ANSWERS TO
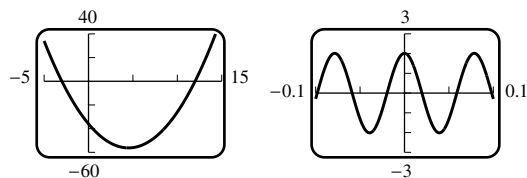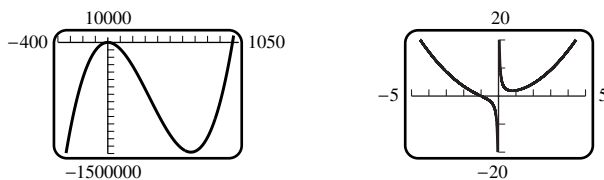# ODD-NUMBERED EXERCISES

▶ **Appendix A (Page A1)**
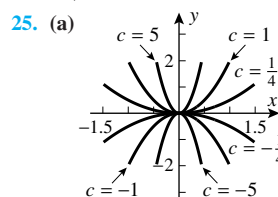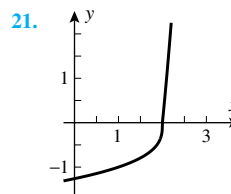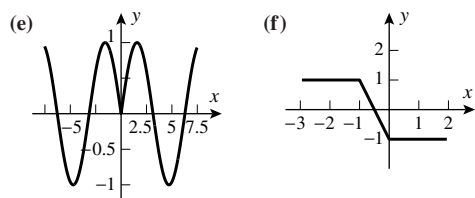
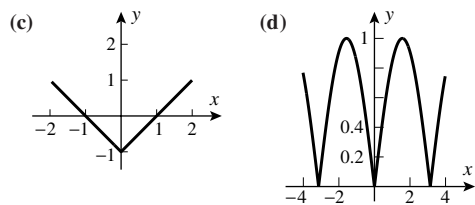**1.** (e)   **3.** (b), (c)   **5.** $[-3, 3] \times [0, 5]$

7. $[-5, 14] \times [-60, 40]$ **9.** $[-0.1, 0.1] \times [-3, 3]$

11. $[-400, 1050] \times [-1500000, 10000]$ **13.** $[-2, 2] \times [-20, 20]$

17. **(a)** $f(x) = \sqrt{16 - x^2}$ **(b)** $f(x) = -\sqrt{16 - x^2}$ **(e)** no

19. **(a)**   **(b)**

(c)   **(d)**

(e)   **(f)**

21.

25. **(a)**
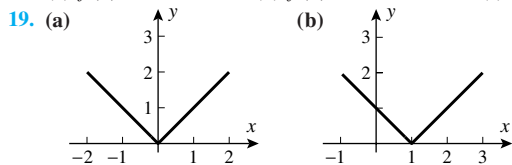
The graph is stretched in the vertical direction, and reflected across the x-axis if $c < 0$.

(b)
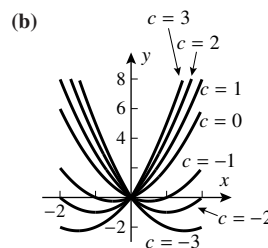
The graph is translated so its vertex is on the parabola $y = -x^2$.

(c)
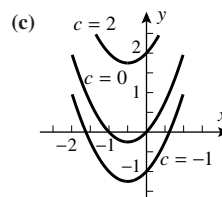
The graph is translated vertically.

27.

29. **(a)**   **(b)**

31.

33.
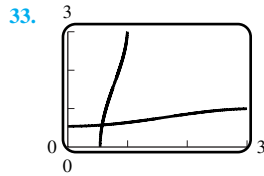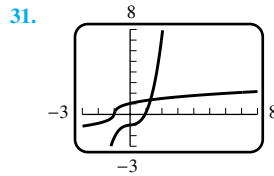
35. (a) $x = 4\cos t$, $y = 3\sin t$ (b) $x = -1 + 4\cos t$, $y = 2 + 3\sin t$

▶ **Appendix B (Page B1)**

1. (a) $\frac{5}{12}\pi$ (b) $\frac{13}{6}\pi$ (c) $\frac{1}{9}\pi$ (d) $\frac{23}{30}\pi$

3. (a) $12°$ (b) $(270/\pi)°$ (c) $288°$ (d) $540°$

5.

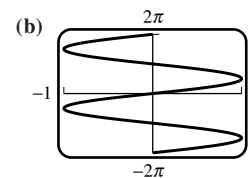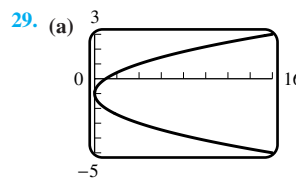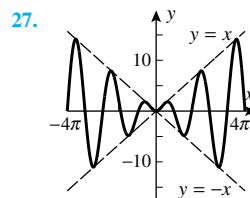|	$\sin\theta$	$\cos\theta$	$\tan\theta$	$\csc\theta$	$\sec\theta$	$\cot\theta$
(a)	$\sqrt{21}/5$	$2/5$	$\sqrt{21}/2$	$5/\sqrt{21}$	$5/2$	$2/\sqrt{21}$
(b)	$3/4$	$\sqrt{7}/4$	$3/\sqrt{7}$	$4/3$	$4/\sqrt{7}$	$\sqrt{7}/3$
(c)	$3/\sqrt{10}$	$1/\sqrt{10}$	3	$\sqrt{10}/3$	$\sqrt{10}$	$1/3$

7. $\sin\theta = 3/\sqrt{10}$, $\cos\theta = 1/\sqrt{10}$ **9.** $\tan\theta = \sqrt{21}/2$, $\csc\theta = 5/\sqrt{21}$

11. 1.8

13.

	θ	$\sin\theta$	$\cos\theta$	$\tan\theta$	$\csc\theta$	$\sec\theta$	$\cot\theta$
(a)	$225°$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	1	$-\sqrt{2}$	$-\sqrt{2}$	1
(b)	$-210°$	$1/2$	$-\sqrt{3}/2$	$-1/\sqrt{3}$	2	$-2/\sqrt{3}$	$-\sqrt{3}$
(c)	$5\pi/3$	$-\sqrt{3}/2$	$1/2$	$-\sqrt{3}$	$-2/\sqrt{3}$	2	$-1/\sqrt{3}$
(d)	$-3\pi/2$	1	0	—	1	—	0

15.

	$\sin\theta$	$\cos\theta$	$\tan\theta$	$\csc\theta$	$\sec\theta$	$\cot\theta$
(a)	$4/5$	$3/5$	$4/3$	$5/4$	$5/3$	$3/4$
(b)	$-4/5$	$3/5$	$-4/3$	$-5/4$	$5/3$	$-3/4$
(c)	$1/2$	$-\sqrt{3}/2$	$-1/\sqrt{3}$	2	$-2/\sqrt{3}$	$-\sqrt{3}$
(d)	$-1/2$	$\sqrt{3}/2$	$-1/\sqrt{3}$	-2	$2/\sqrt{3}$	$-\sqrt{3}$
(e)	$1/\sqrt{2}$	$1/\sqrt{2}$	1	$\sqrt{2}$	$\sqrt{2}$	1
(f)	$1/\sqrt{2}$	$-1/\sqrt{2}$	-1	$\sqrt{2}$	$-\sqrt{2}$	-1

17. (a) 1.2679 (b) 3.5753

19.

	$\sin\theta$	$\cos\theta$	$\tan\theta$	$\csc\theta$	$\sec\theta$	$\cot\theta$
(a)	$a/3$	$\sqrt{9-a^2}/3$	$a/\sqrt{9-a^2}$	$3/a$	$3/\sqrt{9-a^2}$	$\sqrt{9-a^2}/a$
(b)	$a/\sqrt{a^2+25}$	$5/\sqrt{a^2+25}$	$a/5$	$\sqrt{a^2+25}/a$	$\sqrt{a^2+25}/5$	$5/a$
(c)	$\sqrt{a^2-1}/a$	$1/a$	$\sqrt{a^2-1}$	$a/\sqrt{a^2-1}$	a	$1/\sqrt{a^2-1}$

21. (a) $3\pi/4 \pm n\pi$, $n = 0, 1, 2, \dots$
  (b) $\pi/3 \pm 2n\pi$ and $5\pi/3 \pm 2n\pi$, $n = 0, 1, 2, \dots$
23. (a) $\pi/6 \pm n\pi$, $n = 0, 1, 2, \dots$
  (b) $4\pi/3 \pm 2n\pi$ and $5\pi/3 \pm 2n\pi$, $n = 0, 1, 2, \dots$
25. (a) $3\pi/4 \pm n\pi$, $n = 0, 1, 2, \dots$
  (b) $\pi/6 \pm n\pi$, $n = 0, 1, 2, \dots$
27. (a) $\pi/3 \pm 2n\pi$ and $2\pi/3 \pm 2n\pi$, $n = 0, 1, 2, \dots$
  (b) $\pi/6 \pm 2n\pi$ and $11\pi/6 \pm 2n\pi$, $n = 0, 1, 2, \dots$
29. $\sin\theta = 2/5$, $\cos\theta = -\sqrt{21}/5$, $\tan\theta = -2/\sqrt{21}$,
  $\csc\theta = 5/2$, $\sec\theta = -5/\sqrt{21}$, $\cot\theta = -\sqrt{21}/2$
31. (a) $\theta = \pm n\pi$, $n = 0, 1, 2, \dots$ (b) $\theta = \pi/2 \pm n\pi$, $n = 0, 1, 2, \dots$
  (c) $\theta = \pm n\pi$, $n = 0, 1, 2, \dots$ (d) $\theta = \pm n\pi$, $n = 0, 1, 2, \dots$
  (e) $\theta = \pi/2 \pm n\pi$, $n = 0, 1, 2, \dots$ (f) $\theta = \pm n\pi$, $n = 0, 1, 2, \dots$
33. (a) $2\pi/3$ cm (b) $10\pi/3$ cm **35.** $\frac{2}{5}$
37. (a) $\dfrac{2\pi - \theta}{2\pi}R$ (b) $\dfrac{\sqrt{4\pi\theta - \theta^2}}{2\pi}R$ **39.** $\frac{21}{4}\sqrt{3}$ **41.** 9.2 ft
43. $h = d(\tan\beta - \tan\alpha)$ **45.** (a) $4\sqrt{5}/9$ (b) $-\frac{1}{9}$
47. $\sin 3\theta = 3\sin\theta\cos^2\theta - \sin^3\theta$, $\cos 3\theta = \cos^3\theta - 3\sin^2\theta\cos\theta$

61. (a) $\cos\theta$ (b) $-\sin\theta$ (c) $-\cos\theta$ (d) $\sin\theta$
69. (a) $153°$ (b) $45°$ (c) $117°$ (d) $89°$ **71.** (a) $60°$ (b) $117°$

▶ **Appendix C (Page C1)**

1. (a) $q(x) = x^2 + 4x + 2$, $r(x) = -11x + 6$
  (b) $q(x) = 2x^2 + 4$, $r(x) = 9$
  (c) $q(x) = x^3 - x^2 + 2x - 2$, $r(x) = 2x + 1$
3. (a) $q(x) = 3x^2 + 6x + 8$, $r(x) = 15$
  (b) $q(x) = x^3 - 5x^2 + 20x - 100$, $r(x) = 504$
  (c) $q(x) = x^4 + x^3 + x^2 + x + 1$, $r(x) = 0$
5.

x	0	1	-3	7
$p(x)$	-4	-3	101	5001

7. (a) $q(x) = x^2 + 6x + 13$, $r = 20$ (b) $q(x) = x^2 + 3x - 2$, $r = -4$
9. (a) $\pm 1, \pm 2, \pm 3, \pm 4, \pm 6, \pm 8, \pm 12, \pm 24$
  (b) $\pm 1, \pm 2, \pm 5, \pm 10, \pm\frac{1}{3}, \pm\frac{2}{3}, \pm\frac{5}{3}, \pm\frac{10}{3}$ (c) $\pm 1, \pm 17$
11. $(x+1)(x-1)(x-2)$ **13.** $(x+3)^3(x+1)$
15. $(x+3)(x+2)(x+1)^2(x-3)$ **17.** -3 **19.** $-2, -\frac{2}{3}, -1 \pm \sqrt{3}$
21. $-2, 2, 3$ **23.** $2, 5$ **25.** 7 cm

▶ **Appendix E (Page E1)**

1. (a) rational (b) integer, rational (c) integer, rational (d) rational
  (e) integer, rational (f) irrational (g) rational
  (h) integer, rational **3.** (a) $\frac{41}{333}$ (b) $\frac{115}{9}$ (c) $\frac{20943}{550}$ (d) $\frac{537}{1250}$
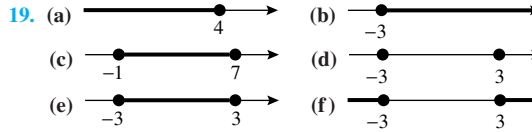**5.** (a) $\frac{256}{81}$ (b) worse
7.

Line	2	3	4	5	6	7
Blocks	3, 4	1, 2	3, 4	2, 4, 5	1, 2	3, 4

9. (a), (d), (f) **11.** (a) all values (b) none **13.** (a) yes (b) no
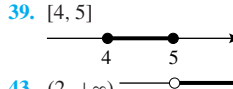**15.** (a) $\{x : x \text{ is a positive odd integer}\}$ (b) $\{x : x \text{ is an even integer}\}$
  (c) $\{x : x \text{ is irrational}\}$ (d) $\{x : x \text{ is an integer and } 7 \le x \le 10\}$
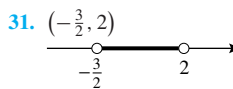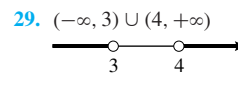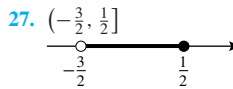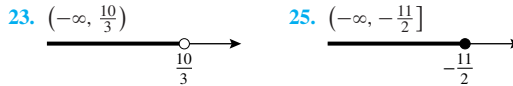**17.** (a) false (b) true (c) true (d) false (e) true (f) true (g) true
19. (a)

  (b)

  (c)

  (d)

  (e)

  (f)

21. (a) $[-2, 2]$ (b) $(-\infty, -2) \cup (2, +\infty)$
23. $\left(-\infty, \frac{10}{3}\right)$ **25.** $\left(-\infty, -\frac{11}{2}\right]$

27. $\left(-\frac{3}{2}, \frac{1}{2}\right]$ **29.** $(-\infty, 3) \cup (4, +\infty)$

31. $\left(-\frac{3}{2}, 2\right)$ **33.** $(-\infty, -2] \cup (2, +\infty)$

35. $(-\infty, -3) \cup (3, +\infty)$ **37.** $(-\infty, -2) \cup (4, +\infty)$

39. $[4, 5]$ **41.** $(-8, 0) \cup (4, +\infty)$

43. $(2, +\infty)$

45. $(-\infty, -3) \cup [2, +\infty)$
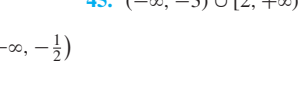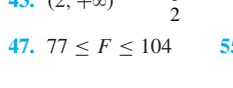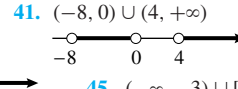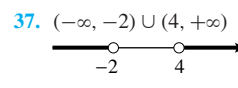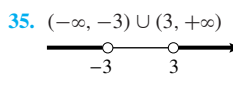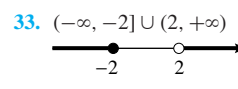
47. $77 \le F \le 104$ **55.** $\left(-\infty, -\frac{1}{2}\right)$

▶ **Exercise Set F (Page F1)**

1. (a) 7   **(b)** $\sqrt{2}$ **(c)** k^2 **(d)** k^2 **3.** $x \leq 3$ **5.** all real x

7. $x \geq 0$ or $x = -\frac{2}{3}$ **9.** $x \geq -5$

13. (a) 2   **(b)** 1   **(c)** 14   **(d)** $3 + \sqrt{2}$ **(e)** 7   **(f)** 5

15. (a) -9 **(b)** 7   **(c)** 12

17. $-\frac{5}{6}, \frac{3}{2}$ **19.** $\frac{1}{2}, \frac{5}{2}$ **21.** $-\frac{11}{10}, \frac{11}{8}$ **23.** $1, \frac{17}{5}$

25. $(-9, -3)$ **27.** $\left[-\frac{3}{2}, \frac{9}{2}\right]$ **29.** $(-\infty, -3) \cup (-1, +\infty)$

31. $\left(-\infty, \frac{1}{2}\right] \cup \left[\frac{9}{2}, +\infty\right)$ **33.** $\left(-\infty, \frac{1}{2}\right) \cup \left(\frac{3}{2}, +\infty\right)$

35. $\left[\frac{1}{8}, \frac{1}{2}\right) \cup \left(\frac{1}{2}, \frac{7}{8}\right]$ **37.** $x \in (-\infty, 2] \cup [3, +\infty)$ **39.** $-3, 9$
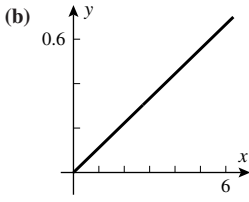
▶ **Appendix G (Page G1)**

1. $(-4, 7)$

3. (a)

(b)

(c)

(d)

(e)

(f)

5.

7.

9.

11.

13. (a) $\frac{1}{2}$
(b) -1
(c) 0
(d) not defined
15. (a) yes
(b) no

17.

19. $\text{III} < \text{II} < \text{IV} < \text{I}$
21. (a) 14   **(b)** $-\frac{1}{3}$
23. 29
25. $\frac{13}{7}$

29. (a)

(b)

(c)

(d)

31. (a)

(b)

(c)

33.

	(a)	(b)	(c)	(d)	(e)
Slope	3	$-1/4$	$-3/5$	0	$-b/a$
y-intercept	2	3	8/5	1	b

35. (a) $y = \frac{3}{2}x - 3$ **(b)** $y = -\frac{3}{4}x$ **37.** $y = -2x + 4$
39. $y = 4x + 7$ **41.** $y = -\frac{1}{5}x + 6$ **43.** $y = 11x - 18$
45. $y = \frac{1}{2}x + 2$ **47.** $y = 1$ **49. (a)** parallel
  (b) perpendicular   **(c)** parallel   **(d)** perpendicular   **(e)** neither
51. (a) $-\frac{3}{2}$ **53.** the union of the graphs of $x - y = 0$ and $x + y = 0$
  (b) $\frac{4}{5}$
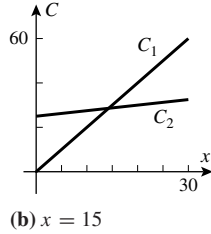 **(c)** $\frac{5}{2}$
  (d) $-\frac{15}{2}$
  (e) -4

55.

59. $\frac{49}{6}$

A48   Answers to Odd-Numbered Exercises

61. (a) $y = x/9$ **(b)**

(c) 26.11 in
(d) 135 lb
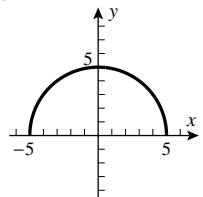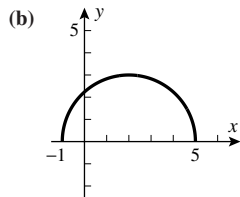
63. $y = 1.2x + 2$ **65. (a)** $T_C = \frac{5}{9}(T_F - 32)$ **(b)** $\frac{5}{9}$
(c) $-40°$ (F or C)   **(d)** $37°\text{C}$
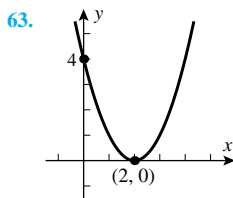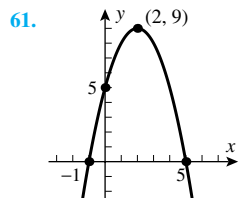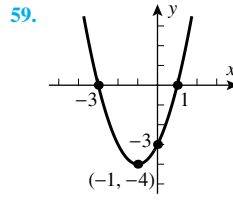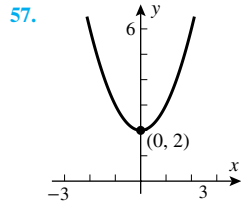**67. (a)** $p = 0.098h + 1$ **(b)** 10.20 m
69. (a) $r = -0.0125t + 0.8$ **71. (a)** $C_1 = 2x, C_2 = 25 + (x/4)$
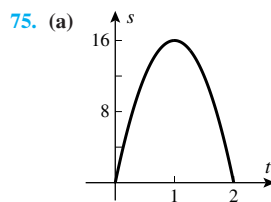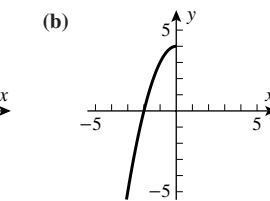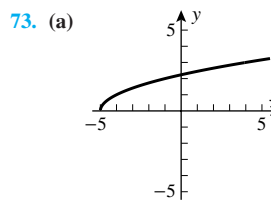**(b)** 64 days

(b) $x = 15$

▶ **Appendix H (Page H1)**

1. in the proof of Theorem H.1   **3. (a)** 10   **(b)** (4, 5)
5. (a) $\sqrt{29}$ **(b)** $\left(-\frac{9}{2}, -5\right)$ **11.** 0   **13.** $y = -3x + 4$
15. $\left(-\frac{29}{8}, -\frac{23}{4}\right)$ **17.** 3   **21.** 4   **23. (a)** (0, 0); 5   **(b)** (1, 4); 4
(c) $(-1, -3); \sqrt{5}$ **(d)** (0, -2); 1   **25.** $(x-3)^2 + (y+2)^2 = 16$
27. $(x+4)^2 + (y-8)^2 = 64$ **29.** $(x+3)^2 + (y+4)^2 = 25$
31. $(x-1)^2 + (y-1)^2 = 2$ **33.** circle; center (1, 2), radius 4
35. circle; center (-1, 1), radius $\sqrt{2}$ **37.** the point $(-1, -1)$
39. circle; center (0, 0), radius $\frac{1}{3}$ **41.** no graph
43. circle; center $\left(-\frac{5}{4}, -\frac{1}{2}\right)$, radius $\frac{3}{2}$
45. (a) $y = -\sqrt{16 - x^2}$ **(b)** $y = 2 + \sqrt{3 - 2x - x^2}$
47. (a)   **(b)**

49. $y = -\frac{3}{4}x + \frac{25}{4}$ **51. (a)** inside   **(b)** largest $3\sqrt{5}$, smallest $\sqrt{5}$
53. $(1/3, \pm\sqrt{8}/3)$ **55. (a)** equation: $2x^2 + 2y^2 - 12x + 8y + 1 = 0$
(b) center (3, -2), radius $5/\sqrt{2}$
57.   **59.**

61.   **63.**

65.

67.

69.

71. (a) $x = \sqrt{3 - y}$
(b) $x = 1 - \sqrt{y + 1}$

73. (a)   **(b)**

75. (a)
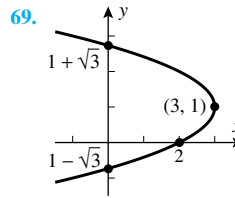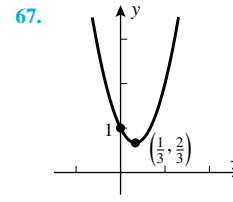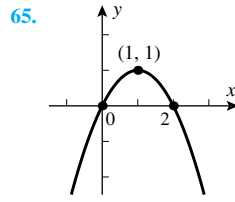
77. (a) $y = 150 - \frac{3}{2}x$
(b) $A = 150x - \frac{3}{2}x^2$
(c) 3750 ft^2

79. (a) $(-5 - \sqrt{33})/4 < x < (-5 + \sqrt{33})/4$ **(b)** $-\infty < x < +\infty$
81. (a) 30 ft   **(b)** 2.6 s   **(c)** 2.1 s
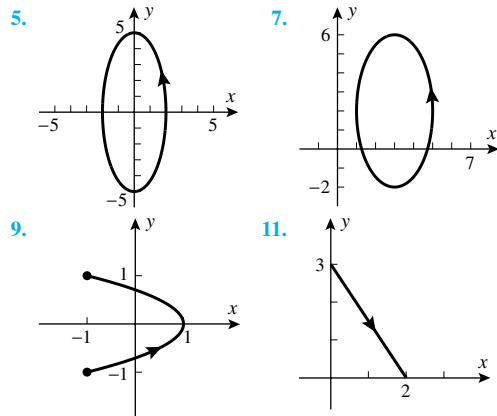
▶ **Appendix I (Page I1)**

1. (a) $y = x + 2$

(c)

t	0	1	2	3	4	5
x	-1	0	1	2	3	4
y	1	2	3	4	5	6

(d)

3.

5.

7.

9.

11.
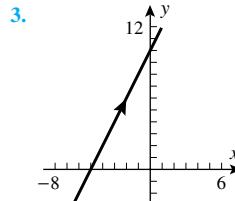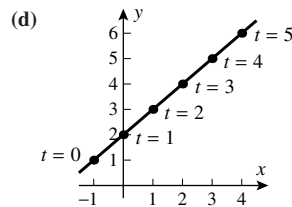
13. $x = 5\cos t, y = -5\sin t, 0 \le t \le 2\pi$ **15.** $x = 2, y = t$

17. $x = t^2, y = t, -1 \le t \le 1$

19. (a)
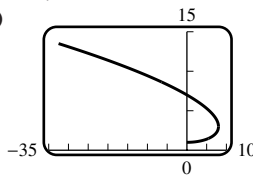
(b)

t	0	1	2	3	4	5
x	0	5.5	8	4.5	-8	-32.5
y	1	1.5	3	5.5	9	13.5

(c) $t = 0, 2\sqrt{3}$ **(d)** $0 < t < 2\sqrt{2}$ **(e)** 2

21. (a)   **(b)**
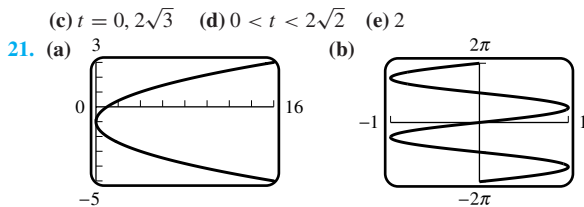
Responses to True–False questions may be abridged to save space.

23. True; the graph is the upper half of the unit circle.

25. False; the graph is the reflection of the graph of $y = f(x)$ about the line $y = x$

27. (b) $\frac{1}{2}$ **(c)** $\frac{3}{4}$

29. (b) (x_0, y_0) to (x_1, y_1) **(c)** $x = 3 - 2(t - 1), y = -1 + 5(t - 1)$

31.   **33.**
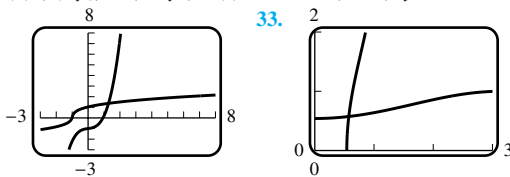
35.

37. (a) $x = 4\cos t, y = 3\sin t$ **(b)** $x = -1 + 4\cos t, y = 2 + 3\sin t$

39. (a) ellipses with fixed center, varying axes of symmetry   **(b)** (assume $a \ne 0, b \ne 0$) ellipses with varying center, fixed axes of symmetry   **(c)** circles of radius 1 with centers on line $y = x - 1$

▶ **Appendix J (Page J1)**

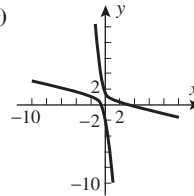**1.** II   **3.** $S = 0.0815686t + 63.7661$, coefficient $= 0.104805$
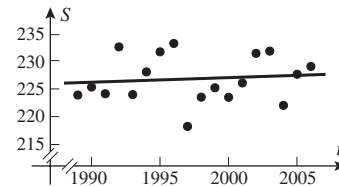
5. (a) $p = 0.0146T + 3.98, 0.9999$ **(b)** 3.25 atm   **(c)** $\approx -272°\,C$

7. (a) $R = 0.00723T + 1.55$ **(b)** $\approx -214°C$

9. (a) $S = 0.50179\omega - 0.00643$ **(b)** ≈ 16.0 lb

11. (a) $R = 0.2087h - 1.0549, 0.842333$

(b)
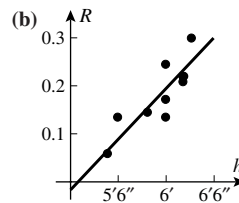
13. (a) 181.8 km/s/Mly   **(b)** 1.492×10^{10} years   **(c)** increase

15. $T = 849.5 + 143.5\sin\left[\dfrac{\pi}{183}t - \dfrac{\pi}{2}\right]$ **17.** $t = 0.445\sqrt{d}$

▶ **Appendix K (Page K1)**

1. circle   **3.** parabola   **5.** ellipse

9. (a) hyperbola   **(b)** $y = -\frac{9}{2}x - \frac{1}{2} + \frac{1}{2}\sqrt{73x^2 + 42x + 17}$

(c)

▶ **Appendix L (Page L1)**

3. $y = c_1 e^x + c_2 e^{-4x}$ **5.** $y = c_1 e^x + c_2 x e^x$

7. $y = c_1\cos x + c_2\sin x$ **9.** $y = c_1 + c_2 e^x$

11. $y = c_1 e^{2t} + c_2 t e^{2t}$ **13.** $y = e^{-2x}(c_1\cos 3x + c_2\sin 3x)$

15. $y = c_1 e^{-x/4} + c_2 e^{x/2}$ **17.** $y = 3e^x - 2e^{-3x}$

19. $y = 2e^{-3x} + xe^{-3x}$ **21.** $y = -e^{-2x}(3\cos x + 6\sin x)$

23. (a) $y'' - 3y' - 10y = 0$

   (b) $y'' - 8y' + 16y = 0$ **(c)** $y'' + 2y' + 17y = 0$

25. (a) $k < 0$ or $k > 4$ **(b)** $0, 4$ **(c)** $0 < k < 4$

27. (a) $y = (1/x)[c_1\cos(\ln x) + c_2\sin(\ln x)]$

   (b) $y = c_1 x^{1+\sqrt{3}} + c_2 x^{1-\sqrt{3}}$

33. (a) $x(t) = 0.4\cos(t/2)$ m   **(b)** period $= 4\pi$ s, frequency $= \dfrac{1}{4\pi}$ Hz

(c)   **(d)** $t = \pi$ s
   (e) $t = 2\pi$ s

35. (a) Maximum speed occurs when $x = 0$.

   (b) Minimum speed occurs when $x = \pm x_0$.

A50   Answers to Odd-Numbered Exercises

39. (a) $x = e^{-1.2t} + 3.2te^{-1.2t}$ **(b)** 1.427364 cm

41. (a) $x = e^{-t/2} \cos(\sqrt{19}t/2) - \frac{6}{19}\sqrt{19}e^{-t/2} \sin(\sqrt{19}t/2)$
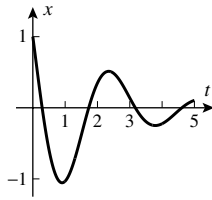
(b) 1.0545 cm

(c) -3.210357 cm/s   **(d)** 3.210357 cm/s^2

43. (a) $x = (4 + 2v_0)e^{-3t/2} - (3 + 2v_0)e^{-2t}$

(b) $8e^{-3t/2} - 7e^{-2t}, 2e^{-3t/2} - e^{-2t}, -4e^{-3t/2} + 5e^{-2t}$