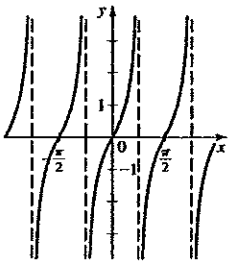
23. 2π



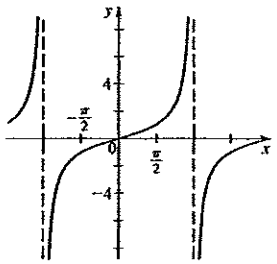
24. 2π



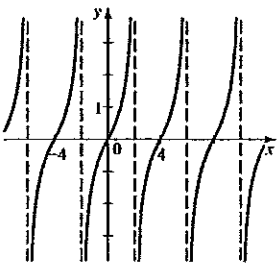
25. $\pi/2$



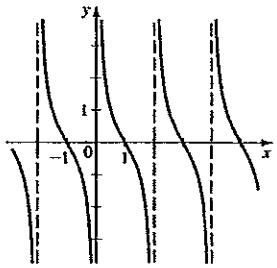
26. 2π



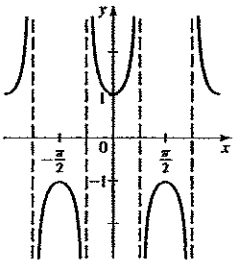
27. 4



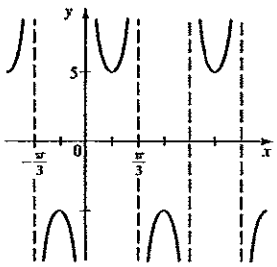
28. 2



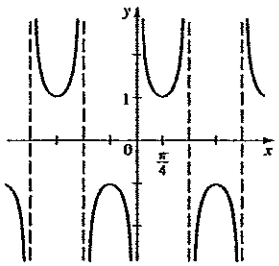
29. π



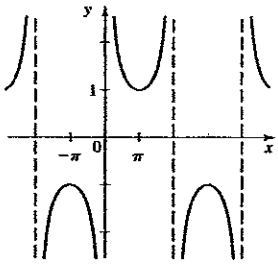
30. $2\pi/3$



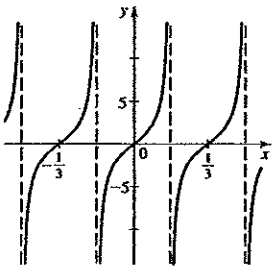
31. π



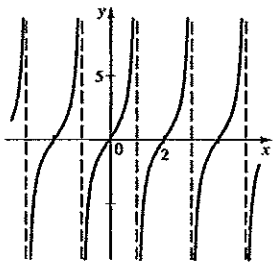
32. 4π



33. $\frac{1}{3}$

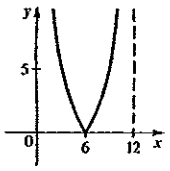


34. 2



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

(b)



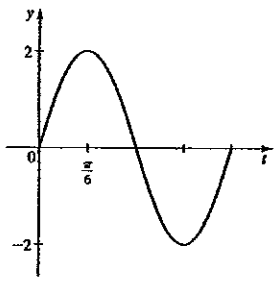
(c) 3, 9; 9:00 A.M., 3:00 P.M.

(d) The shadow gets increasingly longer.

Section 4.5 ■ page 478

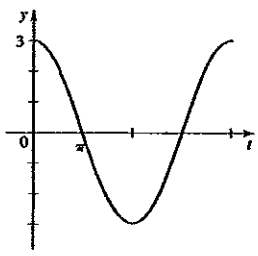
1. (a) $2, 2\pi/3, 3/(2\pi)$

(b)



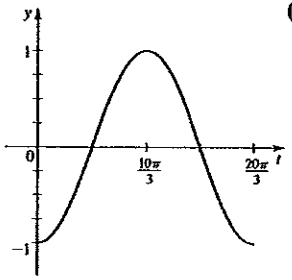
2. (a) $3, 4\pi, 1/(4\pi)$

(b)



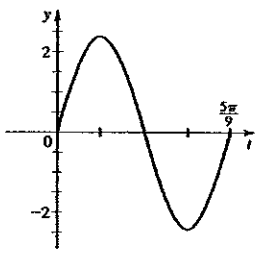
3. (a) $1, 20\pi/3, 3/(20\pi)$

(b)

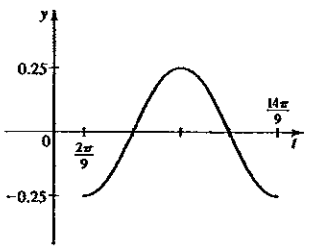


4. (a) $2.4, 5\pi/9, 9/(5\pi)$

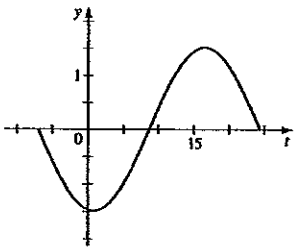
(b)



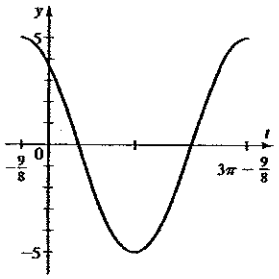
5. (a) $\frac{1}{4}, 4\pi/3, 3/(4\pi)$ (b)



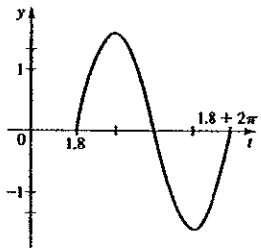
6. (a) $\frac{3}{2}, 10\pi, 1/(10\pi)$ (b)



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



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

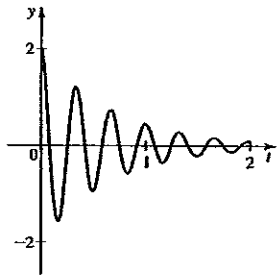


9. $y = 10 \sin\left(\frac{2\pi}{3}t\right)$ **10.** $y = 24 \sin(\pi t)$ **11.** $y = 6 \sin(10t)$

12. $y = 1.2 \sin(\pi t)$ **13.** $y = 60 \cos(4\pi t)$ **14.** $y = 35 \cos(\frac{1}{4}\pi t)$

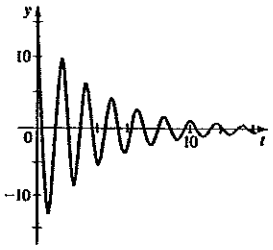
15. $y = 2.4 \cos(1500\pi t)$ **16.** $y = 6.25 \cos(120\pi t)$

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



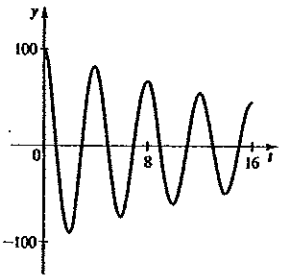
18. (a) $y = 15e^{-0.25t} \cos(1.2\pi t)$

(b)



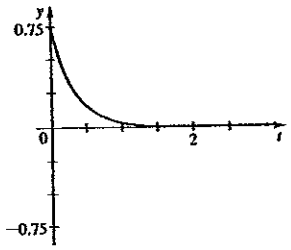
19. (a) $y = 100e^{-0.05t} \cos \frac{\pi}{2}t$

(b)

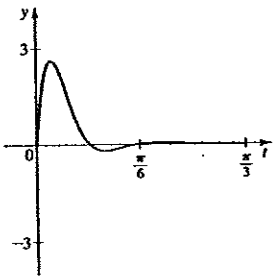


20. (a) $y = 0.75e^{-3t}\cos\left(\frac{2}{3}t\right)$

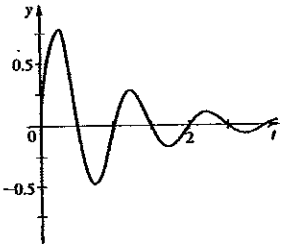
(b)



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

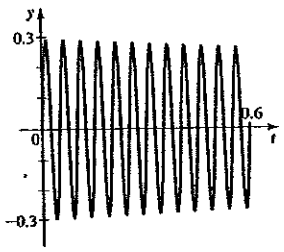


22. (a) $y = e^{-t}\sin(2\pi t)$ (b)



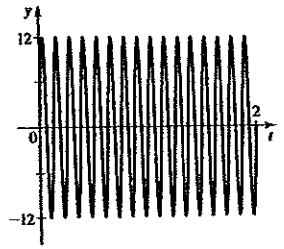
23. (a) $y = 0.3e^{-0.2t}\sin(40\pi t)$

(b)



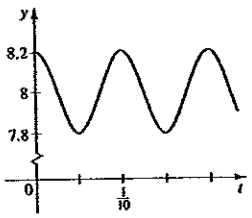
24. (a) $y = 12e^{-0.01t}\sin(16\pi t)$

(b)



25. (a) 10 cycles per minute

(b)

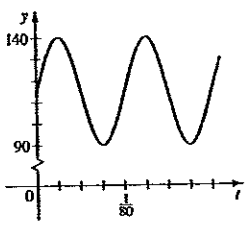


(c) 0.4 m

26. $1.09 \times 10^{-8}, 9.15 \times 10^{7}$

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

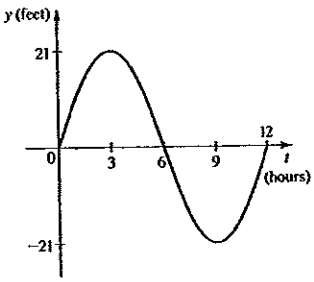
28. (a) 25, 0.0125, 80 (b)



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

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

Chapter 4 Review

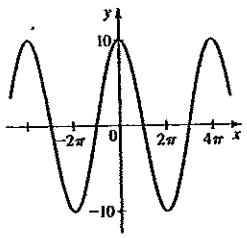
1. (b) $\frac{1}{2}, -\sqrt{3}/2, -\sqrt{3}/3$ **2.** (b) $-\frac{4}{5}, \frac{3}{5}, -\frac{4}{3}$
3. (a) $\pi/3$ (b) $\left(-\frac{1}{2}, \sqrt{3}/2\right)$
(c) $\sin t = \sqrt{3}/2, \cos t = -\frac{1}{2}, \tan t = -\sqrt{3}, \csc t = 2\sqrt{3}/3,$ $\sec t = -2, \cot t = -\sqrt{3}/3$
4. (a) $\pi/3$ (b) $\left(\frac{1}{2}, -\sqrt{3}/2\right)$ (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) $\left(-\sqrt{3}/2, \frac{1}{2}\right)$
(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.** $\dfrac{1 - \cos^2 t}{\cos^3 t}$

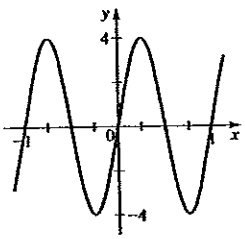
19. $(\sin t)/\sqrt{1 - \sin^2 t}$ **20.** $\dfrac{1}{-\sqrt{1 - \sin^2 t}}$

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

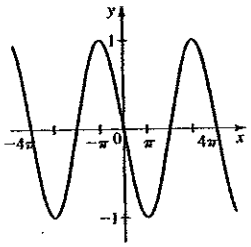
29. (a) 10, 4π, 0
(b)



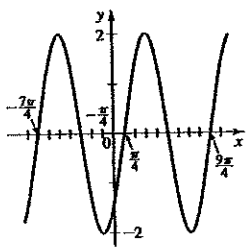
30. (a) 4, 1, 0
(b)



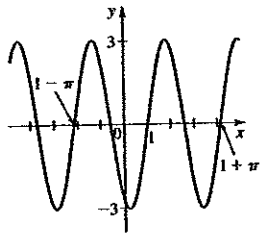
31. (a) 1, 4π, 0
(b)



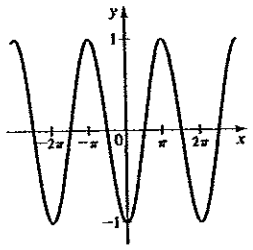
32. (a) 2, 2π, $\pi/4$
(b)



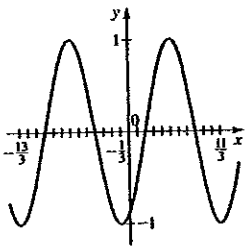
33. (a) 3, π, 1
(b)



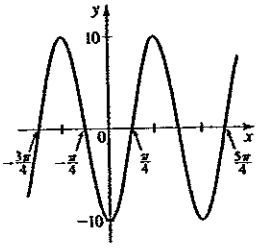
34. (a) 1, π, $\pi/2$
(b)



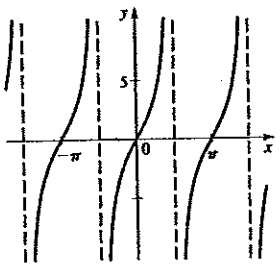
35. (a) 1, 4, $-\frac{1}{3}$
(b)

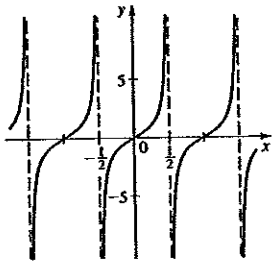


36. (a) 10, π, $\pi/4$
(b)

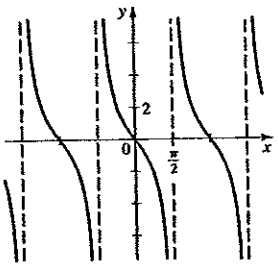


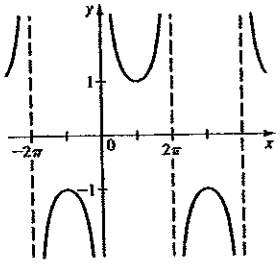
37. $y = 5\sin 4x$
38. $y = 2\sin\left(\frac{\pi}{2}x\right)$
39. $y = \frac{1}{2}\sin 2\pi\left(x + \frac{1}{3}\right)$
40. $y = 4\sin\frac{3}{2}(x + \pi/3)$
41. π
42. 1



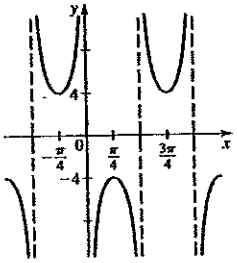


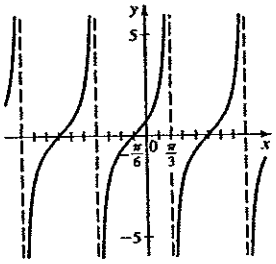
43. π
44. 4π



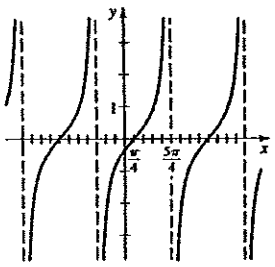


45. π
46. π

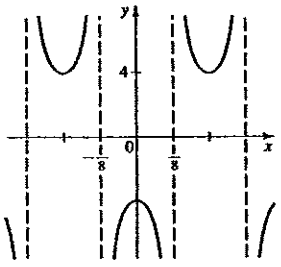




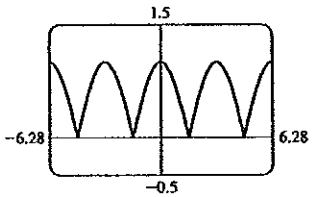
47. 2π



48. $\frac{1}{2}$

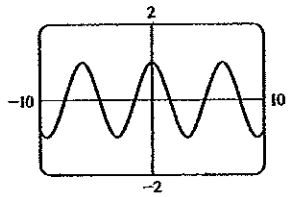


49. (a)



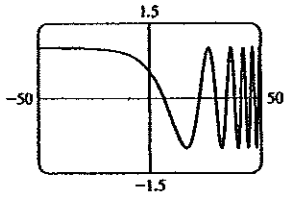
(b) Period π
(c) Even

50. (a)



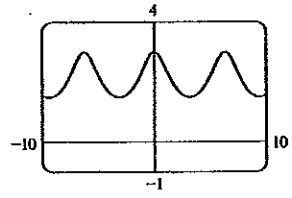
(b) Period 2π
(c) Even

51. (a)



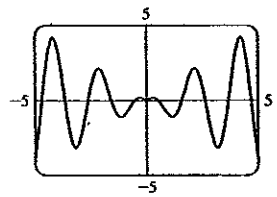
(b) Not periodic
(c) Neither

52. (a)



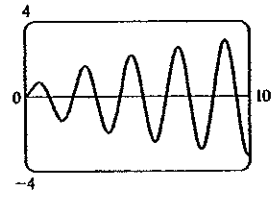
(b) Period 2π
(c) Even

53. (a)



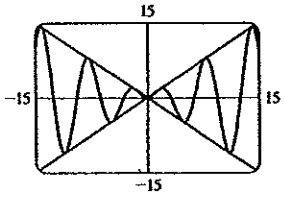
(b) Not periodic
(c) Even

54. (a)



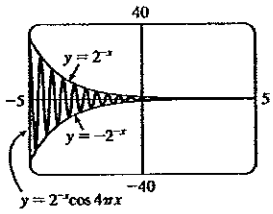
(b) Not periodic
(c) Neither

55.



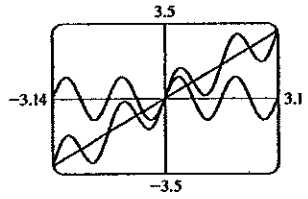
$y = x \sin x$ is a sine function whose graph lies between those of $y = x$ and $y = -x$

56.



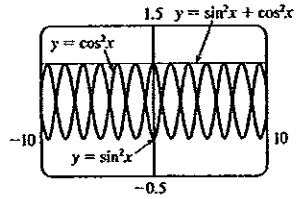
$y = 2^{-x} \cos 4\pi x$ is a cosine function whose graph lies between the graphs of $y = 2^{-x}$ and $y = -2^{-x}$

57.



The graphs are related by graphical addition.

58.

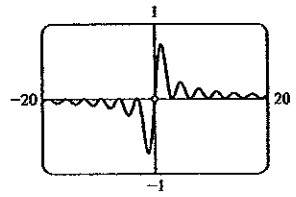


The graphs are related by graphical addition.

59. 1.76, −1.76 **60.** 1.25, −1 **61.** 0.30, 2.84 **62.** 0.390

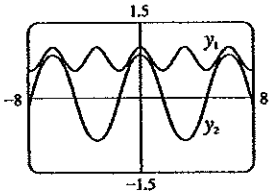
63. (a) Odd (b) $0, \pm\pi, \pm 2\pi, \ldots$

(c)



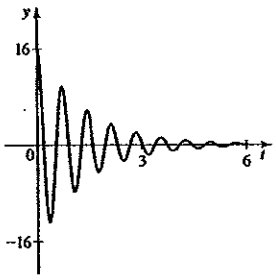
(d) $f(x)$ approaches 0
(e) $f(x)$ approaches 0

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)

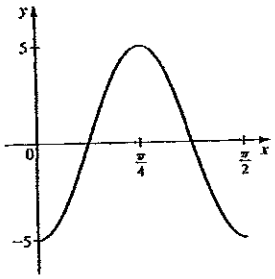


(c) 0.012 cm

Chapter 4 Test ■ page 458

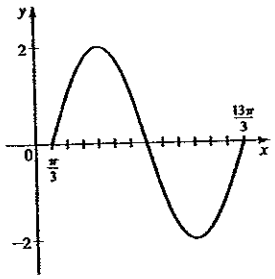
1. $y = -\frac{5}{6}$ 2. (a) $\frac{4}{5}$ (b) $-\frac{3}{5}$ (c) $-\frac{4}{3}$ (d) $-\frac{5}{3}$
3. (a) $-\frac{1}{2}$ (b) $-\sqrt{2}/2$ (c) $\sqrt{3}$ (d) -1
4. $\tan t = -(\sin t)/\sqrt{1 - \sin^2 t}$ 5. $-\frac{2}{15}$
6. (a) $5, \pi/2, 0$

(b)

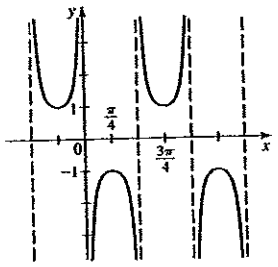


7. (a) $2, 4\pi, \pi/3$

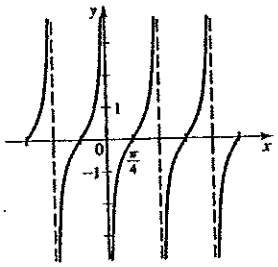
(b)



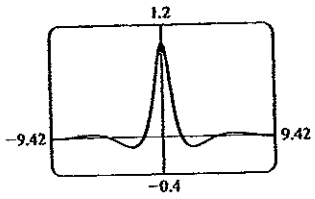
8. π



9. $\pi/2$

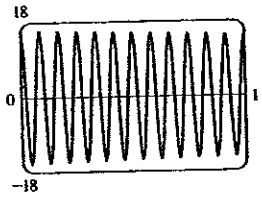


10. $y = 2 \sin 2(x + \pi/3)$
11. (a)



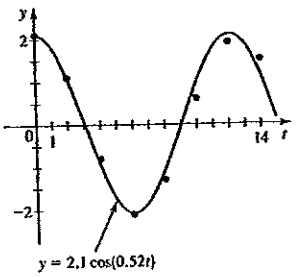
(b) Even
(c) Minimum value -0.11 when $x \approx \pm 2.54$, maximum value 1 when $x = 0$

12. $y = 5 \sin(4\pi t)$
13. $y = 16e^{-0.1t} \cos 24\pi t$



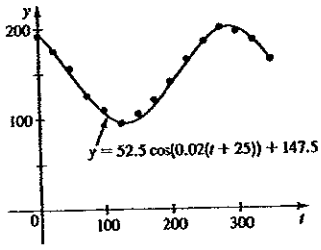
Focus on Modeling ■ page 463

1. (a) and (c)



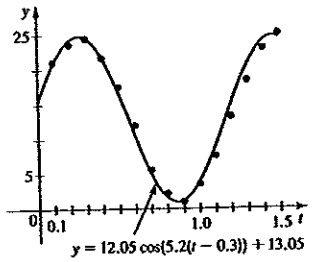
(b) $y = 2.1 \cos(0.52t)$
(d) $y = 2.05 \sin(0.50t + 1.55) - 0.01$ (e) The formula of (d) reduces to $y = 2.05 \cos(0.50t - 0.02) - 0.01$. Same as (b), correct to one decimal.

2. (a) and (c)



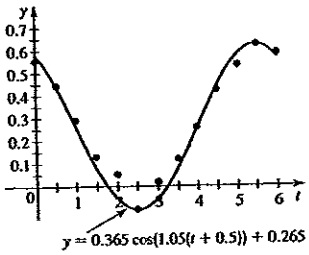
(b) $y = 52.5 \cos(0.02(t + 25)) + 147.5$
(d) $y = 49.70 \sin(0.02t + 2.09) + 149.13$ (e) The formula of (d) reduces to $y = 49.70 \cos(0.02t + 0.52) + 149.13$. Close, but not identical, to (b).

3. (a) and (c)



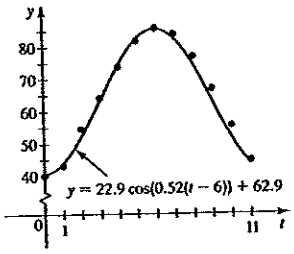
(b) $y = 12.05 \cos(5.2(t - 0.3)) + 13.05$
(d) $y = 11.72 \sin(5.05t + 0.24) + 12.96$ (e) The formula of (d) reduces to $y = 11.72 \cos(5.05(t - 0.26)) + 12.96$. Close, but not identical, to (b).

4. (a) and (c)



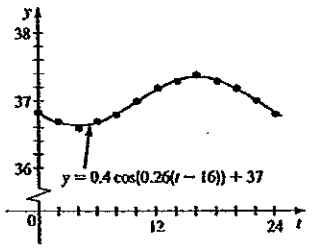
(b) $y = 0.365 \cos(1.05(t + 0.5)) + 0.265$
(d) $y = 0.33 \sin(1.02t + 2.12) + 0.29$ (e) The formula of (d) reduces to $y = 0.33 \cos(1.02(t + 0.52)) + 0.29$. Same as (b), correct to one decimal.

5. (a) and (c)



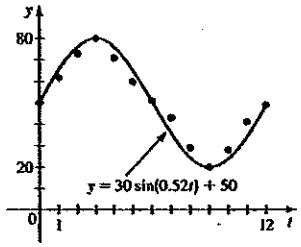
(b) $y = 22.9\cos(0.52(t - 6)) + 62.9$, where y is temperature (°F) and t is months (January = 0)
(d) $y = 23.4\sin(0.48t - 1.36) + 62.2$

6. (a) and (c)



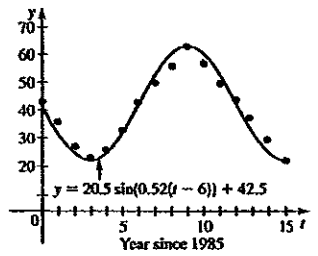
(b) $y = 0.4\cos(0.26(t - 16)) + 37$, where y is the body temperature (°C) and t is hours since midnight
(d) $y = 0.37\sin(0.26t - 2.62) + 37.0$

7. (a) and (c)



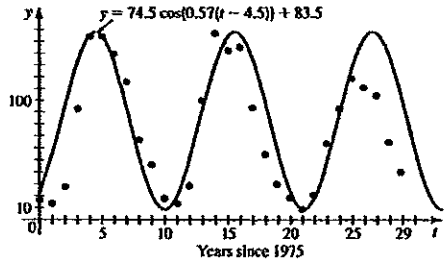
(b) $y = 30\sin(0.52t) + 50$ where y is the owl population in year t (d) $y = 25.8\sin(0.52t - 0.02) + 50.6$

8. (a) and (c)



(b) $y = 20.5\sin(0.52(t - 6)) + 42.5$, where y is the salmon population (× 1000), and t is years since 1985
(d) $y = 17.8\sin(0.52t + 3.11) + 42.4$

9. (a) and (c)

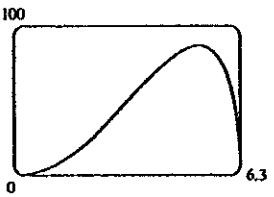


(b) $y = 74.5\cos(0.57(t - 4.5)) + 83.5$, where y is the average daily sunspot count, and t is the years since 1975
(d) $y = 67.65\sin(0.62t - 1.65) + 74.5$

Chapter 5 Solutions

Section 5.1 ■ 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. $540/\pi \approx 171.9°$ **18.** $-360/\pi \approx 114.6°$
19. $-216/\pi \approx 68.8°$ **20.** $612/\pi \approx 194.8°$
21. 18° **22.** 50° **23.** −24° **24.** −195°
25. 410°, 770°, −310°, −670° **26.** 495°, 855°, −225°, −585°
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°, 675°, −405°, −765° **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.** $360/\pi \approx 114.6°$ **51.** 4
52. $5\pi/2 \approx 7.85$ m **53.** 4 mi **54.** $216/\pi \approx 68.8°$, 1.2 rad
55. 2 rad ≈ 114.6° **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 ≈ 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)

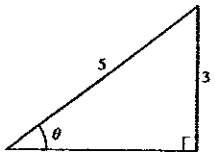


(c) 5.13 rad **88.** $11.5\pi \approx 36.128$ rad, $\dfrac{23\pi}{24} \approx 3.011$ rad

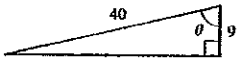
Section 5.2 ■ page 484

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.** $\sin\theta = \frac{15}{17}$, $\cos\theta = \frac{8}{17}$, $\tan\theta = \frac{15}{8}$, $\csc\theta = \frac{17}{15}$, $\sec\theta = \frac{17}{8}$, $\cot\theta = \frac{8}{15}$

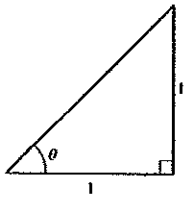
5. $\sin\theta = 2\sqrt{13}/13, \cos\theta = 3\sqrt{13}/13, \tan\theta = \frac{2}{3}$, $\csc\theta = \sqrt{13}/2, \sec\theta = \sqrt{13}/3, \cot\theta = \frac{3}{2}$
6. $\sin\theta = \frac{7}{8}, \cos\theta = \sqrt{15}/8, \tan\theta = 7\sqrt{15}/15$, $\csc\theta = \frac{8}{7}, \sec\theta = 8\sqrt{15}/15, \cot\theta = \sqrt{15}/7$
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. $\cos\theta = \frac{4}{5}, \tan\theta = \frac{3}{4}, \csc\theta = \frac{5}{3}, \sec\theta = \frac{5}{4}, \cot\theta = \frac{4}{3}$



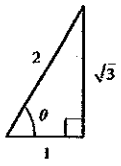
18. $\sin\theta = 7\sqrt{31}/40, \tan\theta = 7\sqrt{31}/9, \csc\theta = 40\sqrt{31}/217$, $\sec\theta = \frac{40}{9}, \cot\theta = 9\sqrt{31}/217$



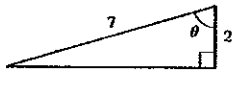
19. $\sin\theta = \sqrt{2}/2, \cos\theta = \sqrt{2}/2, \tan\theta = 1$, $\csc\theta = \sqrt{2}, \sec\theta = \sqrt{2}$



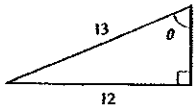
20. $\sin\theta = \sqrt{3}/2, \cos\theta = \frac{1}{2}, \csc\theta = 2\sqrt{3}/3$, $\sec\theta = 2, \cot\theta = \sqrt{3}/3$



21. $\sin\theta = 3\sqrt{5}/7, \cos\theta = \frac{2}{7}, \tan\theta = 3\sqrt{5}/2$, $\csc\theta = 7\sqrt{5}/15, \cot\theta = 2\sqrt{5}/15$

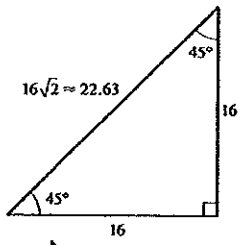


22. $\sin\theta = \frac{12}{13}, \cos\theta = \frac{5}{13}, \tan\theta = \frac{12}{5}, \sec\theta = \frac{13}{5}, \cot\theta = \frac{5}{12}$



23. $(1 + \sqrt{3})/2$ 24. 1 25. 1 26. 1 27. $\frac{1}{2}$
28. $\frac{1}{4}(2 - \sqrt{3})$

29.



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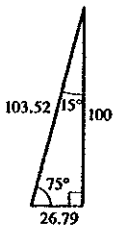

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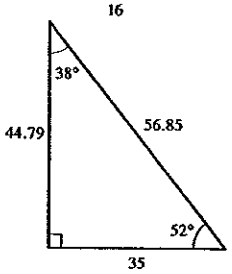
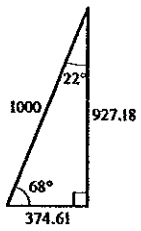


32.



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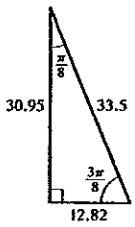
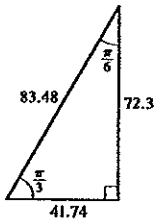


34.



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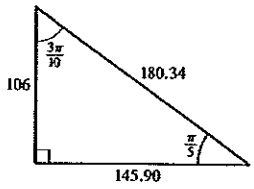
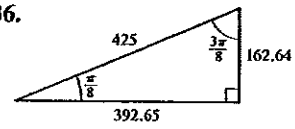


36.



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. $\sin 40° \approx 0.64$, $\cos 40° \approx 0.77, \tan 40° \approx 0.83, \csc 40° \approx 1.56$, $\sec 40° \approx 1.39, \cot 40° \approx 1.20$ 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 5.3

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

33. III **34.** IV **35.** IV **36.** II

37. $\tan\theta = -\sqrt{1-\cos^2\theta}/\cos\theta$ **38.** $\cot\theta = -\dfrac{\sqrt{1-\sin^2\theta}}{\sin\theta}$

39. $\cos\theta = \sqrt{1-\sin^2\theta}$ **40.** $\sec\theta = \dfrac{1}{\sqrt{1-\sin^2\theta}}$

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

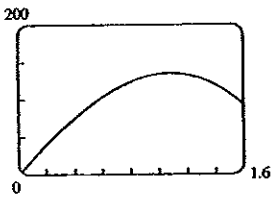
55. 66.1° **56.** $\sqrt{96}$ cm $\approx$ 9.8 cm **57.** $(4\pi/3) - \sqrt{3} \approx 2.46$

58. $120\pi + 36\sqrt{3} \approx 439.3$

61. (b)

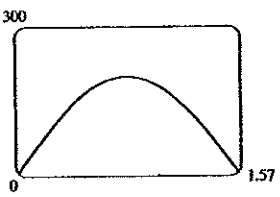
θ	20°	60°	80°	85°
h	1922	9145	29,944	60,351

62. (b)



(c) 60° **63.** (a) $A(\theta) = 400 \sin\theta\cos\theta$

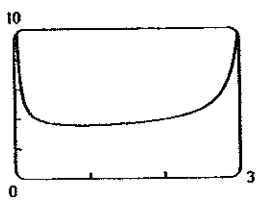
(b)



(c) width = depth $\approx$ 14.14 in. **64.** $S(\theta) = 8000\,k\cos\theta\sin^2\theta$

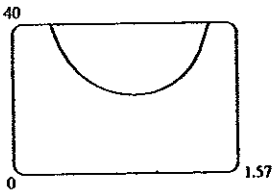
65. (a) $9\sqrt{3}/4$ ft $\approx$ 3.897 ft, $\frac{9}{16}$ ft = 0.5625 ft (b) 23.982 ft, 3.462 ft **66.** 15.8 s

67. (a)



(b) 0.946 rad or 54°

68. (b)



(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.** 144.9

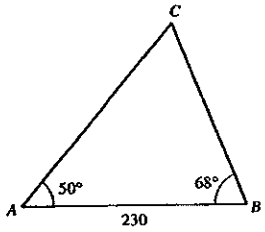
7. $\angle C = 114°$, $a \approx 51$, $b \approx 24$

8. $\angle B = 50°$, $a \approx 1.31$, $c \approx 2.57$

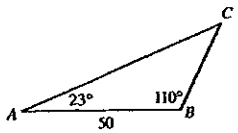
9. $\angle A = 44°$, $\angle B = 68°$, $a \approx 8.99$

10. $\angle B \approx 31.0°$, $\angle C \approx 69°$, $c \approx 6.2$

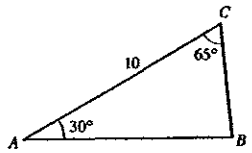
11. $\angle C = 62°$, $a \approx 200$, $b \approx 242$



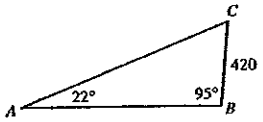
12. $\angle C = 47°$, $a \approx 26.7$, $b \approx 64.2$



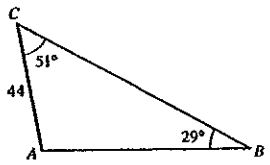
13. $\angle B = 85°$, $a \approx 5$, $c \approx 9$



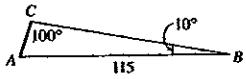
14. $\angle C = 63°$, $b \approx 1116.9$, $c \approx 999.0$



15. $\angle A = 100°$, $a \approx 89$, $c \approx 71$



16. $\angle A = 70°$, $a \approx 109.7$, $b \approx 20.3$



17. $\angle B \approx 30°$, $\angle C \approx 40°$, $c \approx 19$

18. $\angle B_1 \approx 89.6°$, $\angle C_1 \approx 53.4°$, $b_1 \approx 49.8$; $\angle B_2 \approx 16.4°$, $\angle C_2 \approx 126.6°$, $b_2 \approx 14.1$ **19.** No solution

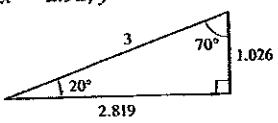
20. $\angle A_1 \approx 100.7°$, $\angle B_1 \approx 41.3°$, $a_1 \approx 67.0$; $\angle A_2 \approx 3.3°$, $\angle B_2 \approx 138.7°$, $a_2 \approx 3.9$
21. $\angle A_1 \approx 125°$, $\angle C_1 \approx 30°$, $a_1 \approx 49$; $\angle A_2 \approx 5°$, $\angle C_2 \approx 150°$, $a_2 \approx 5.6$
22. $\angle B_1 \approx 41.8°$, $\angle C_1 \approx 108.2°$, $c_1 \approx 142.5$; $\angle B_2 \approx 138.2°$, $\angle C_2 \approx 11.8°$, $c_2 \approx 30.7$ 23. No solution
24. $\angle B \approx 34.4°$, $\angle C = 10.6°$, $c \approx 25.9$
25. $\angle A_1 \approx 57.2°$, $\angle B_1 \approx 93.8°$, $b_1 \approx 30.9$; $\angle A_2 \approx 122.8°$, $\angle B_2 \approx 28.2°$, $b_2 \approx 14.6$
26. $\angle A_1 \approx 49.7°$, $\angle C_1 \approx 72.3°$, $a_1 \approx 65.7$; $\angle A_2 \approx 14.3°$, $\angle C_2 \approx 107.7°$, $a_2 \approx 21.3$
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 [illegible]

1. 28.9 2. 26.8 3. 47 4. 8.2 5. 29.89° 6. 111°
7. 15 8. 130.54° 9. $\angle A \approx 39.4°$, $\angle B \approx 20.6°$, $c \approx 24.6$
10. $\angle A \approx 63.0°$, $\angle B \approx 15.5°$, $\angle C \approx 101.5°$
11. $\angle A \approx 48°$, $\angle B \approx 79°$, $c \approx 3.2$
12. $\angle B \approx 80.5°$, $\angle C \approx 29.5°$, $a \approx 57.2$
13. $\angle A \approx 50°$, $\angle B \approx 73°$, $\angle C \approx 57°$
14. $\angle A \approx 38.6°$, $\angle B \approx 48.5°$, $\angle C \approx 92.9°$
15. $\angle A_1 \approx 83.6°$, $\angle C_1 \approx 56.4°$, $a_1 \approx 193$; $\angle A_2 \approx 16.4°$, $\angle C_2 \approx 123.6$, $a_2 \approx 54.9$ 16. No such triangle
17. No such triangle 18. $\angle A = 36°$, $b \approx 109.4$, $c \approx 124.1$
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 cm^2 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 [illegible] Review

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) $(558/\pi)° \approx 177.6°$
4. (a) $(1440/\pi)° \approx 458.37°$ (b) $(450/\pi)° \approx 143.24°$
(c) 330° (d) 108° 5. 8 m 6. 1.4 rad ≈ 80.2°
7. 82 ft 8. 21,609 9. 0.619 rad ≈ 35.4° 10. 25 m^2
11. 18,151 ft^2 12. 0.4 rad ≈ 22.9°
13. 300π rad/min ≈ 942.5 rad/min, 7539.8 in./min = 628.3 ft/min
14. (a) 7000π rad/min ≈ 21,991 rad/min
(b) 7777.8π rad/min ≈ 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. $x \approx 3.46$, $y \approx 1.73$
21.



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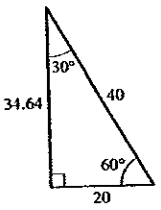


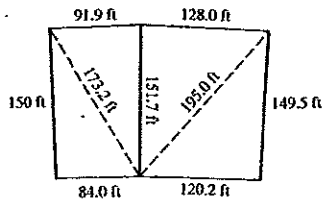
23. $a = \cot\theta$, $b = \csc\theta$ 24. 550 m
25. 48 m
26. $h = \sqrt{64 - 4\cos^2\theta} + 2\sin\theta$
27. 1076 mi 28. 14,400 ft
29. $-\sqrt{2}/2$ 30. $\sqrt{2}$
31. 1 32. $-\sqrt{3}/2$ 33. $-\sqrt{3}/3$
34. $\sqrt{2}/2$ 35. $-\sqrt{2}/2$ 36. −2
37. $2\sqrt{3}/3$ 38. $2\sqrt{3}/3$ 39. $-\sqrt{3}$ 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. $\csc^2\theta\cos^2\theta = \dfrac{1}{\sin^2\theta} - 1$
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 [illegible] Test

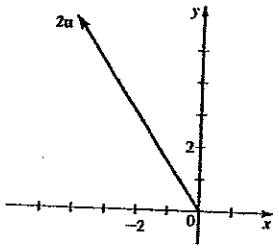
1. $11\pi/6$, $-3\pi/4$ 2. 240°, −74.5°
3. (a) 240π rad/min ≈ 753.98 rad/min
(b) 12,063.7 ft/min = 137 mi/h 4. (a) $\sqrt{2}/2$
(b) $\sqrt{3}/3$ (c) 2 (d) 1 5. $(26 + 6\sqrt{13})/39$
6. $a = 24\sin\theta$, $b = 24\cos\theta$ 7. $(4 - 3\sqrt{2})/4$
8. $-\frac{13}{12}$ 9. $\tan\theta = -\sqrt{\sec^2\theta - 1}$ 10. 19.6 ft
11. 9.1 12. 250.5 13. 8.4 14. 19.5 15. (a) 15.3 m^2
(b) 24.3 m 16. (a) 129.9° (b) 44.9 17. 554 ft

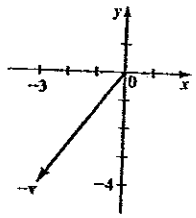
Focus on Modeling

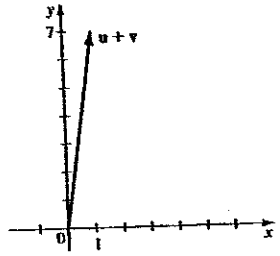
1. 1.41 mi 2. 1.31 mi
3. 14.3 m 4. 119.2 m
5. (c) 2349.8 ft 6. 4194 ft
7.

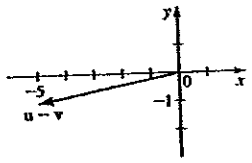


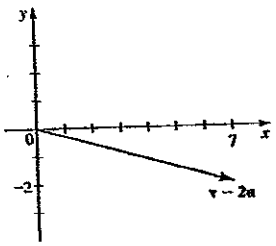
Section 5.6

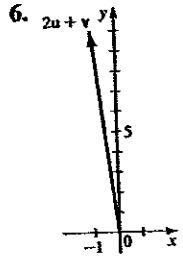
1. 

2. 

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. $800 \cos 125°\mathbf{i} + 800 \sin 125°\mathbf{j} \approx -458.86\mathbf{i} + 655.32\mathbf{j}$
31. $4 \cos 10°\mathbf{i} + 4 \sin 10°\mathbf{j} \approx 3.94\mathbf{i} + 0.69\mathbf{j}$
32. $\frac{\sqrt{3}}{2}\mathbf{i} - \frac{3}{2}\mathbf{j}$ 33. 5, 53.13° 34. 1, 225° 35. 13, 157.38°
36. 41, 12.68° 37. 2, 60° 38. $\sqrt{2}$, 45° 39. $15\sqrt{3}$, −15
40. 469.85 mi/h, 171.01 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 mi/h, N 84.6° 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 mi/h, N 44°E
45. 794 mi/h, N 26.6°W 46. N 2.1°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 mi/h, N 49.1°E 48. N 30°W
49. (a) $22.8\mathbf{i} + 7.4\mathbf{j}$ (b) 7.4 mi/h, 22.8 mi/h
50. 25.08 mi/h, N 4.57°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 5.7

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 38. $\mathbf{u} \cdot \mathbf{v}$
39. 16 ft-lb 40. 82 ft-lb 41. 8660 ft-lb 42. 260,000 ft-lb
43. 1164 lb 44. (a) 2822 lb (b) 2779 lb 45. 23.6°
46. 54.6 lb

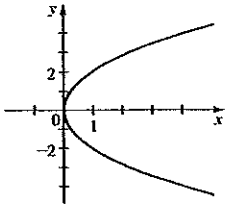
Chapter 6 Solutions

Section 6.1

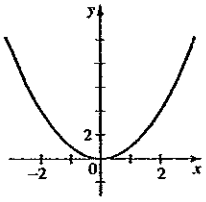
1. III **2.** V **3.** II **4.** I **5.** VI **6.** IV

Order of answers: focus; directrix; focal diameter

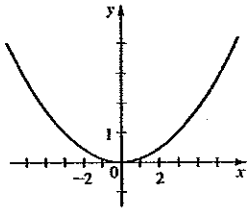
7. $F(1,0); x = -1; 4$



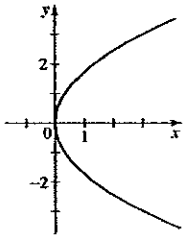
8. $F\left(0,\frac{1}{4}\right); y = -\frac{1}{4}; 1$



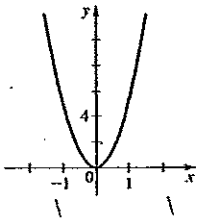
9. $F\left(0,\frac{9}{4}\right); y = -\frac{9}{4}; 9$



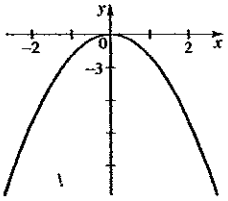
10. $F\left(\frac{3}{4},0\right); x = -\frac{3}{4}; 3$



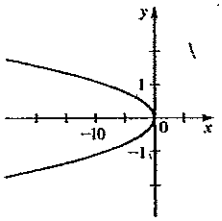
11. $F\left(0,\frac{1}{20}\right); y = -\frac{1}{20}; \frac{1}{5}$



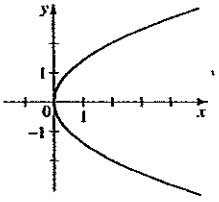
12. $F\left(0,-\frac{1}{8}\right); y = \frac{1}{8}; \frac{1}{2}$



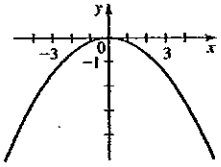
13. $F\left(-\frac{1}{32},0\right); x = \frac{1}{32}; \frac{1}{8}$



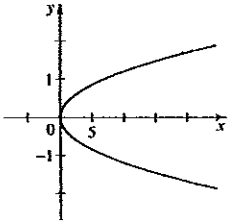
14. $F\left(\frac{1}{2},0\right); x = -\frac{1}{2}; 2$



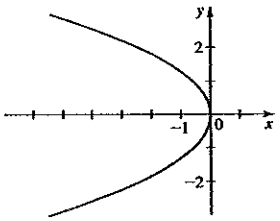
15. $F\left(0,-\frac{3}{2}\right); y = \frac{3}{2}; 6$



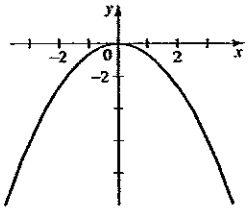
16. $F\left(\frac{1}{28},0\right); x = -\frac{1}{28}; \frac{1}{7}$



17. $F\left(-\frac{5}{12}, 0\right)$; $x = \frac{5}{12}$; $\frac{5}{3}$



18. $F\left(0, -\frac{3}{8}\right)$; $y = \frac{3}{8}$; $\frac{3}{2}$



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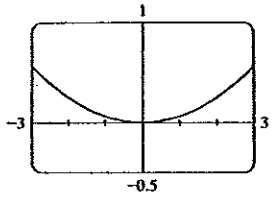

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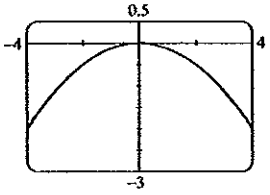

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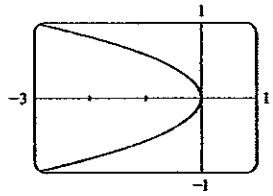
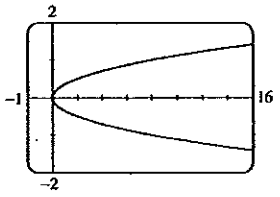


22.



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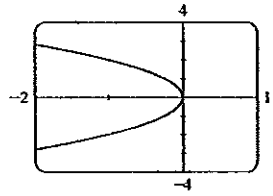

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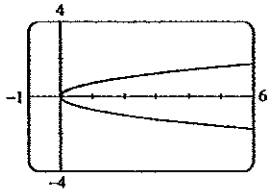
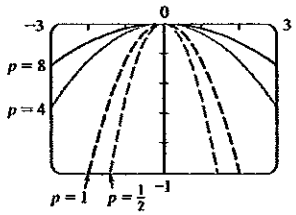
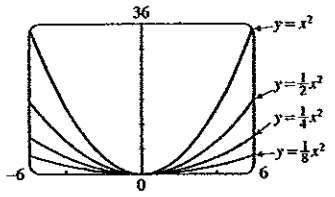


25. $x^2 = 8y$ 26. $x^2 = -2y$ 27. $y^2 = -32x$ 28. $y^2 = 20x$
29. $y^2 = -8x$ 30. $x^2 = -24y$ 31. $x^2 = 40y$ 32. $y^2 = \frac{1}{2}x$
33. $y^2 = 4x$ 34. $x^2 = -24y$ 35. $x^2 = 20y$ 36. $x^2 = -8y$
37. $x^2 = 8y$ 38. $y^2 = 8x$ 39. $y^2 = -16x$ 40. $x^2 = -12y$
41. $y^2 = -3x$ 42. $x^2 = 10y$ 43. $x = y^2$ 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)



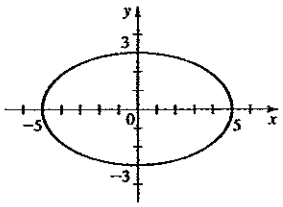
(b) The larger the focal diameter, the wider the parabola.
49. (a) $y^2 = 12x$ (b) $8\sqrt{15} \approx 31$ cm 50. 25 ft
51. $x^2 = 600y$ 52. 659.63 in.

Section 6.2

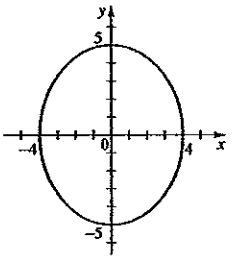
1. II 2. IV 3. I 4. III

Order of answers: vertices; foci; eccentricity; major axis and minor axis

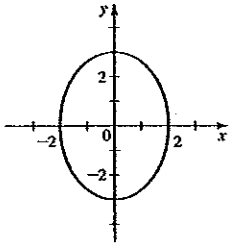
5. $V(\pm 5, 0)$; $F(\pm 4, 0)$; $\frac{4}{5}$; 10, 6



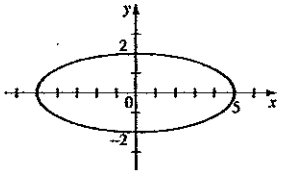
6. $V(\pm 5, 0)$; $F(0, \pm 3)$; 0.6; 10, 8



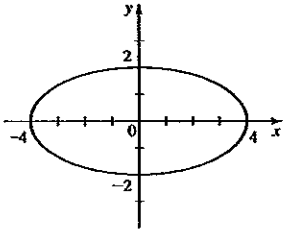
7. $V(0, \pm 3)$; $F(0, \pm \sqrt{5})$; $\sqrt{5}/3$; 6, 4



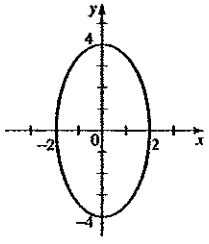
8. $V(\pm 5, 0)$; $F(\pm \sqrt{21}, 0)$; $\sqrt{21}/5$; 10, 4



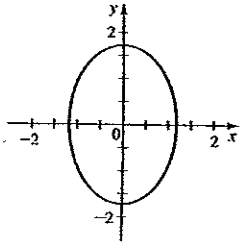
9. $V(\pm 4, 0)$; $F(\pm 2\sqrt{3}, 0)$; $\sqrt{3}/2$; 8, 4



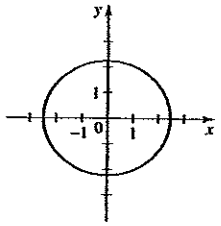
10. $V(0, \pm 4)$; $F(0, \pm 2\sqrt{3})$; $\sqrt{3}/2$; 8, 4



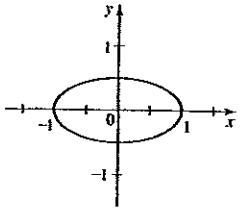
11. $V(0, \pm\sqrt{3})$; $F(0, \pm\sqrt{3/2})$; $1/\sqrt{2}$; $2\sqrt{3}$, $\sqrt{6}$



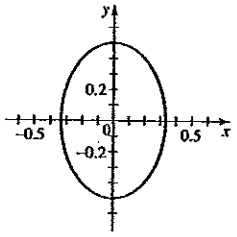
12. $V(\pm\sqrt{6}, 0)$; $F(\pm 1, 0)$; $\sqrt{6}/6$; $2\sqrt{6}$, $2\sqrt{5}$



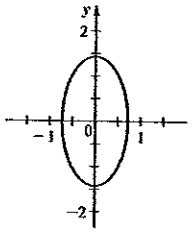
13. $V(\pm 1, 0)$; $F(\pm\sqrt{3}/2, 0)$; $\sqrt{3}/2$; 2, 1



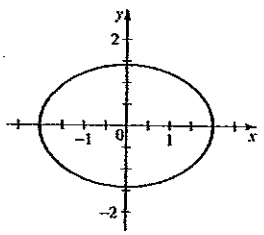
14. $V(0, \pm\frac{1}{2})$; $F(0, \pm\sqrt{5}/6)$; $\sqrt{5}/3$; 1, $\frac{2}{3}$



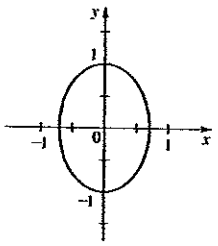
15. $V(0, \pm\sqrt{2})$; $F(0, \pm\sqrt{3/2})$; $\sqrt{3}/2$; $2\sqrt{2}$, $\sqrt{2}$



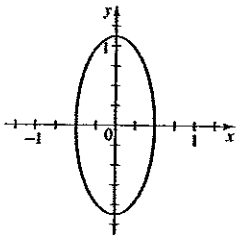
16. $V(\pm 2, 0)$; $F(\pm\sqrt{2}, 0)$; $\sqrt{2}/2$; 4, $2\sqrt{2}$



17. $V(0, \pm 1)$; $F(0, \pm 1/\sqrt{2})$; $1/\sqrt{2}$; 2, $\sqrt{2}$



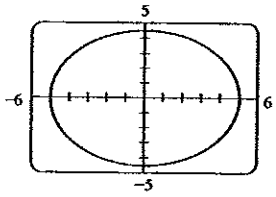
18. $V(0, \pm\sqrt{5}/2)$; $F(0, \pm 1)$; $2\sqrt{5}/5$; $\sqrt{5}$, 1



19. $\dfrac{x^2}{25} + \dfrac{y^2}{16} = 1$ **20.** $\dfrac{x^2}{4} + \dfrac{y^2}{25} = 1$ **21.** $\dfrac{x^2}{4} + \dfrac{y^2}{8} = 1$

22. $\dfrac{x^2}{7} + \dfrac{y^2}{16} = 1$ **23.** $\dfrac{x^2}{256} + \dfrac{y^2}{48} = 1$ **24.** $\dfrac{x^2}{4} + \dfrac{3y^2}{16} = 1$

25.



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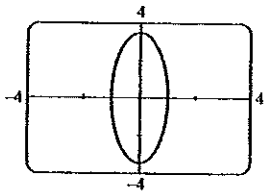

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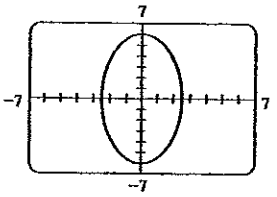

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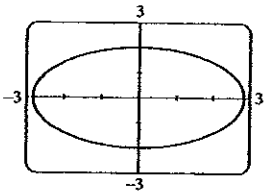


29. $\dfrac{x^2}{25} + \dfrac{y^2}{9} = 1$ **30.** $\dfrac{x^2}{16} + \dfrac{y^2}{25} = 1$ **31.** $x^2 + \dfrac{y^2}{4} = 1$

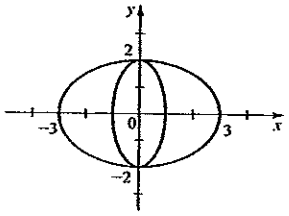
32. $\dfrac{x^2}{9} + \dfrac{y^2}{4} = 1$ **33.** $\dfrac{x^2}{9} + \dfrac{y^2}{13} = 1$ **34.** $\dfrac{x^2}{36} + \dfrac{y^2}{11} = 1$

35. $\dfrac{x^2}{100} + \dfrac{y^2}{91} = 1$ **36.** $\dfrac{x^2}{25} + \dfrac{y^2}{9} = 1$ **37.** $\dfrac{x^2}{25} + \dfrac{y^2}{5} = 1$

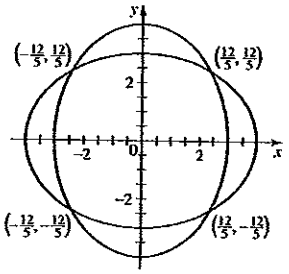
38. $\dfrac{x^2}{320} + \dfrac{y^2}{324} = 1$ **39.** $\dfrac{64x^2}{225} + \dfrac{64y^2}{81} = 1$

40. $x^2 + \dfrac{y^2}{4} = 1$

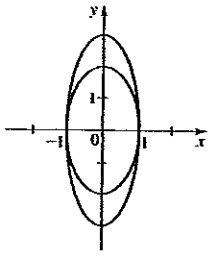
41. $(0, \pm 2)$



42. $\left(\pm\frac{12}{5}, \pm\frac{12}{5}\right)$

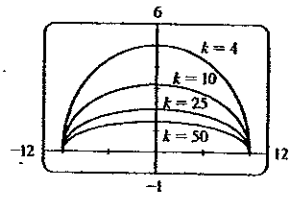


43. $(\pm 1, 0)$



44. (a) $x^2 + y^2 = 4$

45. (a)



(b) Common major axes and vertices; eccentricity increases as k increases.

47. $\dfrac{x^2}{2.2500 \times 10^{16}} + \dfrac{y^2}{2.2491 \times 10^{16}} = 1$

48. Perihelion 3.87×10^9 km; aphelion 6.45×10^9 km

49. $\dfrac{x^2}{1{,}455{,}642} + \dfrac{y^2}{1{,}451{,}610} = 1$ 50. 8 ft; 6.92 ft apart

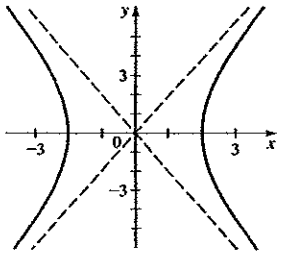
51. $5\sqrt{39}/2 \approx 15.6$ in.

Section 10.3 ■ page 708

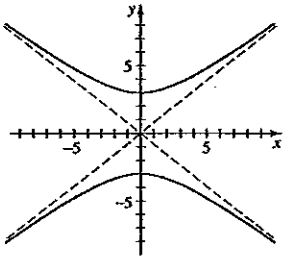
1. III 2. IV 3. II 4. I

Order of answers: vertices; foci; asymptotes

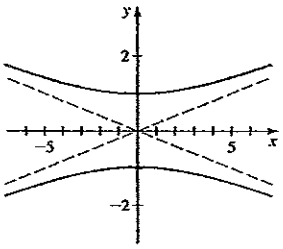
5. $V(\pm 2, 0)$; $F(\pm 2\sqrt{5}, 0)$; $y = \pm 2x$



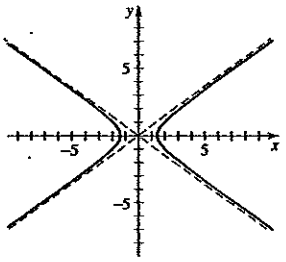
6. $V(0, \pm 3)$; $F(0, \pm 5)$; $y = \pm \frac{3}{4}x$



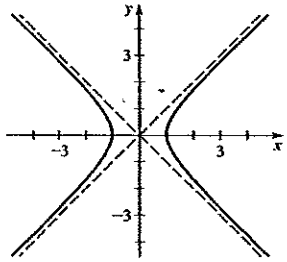
7. $V(0, \pm 1)$; $F(0, \pm \sqrt{26})$; $y = \pm \frac{1}{5}x$



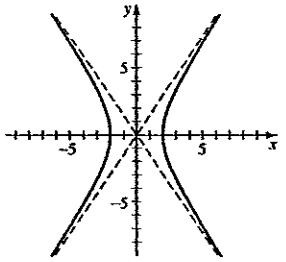
8. $V(\pm \sqrt{2}, 0)$; $F(\pm \sqrt{3}, 0)$; $y = \pm \dfrac{1}{\sqrt{2}}x$



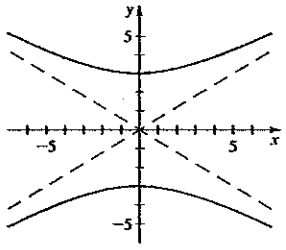
9. $V(\pm 1, 0)$; $F(\pm \sqrt{2}, 0)$; $y = \pm x$



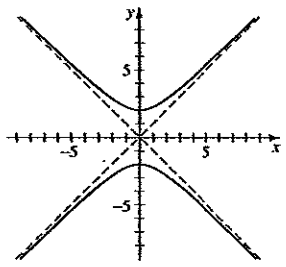
10. $V(\pm 2, 0)$; $F(\pm \sqrt{13}, 0)$; $y = \pm \frac{3}{2}x$



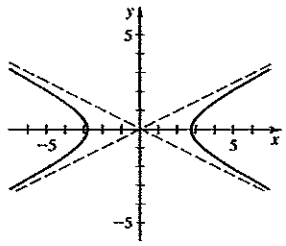
11. $V(0, \pm 3)$; $F(0, \pm \sqrt{34})$; $y = \pm \frac{3}{5}x$



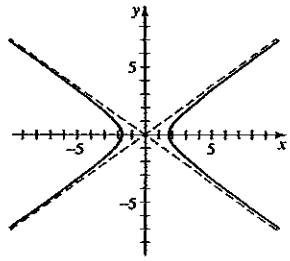
12. $V(0, \pm 2)$; $F(0, \pm 2\sqrt{2})$; $y = \pm x$



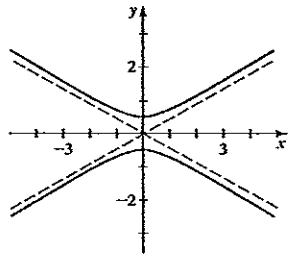
13. $V(\pm 2\sqrt{2}, 0)$; $F(\pm \sqrt{10}, 0)$; $y = \pm \frac{1}{2}x$



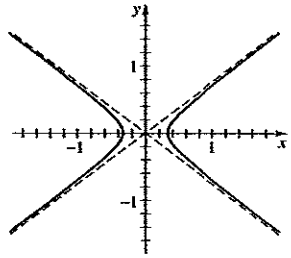
14. $V(\pm \sqrt{3}, 0)$; $F(\pm \sqrt{\frac{3}{2}}, 0)$; $y = \pm \dfrac{\sqrt{2}}{2}x$



15. $V(0, \pm \frac{1}{2})$; $F(0, \pm \sqrt{5}/2)$; $y = \pm \frac{1}{2}x$



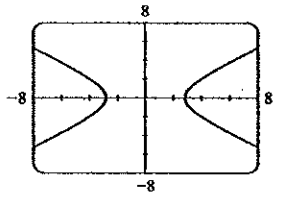
16. $V(\pm \frac{1}{3}, 0)$; $F(\pm \frac{5}{12}, 0)$; $y = \pm \frac{3}{4}x$



17. $\dfrac{x^2}{4} - \dfrac{y^2}{12} = 1$ 18. $\dfrac{y^2}{144} - \dfrac{x^2}{25} = 1$ 19. $\dfrac{y^2}{16} - \dfrac{x^2}{16} = 1$

20. $\dfrac{x^2}{12} - \dfrac{y^2}{48} = 1$ 21. $\dfrac{x^2}{9} - \dfrac{4y^2}{9} = 1$ 22. $\dfrac{y^2}{9} - x^2 = 1$

23.



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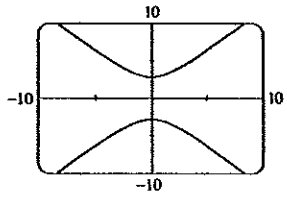

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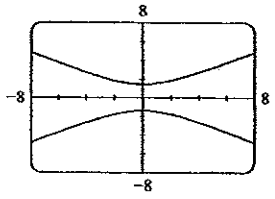

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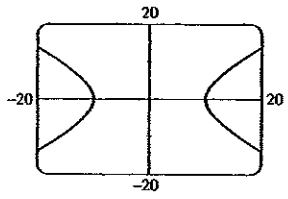


27. $\frac{x^2}{9} - \frac{y^2}{16} = 1$ 28. $\frac{y^2}{64} - \frac{x^2}{36} = 1$

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. $\frac{y^2}{36} - \frac{x^2}{324} = 1$

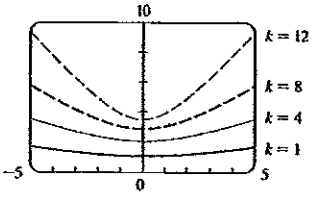
33. $\frac{5y^2}{64} - \frac{5x^2}{256} = 1$ 34. $\frac{y^2}{36} - \frac{x^2}{20} = 1$

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)



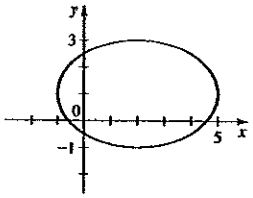
As k increases, the asymptotes get steeper.

44. (a) 490 mi (b) $\frac{y^2}{60{,}025} - \frac{x^2}{2475} = 1$ (c) 10.1 mi

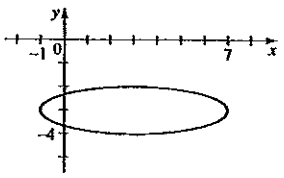
45. $x^2 - y^2 = 2.3 \times 10^{19}$

Section 6.4 page 701

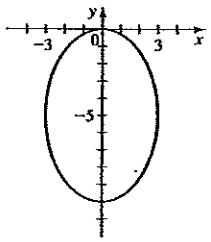
1. Center $C(2, 1)$;
foci $F(2 \pm \sqrt{5}, 1)$;
vertices $V_1(-1, 1), V_2(5, 1)$;
major axis 6, minor axis 4



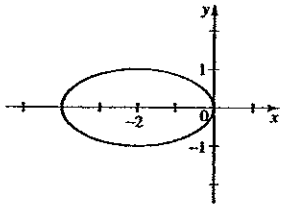
2. Center $C(3, -3)$;
foci $F(3 \pm \sqrt{15}, -3)$;
vertices $V_1(-1, -3), V_2(7, -3)$;
major axis 8, minor axis 2



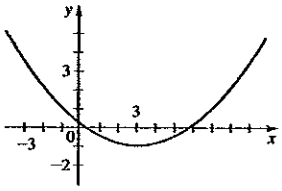
3. Center $C(0, -5)$;
foci $F_1(0, -1), F_2(0, -9)$;
vertices $V_1(0, 0), V_2(0, -10)$;
major axis 10, minor axis 6



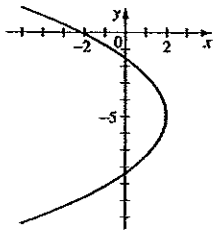
4. Center $C(-2, 0)$;
foci $F(-2 \pm \sqrt{3}, 0)$;
vertices $V_1(-4, 0), V_2(0, 0)$;
major axis 4, minor axis 2



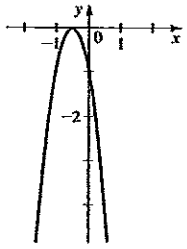
5. Vertex $V(3, -1)$;
focus $F(3, 1)$;
directrix $y = -3$



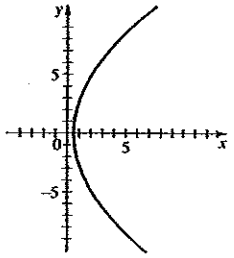
6. Vertex $V(2, -5)$;
focus $F(\frac{1}{2}, -5)$;
directrix $x = \frac{7}{2}$



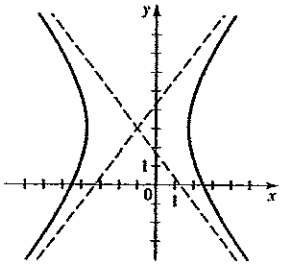
7. Vertex $V(-\frac{1}{2}, 0)$;
focus $F(-\frac{1}{2}, -\frac{1}{16})$;
directrix $y = \frac{1}{16}$



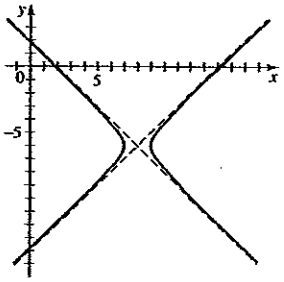
8. Vertex $V(\frac{1}{2}, 0)$;
focus $F(\frac{9}{2}, 0)$;
directrix $x = -\frac{7}{2}$



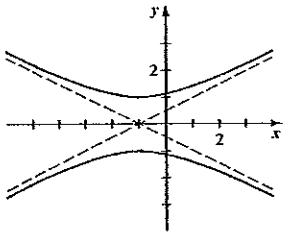
9. Center $C(-1, 3)$;
foci $F_1(-6, 3), F_2(4, 3)$;
vertices $V_1(-4, 3), V_2(2, 3)$;
asymptotes
$y = \pm\frac{4}{3}(x + 1) + 3$



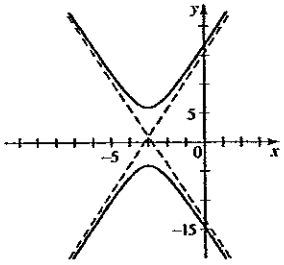
10. Center $C(8, -6)$;
foci $F(8 \pm \sqrt{2}, -6)$;
vertices $V_1(7, -6), V_2(9, -6)$;
asymptotes $y = -x + 2$,
$y = x - 14$



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 $y = -5x - 14$, $y = 5x + 16$



13. $x^2 = -\frac{1}{4}(y - 4)$

14. $y^2 = 24(x + 6)$

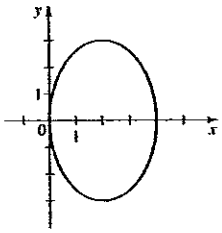
15. $\dfrac{(x-5)^2}{25} + \dfrac{y^2}{16} = 1$

16. $\dfrac{(x-2)^2}{4} + \dfrac{(y+3)^2}{9} = 1$

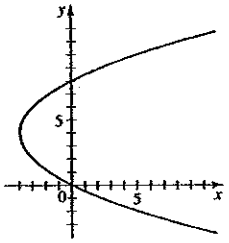
17. $(y - 1)^2 - x^2 = 1$

18. $\dfrac{(x-4)^2}{4} - \dfrac{3y^2}{16} = 1$

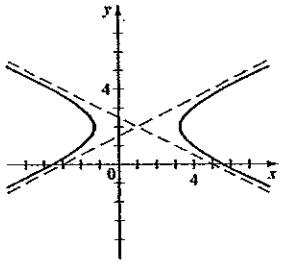
19. Ellipse; $C(2, 0)$; $F(2, \pm\sqrt{5})$; $V(2, \pm 3)$; major axis 6, minor axis 4



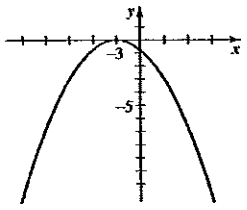
20. Parabola; $V(-4, 4)$; $F(-3, 4)$; $x = -5$



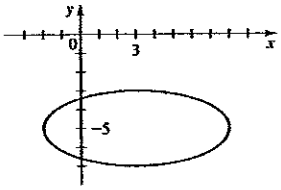
21. Hyperbola; $C(1, 2)$; $F_1(-\frac{3}{2}, 2)$, $F_2(\frac{7}{2}, 2)$; $V(1 \pm \sqrt{5}, 2)$; asymptotes $y = \pm\frac{1}{2}(x - 1) + 2$



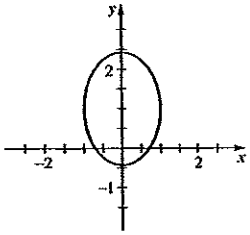
22. Parabola; $V(-3, 0)$; $F(-3, -3)$; $y = 3$



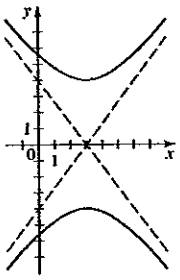
23. Ellipse; $C(3, -5)$; $F(3 \pm \sqrt{21}, -5)$; $V_1(-2, -5)$, $V_1(8, -5)$; major axis 10, minor axis 4



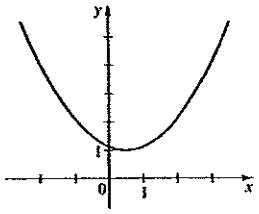
24. Ellipse; $C(0, 1)$; $F_1(0, 0)$, $F_2(0, 2)$; $V(0, 1 \pm \sqrt{2})$; major axis $2\sqrt{2}$, minor axis 2



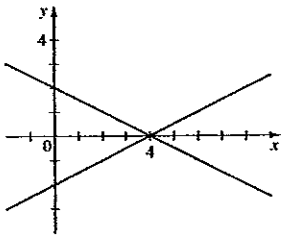
25. Hyperbola; $C(3, 0)$; $F(3, \pm 5)$; $V(3, \pm 4)$; asymptotes $y = \pm\frac{4}{3}(x - 3)$



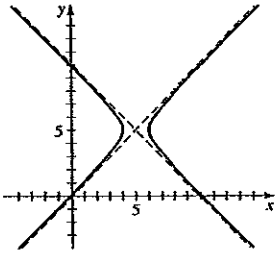
26. Parabola; $V(\frac{1}{2}, 1)$; $F(\frac{1}{2}, \frac{3}{2})$; $y = \frac{1}{2}$



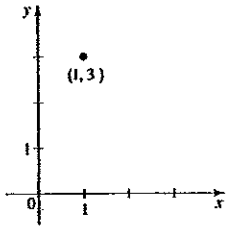
27. Degenerate conic (pair of lines), $y = \pm\frac{1}{2}(x - 4)$



28. Hyperbola; $C(5, 5)$; $F(5 \pm \sqrt{2}, 5)$; $V_1(4, 5)$, $V_2(6, 5)$; asymptotes $y = x$, $y = -x + 10$

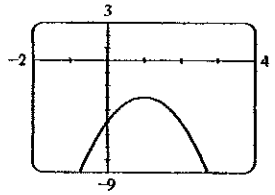


29. Point $(1, 3)$

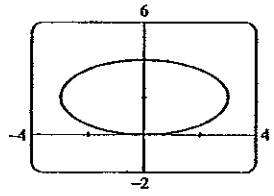


30. No graph

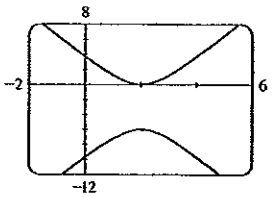
31.



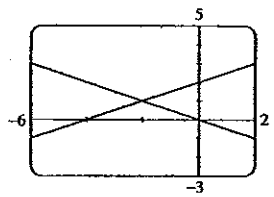
32.



33.



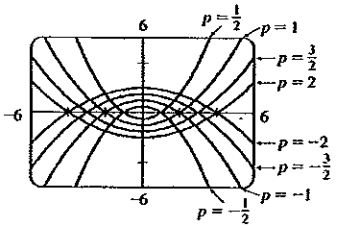
34.



35. (a) $F < 17$ (b) $F = 17$ (c) $F > 17$

36. $\dfrac{x^2}{25} + \dfrac{(8y - 399)^2}{160{,}801} = 1$

37. (a)



(c) The parabolas become narrower.

38. $(x - 800)^2 = -200(y - 3200)$

39. $\dfrac{(x + 150)^2}{18{,}062{,}500} + \dfrac{y^2}{18{,}040{,}000} = 1$

Section 10.5

1. $(\sqrt{2}, 0)$ **2.** $\left(1 - \dfrac{\sqrt{3}}{2}, 1 + \dfrac{\sqrt{3}}{2}\right)$ **3.** $(0, -2\sqrt{3})$

4. $(1.9319, -0.5176)$ **5.** $(1.6383, 1.1472)$ **6.** $(5, 3)$

7. $X^2 + \sqrt{3}XY + 2 = 0$

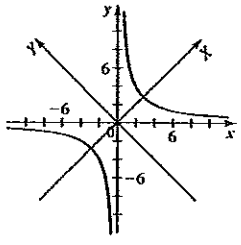
8. $X^2 + Y^2 - 2XY - 3\sqrt{2}X + \sqrt{2}Y + 2 = 0$

9. $7Y^2 - 48XY - 7X^2 - 40X - 30Y = 0$

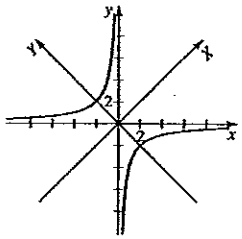
10. $34X^2 + 41Y^2 + 24XY = 400$ **11.** $X^2 - Y^2 = 2$

12. $\dfrac{(X - \sqrt{2})^2}{2} - \dfrac{Y^2}{2} = 1$

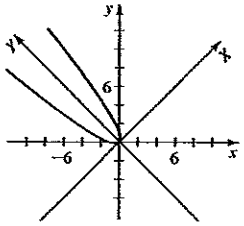
13. (a) Hyberbola (b) $X^2 - Y^2 = 16$
(c) $\phi = 45°$



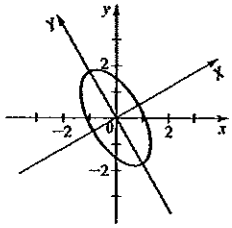
14. (a) Hyperbola
(b) $\dfrac{Y^2}{8} - \dfrac{X^2}{8} = 1$
(c) $\phi = 45°$



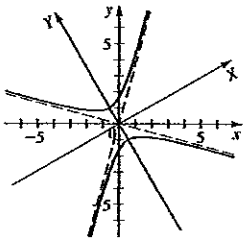
15. (a) Parabola
(b) $Y = \sqrt{2}X^2$
(c) $\phi = 45°$



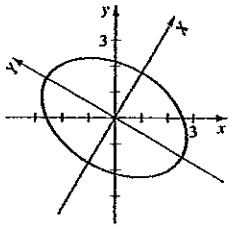
16. (a) Ellipse
(b) $X^2 + \dfrac{Y^2}{4} = 1$
(c) $\phi = 30°$



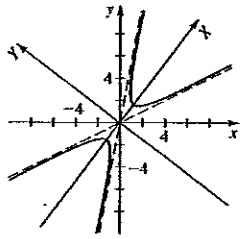
17. (a) Hyberbola
(b) $Y^2 - X^2 = 1$
(c) $\phi = 30°$



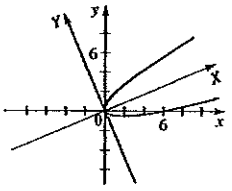
18. (a) Ellipse
(b) $\dfrac{X^2}{4} + \dfrac{Y^2}{9} = 1$
(c) $\phi = 60°$



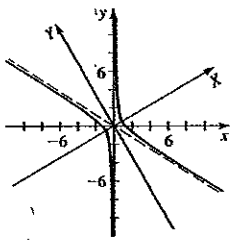
19. (a) Hyberbola
(b) $\dfrac{X^2}{4} - Y^2 = 1$
(c) $\phi \approx 53°$



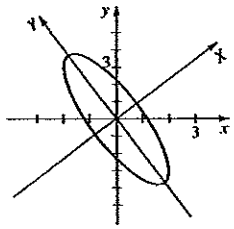
20. (a) Parabola
(b) $X = Y^2$
(c) $\phi \approx 23°$



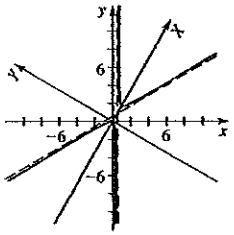
21. (a) Hyberbola
(b) $3X^2 - Y^2 = 2\sqrt{3}$
(c) $\phi = 30°$



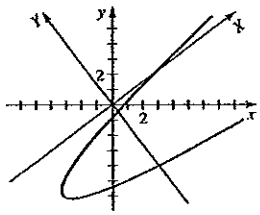
22. (a) Ellipse
(b) $X^2 + \frac{Y^2}{9} = 1$
(c) $\phi \approx 37°$



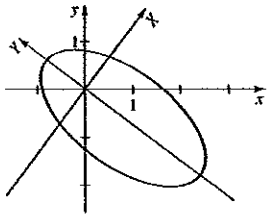
23. (a) Hyberbola
(b) $(X - 1)^2 - 3Y^2 = 1$
(c) $\phi = 60°$



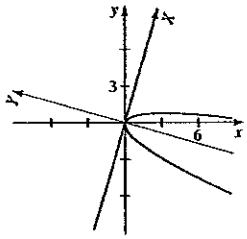
24. (a) Parabola
(b) $\frac{4}{5}\left(X + \frac{24}{5}\right) = \left(Y + \frac{14}{5}\right)^2$
(c) $\phi \approx 37°$



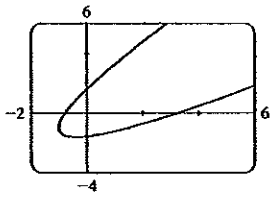
25. (a) Ellipse
(b) $X^2 + \frac{(Y + 1)^2}{4} = 1$
(c) $\phi \approx 53°$



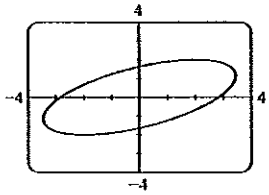
26. (a) Parabola
(b) $X^2 = -\left(Y - \frac{1}{25}\right)$
(c) $\phi \approx 74°$



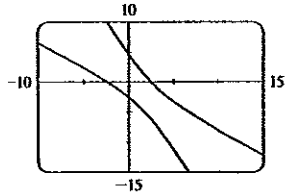
27. (a) Parabola
(b)



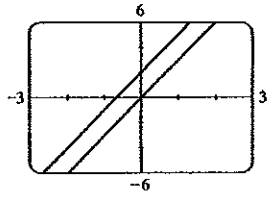
28. (a) Ellipse
(b)



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:
$C(4, 3)$; $V_1\left(\frac{24}{5}, \frac{18}{5}\right)$, $V_2\left(\frac{16}{5}, \frac{12}{5}\right)$; $F_1\left(4 + \frac{4}{5}\sqrt{2}, 3 + \frac{3}{5}\sqrt{2}\right)$,
$F_2\left(4 - \frac{4}{5}\sqrt{2}, 3 - \frac{3}{5}\sqrt{2}\right)$
(c) $Y = \pm(X - 5)$; $7x - y - 25 = 0$, $x + 7y - 25 = 0$

32. (a) $4(X + 1)^2 = Y + 4$
(b) XY-coordinates: $V(-1, -4)$, $F\left(-1, -\frac{63}{16}\right)$; xy-coordinates:

$$V\left(\frac{3\sqrt{2}}{2}, -\frac{5\sqrt{2}}{2}\right), F\left(\frac{47\sqrt{2}}{32}, -\frac{79\sqrt{2}}{32}\right)$$

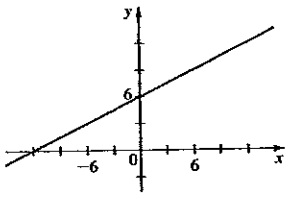
(c) $Y = -\frac{65}{16}$; $y = x - \frac{65\sqrt{2}}{16}$

33. $X = x\cos\phi + y\sin\phi$; $Y = -x\sin\phi + y\cos\phi$

34. $Y^2 = \sqrt{2}\left(X - \frac{\sqrt{2}}{4}\right)$

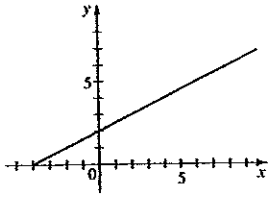
Section [illegible]

1. (a)



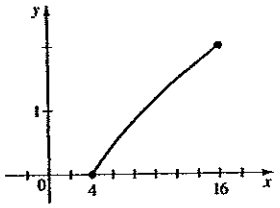
(b) $x - 2y + 12 = 0$

2. (a)



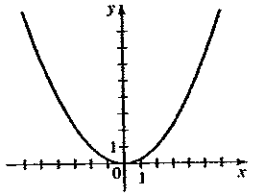
(b) $2y = x + 4$, $y \geq 0$

3. (a)



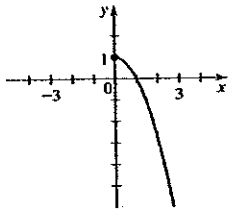
(b) $x = (y + 2)^2$

4. (a)



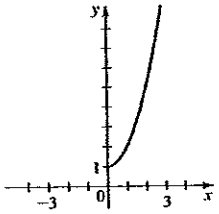
(b) $y = \frac{1}{4}x^2$

5. (a)



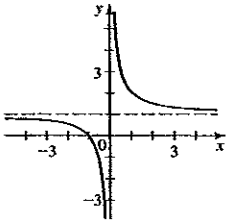
(b) $x = \sqrt{1 - y}$

6. (a)



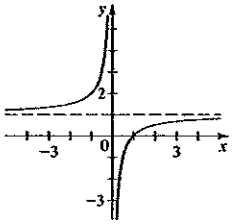
(b) $y = x^2 + 1$, $x \geq 0$

7. (a)



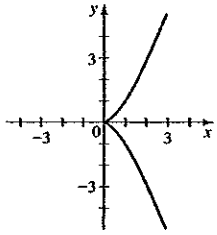
(b) $y = \dfrac{1}{x} + 1$

8. (a)



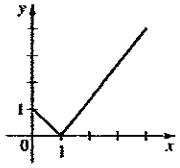
(b) $y = \dfrac{x-1}{x}$

9. (a)



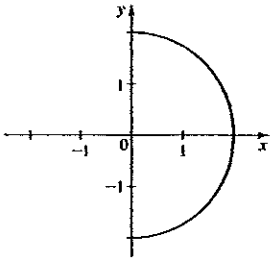
(b) $x^3 = y^2$

10. (a)



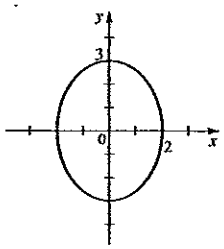
(b) $y = |1 - x|, x \geq 0$

11. (a)



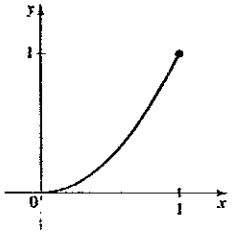
(b) $x^2 + y^2 = 4, x \geq 0$

12. (a)



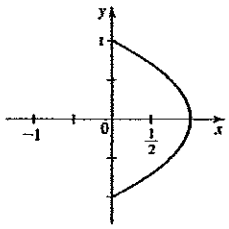
(b) $\dfrac{x^2}{4} + \dfrac{y^2}{9} = 1$

13. (a)



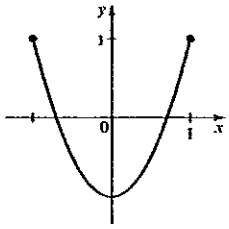
(b) $y = x^2, 0 \leq x \leq 1$

14. (a)



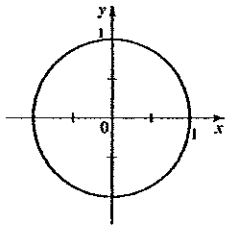
(b) $x = 1 - y^2, -1 \leq y \leq 1$

15. (a)



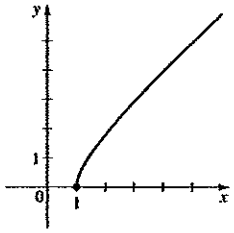
(b) $y = 2x^2 - 1, -1 \leq x \leq 1$

16. (a)



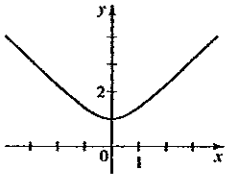
(b) $x^2 + y^2 = 1$

17. (a)



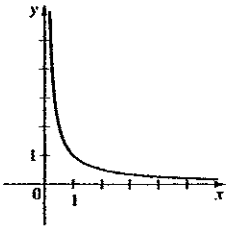
(b) $x^2 - y^2 = 1, x \geq 1, y \geq 0$

18. (a)



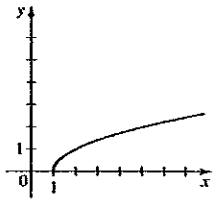
(b) $y^2 - x^2 = 1, y \geq 1$

19. (a)



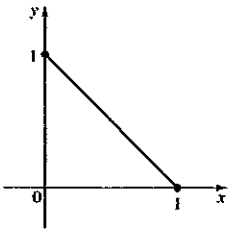
(b) $xy = 1, x \geq 0$

20. (a)



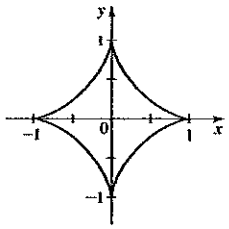
(b) $x = y^2 + 1, y \geq 0$

21. (a)



(b) $x + y = 1, 0 \leq x \leq 1$

22. (a)



(b) $x^{2/3} + y^{2/3} = 1$

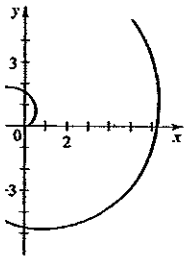
23. $x = 4 + t, y = -1 + \frac{1}{2}t$

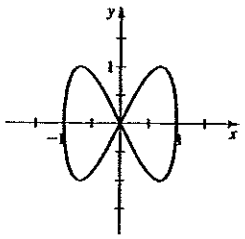
24. $x = -10 + t, y = -20 - 2t$

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.** $x = a \cos t, y = b \sin t$

32.





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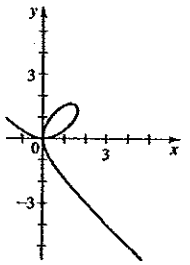
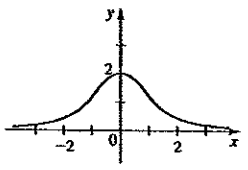
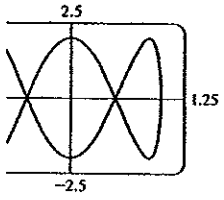
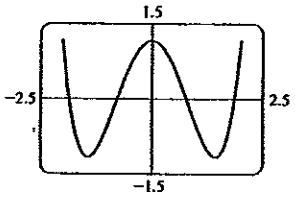




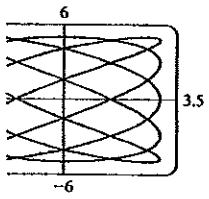
4 s (b) 21.5 mi
4 ft ≈ 3.1 mi

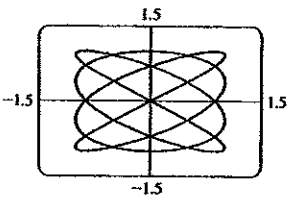
38.



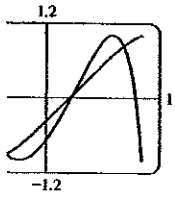


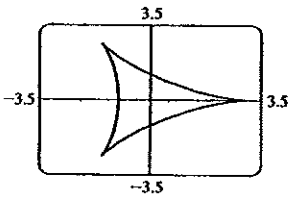
40.





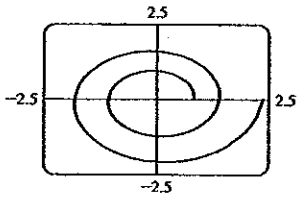
42.





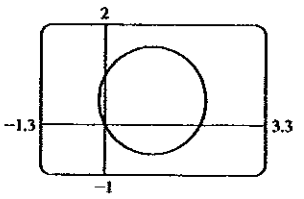
43. (a) $x = 2^{t/12}\cos t,\ y = 2^{t/12}\sin t$

(b)



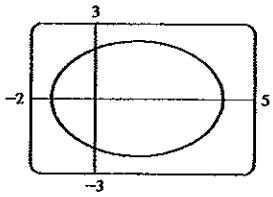
44. (a) $x = (\sin t + 2\cos t)\cos t,\ y = (\sin t + 2\cos t)\sin t$

(b)



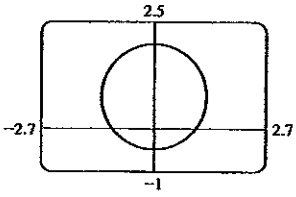
45. (a) $x = \dfrac{4\cos t}{2 - \cos t},\ y = \dfrac{4\sin t}{2 - \cos t}$

(b)



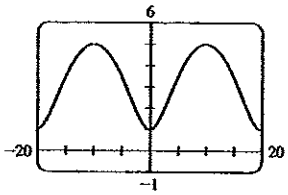
46. (a) $x = 2^{\sin t}\cos t,\ y = 2^{\sin t}\sin t$

(b)

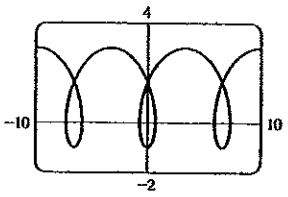


47. III 48. IV 49. II 50. I

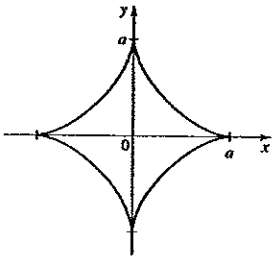
51.



52.



53. (b) $x^{2/3} + y^{2/3} = a^{2/3}$



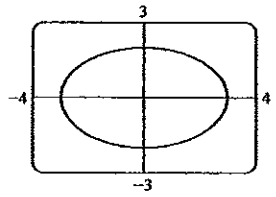
54. $x = (a + b)\cos t - b\cos\left(\frac{a+b}{b}\right)t$,

$y = (a + b)\sin t - b\sin\left(\frac{a+b}{b}\right)t$

55. $x = a(\sin\theta\cos\theta + \cot\theta)$, $y = a(1 + \sin^2\theta)$

56. (a) $x = a\cos\theta$, $y = b\sin\theta$

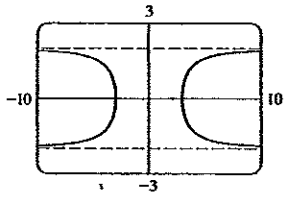
(b)



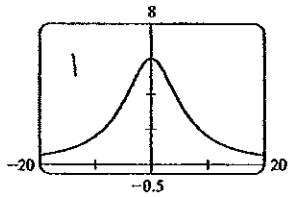
(c) $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

57. (a) $x = a\sec\theta$, $y = b\sin\theta$

(b)

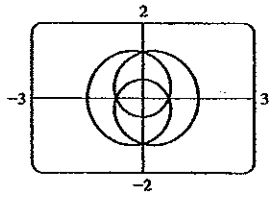


58. (b)

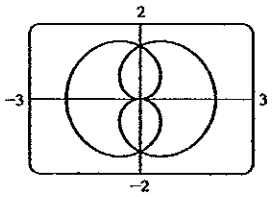


59. $y = a - a\cos\left(\frac{x + \sqrt{2ay - y^2}}{a}\right)$

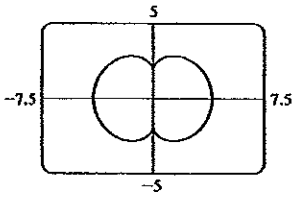
60. (a)



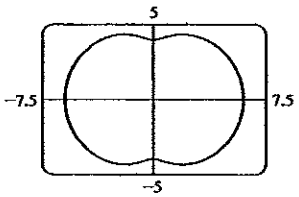
$R = 0.5$



$R = 1$



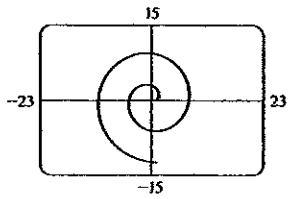
$R = 3$



$R = 5$

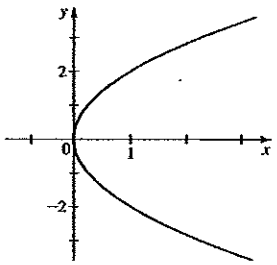
(b) $R = 5$

61. (b)

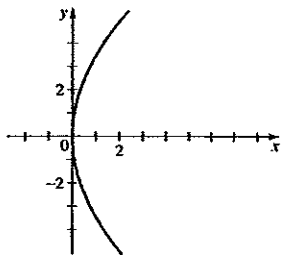


Chapter 10 Review ■ page 810

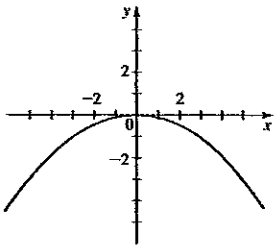
1. $V(0,0)$; $F(1,0)$; $x = -1$



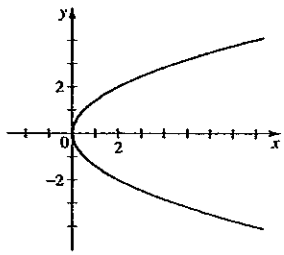
2. $V(0,0)$; $F(3,0)$; $x = -3$



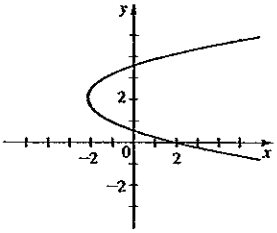
3. $V(0,0)$; $F(0,-2)$; $y = 2$



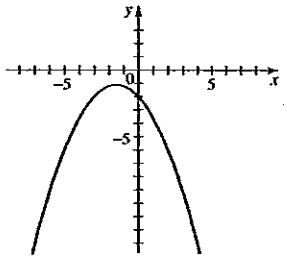
4. $V(0,0)$; $F\left(\frac{1}{2},0\right)$; $x = -\frac{1}{2}$



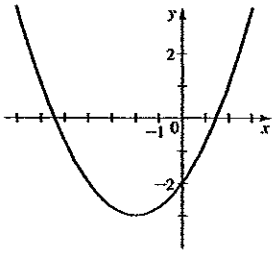
5. $V(-2,2)$; $F\left(-\frac{7}{4},2\right)$; $x = -\frac{9}{4}$



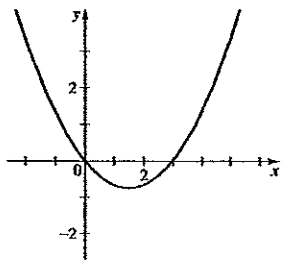
6. $V\left(-\frac{3}{2},-\frac{11}{10}\right)$; $F\left(-\frac{3}{2},-\frac{69}{20}\right)$; $y = -\frac{19}{40}$



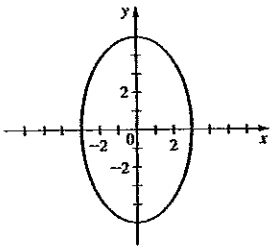
7. $V(-2,-3)$; $F(-2,-2)$; $y = -4$



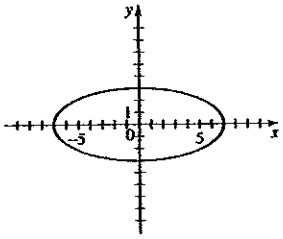
8. $V\left(\frac{3}{2},-\frac{3}{4}\right)$; $F\left(\frac{3}{2},0\right)$; $y = -\frac{3}{2}$



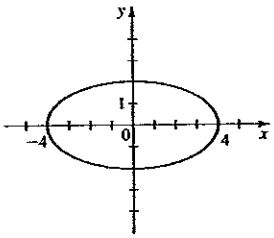
9. $C(0,0)$; $V(0,\pm5)$; $F(0,\pm4)$; axes 10, 6



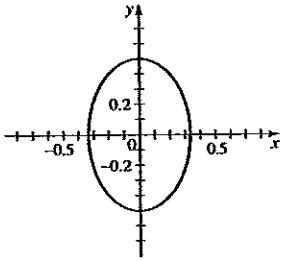
10. $C(0,0)$; $V(\pm7,0)$; $F(\pm2\sqrt{10},0)$; axes 14, 6



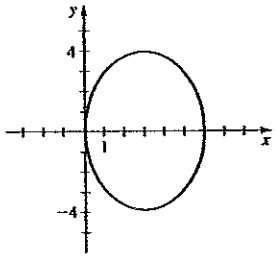
11. $C(0,0)$; $V(\pm4,0)$; $F(\pm2\sqrt{3},0)$; axes 8, 4



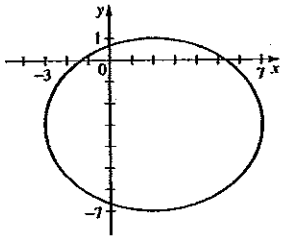
12. $C(0,0)$; $V(0,\pm\frac{1}{2})$; $F(0,\pm\frac{1}{6}\sqrt{5})$; axes 1, $\frac{2}{3}$



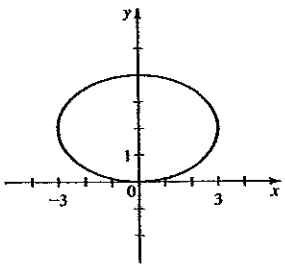
13. $C(3,0)$; $V(3,\pm4)$; $F(3,\pm\sqrt{7})$; axes 8, 6



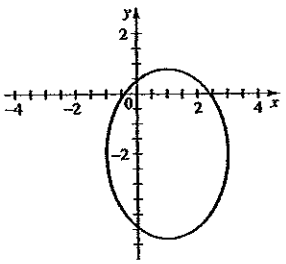
14. $C(2,-3)$; $V_1(-3,-3)$, $V_2(7,-3)$; $F_1(-1,-3)$, $F_2(5,-3)$; axes 10, 8



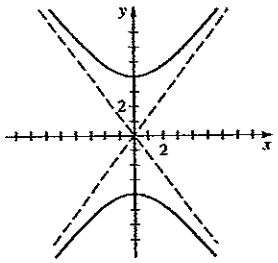
15. $C(0,2)$; $V(\pm3,2)$; $F(\pm\sqrt{5},2)$; axes 6, 4



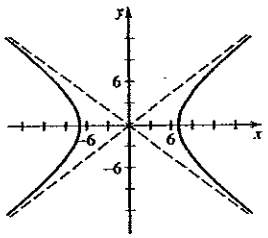
16. $C(1,-2)$; $V(1,-2\pm2\sqrt{2})$; $F_1(1,0)$, $F_2(1,-4)$; axes $4\sqrt{2}$, 4



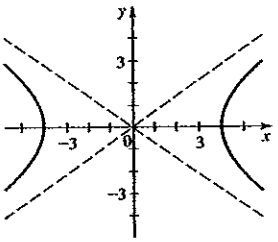
17. $C(0,0)$; $V(0,\pm4)$; $F(0,\pm5)$; asymptotes $y=\pm\frac{4}{3}x$



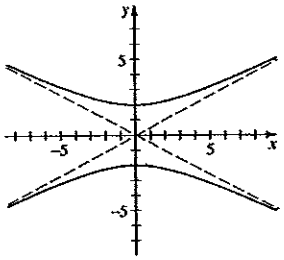
18. $C(0,0)$; $V(\pm7,0)$; $F(\pm9,0)$; asymptotes $y=\pm\frac{4\sqrt{2}}{7}x$



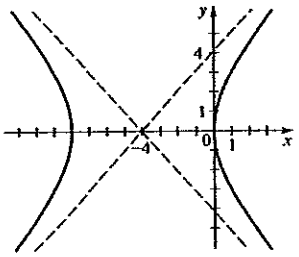
19. $C(0,0)$; $V(\pm4,0)$; $F(\pm2\sqrt{6},0)$; asymptotes $y=\pm\frac{1}{\sqrt{2}}x$



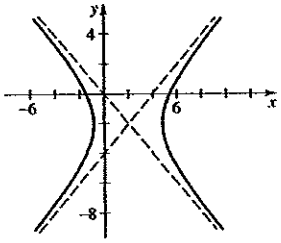
20. $C(0,0)$; $V(0,\pm2)$; $F(0,\pm2\sqrt{5})$; asymptotes $y=\pm\frac{1}{2}x$



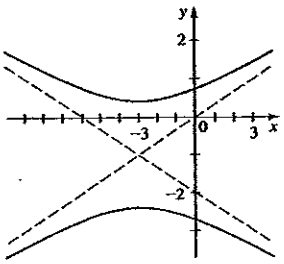
21. $C(-4,0)$; $V_1(-8,0)$, $V_2(0,0)$; $F(-4\pm4\sqrt{2},0)$; asymptotes $y=\pm(x+4)$



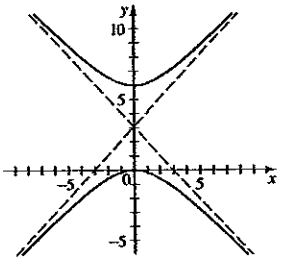
22. $C(2,-2)$; $V(2\pm2\sqrt{2},-2)$; $F_1(-2,-2)$, $F_2(6,-2)$; asymptotes $y=-x$, $y=x-4$



23. $C(-3,-1)$; $V(-3,-1\pm\sqrt{2})$; $F(-3,-1\pm2\sqrt{5})$; asymptotes $y=\frac{1}{3}x$, $y=-\frac{1}{3}x-2$



24. $C(0,3)$; $V_1(0,0)$, $V_2(0,6)$; $F(0,3\pm3\sqrt{2})$; asymptotes $y=x+3$, $y=-x+3$

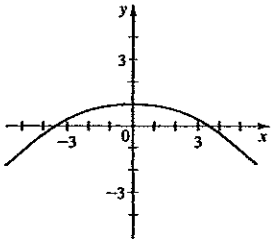


25. $y^2 = 8x$ **26.** $\frac{x^2}{144} + \frac{y^2}{25} = 1$ **27.** $\frac{y^2}{16} - \frac{x^2}{9} = 1$

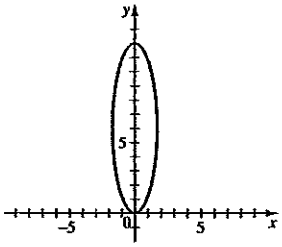
28. $(y-4)^2 = -4(x-4)$ **29.** $\frac{(x-4)^2}{16} + \frac{(y-2)^2}{4} = 1$

30. $(x-1)^2 - y^2 = 1$

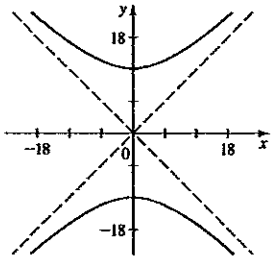
31. Parabola;
$F(0,-2)$; $V(0,1)$



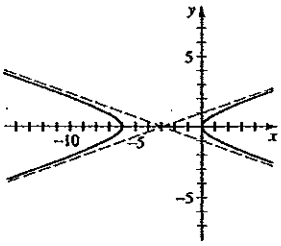
32. Ellipse; $F(0, 6 \pm \sqrt{33})$;
$V_1(0,0)$, $V_2(0,12)$



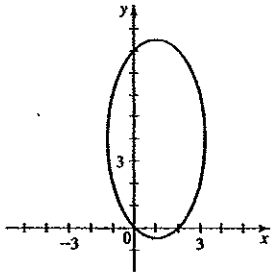
33. Hyperbola;
$F(0, \pm 12\sqrt{2})$; $V(0, \pm 12)$



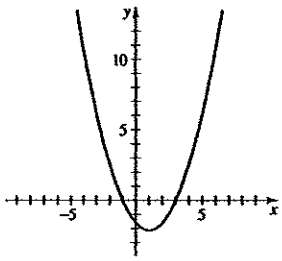
34. Hyperbola;
$F(-3 \pm \sqrt{10}, 0)$;
$V_1(-6,0)$, $V_2(0,0)$



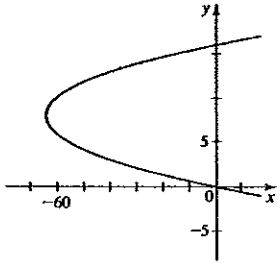
35. Ellipse; $F(1, 4 \pm \sqrt{15})$;
$V(1, 4 \pm 2\sqrt{5})$



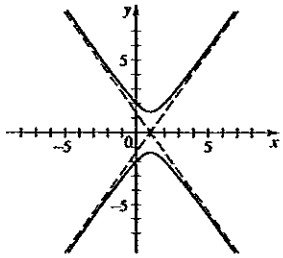
36. Parabola;
$F(1, -\frac{5}{3})$; $V(1, -\frac{13}{6})$



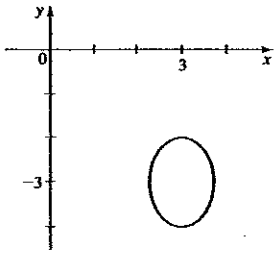
37. Parabola;
$F(-\frac{255}{4}, 8)$; $V(-64, 8)$



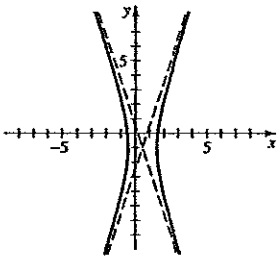
38. Hyperbola;
$F(1, \pm\sqrt{3})$; $V(1, \pm\sqrt{2})$



39. Ellipse;
$F(3, -3 \pm 1/\sqrt{2})$;
$V_1(3,-4)$, $V_2(3,-2)$

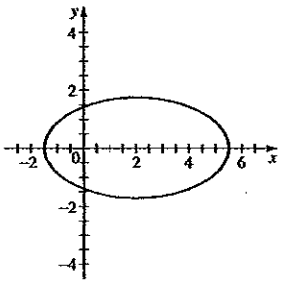


40. Hyperbola;
$F(\frac{1}{2} \pm \sqrt{10}, -1)$;
$V_1(-\frac{1}{2}, -1)$, $V_2(\frac{3}{2}, -1)$



41. Has no graph

42. Ellipse; $F_1(-1,0)$, $F_2(5,0)$; $V(2 \pm 2\sqrt{3}, 0)$



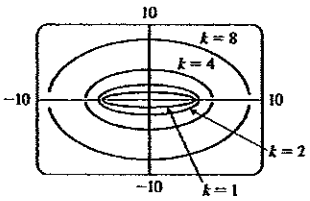
43. $x^2 = 4y$ **44.** $\frac{x^2}{9} + \frac{(y-4)^2}{25} = 1$ **45.** $\frac{y^2}{4} - \frac{x^2}{16} = 1$

46. $\frac{(y-4)^2}{4} - \frac{(x-2)^2}{5} = 1$ **47.** $\frac{(x-1)^2}{3} + \frac{(y-2)^2}{4} = 1$

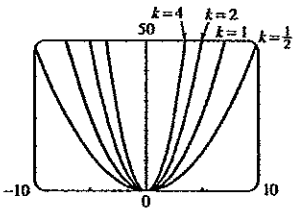
48. $(y-5)^2 = 20(x-5)$ **49.** $\frac{4(x-7)^2}{225} + \frac{(y-2)^2}{100} = 1$

50. $y^2 = 4(x+1)$ **51.** (a) 91,419,000 mi
(b) 94,581,000 mi **52.** (40, 41.5)

53. (a)

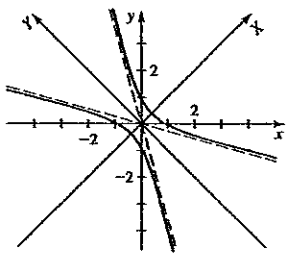


54. (a)



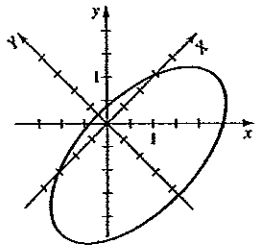
(b) $F(0, \frac{1}{4}k)$ (c) As k increases, the focus gets closer to the vertex.

55. (a) Hyperbola (b) $3X^2 - Y^2 = 1$
(c) $\phi = 45°$



56. (a) Ellipse (b) $\dfrac{X^2}{6} + \dfrac{(Y+1)^2}{\frac{3}{2}} = 1$

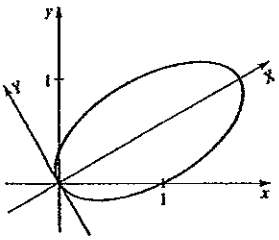
(c) $\phi = 45°$



57. (a) Ellipse

(b) $(X-1)^2 + 4Y^2 = 1$

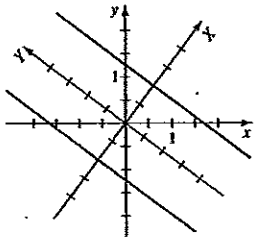
(c) $\phi = 30°$



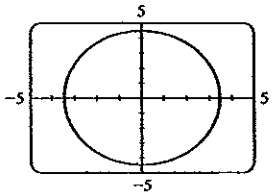
58. (a) Parabola

(b) $X = \pm 1$

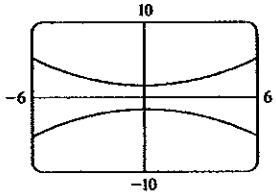
(c) $\phi \approx 53°$



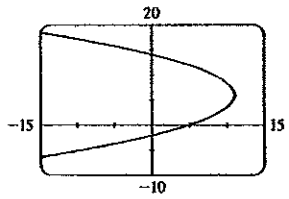
59. Ellipse



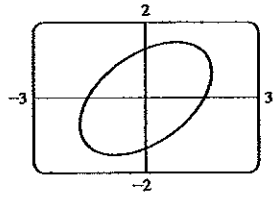
60. Hyperbola



61. Parabola

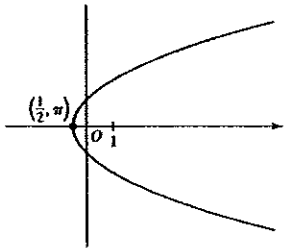


62. Ellipse



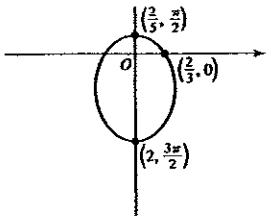
63. (a) $e = 1$, parabola

(b)

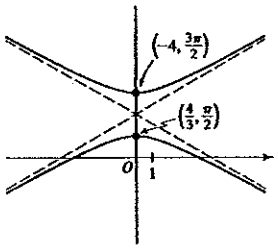


64. (a) $e = \frac{2}{3}$, ellipse

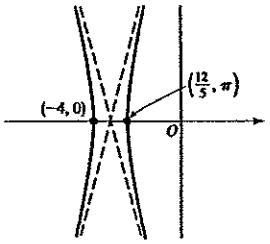
(b)



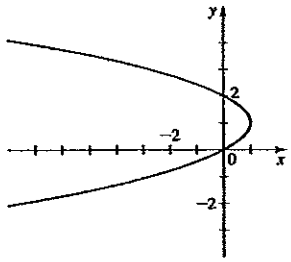
65. (a) $e = 2$, hyperbola



66. (a) $e = 4$, hyperbola

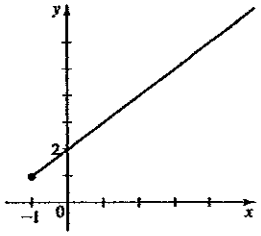


67. (a)



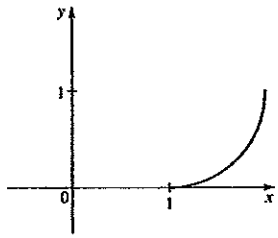
(b) $x = 2y - y^2$

68. (a)



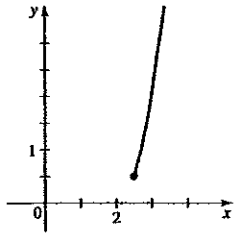
(b) $y = x + 2, x \geq -1$

69. (a)



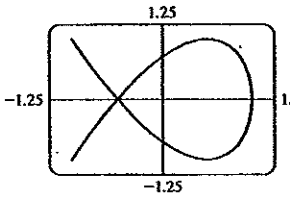
(b) $(x-1)^2 + (y-1)^2 = 1$, $1 \leq x \leq 2, 0 \leq y \leq 1$

70. (a)

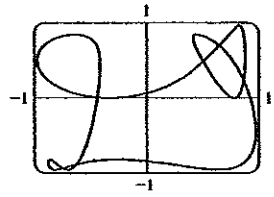


(b) $y = 2(x-2)^2, x \geq \frac{5}{2}$

71.



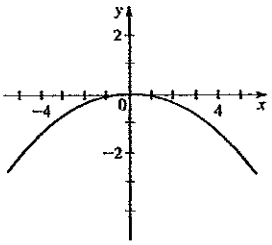
72.



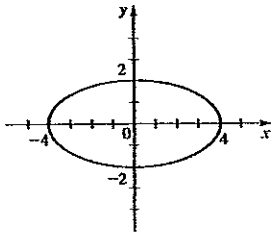
73. $x = \frac{1}{2}(1 + \cos\theta), y = \frac{1}{2}(\sin\theta + \tan\theta)$

Chapter 10 Test ■ page 814

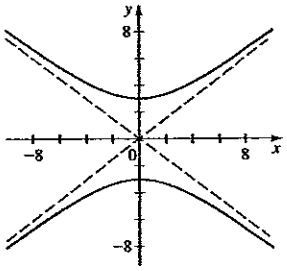
1. $F(0, -3), y = 3$



2. $V(\pm 4, 0); F(\pm 2\sqrt{3}, 0); 8, 4$



3. $V(0, \pm 3); F(0, \pm 5); y = \pm\frac{3}{4}x$

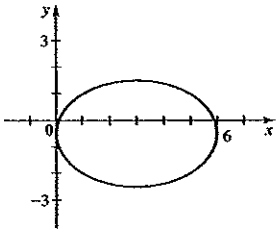


4. $y^2 = -x$

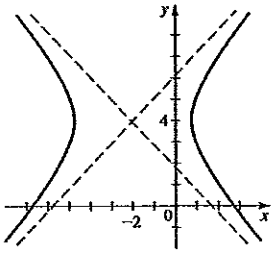
5. $\dfrac{x^2}{16} + \dfrac{(y-3)^2}{9} = 1$

6. $(x-2)^2 - \dfrac{y^2}{3} = 1$

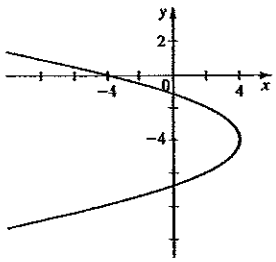
7. $\dfrac{(x-3)^2}{9} + \dfrac{(y+\frac{1}{2})^2}{4} = 1$



8. $\dfrac{(x+2)^2}{8} - \dfrac{(y-4)^2}{9} = 1$



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



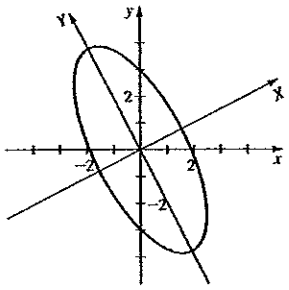
10. $\dfrac{y^2}{9} - \dfrac{x^2}{16} = 1$

11. $x^2 - 4x - 8y + 20 = 0$

12. $\frac{3}{4}$ in.

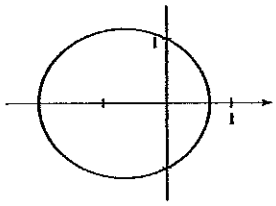
13. (a) Ellipse (b) $\dfrac{X^2}{3} + \dfrac{Y^2}{18} = 1$

(c) $\phi \approx 27°$

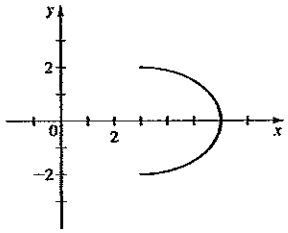


(d) $(-3\sqrt{2/5}, 6\sqrt{2/5}), (3\sqrt{2/5}, -6\sqrt{2/5})$

14. (a) $r = \dfrac{1}{1 + 0.5\cos\theta}$ (b) Ellipse



15. (a)

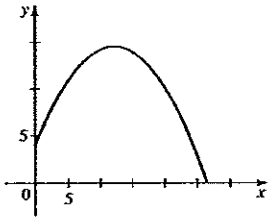


(b) $\dfrac{(x-3)^2}{9} + \dfrac{y^2}{4} = 1, x \geq 3$

Focus on Modeling ■ page 818

1. $y = -\left(\dfrac{g}{2v_0^2\cos^2\theta}\right)x^2 + (\tan\theta)x$

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