

APPENDIX

B

ANSWERS TO ODD-NUMBERED EXERCISES

CHAPTER 0

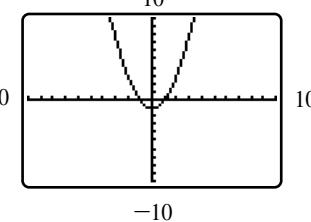
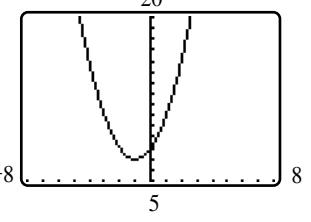
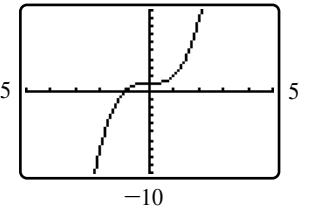
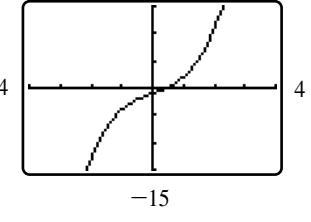
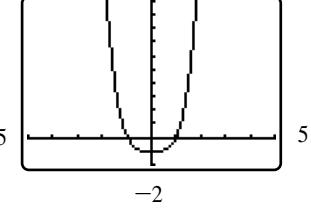
Exercises Section 0.1

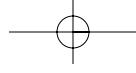
5. $x < 3$ 7. $x < -2$ 9. $x > -\frac{2}{3}$ 11. $3 \leq x < 6$
 13. $-\frac{1}{2} < x < 2$ 15. $x < -4$ or $x > 1$
 17. $-2 < x < 3$ 19. all reals 21. $-1 < x < 7$
 23. $2 < x < 4$ 25. $x < -\frac{3}{2}$ or $x > \frac{1}{2}$
 27. $x < -2$ or $x > 2$
 29. $x < -4$ or $-4 < x < -1$ or $x > 2$
 31. $x < -1$ or $x > 0$ 33. $\sqrt{13}$ 35. 4
 37. $\sqrt{20}$ 39. yes 41. yes
 43. increases by 550, 650, 750; predict $3200 + 850 = 4050$
 45. decreases by 10, 30, 50; predict $3910 - 70 = 3840$
 47. finite number of digits terminate
 49. $\frac{\left(\frac{1}{2}\right)^7 - \left(\frac{2}{3}\right)^{12}}{\left(\frac{1}{2}\right)^7} = 0.013$
 51. P: 0.551, 0.587, 0.404, 0.538, 0.605
 win%: 0.568, 0.593, 0.414, 0.556, 0.615

Exercises Section 0.2

5. yes 7. yes 9. no 11. no 13. 2
 15. $\frac{1}{2}$ 17. $-\frac{5}{2}$ 19. $-\frac{5}{7}$
 21. $(2, 5)$, $y = 2(x - 1) + 3$ 23. $(2, 2)$, $y = -2(x - 1) + 4$
 25. $(0, 1)$, $y = 1$ 27. $(4, 2)$, $y = \frac{1}{2}(x - 2) + 1$
 29. $(3.3, 2.3)$, $y = 1.2(x - 2.3) + 1.1$
 31. parallel 33. perpendicular 35. neither
 37. neither 39. parallel
 41. (a) $y = 2(x - 2) + 1$ (b) $y = -\frac{1}{2}(x - 2) + 1$
 43. (a) $y = -1$ (b) $x = 0$
 45. (a) $y = 2(x - 3) + 1$ (b) $y = -\frac{1}{2}(x - 3) + 1$
 47. $y = 2(x - 1) + 1$; 7 49. $y = -2(x - 1) + 3$; -3
 51. $y = \frac{1}{2}(x + 2) + 1$; 4 53. yes 55. no 57. yes
 59. both 61. rational 63. neither 65. both
 67. $x \geq -2$ 69. all reals 71. $x \neq \pm 1$ 73. all reals
 75. $-1, 1, 11, -\frac{5}{4}$ 77. $1, 2, 0, \sqrt{\frac{3}{2}}$ 79. $50 < x$
 81. $0 \leq x \leq$ number made 83. no: many y's for one x
 85. no: many y's for one x 87. days 1, 9
 89. constant, increasing, decreasing; graph going down;
 graph going up
 95. 63,000 feet 97. 9550 rpm

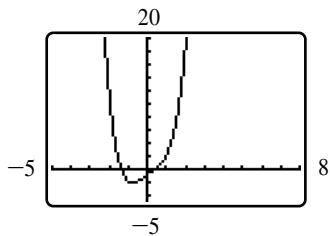
Exercises Section 0.3

5. 
7. 
9. 
11. 
13. 

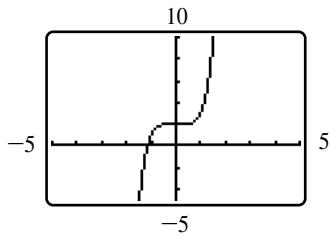


1200 Appendix B Answers to Odd-Numbered Exercises

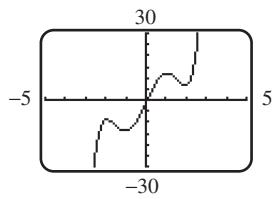
15.



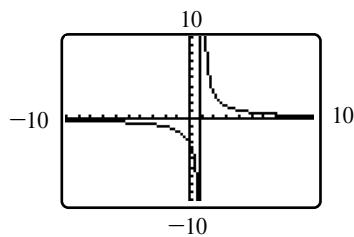
17.



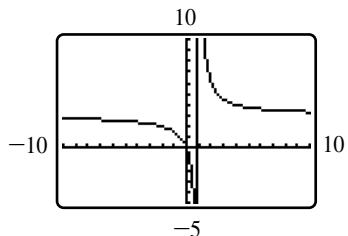
19.



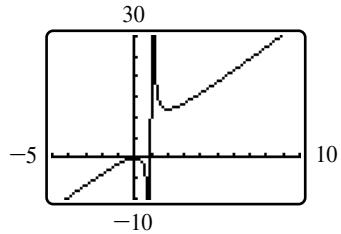
21.



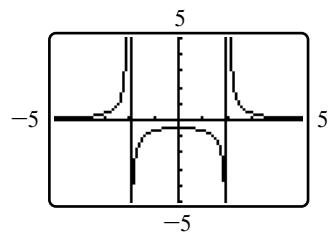
23.



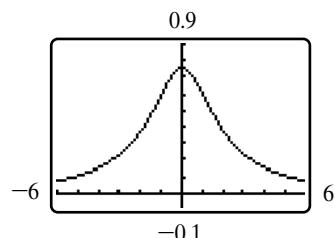
25.



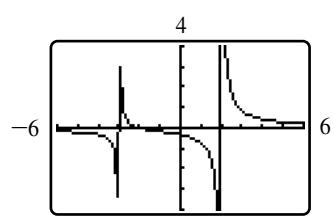
27.



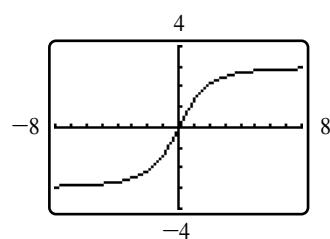
29.



31.



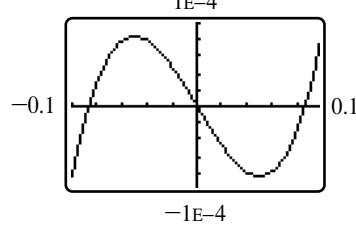
33.

35. $x = -2, x = 2, y = -4$ 37. $y = 4$ 39. $x = -1, x = 4, y = -4$ 41. $x = -1, x = 1, x = 2, y = 2$ 43. $x = -1, y = -\frac{1}{4}$ 45. $x = -2, x = 2$ 47. $x = -5, x = 2$

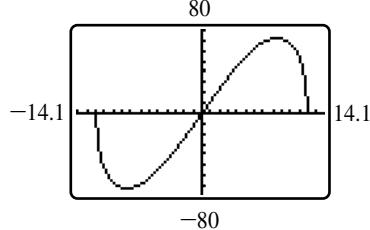
49. none

51. $x = -2, x = -1, x = 0$ 53. $x = -3, x = 3$

55.



57.



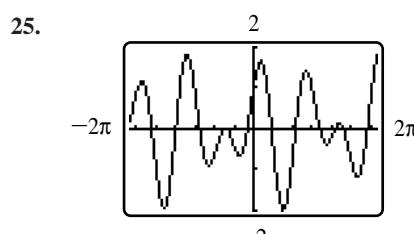
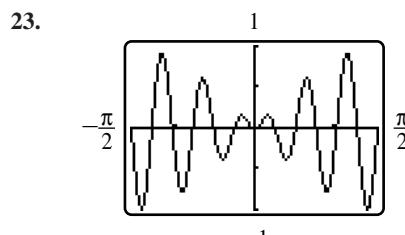
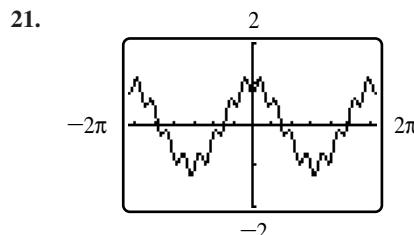
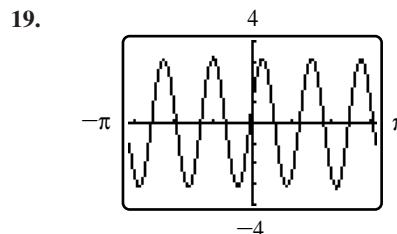
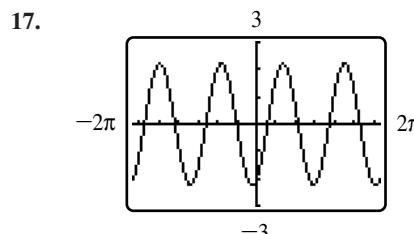
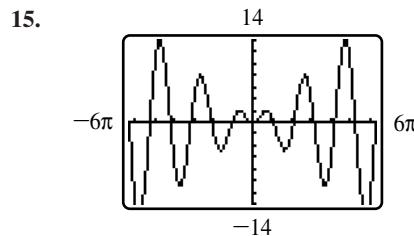
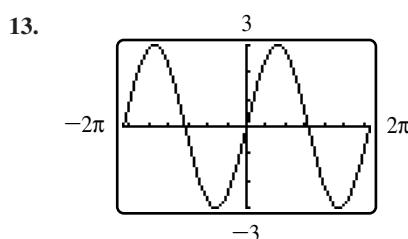
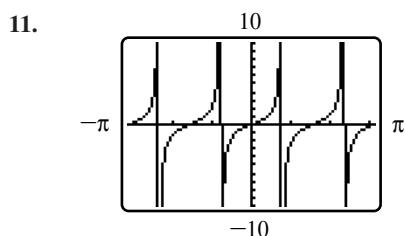
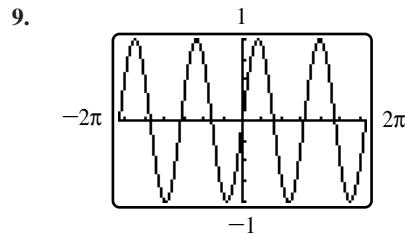
- 59.** $y = 0$ **61.** $y = 3$ **63.** $y = 1$
65. possible answer: $-9 \leq x \leq 11, -17 \leq x \leq 23$
67. parabola $y = \frac{1}{4}x^2 + 1$ **69.** lead $v_T = \sqrt{2}$ (wood v_T)

Exercises Section 0.4

- 5.** 1, 3 **7.** $-3, 5$ **9.** $2 - \sqrt{2}, 2 + \sqrt{2}$
11. $-1 + \frac{\sqrt{6}}{2}, -1 - \frac{\sqrt{6}}{2}$ **13.** 0, 1, 2 **15.** $-2, -1, 2$
17. $-1, 1$ **19.** $-\sqrt[3]{2}, 1$ **21.** $-1.879, 0.347, 1.532$
23. -1.325 **25.** $-2.831, -1$ **27.** 0.125
29. $-5.248, 10.006$ **31.** 2; $x = 1, x \approx 1.206$
33. 1; $x = 1$ **35.** 2; $x = 0, x \approx 9.534$ **37.** 1; $x = 0$
39. 2; $x \approx -1.18, x \approx 1.18$ **45.** 3 (true); -1 (extraneous)
47. $-1 - 2i, -1 + 2i$ **49.** $-1 - \sqrt{6}, -1 + \sqrt{6}$
51. $1, -\frac{1}{2} - \frac{\sqrt{3}}{2}i, -\frac{1}{2} + \frac{\sqrt{3}}{2}i$ **53.** $\frac{1}{2} + \frac{\sqrt{5}}{2}, \frac{1}{2} - \frac{\sqrt{5}}{2}$
55. $-1, 0, 1$ **59.** 123 ft/s ≈ 84 mph **61.** 81 feet

Exercises Section 0.5

- 5.** (a) 45° (b) 60° (c) 30° (d) 240°
7. (a) π (b) $\frac{3\pi}{2}$ (c) $\frac{2\pi}{3}$ (d) $\frac{\pi}{6}$



- 27.** Domain: all real numbers except odd multiples of $\frac{\pi}{2}$;
range: all real numbers.

1202 Appendix B Answers to Odd-Numbered Exercises

29. Domain: all real numbers except odd multiples of $\frac{\pi}{2}$; Range: $(-\infty, -1] \cup [1, \infty)$.

31. $A = 3$, period = π , frequency = $\frac{1}{\pi}$

33. $A = 5$, period = $\frac{2\pi}{3}$, $f = \frac{3}{2\pi}$

35. $A = 3$, period = π , $f = \frac{1}{\pi}$

37. $A = 4$, period = 2π , $f = \frac{1}{2\pi}$

43. $\beta \approx 0.6435$ **45.** no **47.** yes, 2π

49. $-\frac{\pi}{3} + 2n\pi; \frac{\pi}{3} + 2n\pi$ **51.** $\pi + 2n\pi; \frac{\pi}{2} + n\pi$

53. $\frac{\pi}{2} + 2n\pi$ **55.** $-\frac{\pi}{2} + 2n\pi; \frac{\pi}{2} + 2n\pi; 2n\pi$

57. $\frac{\sqrt{8}}{3}$ **59.** $-\frac{\sqrt{3}}{2}$ **61.** 3; $x = 0, x \approx 1.109, x \approx 3.698$

63. 2; $x \approx -1.455, x \approx 1.455$ **65.** 1; $x \approx 1.249$

67. 2; $x = 0, x \approx 0.877$ **69.** $2 \tan 20^\circ \approx 0.73$ miles

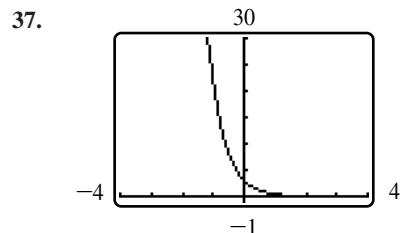
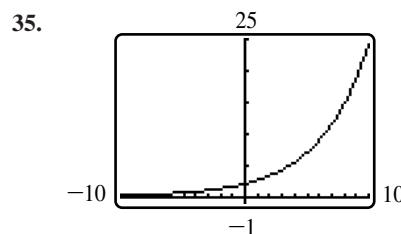
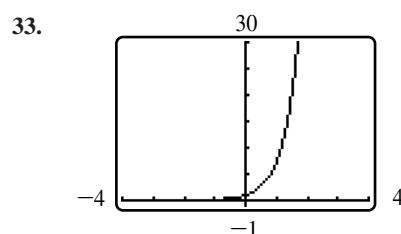
71. $100 \tan 50^\circ \approx 119$ feet **73.** $f = \frac{30}{\pi}, \frac{170}{\sqrt{2}} \approx 120.2$ volts

75. \$24,000 per year

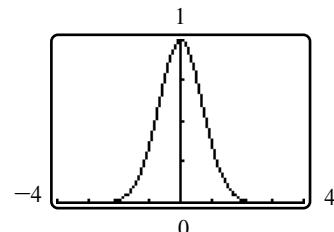
Exercises Section 0.6

5. $\frac{1}{8}$ **7.** $\sqrt{3}$ **9.** $\sqrt[3]{25}$ **11.** $\frac{1}{\sqrt[3]{16}}$ **13.** x^{-2}

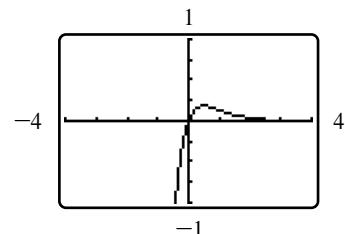
15. $x^{1/2}$ **17.** $2x^{-3}$ **19.** $\frac{1}{2}x^{-1/2}$ **21.** 8 **23.** 2
25. 7.389 **27.** 1.213 **29.** 4.415 **31.** 9.900



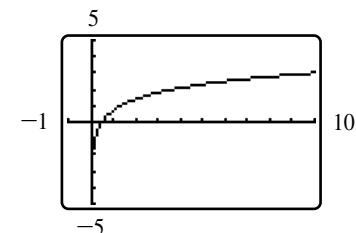
39.



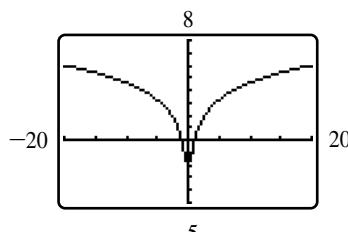
41.



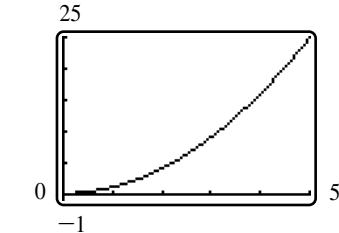
43.



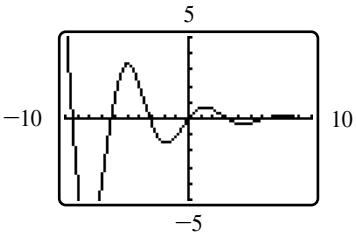
45.



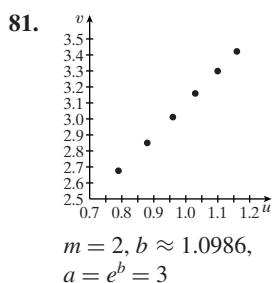
47.



49.



51. $\frac{1}{2} \ln 2$ 53. $-\frac{1}{2} \ln \frac{1}{2}$ 55. $\frac{1}{2} e^4$ 57. $\frac{1}{4} e^{7/2}$
 59. 2 61. (a) 2 (b) 3 (c) -3
 63. (a) 1.771 (b) 2.953 (c) -2.893 65. $\ln \frac{3}{4}$
 67. 0 69. $\ln 12$ 71. $2e^{(1/2 \ln 3)x}$ 73. $4e^{(1/2 \ln 1/2)x}$
 75. $-2e^{(\ln 3/2)x}$ 77. 0.651 79. $1 - e \approx 0.632$



$m = 2, b \approx 1.0986,$
 $a = e^b = 3$

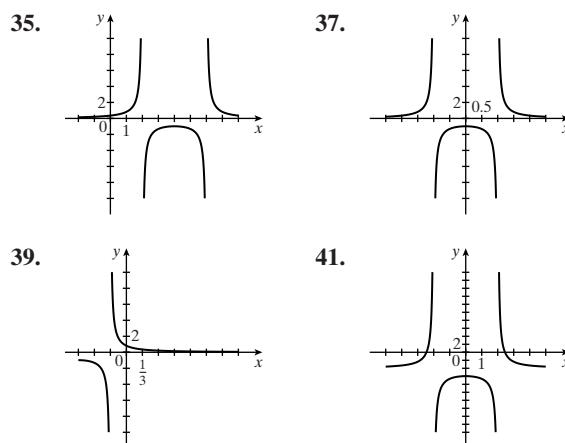
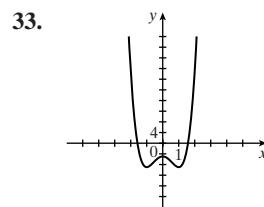
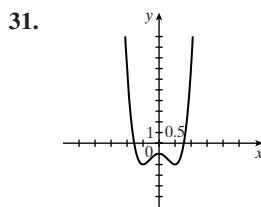
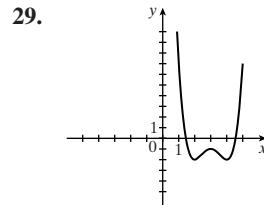
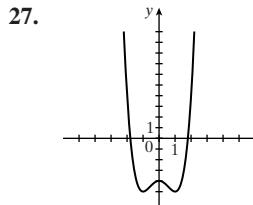
81. 83.

A scatter plot with the vertical axis labeled v ranging from 15 to 17 and the horizontal axis labeled u ranging from 0 to 2. There are approximately 10 data points showing a non-linear, increasing trend.

no, exponential

Exercises Section 0.7

5. $(f \circ g)(x) = \sqrt{x-3} + 1, x \geq 3$
 $(g \circ f)(x) = \sqrt{x-2}, x \geq 2$
 7. $(f \circ g)(x) = x, x > 0$
 $(g \circ f)(x) = x, \text{ all reals}$
 9. $(f \circ g)(x) = \sin^2 x + 1, \text{ all reals}$
 $(g \circ f)(x) = \sin(x^2 + 1), \text{ all reals}$
 11. possible answer: $f(x) = \sqrt{x}, g(x) = x^4 + 1$
 13. possible answer: $f(x) = \frac{1}{x}, g(x) = x^2 + 1$
 15. possible answer: $f(x) = x^2 + 3, g(x) = 4x + 1$
 17. possible answer: $f(x) = x^3, g(x) = \sin x$
 19. possible answer: $f(x) = \cos x, g(x) = 4x$
 21. possible answer: $f(x) = e^x, g(x) = x^2 + 1$
 23. possible answer: $f(x) = \sqrt{x}, g(x) = e^x + 1$
 25. possible answer: $f(x) = \ln x, g(x) = 3x - 5$



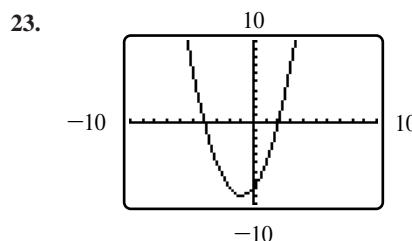
43. $y = (x+1)^2$, shift left one
 45. $y = (x+1)^2 + 3$, shift left one, up three
 47. $y = 2[(x+1)^2 + 1]$, shift left one, up one, double vertical scale
 49. upside down, vertical scale doubled
 51. upside down, vertical scale tripled, shifted up two
 53. mirror image across y -axis
 55. mirror image across y -axis, shifted up one
 57. mirror image across x -axis, vertical scale times $|c|$
 59. oscillations dying out 63. go to 0 65. 0.739085

Exercises Section 0.8

3. 2 5. 0 7. 0 9. $\frac{1}{2}$ 11. 1 13. 1
 15. 4.6267, 4.6417, 4.64678 17. 1.90626, 1.90913, 1.91010
 19. 3.16732, 3.16770, 3.16784
 21. 9.15298, 9.25344, 9.29357 23. 1, $\frac{4}{3}, \frac{7}{5}, \frac{10}{7}; \frac{3}{2}$
 25. $0, \frac{1}{2}, \frac{2}{3}, \frac{3}{4}; 1$ 27. $2, \frac{3}{2}, \frac{4}{5}, \frac{5}{10}; 0$ 29. $0, \frac{2}{5}, \frac{8}{3}, \frac{18}{13}; 2$
 31. $2, 1, \frac{2}{3}, \frac{1}{2}; 0$ 33. $0, \frac{1}{2}, \frac{2}{3}, \frac{3}{4}; 1$
 35. $e^{-1}, e^{-2}, e^{-3}, e^{-4}; 0$ 37. $\cos(1), \cos(\frac{1}{2}), \cos(\frac{1}{3}), \cos(\frac{1}{4}); 1$
 39. $0, \frac{1}{\sqrt{2}}, \frac{2}{\sqrt{5}}, \frac{3}{\sqrt{10}}; 1$ 41. $3, 4, 4\frac{1}{9}, 4\frac{1}{8}; 4$
 43. $\lim_{n \rightarrow \infty} a_n = 0$

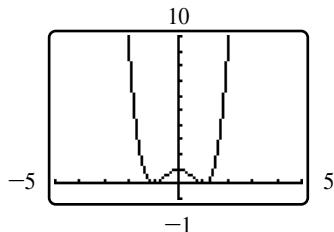
Chapter 0 Review Exercises

1. $x > 1$ 3. $x < -2$ or $x > 4$ 5. $-1 < x < 2$
 7. $\sqrt{20}$ 9. -2 11. parallel 13. no
 15. $y = \frac{1}{2}(x-1) + 1, y = \frac{5}{2}$ 17. $y = -\frac{1}{3}(x+1) - 1$
 19. yes 21. $-2 \leq x \leq 2$

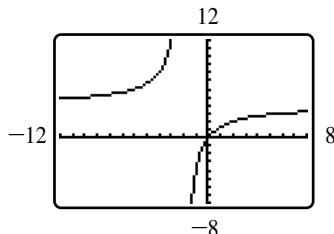


1204 Appendix B Answers to Odd-Numbered Exercises

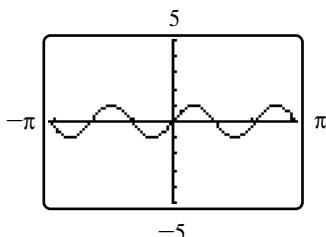
25.



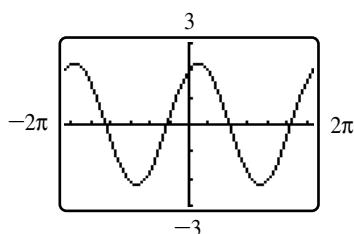
27.



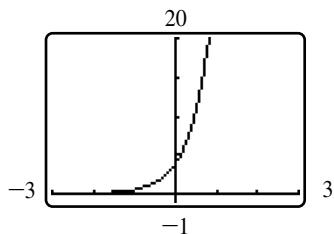
29.



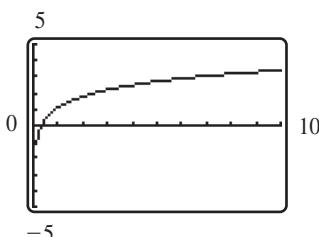
31.



33.



35.

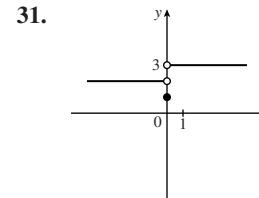
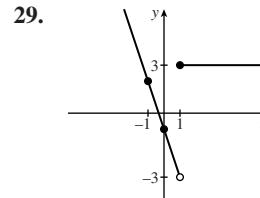
37. $x = -4, x = 2, y = -8$ 39. vertical $x = -2$, horizontal $y = 4$ 41. $-2, 5$ 43. $1, 1 + \sqrt{3}, 1 - \sqrt{3}$ 45. 3 47. yes49. $50 \tan 34^\circ = 33.7$ feet 51. (a) $\frac{1}{\sqrt{5}}$ (b) $\frac{1}{9}$ 53. $\ln 2$ 55. $\frac{1}{2} \ln \frac{8}{3}$ 57. $(f \circ g)(x) = x - 1, x \geq 1$
 $(g \circ f)(x) = \sqrt{x^2 - 1}, x \leq -1 \text{ or } x \geq 1$ 59. $f(x) = e^x, g(x) = 3x^2 + 2$ 61. $(x - 2)^2 - 3$, shift two right and three down

63. 2 65. (a) 1.05799 (b) 1.05806

67. $3, \frac{1}{2}, \frac{3}{13}, \frac{3}{22}; 0$ **CHAPTER 1****Exercises Section 1.1**5. (a) -2 (b) 2 (c) does not exist (d) 1 (e) $\frac{1}{2}$ (f) -1
(g) 3 (h) does not exist (i) 1.5 (j) 2.5 7. $2.2247, 2.0488, 2.0049, 2.0004 \rightarrow 2$;
 $1.7071, 1.9486, 1.9949, 1.9994 \rightarrow 2$ 9. -2 11. $\frac{1}{3}$ 13. 1 15. 1 17. no; jump

19. yes 21. no; vertical asymptote 23. yes

25. no; vertical asymptote 27. does not exist

33. The first argument doesn't depend on specific values of x .

35. 2.7182818 37. 0

Exercises Section 1.25. 1 7. $\sqrt{7}$ 9. $-\frac{3}{8}$ 11. 5 13. $\frac{3}{4}$ 25. 915. $\frac{3}{4}$ 17. 1 19. 0 21. 2 23. 2 25. 9

27. 4 29. 1 31. does not exist

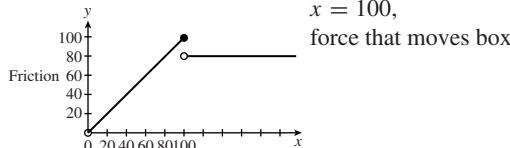
33. 0, $f(x) = -x^2$, $h(x) = x^2$ 35. $f(x) = 0, h(x) = \sqrt{x}$ 37. does not exist—undefined for $x > 4$ 39. does not exist—see #37 41. $\sqrt{\frac{1}{2}}$ 43. $h(a)$ 45. (a) -1 (b) -2 47. 4 49. 0 51. $m = \frac{1}{2}$ 53. 2.7182818 55. 1 61. $f(x) = \frac{1}{x}, g(x) = -\frac{1}{x}$

63. yes 65. 0, does not exist

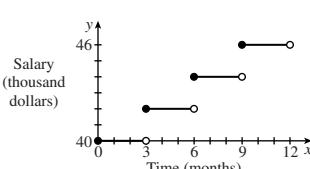
67. for $2 \leq x < 3$, $[x] = 2$ and for $3 \leq x < 4$, $[x] = 3$,
so $\lim_{x \rightarrow 3^-} [x] \neq \lim_{x \rightarrow 3^+} [x]$.**Exercises Section 1.3**5. $x = -2, x = 2$ 7. $x = -2, x = 1, x = 4$ 9. $x = -2, x = 2, x = 4$ 11. $f(1)$ is not defined and $\lim_{x \rightarrow 1} f(x)$ does not exist13. $f(0)$ is not defined and $\lim_{x \rightarrow 0} f(x)$ does not exist15. $\lim_{x \rightarrow 2} f(x) \neq f(2)$

17. $x = 1$ (removable), $x = -1$; $g(x) = \frac{1}{x+1}$
 19. none 21. $\frac{n\pi}{2}$ for odd integers n
 23. $x = n\pi$ for nonzero integers n , $x = 0$ is removable;

$$g(x) = \begin{cases} \cos x, & x = 0 \\ \frac{x \cos x}{\sin x}, & x \neq 0 \end{cases}$$

 25. $x = 1$ 27. $x = 1$ 29. $[-3, \infty)$
 31. $(-\infty, \infty)$ 33. $(-\infty, \infty)$ 35. $(-1, \infty)$
 37. -700
 39. (a) $34,573.5 + 0.36(x - 128,100)$
 (b) $88,699.5 + 0.396(x - 278,450)$
 41. $f(2) < 0, f(3) > 0, [2\frac{20}{32}, 2\frac{21}{32}]$
 43. $f(-1) > 0, f(0) < 0, [-\frac{18}{32}, -\frac{17}{32}]$
 45. $f(0) > 0, f(1) < 0, [\frac{23}{32}, \frac{24}{32}]$ 47. yes 49. no
 51. #49 is 53. $g(T) = 100 - 25(T - 30)$
 55.


$x = 100$,
force that moves box

57. $M(t)$ = distance from home at time t on Monday
 $T(t)$ = distance from home at time t on Tuesday
 $M(1:59) - T(1:59) > 0$ and $M(7:13) - T(7:13) < 0$
 59. raises at 3-month marks, $f(t) = s(t)$ when t is a multiple of 3


61. If $f(d) < 0$, then $f(x) = 0$ for some x between c and d .

Exercises Section 1.4

5. ∞ 7. does not exist 9. $-\infty$ 11. ∞
 13. ∞ 15. $-\infty$ 17. ∞ 19. 1 21. $\frac{1}{3}$
 23. ∞ 25. 1 27. $\frac{3}{4}$ 29. 0 31. ∞
 33. does not exist 35. 0 37. ∞ 39. 0
 41. $y = -1, y = 1$ 43. $x = -2, x = 2, y = 0$
 45. $x = -2, x = 2, y = -x$ 47. $y = x$
 49. $y = 2x + 2$ 51. $y = 0$ as $x \rightarrow \infty, \infty$ crosses
 55. 30 mm, 300 mm
 57. with no light, $80/9$ or $8.888\dots$; with an infinite amount of light, 12
 59. $f(x) = \frac{80x^{-0.3} + 60}{10x^{-0.3} + 30}$ 61. ∞, c
 63. $t = 4.6$ for A, $t = 17.8$ for B 67. $g(x) = \sin x, h(x) = x$
 69. 2.7183 71. 0.3679 73. 1

Exercises Section 1.5

5. $\sqrt{0.1} \approx 0.32$ 7. 0.45 9. 0.39 11. 0.02
 13. $\frac{\varepsilon}{3}$ 15. $\frac{\varepsilon}{3}$ 17. $\frac{\varepsilon}{4}$ 19. 2ε 21. $\min\left\{1, \frac{\varepsilon}{3}\right\}$
 23. $\min\left\{1, \frac{\varepsilon}{5}\right\}$ 25. $\frac{\varepsilon}{|m|}$, no 29. 0.02 31. 0.0095
 33. 0.0001 35. 12 37. -10 39. 1.15
 41. $M = \sqrt[3]{\frac{2}{\varepsilon}}$ 43. $M = \sqrt[k]{\frac{1}{\varepsilon}}$ 45. $N = -\sqrt{\frac{1}{\varepsilon} - 2}$
 47. $\delta = \sqrt[4]{-\frac{2}{N}}$ 49. $\delta = \frac{2}{\sqrt{M}}$ 51. 1 53. 1
 55. $\min\left\{1, \frac{\varepsilon}{10}\right\}$

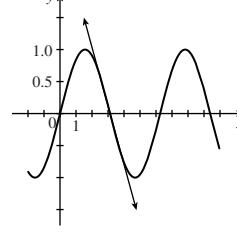
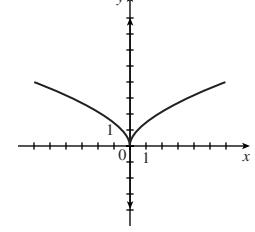
Exercises Section 1.6

5. $\frac{1}{4}; \frac{x}{\sqrt{4x^2 + 1} + 2x}$ 7. 1; $\frac{2\sqrt{x}}{\sqrt{x+4} + \sqrt{x+2}}$
 9. 1; $\frac{2x}{\sqrt{x^2 + 4} + \sqrt{x^2 + 2}}$ 11. $\frac{1}{6}; \frac{\sin^2 2x}{12x^2(1 + \cos 2x)}$
 13. $3, \pm\infty$
 15. $f(x) = 0, g(x) = 0.0016, -0.0159, -0.1586, -0.9997$
 17. 20, 0

Chapter 1 Review Exercises

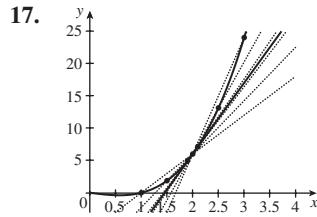
1. does not exist 3. 7.39 (exact: e^2)
 5. (a) 1 (b) -2 (c) does not exist (d) 0
 7. $x = -1, x = 1$ 9. $\frac{1}{4}$ 11. does not exist
 13. 0 15. does not exist 17. $\sqrt{2}$ 19. ∞
 21. $\frac{1}{3}$ 23. 0 25. ∞ 27. 0
 31. $x = -3, x = 1$ (removable) 33. $x = 2$
 35. $(-\infty, -2) \cup (-2, 3) \cup (3, \infty)$ 37. $(-\infty, \infty)$
 39. $x = 1, x = 2, y = 0$ 41. $x = -1, x = 1, y = 1$
 43. 0.4 45. $\frac{\varepsilon}{2}$ 47. 3

CHAPTER 2**Exercises Section 2.1**

5.

 7.

 9. -1 11. C, B, A, D
 13. (a) 6 (b) 18 (c) 8.25 (d) 14.25 (e) 10.41
 (f) 11.61 (g) 11

1206 Appendix B Answers to Odd-Numbered Exercises

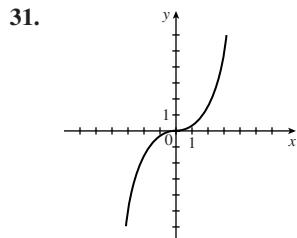
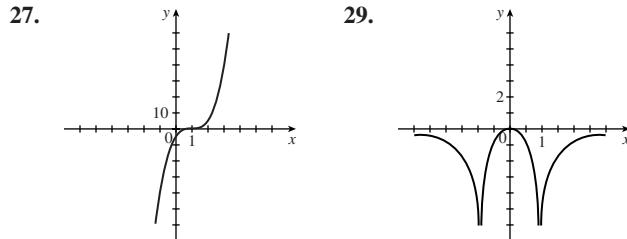
- 15.** (a) -1.19 (b) -0.26 (c) -0.05 (d) 3.3 (e) 2.4
(f) 3.5 (g) 3



- 21.** $y = 2(x - 1) - 1$ **23.** $y = -7(x + 2) + 10$
25. $y = -\frac{1}{2}(x - 1) + 1$ **27.** $y = \frac{1}{2}(x + 2) + 1$
29. no; corner point **31.** yes: 0
33. no; jump discontinuity
35. (a) 32 (b) 48 (c) 62.4 (d) 63.84 (e) 64
37. (a) 2.236 (b) 1.472 (c) 1.351 (d) 1.343 (e) 1.342
39. -32 **41.** $\frac{1}{8}$
43. about 1.75 hours; 1.5 hours; 4 hours; rest **47.** 15 rad/s
51. 0.359 million people per year **55.** yes

Exercises Section 2.2

- 5.** 3 **7.** $\frac{3}{4}$ **9.** 2 **11.** 3 **13.** $6x$
15. $\frac{-3}{(x+1)^2}$ **17.** $\frac{3}{2\sqrt{3x+1}}$ **19.** $3x^2+2$ **21.** c
23. a **25.** b



- 33.** $x = -3, x = -1, x = 3$ **35.** 5 **37.** 10 **41.** 1
43. $D_+f(0) = 3, D_-f(0) = 2$ **45.** $D_-f(0) \neq g'(0)$
51. $f(x) = -1 - x^2$ **53.** meters per second
55. items per dollar **57.** 0.016 s; 0.008 s

Exercises Section 2.3

- 5.** $3x^2 - 2$ **7.** $6x$ **9.** 0 **11.** $9t^2 - \frac{1}{\sqrt{t}}$
13. $-\frac{3}{x^2} - 8$ **15.** $-5x^{-3/2} - 2$

- 17.** $3s^{1/2} + s^{-4/3}$ **19.** $\frac{2}{3}x^{-2/3}$ **21.** $9x^2 - \frac{3}{2}x^{1/2}$
23. $\frac{3}{2} - \frac{1}{2}x^{-2}$ **25.** $12x^2 + 6$ **27.** $30x^4 + \frac{1}{4}x^{-3/2}$
29. $-96t^{-5}$ **31.** 24 **33.** $-\frac{3}{8}x^{-3/2} - \frac{3}{8}x^{-5/2} - \frac{15}{8}x^{-7/2}$
35. $v(t) = -32t + 40, a(t) = -32$
37. $v(t) = \frac{1}{2}t^{-1/2} + 2, a(t) = -\frac{1}{4}t^{-3/2}$
39. $v(1) = 8$ (going up); $a(1) = -32$ (slowing down)
41. $v(2) = 16$ (going up); $a(2) = 20$ (speeding up)
43. $y = -x + 4$ **45.** $y = 4(x - 2) + 2$
47. $x = -1$ (peak) $x = 1$ (trough) **49.** $x = 0$ (minimum)
51. (a) $f(x)$ (b) $f''(x)$ (c) $f'(x)$
53. $(-1)^{(n-1)} \frac{1 \cdot 3 \dots (2n-3)}{2^n} x^{-(2n-1)/2}$ **55.** $\frac{3}{2}x^2 + 2x - 2$
59. second; not much **61.** $b > \frac{4}{9c^2}$ **63.** x^4
65. $\frac{1}{5}x^5$ **67.** $\frac{3}{2}x^2 - x$ **69.** $\frac{2}{3}x^{3/2}$

Exercises Section 2.4

- 5.** $2x(x^3 - 3x + 1) + (x^2 + 3)(3x^2 - 3)$
7. $3(x^3 - 2x^2 + x) + (3x + 4)(3x^2 - 4x + 1)$
9. $\left(\frac{1}{2}x^{-1/2} + 3\right)\left(5x^2 - \frac{3}{x}\right) + (\sqrt{x} + 3x)(10x + 3x^{-2})$
11. $\frac{3(5x+1) - (3x-2)5}{(5x+1)^2} = \frac{13}{(5x+1)^2}$
13. $\frac{1(x^2+x+1) - (x-2)(2x+1)}{(x^2+x+1)^2} = \frac{-x^2+4x+3}{(x^2+x+1)^2}$
15. $\frac{(3-3x^{-1/2})(5x^2-2) - (3x-6\sqrt{x})10x}{(5x-2)^2}$
17. $\frac{(2x-1)(x^2-5x+1) - (x^2-x-2)(2x-5)}{(x^2-5x+1)^2}$
 $= \frac{-4x^2+6x-11}{(x^2-5x+1)^2}$
19. $\frac{3}{2}x^{1/2} + \frac{3}{2}x^{-1/2} + x^{-3/2}$ **21.** $\frac{4}{3}x^{1/3} + 3$
23. $2x \frac{x^3+3x^2}{x^2+2} + (x^2-1) \frac{(3x^2+6x)(x^2+2) - (x^3+3x^2)(2x)}{(x^2+2)^2}$
25. $f'(x)g(x)h(x) + f(x)g'(x)h(x) + f(x)g(x)h'(x)$
33. $\frac{2}{3}x^{-1/3}(x^2-2)(x^3-x+1) + x^{2/3}(2x)(x^3-x+1)$
 $+ x^{2/3}(x^2-2)(3x^2-1)$
35. $(x^3+4x)(x^5-3x^2+1) + (x+1)(3x^2+4)(x^5-3x^2+1)$
 $+ (x+1)(x^3+4x)(5x^4-6x)$
37. $P'(t) = 0.03P(t); 3 - 4 = -1$ **39.** \$65,000 per year.
41. $\frac{19.125}{(m+0.15)^2}$ **43.** $\frac{-5644}{(20m+1)^2}$
45. $F'''(x) = f'''(x)g(x) + 3f''(x)g'(x) + 3f'(x)g''(x) + f(x)g'''(x)$
49. $T_c = \frac{8a}{27Rb}, V_c = 3nb, P_c = \frac{a}{27b^2}; 647 \text{ K}$

Exercises Section 2.5

5. $4 \cos x - 1$ 7. $\sec^2 x + \csc x \cot x$
 9. $\cos x - x \sin x$ 11. $2x^{-1/2} - 2 \cos x$
 13. $\frac{x \cos x - \sin x}{x^2}$ 15. $\sec^2 t$
 17. $\frac{-x^2 \sin x - (\cos x - 1)2x}{x^4}$ 19. $2 \cos^2 x - 2 \sin^2 x$
 21. $8x \tan x + 4x^2 \sec^2 x$ 23. 0 29. $y = 1$
 31. $y = -x + \frac{\pi}{2}$ 33. -1 35. $\frac{1}{\pi^2}$
 37. $y(t) = \sin t; x(t) = 3 \cos t, y(t) = 3 \sin t;$
 $x(t) = \cos 2t, y(t) = \sin 2t; x(t) = \cos \pi t, y(t) = \sin \pi t;$
 $x(t) = \cos t, y = -\sin t;$
 $x(t) = \cos\left(t + \frac{\pi}{2}\right), y(t) = \sin\left(t + \frac{\pi}{2}\right)$
 39. $4 \cos t$ 41. 4 amps, 2.62 amps 45. $-\cos x; -\sin x$
 51. (a) 3 (b) $\frac{1}{4}$ (c) 0 (d) 1

Exercises Section 2.6

5. $4e^x - 1$ 7. $e^x + xe^x$ 9. $1 + (\ln 2)2^x$
 11. $2e^{x+1}$ 13. $(\ln \frac{1}{3})(\frac{1}{3})^x$ 15. $-(\ln 4)4^{-x+1}$
 17. $\frac{xe^x - e^x}{x^2}$ 19. $\frac{1}{x}$ 21. $\frac{3}{x}$ 23. $2e^{2x}$
 25. $2xe^{-x} - x^2e^{-x}$ 27. $\frac{1 - \ln x}{x^2}$
 29. $y = 3e(x - 1) + 3e$ 31. $y = 3 \ln 3(x - 1) + 3$
 33. $y = 2e(x - 1) + e$ 35. $y = x - 1$
 37. $100 \ln 3 = 109.86\%$ 39. 100%
 41. $p(t) = 200 \cdot 3^t; 110\%$
 43. (a) $e^{0.05} - 1 \rightarrow 5.1\%$ (b) 10.5% (c) 22.1% (d) 100%
 (e) 171.8%
 45. $-e^{-t} \cos t - e^{-t} \sin t$; vel. is 0 at $t = \frac{3\pi}{4}, \frac{7\pi}{4}, \dots$
 47. The maximum velocities occur when the spring passes through the neutral position.
 53. $\ln 3 \approx 1.098612$ 55. $\frac{1}{4} = 0.25$
 57. $a = 1, b = \frac{1}{2}, c = -\frac{1}{2}$

Exercises Section 2.7

5. $6x^2(x^3 - 1)$ 7. $-2e^{-2x}$ 9. $x(x^2 + 4)^{-1/2}$
 11. $3(3x^2 + 1)(x^3 + x - 1)^2$ 13. $4x \cos(2x^2 + 3)$
 15. $4 \sin^3 x \cos x$ 17. $2 \tan x \sec^2 x$ 19. $2xe^{x^2}$
 21. $-\frac{1}{3x^2}e^{\frac{1}{3x}}$ 23. $\frac{3x^2 + 3}{x^3 + 3x}$ 25. $2x \sin 4x + 4x^2 \cos 4x$
 27. $12 \sec^3 4x \tan 4x$ 29. $\frac{2x^3 \cos x^2 - 2x \sin x^2}{x^4}$
 31. $-3x^2 \cos(\ln(\cos x^3)) \tan x^3$ 33. $x \cos x^2 (\sin x^2)^{-1/2}$
 35. $f'(x) = 8[\ln(x^2 + 1)]^7 \frac{1}{x^2 + 1}(2x)$
 37. $\sin \frac{4x}{x^2 + 1} \left[\frac{4x^2 - 4}{(x^2 + 1)^2} \right]$
 39. $\sec x$ 41. $y = \frac{3}{5}(x - 3) + 5$

43. $e^{-8}(3 \cos 6 - 4 \sin 6) \approx 0.00134$
 45. -0.0353 47. $-(2x + 1)^{-3/2}, 3(2x + 1)^{-5/2},$
 $-15(2x + 1)^{-7/2}, (-1)^{n+1} 3 \cdot 5 \dots (2n - 3)(2x + 1)^{-(2n-1)/2}$
 49. $4e^{2x}, 8e^{2x}, 16e^{2x}, 2^n e^{2x}$ 51. $\frac{1}{3}(x^2 + 3)^3$
 53. $-\frac{3}{2} \cos 2x$ 55. max at $x = 0$ 57. $a^x \ln a$
 59. ± 1 61. $m \pm c$

Exercises Section 2.8

5. $-\frac{1}{2}$ 7. 0 9. $\frac{4 - 2xy^2}{3 + 2x^2y}$ 11. $\frac{y}{16y\sqrt{xy} - x}$
 13. $\frac{y - 4y^2}{x + 3 + 2y^3}$ 15. $\frac{1 - 2xye^{x^2y}}{x^2e^{x^2y} - e^y}$
 17. $\frac{16x\sqrt{x+y}-1}{1-2\sqrt{x+y}}$ 19. $\frac{2y}{4ye^{4y}-1}$
 21. $y = \frac{1}{2}(x - 2) + 1$ 23. $y = \frac{1}{3}(x - 2) + 1$
 25. $y = -(x - 2) + 1$ 27. $y = -\frac{9}{2}(x - 1) + 3$
 29. -65 rad/s 31. 0.03 rad/s 33. $6\pi \text{ mm}^2/\text{hr}$
 35. $24\sqrt{101} \approx 241 \text{ mph}$
 37. $-\frac{100}{\sqrt{5}}, 44.7 \text{ mph is more accurate}$
 41. -2 dollars per year
 43. $s'(20) = 1.47152 \text{ thousand dollars per year}$
 45. 1 ft/s 51. 2.088 when $x = 20, 2.332$ when $x = 10$
 53. horizontal: $(0, 2.2)$ vertical: $(\pm\sqrt{6}, 1), (\pm\sqrt{2}, -1)$
 55. $\frac{-4}{y^3}$ 57. $x = 1.9, y \approx 1 - 4(-0.1) = 1.4$
 $x = 2.1, y \approx 1 - 4(0.1) = 0.6$

59. (4, 7)

61. $y' = \frac{2xy}{2-x^2}$, vertical asymptotes at $x = \pm\sqrt{2}$, horizontal asymptote at $y = 0$

Exercises Section 2.9

5. discontinuous at $x = 0$ 7. discontinuous at $x = \frac{\pi}{2}$
 9. $c = 0$ 11. $c = \frac{\sqrt{7} - 1}{3}$ 13. $c = \cos^{-1}\left(\frac{2}{\pi}\right)$
 17. increasing 19. decreasing 21. increasing
 23. increasing 25. $3x^2 + 5 > 0$
 27. $f'(x) = 4x^3 + 6x$ has one zero 29. $3x^2 + a > 0$
 31. $5x^4 + 3ax^2 + b > 0$ 35. $\frac{1}{3}x^3 + c$ 37. $\frac{1}{5}x^5 + c$
 39. $-\frac{1}{x} + c$ 41. $-\cos x + c$
 43. $f(x) > 0$ in an interval $(b, 0)$ for some $b < 0$
 45. discontinuous at $x = 0$

Chapter 2 Review Exercises

1. 0.8 3. 2 5. $\frac{1}{2}$ 7. $3x^2 + 1$
 9. $y = 2x - 2$ 11. $y = 6x + 3$ 13. $y = -3(x - 1) + 1$
 15. $v(t) = -32t + 40; a(t) = -32$

1208 Appendix B Answers to Odd-Numbered Exercises

17. $v(t) = 10e^{-2t}(4 \cos 4t - 2 \sin 4t)$
 $a(t) = -40e^{-2t}(4 \cos 4t + 3 \sin 4t)$
19. 8 ft/s going up, -24 ft/s coming down
21. (a) 0.3178 (b) 0.3338 (c) 0.3492 (d) 0.35
23. $4x^3 - 9x^2 + 2$ 25. $-\frac{3}{2}x^{-3/2} - 10x^{-3}$
27. $2t(t+2)^3 + 3t^2(t+2)^2$ 29. $\frac{(3x^2-1)-x(6x)}{(3x^2-1)^2}$
31. $2x \sin x + x^2 \cos x$ 33. $\frac{1}{2}x^{-1/2} \sec^2 \sqrt{x}$
35. $\csc t - t \csc t \cot t$ 37. $-4xe^{-x^2}$ 39. $\ln x^2 + 2$
41. $2 \cos 4x(\sin 4x)^{-1/2}$ 43. $2\left(\frac{x+1}{x-1}\right)\frac{-2}{(x-1)^2}$
45. $e^{4t} + 4te^{4t}$ 49. $12x^2 - 18x + 4$
51. $(12+8x)e^{2x}$ 53. $2 \sec^2 x \tan x$
55. $-3^{26} \sin 3x$ 57. $-\$2400$ per year
59. (a) $f(t) = \pm 4$ (b) $f(t) = 0$ (c) $f(t) = 0$
61. $\frac{2x-2xy}{x^2-9y^2}$ 63. $\frac{\sec^2 x + \frac{y}{(x+1)^2}}{\frac{1}{(x+1)} - 3}$
65. $\frac{170}{\sqrt{5}} \approx 76$ mph 67. (a) $(0, 1)$ and $(4, -31)$ (b) none
69. (a) $(0, 0)$ (b) none 71. $3x^2 + 7 > 0$ 73. $c = 1$
75. $x^3 - \sin x + c$

CHAPTER 3**Exercises Section 3.1**

5. $1 + \frac{1}{2}(x-1)$ 7. $3 + \frac{1}{3}x$ 9. $3x$ 11. $1 + 2x$
13. 0.01 and 0.0100003; 0.1 and 0.1003; 1 and 1.557
15. 2.0025 and 2.002498; 2.025 and 2.0248; 2.25 and 2.2361
17. $\frac{\sqrt{3}}{2} + \frac{1}{2}\left(1 - \frac{\pi}{3}\right)$ 19. $2 + \frac{1}{32}(0.04) = 2.00125$
21. $2 + \frac{1}{32}(0.16) = 2.005$
23. 0.00000117; 0.00000467; 0.0000186
25. $-0.307 < x < 0.307$ 27. (a) 16.4 gal (b) 12.8 gal
29. (a) 133.6 (b) 138.4 31. $\frac{1}{4}$ 33. -6 35. 1
37. undefined 39. 0 41. undefined 43. 1
45. $\frac{1}{2}$ 51. c

Exercises Section 3.2

7. $\frac{2}{3}, \frac{79}{144}, 0.53209$ 9. $\frac{1}{2}, \frac{5}{8}, 0.61803$
11. -4.685780 13. 0.525261 15. 0.739085
17. $-0.636733, 1.409624$ 19. -0.567143
21. $f'(0) = 0$; $-0.3454, 0.4362, 1.6591$
23. $f'(0) = 0$; no root
25. $f'(-1)$ does not exist; $0.1339, 1.8660$
29. 3.316625 31. 2.223980 33. 2.213364
35. 2.059133 39. 0.6407
41. $P(1 - 2x/R)$; 104,500 ft

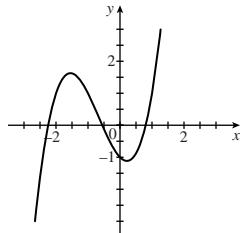
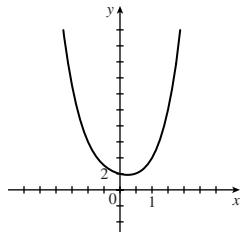
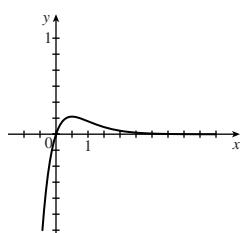
43. $L \approx 20.19$;
 $y = 4.493 - 4.493x - 4.493 \cos 4.493x + \sin 4.493x$

Exercises Section 3.3

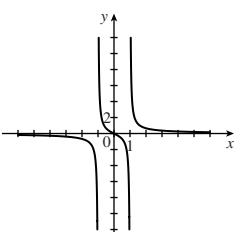
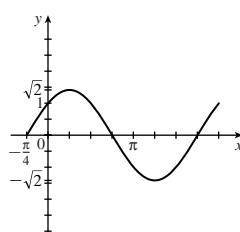
5. $-\frac{5}{2}$, local minimum
7. -1 , local maximum; 1, local minimum
9. 1, neither 11. 0, neither; $\frac{9}{4}$, local minimum
13. 0, neither; $\frac{16}{9}$, local minimum
15. 2, local minimum; $-\frac{2}{3}$, local maximum
17. $\frac{\pi}{4}, \frac{5\pi}{4}$, local maxima; $\frac{3\pi}{4}, \frac{7\pi}{4}$, local minima
19. none 21. -1 , local minimum; 1, local maximum
23. 0, minimum 25. $-2, 1$, local minima
27. $-\frac{2}{3}$, local minimum; -1 , neither
29. 0, maximum
31. $\sqrt{\frac{3\pi}{2}}$, local minimum; $\sqrt{\frac{\pi}{2}}, \sqrt{\frac{5\pi}{2}}$, local maxima
33. max = 3 at $x = 2$, min = -1 at $x = 1$
35. max = 11 at $x = -3$, min = -14 at $x = -2$
37. max = $\sqrt[3]{16}$ at $x = -4$, min = $\sqrt[3]{4}$ at $x = -2$
39. max = $\sqrt{2}$ at $x = \frac{\pi}{4}$, min = $-\sqrt{2}$ at $x = \frac{5\pi}{4}$
41. max = 4.8197 at $x = 2.0287$, min = -1.8144 at $x = 4.9131$
43. (a) absolute min at $(-1, -3)$;
absolute max at $(0.3660, 1.3481)$
(b) absolute min at $(-1.3660, -3.8481)$;
absolute max at $(-3, 49)$
45. (a) absolute min at $(0.6371, -1.1305)$;
absolute max at $(-1.2269, 2.7463)$
(b) absolute min at $(-2.805, -0.0747)$;
absolute max at $(-5, 29.2549)$
47. (ex. 33) no max, min = -1 at $x = 1$
(ex. 35) no max, min = -14 at $x = -2$
(ex. 37) no extrema
53. $x = \sqrt{\frac{1}{3}}$ 55. $x = \sqrt{\frac{1}{2}}$ 57. $f(x) = \sec^2 x$
59. $x = -1.575$, top; $x = 1.575$, bottom; steepest at $x = \pm \sqrt{\frac{6}{5}}$
61. $W'(t) = abe^{-be^{-t}-t}$; max $W' = ae^{-1}$ at $t = \ln b$

Exercises Section 3.4

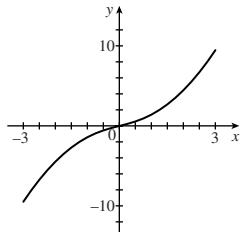
5. increasing: $x < -1, x > 1$; decreasing: $-1 < x < 1$
7. increasing: $-2 < x < 0, x > 2$;
decreasing: $x < -2, 0 < x < 2$
9. increasing: $x > -1$; decreasing: $x < -1$
11. increasing: $-\frac{\pi}{6} < x < \frac{\pi}{6}, \frac{3\pi}{6} < x < \frac{5\pi}{6}$, etc.;
decreasing: $\frac{\pi}{6} < x < \frac{3\pi}{6}, \frac{5\pi}{6} < x < \frac{7\pi}{6}$, etc.

13. increasing: $x > 0$; decreasing: $x < 0$ 15. local max at $x = -\frac{2}{3} - \frac{\sqrt{7}}{3}$; local min at $x = -\frac{2}{3} + \frac{\sqrt{7}}{3}$ 17. min at $x = 0.2367$ 21. max at $x = \frac{1}{2}$ 

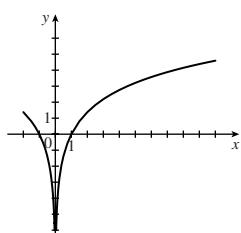
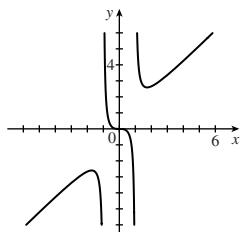
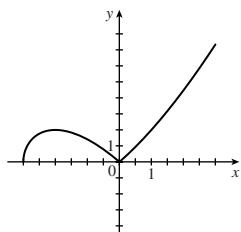
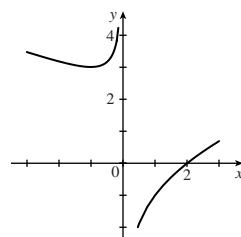
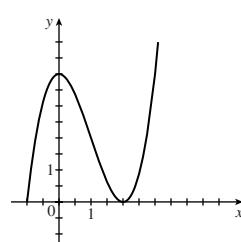
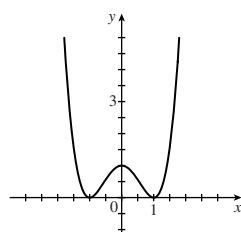
25. no extrema

29. max at $x = \frac{\pi}{4} + 2\pi n$,
min at $x = \frac{5\pi}{4} + 2\pi n$ 

19. no extrema

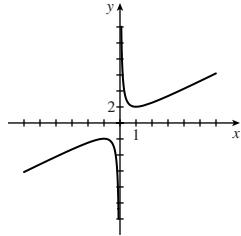


23. no extrema

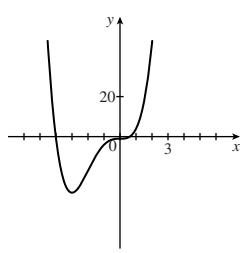
27. local max at $x = -\sqrt{3}$,
local min at $x = \sqrt{3}$ 31. local max at $x = -2$,
min at $x = 0$ 33. local min at $x = -1$ 35. local max: $x = -0.3689$; local min: $x = 9.0356$ 37. local max: $x = 0.9374$;
local min: $x = -0.9474, x = 11.2599$ 39. local max: $x = -10.9079, x = 1.0084$;
local min: $x = -1.0084, x = 10.9079$ 41. local min: $x = 0.2236$; local max: $x = -0.2236$ 51. If $f(x) = 2\sqrt{x}$ and $g(x) = 3 - \frac{1}{x}$, $f(1) = g(1) = 2$
and for $x > 1 f'(x) = \frac{1}{\sqrt{x}} > \frac{1}{x^2} = g'(x)$ 53. If $f(x) = e^x$ and $g(x) = x + 1$, $f(0) = g(0) = 1$
and for $x > 1 f'(x) = e^x > 1 = g'(x)$ 55. $f(x) = 3 + e^{-x}$ has no zeros57. $s'(t) = \frac{1}{2\sqrt{t+4}}$ = rate of increase of sales function**Exercises Section 3.5**5. up: $x < -\frac{1}{2}, x > \frac{1}{2}$; down: $-\frac{1}{2} < x < \frac{1}{2}$ 7. up: $x > 1$; down: $x < 1$ 9. local max at $x = 0$, inflection point at $x = 1$,
local min at $x = 2$ 11. local min at $x = -1$ and $x = 1$, local max at $x = 0$, inflection
points at $x = -\sqrt{\frac{1}{3}}, \sqrt{\frac{1}{3}}$ 

1210 Appendix B Answers to Odd-Numbered Exercises

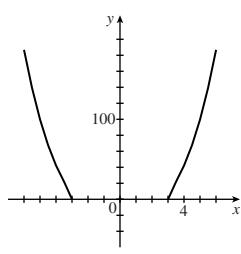
13. local max at $x = -1$,
local min at $x = 1$,
no inflection points



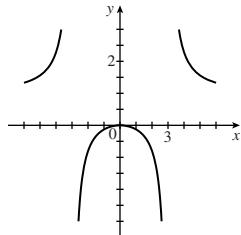
17. min at $x = -3$,
inflection points at
 $x = -2, x = 0$



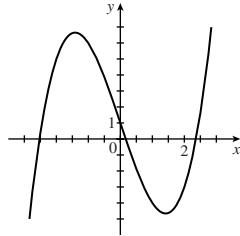
21. inflection points when
 $x^2 = \frac{1}{4}(27 + \sqrt{297})$;
 $x = \pm 3.325$



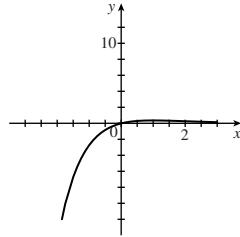
25. local max at $x = 0$



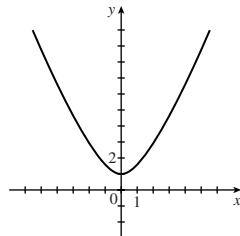
15. local max at $x = -\sqrt{2}$,
inflection point at $x = 0$,
local min at $x = \sqrt{2}$



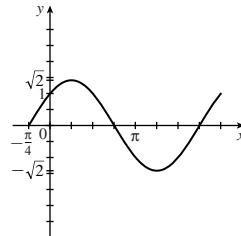
19. max at $x = 1$,
inflection point at $x = 2$



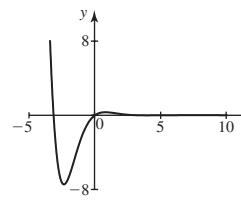
23. min at $x = 0$,
no inflection points



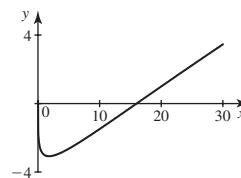
27. max at $x = \frac{\pi}{4}$, inflection point at $x = \frac{3\pi}{4}$
min at $x = \frac{5\pi}{4}$, inflection point at $x = \frac{7\pi}{4}$, etc.



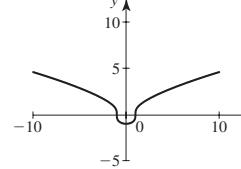
29. local maxima at $\frac{\pi}{4}, \frac{9\pi}{4}, \dots$; local minima at
 $-\frac{3\pi}{4}, \frac{5\pi}{4}, \dots$, inflection points at $\frac{\pi}{2}, \frac{3\pi}{2}, \dots$



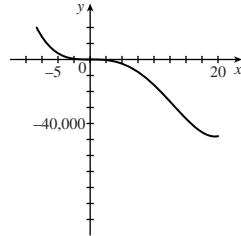
31. local minimum at $x = \frac{16}{9}$; inflection point at $x = 16$



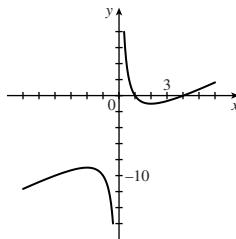
33. minimum at $x = 0$; inflection points at $x = \pm\sqrt{(1/2)}$



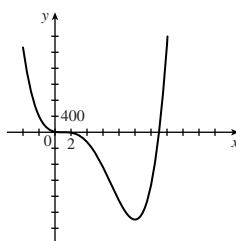
35. local min at $x = -0.1129$ and $x = 19.4993$,
local max at $x = 0.1135$, inflection points at $x = 0, x = 13$



37. local max at $x = -2$, local min at $x = 2$



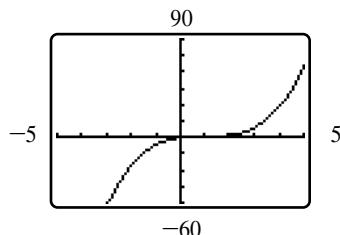
39. local min at $x = 0.8952$ and $x = 9.9987$,
local max at $x = 1.106$, inflection points at $x = 1, x = 7$



47. min at $x = 0$
49. local max at $x = -1$, inflection point at $x = 0$,
local min at $x = 1$
51. need to know $w'(0)$ 53. $x = 30$ 55. $x = 600$
57. min at $x = -\frac{3}{4}c$, second inflection point at $x = -\frac{c}{2}$
59. $f(x) = -1 - x^2$ 61. tangent line points above sun

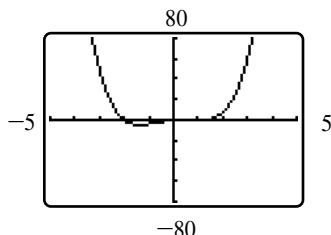
Exercises Section 3.6

5. inflection point at $x = 1$

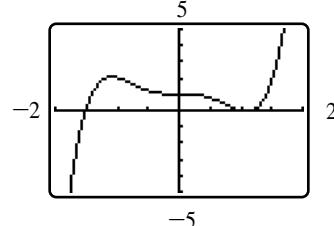


7. local min at $x = -\frac{1}{2} - \frac{\sqrt{3}}{2}$ and $x = 1$

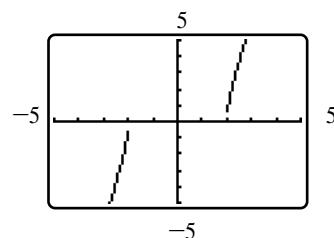
local max at $x = -\frac{1}{2} + \frac{\sqrt{3}}{2}$, inflection points at $x = \pm\sqrt{\frac{1}{2}}$



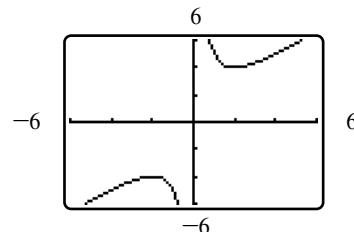
9. local max at $x = -\sqrt{\frac{6}{5}}$, local min at $x = \sqrt{\frac{6}{5}}$,
inflection points at $x = -\sqrt{\frac{3}{5}}, x = 0, x = \sqrt{\frac{3}{5}}$



11. inflection points at $x = -\sqrt{6}, x = \sqrt{6}$

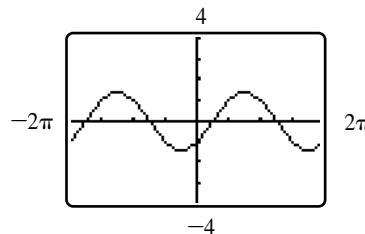


13. local max at $x = -2$, local min at $x = 2$

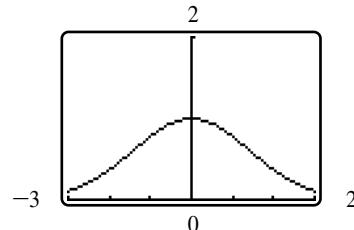


15. inflection point at $x = \frac{\pi}{4}$, max at $x = \frac{3\pi}{4}$

inflection point at $x = \frac{5\pi}{4}$, min at $x = \frac{7\pi}{4}$

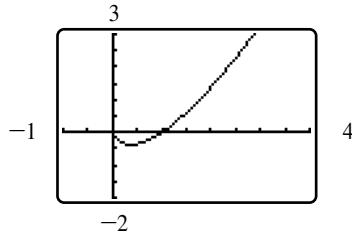


17. max at $x = 0$, inflection points at $x = -\sqrt{2}$ and $x = \sqrt{2}$

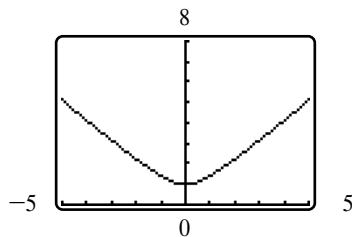


1212 Appendix B Answers to Odd-Numbered Exercises

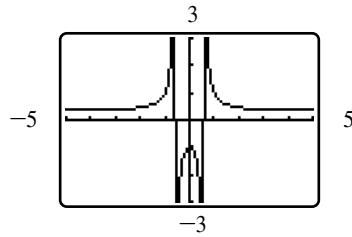
19. min at
- $x = e^{-1}$



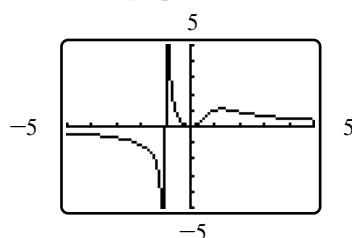
21. min at
- $x = 0$



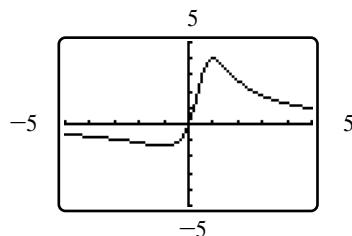
23. local max at
- $x = 0$
- , vertical asymptotes at
- $x = \pm\sqrt{\frac{1}{3}}$
- , horizontal asymptote at
- $y = \frac{1}{3}$



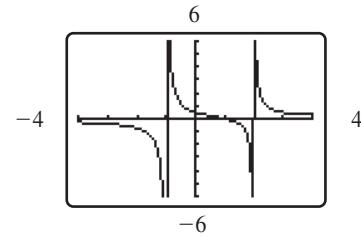
25. local min at
- $x = 0$
- , local max at
- $x = \sqrt[3]{2}$
- , inflection points at
- $x = 0.5264, 1.8995$
- , vertical asymptote at
- $x = -1$
- , horizontal asymptote at
- $y = 0$



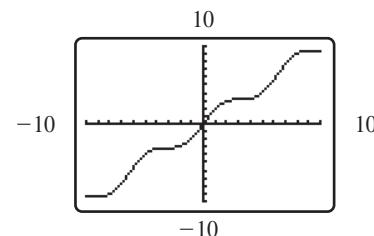
27. local min at
- $x = -1$
- , local max at
- $x = 1$
- , inflection points at
- $x = -1.879, x = 0.347, x = 1.532$
- , horizontal asymptote at
- $y = 0$



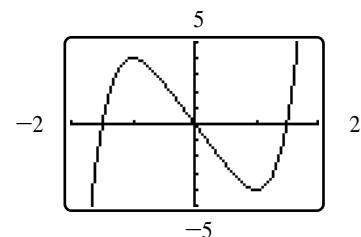
29. inflection point at
- $x = 0.67252$
- ; horizontal asymptote at
- $y = 0$
- ; vertical asymptotes at
- $x = -1$
- and
- $x = 2$



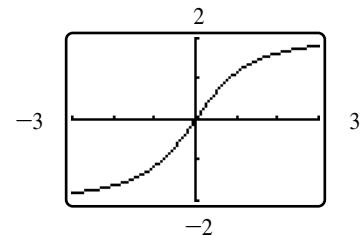
31. inflection points at
- $n\pi$



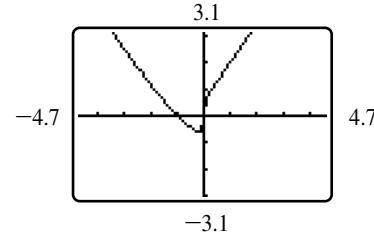
33. local max at
- $x = -1$
- , inflection point at
- $x = 0$
- , local min at
- $x = 1$



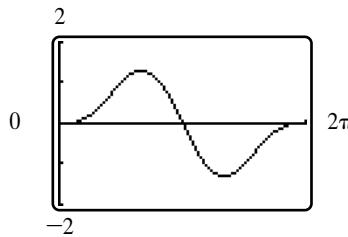
35. inflection point at
- $x = 0$
- , horizontal asymptotes at
- $y = -2, y = 2$



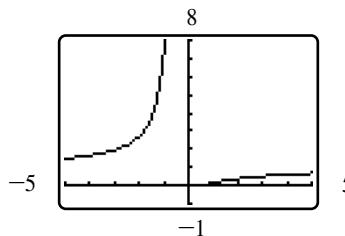
37. min at
- $x = -\frac{1}{6}$
- , inflection points at
- $x = 0$
- and
- $x = \frac{2}{3}$



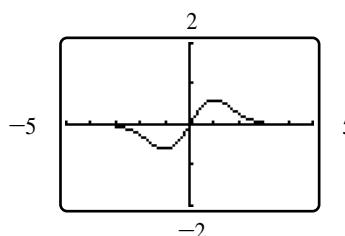
- 39.** max at $x = \frac{2\pi}{3} + 2\pi n$, min at $x = \frac{4\pi}{3} + 2\pi n$, inflection points at $x = n\pi$, $x = 1.318 + 2\pi n$, and $x = -1.318 + 2\pi n$



- 41.** inflection point at $x = 1$, vertical asymptote at $x = 0$, horizontal asymptote at $y = 1$



- 43.** min at $x = -1$, max at $x = 1$, inflection points at $x = -\sqrt{3}$, $x = \sqrt{3}$, $x = 0$, horizontal asymptote at $y = 0$



- 45.** $c < 0$: 3 extrema, 2 inflection points;
 $c \geq 0$: 1 extremum, 0 inflection points;
as $c \rightarrow -\infty$, the graph widens and lowers;
as $c \rightarrow +\infty$, the graph narrows
- 47.** inflection points at $x = \pm \frac{c}{\sqrt{3}}$; graph widens as $c^2 \rightarrow \infty$;
 $y = 1$ for $c = 0$ (undefined at $x = 0$)

49. $|c|$ = frequency of oscillation

- 51.** max at $x = \frac{1}{b}$; most common gestation time;
most common lifespan

- 53.** no; no **55.** $y = 3x$
57. $y = x - 2$ **59.** $y = x$

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

63. $f(x) = \frac{2x}{\sqrt{(x-1)(x+1)}}$

Exercises Section 3.7

- 5.** $f(x) = x^2 + 1$ **7.** $30' \times 60'$; the perimeter is 120'
9. $20' \times 30'$ **13.** $\left(\sqrt{\frac{1}{2}}, \frac{1}{2}\right)$ or $\left(-\sqrt{\frac{1}{2}}, \frac{1}{2}\right)$
15. $(0, 1)$ **19.** $1.2137 = \frac{8}{3} - \frac{\sqrt{19}}{3}$
21. $\frac{15}{7} \approx 2.143$ miles east of first development
23. 1.2529 miles east of bridge; \$1.963 million
25. 1.894 miles east of bridge; \$234,800
29. $r = 1.1989''$, $h = 4.7957''$ **31.** $r = \frac{2}{3}r_0$, contracts
33. $x = R$ **35.** $2' \times 2'$
37. $\sqrt{46}'' \times 2\sqrt{46}''$ printed region **39.** plant 2 acres
41. (a) 50° (b) 45° (c) 40°
43. 2.744 sec; $x = 150$; relay; relay becomes longer
45. $x = 25$; times equal with 0.007 sec delay

Exercises Section 3.8

- 5.** $e^{-2t}(-8 \cos 3t + \sin 3t)$ amps
7. $Q(t) \rightarrow 4 \sin 3t$; transient $e^{-3t}(-3 \cos 2t - 2 \sin 2t)$
steady-state $12 \cos 3t$
9. $x(t) = 2$
11. If $0 < x(t) < 4$, then $x'(t) > 0$
and if $x(t) > 4$, then $x'(t) < 0$; $x(t) = 4$ is max.
13. $r = cK$ **15.** 0; same **17.** 0; a ; increases from 0 to a
19. $4 - \cos x$; less dense at ends **21.** 4; homogenous
23. healthy **25.** in danger
27. $3x^2 + 40x + 90$; 9590 vs. 9421
29. $3x^2 + 42x + 110$; 34,310 vs. 33,990
31. $x = 10$; costs rise more sharply
33. $f'(t) = \left(\frac{96e^{-0.4t}}{(1+3e^{-0.4t})^2}\right) > 0$
35. 43; 4.49, about 4.5 points; 3.017, about 3 points
37. 23; 3.105 = percent to hear rumor in 3rd hour;
70 = percent to eventually hear rumor
39. $f'(x) = \frac{-816x^{-1.4}}{(4x^{-0.4} + 15)^2} < 0$
41. $C'(100) = 42$, $\bar{C}(100) = 77$; $\bar{C}(101) = 76.65 < \bar{C}(100)$
43. min at $x = 600$; $C'(600) = \bar{C}(600) = 52$
45. $P'(x) = 0$ if $R'(x) = C'(x)$ **47.** $f = \frac{1}{2}$, pH $\rightarrow \infty$

Chapter 3 Review Exercises

- 1.** $1 + 3x$ **3.** $2 + \frac{1}{12}(7.96 - 8) \approx 1.99666$
5. 0.198437 **7.** $f'(1) = 0$
9. (a) $x = -3, 1$
(b) increase: $x < -3$, $x > 1$; decrease: $-3 < x < 1$
(c) local max at $x = -3$, local min at $x = 1$
(d) up: $x > -1$, down: $x < -1$ (e) $x = -1$
11. (a) $x = 0, 3$
(b) increase: $x > 3$; decrease: $x < 3$
(c) min at $x = 3$
(d) up: $x < 0$, $x > 2$; down: $0 < x < 2$
(e) $x = 0, x = 2$

1214 Appendix B Answers to Odd-Numbered Exercises

- 13.** (a) $x = \frac{1}{4}$
 (b) increase: $x < \frac{1}{4}$; decrease: $x > \frac{1}{4}$
 (c) local max at $x = \frac{1}{4}$
 (d) up: $x > \frac{1}{2}$; down: $x < \frac{1}{2}$ (e) $x = \frac{1}{2}$

- 15.** (a) none
 (b) increase: $x < -2, x > 2$
 (c) none

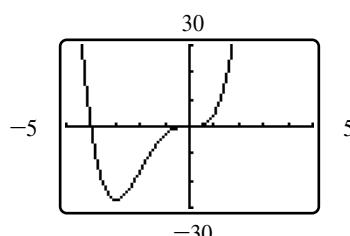
- (d) up: $-\sqrt{6} < x < -2, x > \sqrt{6}$,
 down: $x < -\sqrt{6}, 2 < x < \sqrt{6}$
 (e) $x = -\sqrt{6}, x = \sqrt{6}$

- 17.** (a) $x = -2, 2$
 (b) increase: $-2 < x < 2$, decrease: $x < -2, x > 2$
 (c) min at $x = -2$, max at $x = 2$
 (d) up: $-\sqrt{12} < x < 0, x > \sqrt{12}$;
 down: $x < -\sqrt{12}, 0 < x < \sqrt{12}$
 (e) $x = -\sqrt{12}, x = 0, x = \sqrt{12}$

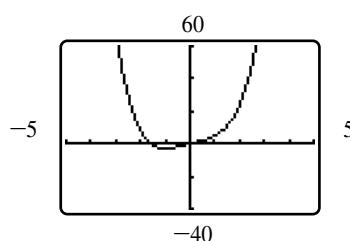
- 19.** min = -5 at $x = 1$, max = 76 at $x = 4$
21. min = 0 at $x = 0$, max = $3^{4/5}$ at $x = 3$

- 23.** local max at $x = -\frac{4}{3} - \frac{\sqrt{10}}{3}$,
 local min at $x = -\frac{4}{3} + \frac{\sqrt{10}}{3}$

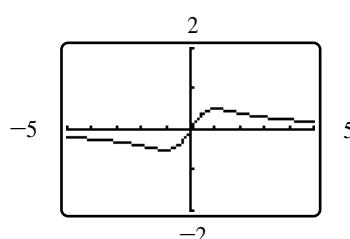
- 25.** local max at $x \approx 0.2553$, local min at $x \approx 0.8227$
29. min at $x = -3$, inflection points at $x = -2, x = 0$



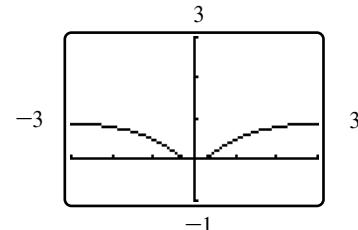
- 31.** min at $x = -1$



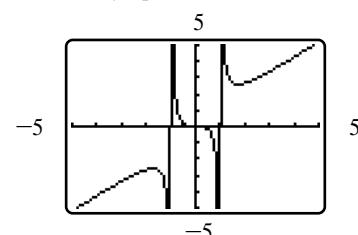
- 33.** min at $x = -1$, max at $x = 1$,
 inflection points at $x = -\sqrt{3}, x = 0$, and $x = \sqrt{3}$,
 horizontal asymptote at $y = 0$



- 35.** min at $x = 0$, inflection points at $x = -\sqrt{\frac{1}{3}}, x = \sqrt{\frac{1}{3}}$
 horizontal asymptote at $y = 1$



- 37.** local max at $x = -\sqrt{3}$, local min at $x = \sqrt{3}$,
 inflection point at $x = 0$,
 vertical asymptotes at $x = -1$ and $x = 1$

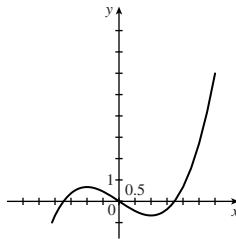


- 39.** (0.8237, 1.3570) **41.** 1.136 miles east of point A

- 43.** $r = 1.663, h = 3.325$
45. $e^{-3t}(2 \cos 2t - 3 \sin 2t)$ amps
47. $2x$, denser to the right
49. $0.04x + 20$, 20.8 versus 20.78

CHAPTER 4**Exercises Section 4.1**

- 5.** $\frac{3}{5}x^5 + c$ **7.** $\frac{3}{5}x^5 - \frac{3}{2}x^2 + c$ **9.** $2x^{3/2} + c$
11. $3x + \frac{1}{3}x^{-3} + c$ **13.** $\frac{3}{2}x^{2/3} - 9x^{1/3} + c$
15. $-2 \cos x + \sin x + c$ **17.** $2 \sec x + c$
19. $5 \tan x + c$ **21.** $3e^x - 2x + c$
23. $3 \sin x - \ln|x| + c$ **25.** $2 \ln|x^2 + 4| + c$
27. $\frac{5}{2}x^2 + 3e^{-x} + c$ **29.** $-\frac{5}{2} \cos 2x + c$
31. $\frac{1}{3}e^{3x} - \frac{1}{2}x^2 + c$ **33.** $\frac{3}{2} \sec 2x + c$
35. $\ln|e^x + 3| + c$ **37.** $x - 3e^{-x} + c$
39. $\frac{2}{5}x^{5/2} - \frac{16}{5}x^{5/4} + c$ **41.** N/A
43. $3x + 4x^{-1} + c$ **45.** N/A
47. $-\frac{1}{2} \cos 4x + c$
49. N/A **51.** $-x^{-1} - x + c$
53. $\ln|\sec x + \tan x|; \frac{1}{4} \sin 2x - \frac{1}{2}x \cos 2x + c$
55. $\frac{4}{3}x^3 - x + 2$ **57.** $3e^x + \frac{1}{2}x^2 + 1$
59. $6x^2 + 2x + 3$ **61.** $-3 \sin x + \frac{1}{3}x^4 + c_1x + c_2$
63. $\frac{2}{3}x^3 - \ln|x| + \frac{c_1}{2}x^2 + c_2x + c_3$
65. $3t - 6t^2 + 3$ **67.** $-3 \sin t + \frac{1}{2}t^2 + 3t + 4$
69. $a = \frac{1}{720}, s = \frac{2}{45}$ miles

71.**73.** translations of the answer to 71**75.** $t \approx 76$ sec, $v \approx -2532$ ft/s**Exercises Section 4.2**

3. $\sum_{i=1}^{50} i^2 = 42,925$ **5.** $\sum_{i=1}^{10} \sqrt{i} \approx 22.47$

7. $3 + 12 + 27 + 48 + 75 + 108 = 273$

9. $12 + 20 + 30 + 42 + 56 = 160$

11. $-1 + 2 + 5 + 8 + 11 + 14 + 17 + 20 = 76$

13. $\sqrt{2} + 2 + \sqrt{3} + 3 + \sqrt{4} + 4 + \sqrt{5} + 5 = 16 + \sqrt{2} + \sqrt{3} + \sqrt{5} \approx 21.38$

15. 7385 **17.** -21,980 **19.** 323,400

21. -2,746,200 **23.** $\frac{n(n+1)(2n+1)}{6} - 3n$

25. $\frac{4n(n+1)(2n+1)}{6} - \frac{n(n+1)}{2}$

27. $\frac{(n+1)(2n+1)}{6n^2} + \frac{n+1}{n} \rightarrow \frac{4}{3}$

29. $\frac{8(n+1)(2n+1)}{3n^2} - \frac{n+1}{n} \rightarrow \frac{13}{3}$ **31.** $\frac{71}{5}$

33. $\frac{1217}{5}$ **35.** 375 miles **37.** $\frac{74}{3}$ miles

41. 2870 **43.** 171,707,655,800

Exercises Section 4.3

3. 0.125, 0.375, 0.625, 0.875; 1.328125

5. 1.125, 1.375, 1.625, 1.875; 2.7265625

7. $\frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}; 2.05234$

9. -0.75, -0.25, 0.25, 0.75; 7.375

11. 0.3320 **13.** 0.6875 **15.** 6.3343

17. 4.0991 **19.** 1.00004 **21.** 16.5

23. 17.9996 **25.** -2.02 **31.** $\frac{7}{3}$ **33.** $\frac{58}{3}$

35. left: 1.81, right: 1.67**37.** left: 3.8, right: 4.32**39.** left: 1.18, right: 1.26**41.** (a) lower, (b) lower, (c) higher**43.** (a) higher, (b) lower, (c) lower**45.** For example, use $x = \frac{1}{\sqrt{6}}$ on $[0, 0.5]$ and $\frac{1}{\sqrt{2}}$ on $[0.5, 1]$ **49.** $a - \frac{1}{2}\Delta x + i\Delta x \quad i = 1, \dots, n$ **Exercises Section 4.4**

5. 24.75 **7.** 0.25 **9.** 0.77 **11.** 1 **13.** $\frac{8}{3}$

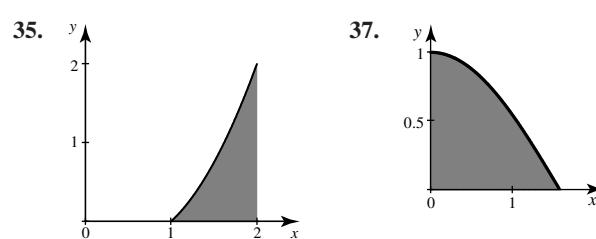
15. 6 **17.** $\int_{-2}^2 (4 - x^2) dx$ **19.** $-\int_{-2}^2 (x^2 - 4) dx$

21. $\int_0^2 x^2 dx$ **23.** $\int_0^\pi \sin x dx$

25. $\int_0^1 (x^3 - 3x^2 + 2x) dx - \int_1^2 (x^3 - 3x^2 + 2x) dx$

27. 90 **29.** 140.01 **31.** $\int_0^3 f(x) dx$

33. $\int_0^1 f(x) dx$

**39.** between -1.23 and 0.72 **41.** between 2 and 6**43.** $\frac{2}{\sqrt{3}}$ **49.** positive **51.** negative**53.** $x = 1$ is not an evaluation point.**55.** 13 **57.** 16.5 **59.** $t < 40$; $t > 40$; $t = 40$ **61.** 6.93 **63.** 5 **65.** 3.33 **67.** 0.64**69.** 9000 lb; 360 ft/s**Exercises Section 4.5**

5. -2 **7.** 0 **9.** $\frac{88}{3}$ **11.** $\frac{12}{5}$ **13.** 2

15. $\sqrt{2} - 1$ **17.** 3 **19.** $e + e^{-1} - 2$ **21.** $\frac{3}{2}e^6 - \frac{21}{2}$

23. $e^2 + 4 - e^{-2}$ **25.** $3 - 3 \ln 4$ **27.** $\frac{16}{3}$

29. $\frac{77}{4} + \cos 3$ **31.** 2.96 **33.** $\frac{1}{2}e^2 + 2e - \frac{3}{2}$

35. 1.71 **37.** 0.772 **39.** $\sqrt{2} - 1$ **41.** $x^2 - 3x + 2$

43. $(e^{-x^4} + 1)2x$ **45.** $-\ln(x^2 + 1)$ **47.** $\frac{32}{3}$

49. $\frac{32}{3}$ **51.** $\frac{8}{3}$ **53.** 2 **55.** $y = 0$

57. $y = x - 2$

59. relative max at $x = 1$, relative min at $x = 2$ **61.** (a) $\frac{1}{x^2} > 0$ (b) $\frac{1}{x^2}$ is discontinuous at $x = 0$ **63.** $40t + \cos t + 1$ **65.** $25(t + \frac{1}{2}e^{-2t} - \frac{1}{2})$ **67.** $2t^2 - \frac{1}{6}t^3 + 8t$ **69.** $12t^2 + e^{-t} + t - 1$ **71.** 8 rad/s; 24 ft/s; 3.2 rad **73.** 14.4 million barrels**75.** 236.36 hp **77.** $\frac{10}{3}$ **79.** $\frac{1}{3}$ **81.** $\frac{2}{\pi}$ **83.** $\int_0^3 f(x) dx, \int_0^2 f(x) dx, \int_0^1 f(x) dx$

1216 Appendix B Answers to Odd-Numbered Exercises**Exercises Section 4.6**

5. $\frac{2}{9}(x^3 + 2)^{3/2} + c$ 7. $\frac{1}{2}(\sqrt{x} + 2)^4 + c$
 9. $\frac{1}{10}(x^2 - 3)^5 + c$ 11. $\frac{1}{4}(x^2 + x)^4 + c$
 13. $\frac{2}{3}(\sin x + 1)^{3/2} + c$ 15. $-2\sqrt{\cos x} + c$
 17. $\frac{1}{3}\sin x^3 + c$ 19. $-\frac{4}{7}(\cos x + 3)^{7/4} + c$
 21. $\frac{1}{2}e^{x^2+1} + c$ 23. $2e^{\sqrt{x}} + c$ 25. $\frac{2}{3}\sqrt{x^3 - 2} + c$
 27. $\frac{1}{3}(\ln x + 2)^3 + c$ 29. $\ln|x^2 + x - 1| + c$
 31. $-2(\sqrt{x} + 1)^{-1} + c$ 33. $e^{\sin x} + c$
 35. $-\frac{1}{4}(\cos x - 1)^4 + c$ 37. $-4(\ln x + 1)^{-1} + c$
 39. $\ln(e^x + e^{-x}) + c$ 41. $2\ln|\ln x| + c$
 43. $2(x + 7) - 11\ln|x + 7| + c$
 45. $\frac{3}{8}(x + 3)^{8/3} - \frac{18}{5}(x + 3)^{5/3} + \frac{27}{2}(x + 2)^{2/3} + c$
 47. $\frac{5}{3}\sqrt{5} - \frac{1}{3}$ 49. 0 51. -2
 53. $-\ln\frac{\sqrt{2}}{2} = \frac{1}{2}\ln 2$ 55. $\frac{8}{3}$ 57. 0.77 59. 0
 61. 3.0 63. 1.414 65. 0.881
 67. $\frac{1}{2}\int_0^4 f(u) du$ 69. $\int_0^1 f(u) du$
 71. $\cos(x) = \cos(-x)$, $(-x)\sin(-x) = x \sin x$
 $\sin(-x) = -\sin x$, $(-x)\cos(-x) = -x \cos x$
 73. odd, 0 75. even, $\frac{16}{15}$ 77. neither, $\frac{2}{3}$
 79. $x\sqrt{4 - x^2}$ is odd, $4 - x^2$ is even, $\bar{y} = \frac{8}{3\pi}$

Exercises Section 4.7

5. midpoint $\frac{85}{64}$, trapezoidal $\frac{43}{32}$, Simpson $\frac{4}{3}$
 7. midpoint $\frac{3776}{3465}$, trapezoidal $\frac{67}{60}$, Simpson $\frac{11}{10}$
 9. (a) 0.75 (b) 0.8 (c) 0.75

n	midpoint	trapezoidal	Simpson
10	0.5538	0.5889	0.5660
20	0.5629	0.5713	0.5655
50	0.5652	0.5666	0.5657

n	midpoint	trapezoidal	Simpson
10	0.88220	0.88184	0.88207
20	0.88211	0.88202	0.88208
50	0.88209	0.88207	0.88208

n	midpoint	trapezoidal	Simpson
10	3.9775	3.9775	3.9775
20	3.9775	3.9775	3.9775
50	3.9775	3.9775	3.9775

17.

n	midpoint error	trapezoidal error	Simpson error
10	0.00832	-0.01665	-0.00007
20	0.00208	-0.00417	-4.2×10^{-6}
40	0.00052	-0.00104	-2.6×10^{-7}
80	0.00013	-0.00026	-1.6×10^{-8}

19.

n	midpoint error	trapezoidal error	Simpson error
10	-5.5×10^{-17}	0	0
20	-2.7×10^{-17}	1.6×10^{-16}	1.1×10^{-16}
40	-2.9×10^{-16}	-6.9×10^{-17}	-1.3×10^{-16}
80	-1.7×10^{-16}	-3.1×10^{-16}	1.5×10^{-16}

21. 4, 4, 16 23. (a) 1.3662 (b) 1.4281 (c) 1.3916

25. (a) 0.8437 (b) 0.8371 (c) 0.8415

27. 4744, 6709, 135

29. answers for $n = 80$: midpoint bound 0.000391, midpoint error 0.00013; trapezoidal bound 0.000781, trapezoidal error 0.00026; Simpson's bound 1.63×10^{-8} , Simpson's error 1.63×10^{-8}

31. (a) 9.1 (b) 9.033 33. (a) 6.96 (b) 6.96

35. 6193 ft² 37. 529 ft 39. 2.6 liters

41. (a) under (b) over (c) can't tell

43. (a) over (b) under (c) can't tell

45. (a) under (b) over (c) exact

49. parabolas curve

51. if $T_n - I \approx -2(M_n - I)$ then $\frac{1}{3}T_n + \frac{2}{3}M_n \approx I$ **Chapter 4 Review Exercises**1. $\frac{4}{3}x^3 - 3x + c$ 3. $4\ln|x| + c$ 5. $-\frac{1}{2}\cos 4x + c$ 7. $\frac{1}{2}x^2 - \frac{1}{4}e^{4x} + c$ 9. $\frac{1}{2}x^2 + 4\ln|x| + c$ 11. $e^x - x + c$ 13. $\frac{1}{3}(x^2 + 4)^{3/2} + c$ 15. $2\sin x^3 + c$ 17. $-e^{1/x} + c$ 19. $-\ln|\cos x| + c$ 21. $x^3 + x + 2$ 23. $-16t^2 + 10t + 2$ 25. $4 + 10 + 18 + 28 + 40 + 54 = 154$ 27. 338,25029. $\frac{n(n+1)(2n-1)}{6n^3} - \frac{n(n+1)}{2n^3} \rightarrow \frac{1}{3}$ 31. 2.65625

33. 4.668 35. (a) 2.84 (b) 2.92 (c) 2.88 (d) 2.907

37. Simpson 39. $\frac{2}{5}$ 41. $\int_0^3 (3x - x^2) dx = \frac{9}{2}$ 43. 25 45. $\frac{1}{2}(e^2 - 1) \approx 3.19$ 47. $-\frac{4}{3}$ 49. 151. $6 + 4e^{-5/2}$ 53. $\frac{1}{2}\ln 5$ 55. $\frac{1}{3}(8^{3/2} - 8)$ 57. $\frac{15}{2} + \frac{1}{2}e^2 - 4e$ 59. $\sin x^2 - 2$

61. (a) 2.079 (b) 2.083 (c) 2.080

63. (a) 2.0841, 2.0845 (b) 2.08055, 2.08048 (c) 2.08046, 2.08046

CHAPTER 5**Exercises Section 5.1**

5. $\frac{40}{3}$ 7. $5 - e^{-2}$ 9. 3 11. $\frac{29}{2}$ 13. $\frac{64}{3}$
 15. $\frac{1}{6}$ 17. $\frac{27}{4}$ 19. $\frac{1}{12}$ 21. 0.08235
 23. 0.135697 25. 4.01449 27. $\int_0^1 (2 - 2y) dy = 1$
 29. $\int_1^2 (3y - 2 - y^2) dy = \frac{1}{6}$ 31. $\int_0^1 2x dx = 1$
 33. $\int_0^2 (6 - 2y) dy = 8$
 35. $3; \int_0^{\sqrt{3}} (3 - x^2) dx = \int_{\sqrt{3}}^3 (x^2 - 3) dx = 2\sqrt{3}$
 37. 14.4 million barrels
 39. 2.45 million people 41. 35.08% 43. 93.02%
 45. 100; the objects are 100 ft apart
 47. (a) 6.48 mi (b) at $t = 2.56$ hr

Exercises Section 5.2

5. 12 7. $\frac{56\pi}{3}$ 9. 123.8 ft³ 11. 93,750,000 ft³
 13. $\frac{215}{2}$ ft³ 15. $33\pi^2 + 32\pi$ in³ 17. 0.2467 cm³
 19. 2.5 ft³ 21. (a) $\frac{8\pi}{3}$ (b) $\frac{28\pi}{3}$
 23. (a) $\frac{32\pi}{5}$ (b) $\frac{224\pi}{15}$
 25. (a) $2\pi e^2 + 2\pi$ (b) $\pi \left(\frac{e^4}{2} + 4e^2 - \frac{9}{2} \right)$
 27. (a) $\frac{2\pi}{5}$ (b) $\frac{\pi}{7}$
 29. (a) 9π (b) 9π (c) 18π (d) 36π (e) 18π (f) 36π
 31. (a) $\frac{\pi}{2}$ (b) $\frac{\pi}{5}$ (c) $\frac{\pi}{6}$ (d) $\frac{7\pi}{15}$ (e) $\frac{7\pi}{6}$ (f) $\frac{13\pi}{15}$
 33. $\frac{\pi h^2}{2a} = \frac{1}{2}\pi h \left(\sqrt{\frac{h}{a}} \right)^2$ 35. $\int_{-1}^1 \pi(1)^2 dy = 2\pi$
 37. $\int_{-1}^1 \pi \left(\frac{1-y}{2} \right)^2 dy = \frac{2\pi}{3}$ 41. same volume

Exercises Section 5.3

5. $r = 2 - x, h = x^2, V = \frac{8\pi}{3}$
 7. $r = x, h = 2x, V = \frac{4\pi}{3}$
 9. $r = 2 - y, h = 2y, V = \frac{8\pi}{3}$
 11. $r = y, h = \sqrt{1 - (y - 1)^2}, V = \pi^2 \approx 9.8696$
 13. $\frac{32\pi}{3}$ 15. $\frac{16\pi}{3}$ 17. $\frac{27\pi}{2}$ 19. $\frac{8\pi}{3}$
 21. (a) $\frac{80\pi}{3}$ (b) 16π (c) 16π (d) $\frac{16\pi}{3}$

23. (a) $\frac{625\pi}{6}$ (b) $\frac{625\pi}{3}$ (c) $\frac{875\pi}{6}$ (d) $\frac{500\pi}{3}$
 25. (a) 16.723 (b) 12.635 (c) 4.088 (d) 1.496
 27. (a) $\frac{32\pi}{15}$ (b) $\frac{5\pi}{6}$ (c) $\frac{3\pi}{2}$ (d) $\frac{38\pi}{15}$
 29. (a) $\frac{5\pi}{6}$ (b) $\frac{64\pi}{15}$ 39. $\frac{\sqrt{3}\pi}{2}$
 41. $\frac{\sqrt{100 - 30\sqrt{10}}}{10} \approx 0.2265$

Exercises Section 5.4

5. 1.4604; 1.4743 7. 3.7242; 3.7900
 9. $\int_{-1}^1 \sqrt{1 + 9x^4} dx \approx 3.0957$
 11. $\int_0^2 \sqrt{1 + (2 - 2x)^2} dx \approx 2.9578$
 13. $\int_0^3 \sqrt{1 + (3x^2 + 1)^2} dx \approx 30.3665$
 15. $\int_0^\pi \sqrt{1 + \sin^2 x} dx \approx 3.8201$
 17. $\int_0^\pi \sqrt{1 + (x \sin x)^2} dx \approx 4.6984$
 19. 22.364 ft 21. 5.43 ft
 23. 60 yards; 60 yards; 139.4 yards; 104.55 ft/s
 31. $\int_0^1 2\pi x^2 \sqrt{1 + 4x^2} dx \approx 3.8097$
 33. $\int_0^2 2\pi(2x - x^2) \sqrt{1 + (2 - 2x)^2} dx \approx 10.9654$
 35. $\int_0^1 2\pi e^x \sqrt{1 + e^{2x}} dx \approx 22.9430$
 37. $\int_0^{\pi/2} 2\pi \cos x \sqrt{1 + \sin^2 x} dx \approx 7.2117$
 39. 0.9998 41. 0.9785 43. 0.99995
 45. 1.672, 1.720, 1.754 \rightarrow 2 47. $4x^3 > 2x$ if $x > \sqrt{\frac{1}{2}}$
 49. 6π 51. $\pi\sqrt{5} + \pi$ 53. 6

Exercises Section 5.5

5. $y(0) = 80, y'(0) = 0$ 7. $y(0) = 60, y'(0) = 10$
 9. $-8\sqrt{30}$ ft/s 11. -37.52 ft/s 13. \sqrt{h}
 15. 256 feet 17. $-16t^2 + 64t$; 64 feet; 4 sec; -64 ft/s
 19. $8\sqrt{\frac{5}{3}}$ ft/sec 21. $\frac{25}{64}$ ft ≈ 4.7 in.
 25. $10\sqrt{3} \approx 17$ sec, $490\sqrt{3} \approx 849$ m
 27. $\frac{15}{4}$ sec, $225\sqrt{3} \approx 390$ ft
 29. serve clears the net and goes in
 31. serve clears the net but goes out
 33. 2.59 ft 35. ball bounces ($h \approx -0.62$)
 37. $7.7^\circ, 120 \tan(7.7^\circ) \approx 16.2$ ft 39. $40\sqrt{\frac{5}{\sqrt{3}}} \approx 68$ ft/s

1218 Appendix B Answers to Odd-Numbered Exercises

41. 400 ft 43. $\frac{25}{16} \sin 4t - \frac{25}{4} t$
 45. $\frac{25}{64} \sin\left(8t + \frac{\pi}{4}\right) - \frac{25\sqrt{2}}{16}t - \frac{25\sqrt{2}}{128}$
 47. $\frac{20\pi}{\sqrt{30}} \approx 11.5$ rad/s 51. Goal! ($x = -0.24$ at $y = 90$)
 53. 25 sec 55. 40.6° , 37.26 m/s

Exercises Section 5.6

5. $\frac{15}{8}$ ft-lb 7. 20 ft-lb 9. $\frac{1250}{3}$ ft-lb 11. 300 ft-lb
 13. 270,000,000 ft-lb 15. 704,000 ft-lb
 17. 8,168,140,899 ft-lb 19. 816,814 ft-lb
 21. $J \approx 2.133$; 113 ft/s 23. $J \approx 7533.3$; 37.7 ft/s
 25. $m = 15$ kg, $\bar{x} = \frac{16}{5}$ m; heavier to right of center
 27. $m = \frac{52}{3}$ kg, $\bar{x} = 0$ m 29. 0.0614 slugs, 31.5 oz
 31. 16.6 in.; same mass, \bar{x} differs by 3
 33. 0.0614 slugs, 31.4 oz; $\bar{x} = 17.8$ in.
 35. 2, 4, $\frac{1}{2}$; 0.4167, 3, 5.33 37. 8,985,600 lb
 39. 196,035 lb 41. 12,252 lb 43. $-16\sqrt{5}$ ft/s
 45. 10,667 hp 47. 27.22, 20.54, 24.53%
 49. $\frac{1}{4}\rho\pi a^3 b$ 51. $\frac{\text{midsized}}{\text{wooden}} \approx 1.35$; $\frac{\text{oversized}}{\text{wooden}} \approx 1.78$

Exercises Section 5.7

13. 4 15. $\frac{4}{1-e^{-4}}$ 17. $\frac{\ln 2}{2} \approx 0.346$ 19. 0.157
 21. 7.76×10^{-11} 23. $1 - e^{-3/2} \approx 0.77687$
 25. $e^{-6} - e^{-12} \approx 0.00247$ 27. $e^{-2/3} - e^{-4/3} \approx 0.2498$
 29. $1 - e^{-4} \approx 0.9817$ 31. 0.594 33. 0.9999995
 35. (a) $\frac{3}{4}$ (b) $\sqrt[3]{\frac{1}{2}}$ 37. (a) $\frac{\pi}{2} \approx 1.57$ (b) $\frac{\pi}{2} \approx 1.57$
 39. (a) 1.23 (b) $-\frac{3 \ln \frac{2}{3}}{\ln 3} \approx 1.11$
 41. (a) 0.2313 (b) $-\frac{1}{4} \ln\left(\frac{e^{-4}+1}{2}\right) \approx 0.1687$
 43. $c = \frac{4}{1-e^{-4b}} \rightarrow 4$ 45. $\frac{6}{1-e^{-6b}} \rightarrow 6$
 47. (a) $\frac{93}{256}$ (b) $\frac{93}{256}$ (c) $\frac{1}{128}$ (d) $\frac{1}{2}$
 49. (a) 0.7101 (b) 0.2899 (c) 0.1552 (d) 0.576
 51. $\frac{100}{99}, 0.0024$ 53. $\frac{5}{2}$ 57. 0.000318, 0.0134

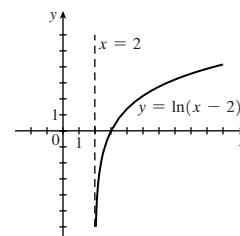
Chapter 5 Review Exercises

1. $\frac{\pi^3}{3} + 2\pi - 2$ 3. $\frac{1}{12}$ 5. 1.452 7. $\frac{5}{6}$
 9. 10,054 11. $\frac{98\pi}{3}$ 13. 4.2
 15. (a) $\frac{256\pi}{5}$ (b) 8π (c) $\frac{128\pi}{3}$ (d) $\frac{1408\pi}{15}$
 17. (a) $\frac{2\pi}{3}$ (b) 2π (c) 4π (d) $\frac{22\pi}{3}$

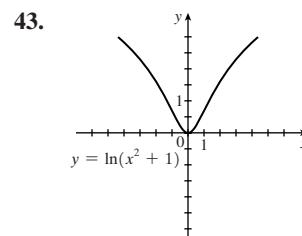
19. $\int_{-1}^1 \sqrt{1+16x^6} dx \approx 3.2$
 21. $\int_{-2}^2 \sqrt{1+\frac{1}{4}e^x} dx \approx 4.767$
 23. $\int_0^1 2\pi(1-x^2)\sqrt{1+4x^2} dx \approx 5.48$
 25. -64 ft/s 27. 1.026 sec, 46.3 ft
 29. no, ball bounces 31. $64\sqrt{2}$ ft/s, $-64\sqrt{2}$ ft/s
 33. $\frac{40}{3}$ ft-lb 35. $m = \frac{112}{3}$, $\bar{x} = \frac{16}{7}$, heavier to right of $x = 2$
 37. 22,630,400 lb 39. 32 ft/s 43. 2
 45. (a) $1 - e^{-2} \approx 0.865$ (b) $e^{-2} - e^{-4} \approx 0.117$
 47. (a) $\frac{11}{15}$ (b) 0.786

CHAPTER 6**Exercises Section 6.1**

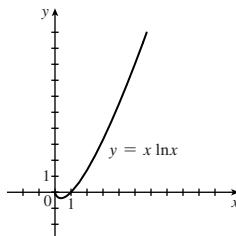
5. $\ln 4 = \int_1^4 \frac{1}{t} dt$ 7. $\ln 8.2 = \int_1^{8.2} \frac{1}{t} dt$ 9. $\frac{1}{x}$
 11. $-\tan x$ 13. $\ln x + 1$ 15. $\frac{2x}{x^2+2}$ 17. $\frac{7}{2} \ln 2$
 19. $\frac{1}{2} \ln 3$ 21. $\ln(x^2+1) + c$ 23. $-\ln|\cos x| + c$
 25. $\frac{1}{2} \ln|x^2+2x-1| + c$ 27. $\ln|\ln x| + c$
 29. $\frac{1}{3}(\ln x+1)^3 + c$ 31. $\ln 3$ 33. $\frac{1}{3} \ln \frac{3}{4}$
 35. $\frac{x}{x^2+1}$ 37. $\frac{4}{x} - \frac{5x^4}{x^5+1}$ 39. $\frac{1}{2} \ln|\ln|x|| + c$



increasing and concave down on $(2, \infty)$



increasing on $(0, \infty)$,
 decreasing on $(-\infty, 0)$;
 concave up on $(-1, 1)$,
 concave down on $(-\infty, -1) \cup (1, \infty)$

45.

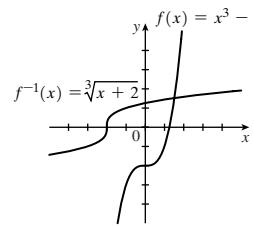
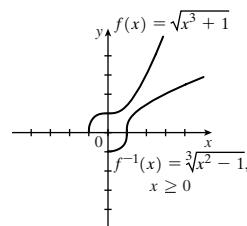
decreasing on $(0, \frac{1}{e})$, increasing on $(\frac{1}{e}, \infty)$;
concave up on $(0, \infty)$

49. $e^{-1/2}$

51. As x increases, the number of primes less than x increases, but at a decreasing rate.

Exercises Section 6.2

- 5.** yes **7.** no **9.** no **11.** yes
13. yes **15.** yes

17. $\sqrt[3]{x+2}$ **21.** not one-to-one**23.** $\sqrt[3]{x^2 - 1}, x \geq 0$;

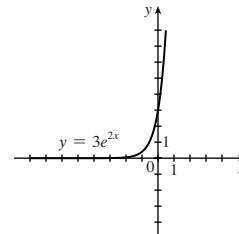
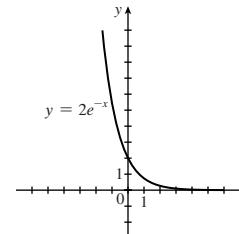
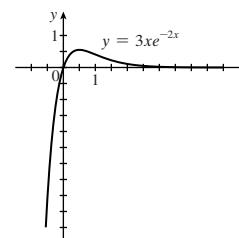
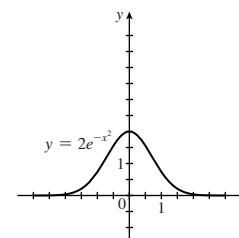
$$\text{25. } \frac{1}{f'(0)} = \frac{1}{4} \quad \text{27. } \frac{1}{f'(1)} = \frac{1}{15}$$

$$\text{29. } \frac{1}{f'(1)} = \frac{4}{5} \quad \text{31. } y = \frac{1}{4}(x+1)$$

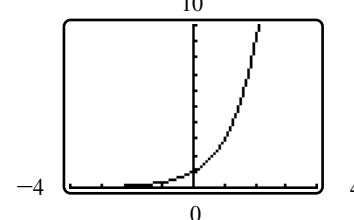
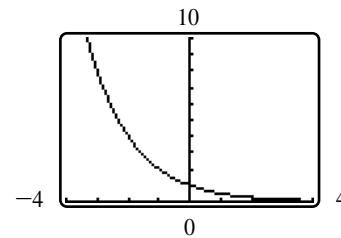
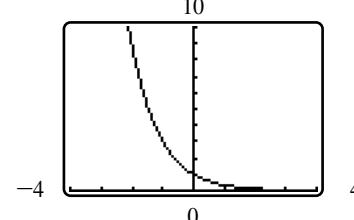
33. increasing, concave down**35.** increasing, concave up**37.** 2.5, high **39.** 2.25, high**41.** probably not one-to-one**43.** inverse exists (before bounce)**45.** not one-to-one

$$\text{47. } k \geq 0 \quad \text{49. } 0.9(1.1)x = 0.99x; \frac{1}{1.1}x \quad \text{51. } 2.575$$

Exercises Section 6.3

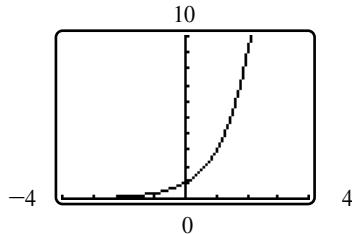
5.**7.****9.****11.**

- 13.** $12e^{3x}$ **15.** $3e^{-2x} - 6xe^{-2x}$ **17.** $-4xe^{-x^2}$
19. $2xe^{-x} - x^2e^{-x}$ **21.** $2(3x^2 - 3)e^{x^3 - 3x}$ **23.** e^x
25. $-\sin xe^{\cos x}$ **27.** $\frac{1}{3}e^{3x} + c$ **29.** $\frac{1}{2}e^{x^2} + c$
31. $-e^{\cos x} + c$ **33.** $-e^{1/x} + c$ **35.** $x + 2e^x + \frac{1}{2}e^{2x} + c$
37. $-2e^{-2x} + c$ **39.** $\frac{1}{3}x^3 + c$ **41.** $\frac{1}{3}e^3 - \frac{1}{3}$ **43.** 0
45. max at $x = \frac{1}{2}$, inflection point at $x = 1$
47. min at $x = 0$, local max at $x = 1$,
inflection points at $x = 1 \pm \frac{\sqrt{2}}{2}$

51.**53.****55.**

1220 Appendix B Answers to Odd-Numbered Exercises

57.



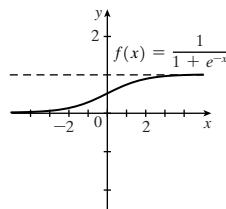
59. increasing, concave up; decreasing, concave up

61. $(\ln 2)2^x$ 63. $2(\ln 3)3^{2x}$ 65. $2x(\ln 3)3^{x^2}$

67. $\frac{1}{x \ln 3}$ 69. $\frac{2}{x \ln 4}$ 71. $\frac{1}{\ln 2}2^x + c$

73. $\frac{1}{2 \ln 2}2^{x^2} + c$ 75. $\frac{1}{3 \ln 4}4^{3x} + c$

77. 1; 0; $x = 0$; $\frac{1}{1 + e^{-(x-4)}}$



79. $k = \frac{1}{3} \ln 2$; $2^{2/3} - 2^{1/3} \approx 0.327$

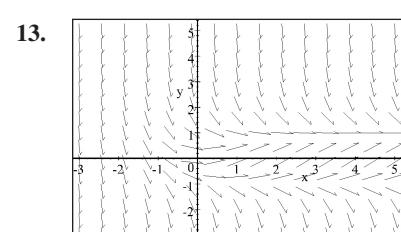
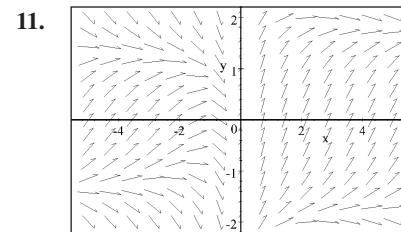
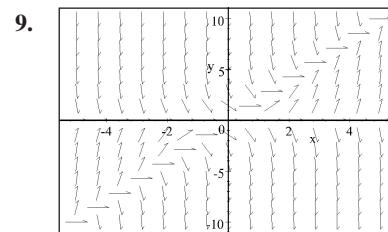
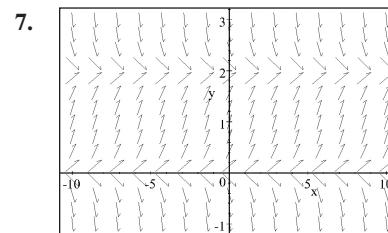
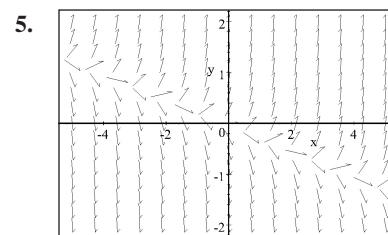
Exercises Section 6.4

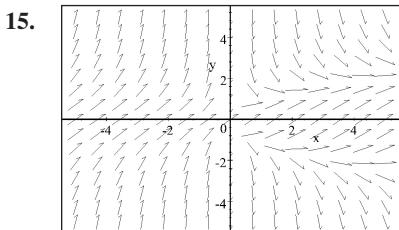
5. $2e^{4x}$ 7. $5e^{-3x}$ 9. $2e^{2(x-1)}$ 11. $-3x + 3$
 13. $100e^{(\ln 2/4)t}$, 23.6 hours 15. $400e^{(\ln 2)t}$, 409,600
 17. $\frac{\ln 2}{0.44} \approx 1.575$ hours 19. $20 \frac{\ln 10}{\ln 2} \approx 66.4$ minutes
 23. $\frac{\ln 2}{1.3863} \approx 0.5$ day 25. $0.4e^{-(\ln 2/3)t}$, 15.97 hours
 27. 29% 29. 13,305 years 31. $\frac{\ln(\frac{5}{13})}{\ln(\frac{11}{13})} \approx 5.72$ minutes
 33. $70 - 20e^{kt}$, $k = \frac{\ln 0.7}{2}$ 35. 9:46 37. 182.6°
 39. \$1080, \$1083, \$1083.28, \$1083.29
 41. $A = \$110,231.76$, $B = \$66,402.34$
 43. $34e^{kt}$, $k = \frac{1}{10} \ln\left(\frac{9800}{34}\right)$, \$2,824,705.88
 47. \$7300; \$7860 vs. \$7665 49. exponential, linear
 51. $P(x) = e^{1.468x+0.182}$ 53. $P(x) = 20e^{0.397x+2.303}$

Exercises Section 6.5

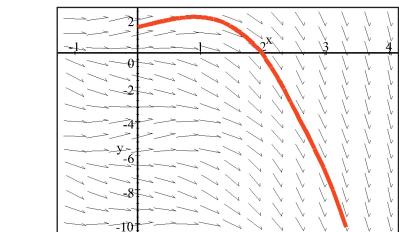
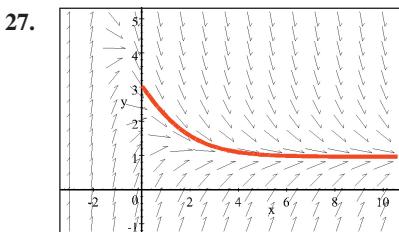
5. yes 7. no 9. yes 11. no 13. $ce^{x+x^3/3}$
 15. $-\frac{1}{\frac{2}{3}x^3 + c}$ 17. $\pm\sqrt{6 \tan^{-1} x + c}$ 19. $\sqrt[3]{4x^3 + c}$
 21. $\frac{1}{1 + ce^x}$ 23. $c\sqrt{1+x^2}$
 25. $\pm\sqrt[4]{16 \sin x - 16x \cos x + c}$
 27. $e^{-1}e^{(x+1)^3}$ 29. $\sqrt[\infty]{\frac{8}{3}x^3 + 4}$ 31. $(x+3)^4$

33. $\sin y = 2x^2$ 35. $\frac{2e^{6t}}{1+e^{6t}}$ 37. $\frac{20e^{10t}}{1+4e^{10t}}$
 39. $\frac{3e^t}{1+3e^t}$ 41. $\frac{(8 \times 10^7)e^{0.71t}}{3+e^{0.71t}}$ 43. $\frac{AME^{kMt}}{Ae^{kMt}-1}$
 45. 0, 2 47. 0, -2, 2 49. 1
 51. (a) $y = 0$ (b) $y = 2$ 53. $\sqrt{80}$ ft/s
 55. $\frac{10e^{2\pi} - 10}{e^{2\pi} - \frac{5}{6}}$

Exercises Section 6.6



17. $h = 0.1$: $y_1 = 1$, $y_2 = 1.02$,
 $y(1) \approx 2.3346$, $y(2) \approx 29.4986$
 $h = 0.05$: $y_1 = 1$, $y_2 = 1.005$,
 $y(1) \approx 2.5106$, $y(2) \approx 39.0930$
19. $h = 0.1$: $y_1 = 1.3$, $y_2 = 1.651$,
 $y(1) \approx 3.8478$, $y(2) \approx 3.9990$
 $h = 0.05$: $y_1 = 1.15$, $y_2 \approx 1.3139$
 $y(1) \approx 3.8188$, $y(2) \approx 3.9978$
21. $h = 0.1$: $y_1 = 2.9$, $y_2 \approx 2.8005$,
 $y(1) \approx 2.0943$, $y(2) \approx 1.5275$
 $h = 0.05$: $y_1 = 2.95$, $y_2 \approx 2.9001$,
 $y(1) \approx 2.0990$, $y(2) \approx 1.5346$
23. $h = 0.1$: $y_1 = 1.1$, $y_2 \approx 1.2095$,
 $y(1) \approx 2.3960$, $y(2) \approx 4.5688$
 $h = 0.05$: $y_1 = 1.05$, $y_2 \approx 1.1024$,
 $y(1) \approx 2.4210$, $y(2) \approx 4.6203$
25. $y(1) = e \approx 2.7183$, $y(2) = e^4 \approx 54.5982$;
 $y(1) = \sqrt{5} \approx 2.236068$, $y(2) = \sqrt{8} \approx 2.828427$



29. $y = 0$ (unstable), $y = 2$ (stable)
31. $y = 0$ (unstable), $y = -1$ (unstable), $y = 1$ (stable)
33. $y = 1$ (stable) 35. $y = 0$ and $y = b$ are stable
37. estimates are 31.64, 218.12, overflow
39. $x = \frac{\ln 2}{2}$

Exercises Section 6.7

5. 0 7. $\frac{\pi}{4}$ 9. $-\frac{\pi}{2}$ 11. 0 13. $-\frac{\pi}{4}$

15. $\frac{\pi}{3}$ 17. $-\frac{\pi}{6}$ 19. $\sqrt{1-x^2}$, $-1 \leq x \leq 1$

21. $\begin{cases} 0 & \text{if } x = n\pi \text{ (} n \text{ even)} \\ \pi & \text{if } x = n\pi \text{ (} n \text{ odd)} \end{cases}$

23. $\sqrt{x^2 - 1}$, $x \geq 1$ or $-\sqrt{x^2 - 1}$, $x \leq -1$

25. $x, x \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ 27. $\frac{\sqrt{3}}{2}$ 29. $\frac{4}{3}$ 31. $\frac{\pi}{8}$

33. $\frac{2}{9}x\sqrt{9-x^2}$, $|x| \leq 3$

35.

37.

39.

41. $\frac{n\pi}{4}$, odd n 43. $\frac{n\pi}{3}$ 45. $\frac{\pi}{20} + \frac{n\pi}{5}$

47. $\frac{\pi}{18} + \frac{2\pi n}{3}$, $\frac{5\pi}{18} + \frac{2\pi n}{3}$ 49. $\pm \frac{\pi}{6} + \pi n$

53. $\tan^{-1}\left(\frac{5}{3x}\right)$

Exercises Section 6.8

3. $\frac{6x}{\sqrt{1-9x^4}}$ 5. $\frac{-3x^2}{\sqrt{1-x^6}}$ 7. $\frac{2x}{1+x^4}$

9. $\frac{2}{x\sqrt{x^4-1}}$ 11. $\cos^{-1} 2x - \frac{2x}{\sqrt{1-4x^2}}$

13. $\frac{-\cos x}{\sqrt{1-\sin^2 x}} = \pm 1$ 15. $\frac{\sec x \tan x}{1+\sec^2 x}$

17. $6 \tan^{-1} x + c$ 19. $4 \sin^{-1} x + c$ 21. $\tan^{-1} x^2 + c$

23. $2 \sin^{-1} x^2 + c$ 25. $\sec^{-1} x^2 + c$

27. $\tan^{-1}\left(\frac{x}{2}\right) + c$ 29. $\sin^{-1}(e^x) + c$

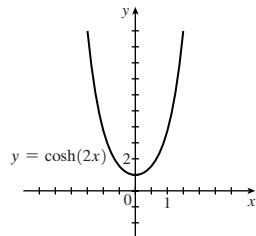
31. $\frac{1}{2} \tan^{-1}\left(\frac{\sin x}{2}\right) + c$ 33. $\frac{3\pi}{4}$

35. $\frac{\pi}{3}$ 37. $\frac{\pi}{4}$

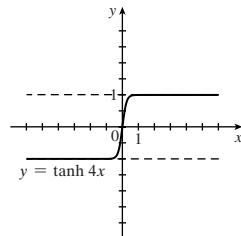
43. $\sqrt{\frac{248}{3}} \approx 9.09$ feet 45. $\sqrt{3} \approx 1.73$ feet

1222 Appendix B Answers to Odd-Numbered Exercises**Exercises Section 6.9**

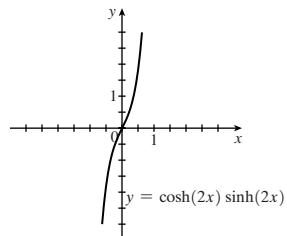
5.



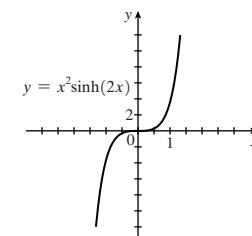
7.



9.



11.



13. $4 \sinh 4x$ 15. $2 \cosh 2x$ 17. $4 \operatorname{sech}^2 4x$

19. $\frac{2}{\sqrt{4x^2 - 1}}$ 21. $2x \sinh 2x + 2x^2 \cosh 2x$

23. $\frac{4}{1 - 16x^2}$ 25. $\frac{1}{6} \sinh 6x + c$

27. $\frac{1}{3} \ln(\cosh 3x) + c$ 29. $\frac{1}{4} \cosh 4 - \frac{1}{4}$

31. $2 \sinh^{-1} x + c$ 33. $\cosh(\sin x) + c$ 35. $e^{\sinh 1} - 1$

41. $f'(x) < 0$ for $x < 0$, $f'(x) > 0$ for $x > 0$, $f''(x) > 0$ for all x

43. $\ln(x + \sqrt{x^2 - 1})$ 45. 27.62 47. 26.13

57. $-80 \text{ m/s}, 19.41 \text{ m}, 75.45 \text{ m}; -40 \text{ m/s}, 18.86 \text{ m}, 68.35 \text{ m}$

59. 9.8 m/s^2

Chapter 6 Review Exercises

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

7. $(3x^2 \ln 4)4^{x^3}$ 9. $\frac{2}{\sqrt{1 - 4x^2}}$ 11. $\frac{-2 \sin 2x}{1 + \cos^2 2x}$

13. $\frac{1}{2}x^{-1/2} \sinh \sqrt{x}$ 15. $\frac{3}{\sqrt{9x^2 + 1}}$

17. $\frac{1}{3} \ln|x^3 + 4| + c$ 19. $\frac{1}{2} \ln 2$ 21. $-\cos(\ln x) + c$

23. $-\frac{1}{4}e^{-4x} + c$ 25. $2e^{\sqrt{x}} + c$ 27. $\frac{1}{3}e^6 - \frac{1}{3}$

29. $\frac{1}{4 \ln 3}3^{4x} + c$ 31. $\frac{3}{2} \tan^{-1}\left(\frac{x}{2}\right) + c$

33. $\frac{1}{3} \sin^{-1}(x^3) + c$ 35. $\frac{9}{2} \sec^{-1} x^2 + c$

37. $4 \sinh^{-1} x + c$ 39. $\frac{1}{4} \sinh 4x + c$

41. yes, $\sqrt[3]{x+1}$ 43. no 45. $\frac{1}{f'(1)} = \frac{1}{11}$

47. $\frac{1}{f'(2)} = \frac{1}{2}$ 49. $3e^{2x}$ 51. $\sqrt{2x^2 + 4}$

53. $\left(\frac{1}{3}x^{3/2} + \frac{5}{3}\right)^2$ 55. $10^4 e^{(\ln 2/2)t}; \frac{2 \ln 100}{\ln 2} \approx 13.29 \text{ hours}$

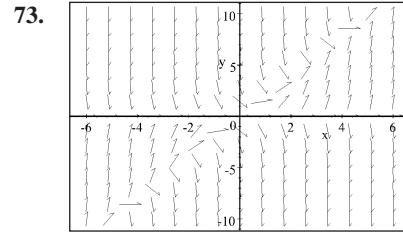
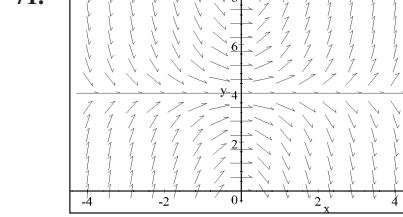
57. $2e^{-(\ln 2/2)t}; \frac{-2 \ln 0.05}{\ln 2} \approx 8.64 \text{ hours}$

59. $\frac{\ln 2}{0.08} \approx 8.66 \text{ years}$

61. $112e^{(\ln 108/112)t} + 68; 21.10 \text{ minutes}$ 63. $ce^{1/2x^4}$

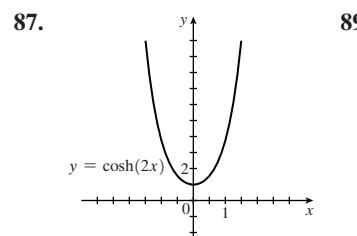
65. $\frac{1}{3}y^3 + \frac{1}{2}y^2 = 4 \tan^{-1} x + c$

67. $y = 0$ (unstable), $y = 2$ (stable) 69. $y = 0$ (stable)

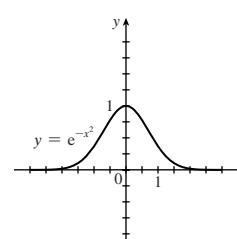
75. $h = 0.1: y_1 = 2.7, y_2 = 2.45;$
 $y(1) \approx 1.7434, y(2) \approx 2.6079$
 $h = 0.05: y_1 = 2.85, y_2 = 2.7125;$
 $y(1) \approx 1.7924, y(2) \approx 2.6426$

77. $\frac{\pi}{2}$ 79. $-\frac{\pi}{4}$ 81. $\frac{\sqrt{3}}{2}$ 83. $\frac{\pi}{4}$

85. $\frac{\pi}{4} + \pi n$



91. $y = \sin^{-1}(2x)$ 93. 17.77



CHAPTER 7**Exercises Section 7.1**

3. $-\frac{1}{6} \cos 6x + c$ 5. $\frac{1}{2} \sec 2x + c$ 7. $-\frac{1}{2} e^{3-2x} + c$
 9. $-2 \cos \sqrt{x} + c$ 11. 0 13. $1 - \sqrt{2}$
 15. $\frac{3}{4} \tan^{-1} \left(\frac{x}{4} \right) + c$ 17. $\frac{1}{3} \tan^{-1} x^3 + c$
 19. $\sin^{-1} \frac{x}{2} + c$ 21. $\frac{1}{2} \sin^{-1} x^2 + c$
 23. $2 \tan^{-1} \left(\frac{x+1}{2} \right) + c$
 25. $2 \ln |x^2 + 2x + 5| - 2 \tan^{-1} \left(\frac{x+1}{2} \right) + c$
 27. $\frac{1}{5} x^5 + \frac{8}{3} x^3 + 16x + c$ 29. $\sin^{-1} \left(\frac{x+1}{2} \right) + c$
 31. $2 \sin^{-1} \left(\frac{x-2}{2} \right) + c$ 33. $\frac{10}{3}$ 35. $\frac{12}{5}$
 37. $\tan^{-1}(e^2) - \frac{1}{4}\pi$ 39. $\frac{72}{5}$ 41. $\frac{1}{2} \cosh 2x + c$
 43. $\frac{1}{3} \ln(\cosh 3x) + c$ 45. $\frac{1}{2} \sinh x^2 + c$
 47. $3 \cosh^{-1} x + c$ 49. $\frac{3}{2} \sec^{-1} x^2 + c$
 51. $\frac{5}{\sqrt{3}} \tan^{-1} \left(\frac{x}{\sqrt{3}} \right) + c$ 53. $\frac{1}{4} (\ln x)^2 + c$
 55. $-\frac{1}{2} e^{-x^2} + c$ 57. $1 + \frac{1}{2} \ln 2 - \tan^{-1}(2) + \frac{1}{4}\pi$

Exercises Section 7.2

3. $x \sin x + \cos x + c$ 5. $\frac{1}{2} x e^{2x} - \frac{1}{4} e^{2x} + c$
 7. $\frac{1}{3} x^3 \ln x - \frac{1}{9} x^3 + c$
 9. $-\frac{1}{3} x^2 e^{-3x} - \frac{2}{9} x e^{-3x} - \frac{2}{27} e^{-3x} + c$
 11. $\frac{1}{2} x^2 \sin 2x + \frac{1}{2} x \cos 2x - \frac{1}{4} \sin 2x + c$
 13. $\frac{1}{17} e^x \sin 4x - \frac{4}{17} e^x \cos 4x + c$
 15. $\frac{2}{3} \sin 2x \cos x - \frac{1}{3} \cos 2x \sin x + c$
 17. $x \tan x + \ln |\cos x| + c$ 19. $x(\ln x)^2 - 2x \ln x + 2x + c$
 21. $\sin x \ln(\sin x) - \sin x + c$
 23. $\frac{1}{2} x \sinh 2x - \frac{1}{4} \cosh 2x + c$ 25. $\frac{1}{4} \sin 2 - \frac{1}{2} \cos 2$
 27. $-\frac{2}{\pi^2}$ 29. $\frac{1}{\pi}$ 31. $10 \ln 10 - 9$
 33. $x \cos^{-1} x - \sqrt{1-x^2} + c$
 35. $-2\sqrt{x} \cos \sqrt{x} + 2 \sin \sqrt{x} + c$ 37. n times
 41. $e^x(x^3 - 3x^2 + 6x - 6) + c$
 43. $\frac{1}{3} \cos^2 x \sin x + \frac{2}{3} \sin x + c$ 45. $9e - 24$ 47. $\frac{8}{15}$
 49. m even: $\frac{(m-1)(m-3)\dots1}{m(m-2)\dots2} \cdot \frac{\pi}{2}$
 m odd: $\frac{(m-1)(m-3)\dots2}{m(m-2)\dots3}$
 51. first column: derivatives; second column: antiderivatives
 53. $x^4 \sin x + 4x^3 \cos x - 12x^2 \sin x - 24x \cos x + 24 \sin x + c$

55. $\left(\frac{1}{2} x^4 - x^3 + \frac{3}{2} x^2 - \frac{3}{2} x + \frac{3}{4} \right) e^{2x} + c$

57. $-\frac{1}{3} x^3 e^{-3x} - \frac{1}{3} x^2 e^{-3x} - \frac{2}{9} x e^{-3x} - \frac{2}{27} e^{-3x} + c$

Exercises Section 7.3

3. $\frac{1}{5} \sin^5 x + c$ 5. $\frac{1}{16}$ 7. $-\frac{1}{3} \cos^3 x + c$
 9. $\frac{1}{2}$ 11. $\frac{1}{2} x + \frac{1}{4} \sin 2x + c$ 13. $\frac{1}{3} \sec^3 x + c$
 15. $\frac{12}{35}$ 17. $\frac{1}{8} x - \frac{1}{32} \sin 4x + c$
 19. $-\frac{1}{5} \csc^5 x + \frac{1}{3} \csc^3 x + c$ 21. $-\frac{8}{21} + \frac{25\sqrt{2}}{168}$
 23. $-\frac{1}{3} \cot^5 x - \frac{1}{3} \cot^3 x + c$ 25. $\sin(x) + c$
 27. $-\frac{1}{9} \frac{\sqrt{9-x^2}}{x} + c$ 29. π
 31. $\frac{3x}{2} \sqrt{\left(\frac{x}{3} \right)^2 - 1} + \frac{9}{2} \ln \left| \frac{x}{3} + \sqrt{\left(\frac{x}{3} \right)^2 - 1} \right| + c$
 33. $2 \cosh^{-1} \left(\frac{x}{2} \right) + c$
 35. $\frac{3x}{2} \sqrt{\left(\frac{x}{3} \right)^2 + 1} - \frac{9}{2} \ln \left| \frac{x}{3} + \sqrt{\left(\frac{x}{3} \right)^2 + 1} \right| + c$
 37. $\frac{1}{2} x \sqrt{16+x^2} + 8 \ln \left| \frac{1}{4} \sqrt{16+x^2} + \frac{x}{4} \right| + c$
 39. $9 - \frac{16\sqrt{2}}{3}$
 41. $\frac{1}{4} \tan 4x + \frac{1}{2} \tan^2 x + c$; $\frac{1}{4} \sec^4 x + c$ 45. $\frac{1}{2} RI^2$

Exercises Section 7.4

3. $\frac{3}{x+1} - \frac{2}{x-1}$; $3 \ln|x+1| - 2 \ln|x-1| + c$
 5. $\frac{2}{x+1} + \frac{4}{x-2}$; $2 \ln|x+1| + 4 \ln|x-2| + c$
 7. $\frac{\frac{1}{5}}{x+2} + \frac{\frac{4}{5}}{x-3}$; $\frac{1}{5} \ln|x+2| + \frac{4}{5} \ln|x-3| + c$
 9. $\frac{2}{x+1} + \frac{\frac{1}{2}}{x-2} - \frac{\frac{5}{2}}{x}$; $2 \ln|x+1| + \frac{1}{2} \ln|x-2| - \frac{5}{2} \ln|x| + c$
 11. $\frac{11}{x+4} + \frac{2}{x-2}$; $x-2$;
 $11 \ln|x+4| + 2 \ln|x-2| + \frac{1}{2} x^2 - 2x + c$
 13. $\frac{1}{x+1} - \frac{2}{x-1} + \frac{1}{x}$; $\ln|x+1| - 2 \ln|x-1| + \ln|x| + c$
 15. $\frac{2}{x+2} - \frac{1}{(x+2)^2}$; $2 \ln|x+2| + (x+2)^{-1} + c$
 17. $\frac{\frac{1}{4}}{x+2} + \frac{\frac{3}{2}}{(x+2)^2} - \frac{\frac{1}{4}}{x}$;
 $\frac{1}{4} \ln|x+2| - \frac{3}{2} (x+2)^{-1} - \frac{1}{4} \ln|x| + c$
 19. $\frac{1}{x+2} - \frac{3}{x+1} + \frac{2}{x}$; $\ln|x+2| - 3 \ln|x+1| + 2 \ln|x| + c$

1224 Appendix B Answers to Odd-Numbered Exercises

- 21.** $\frac{-2x+1}{x^2+1} + \frac{2}{x}; -\ln(x^2+1) + \tan^{-1} x + 2 \ln|x| + c$
- 23.** $\frac{\frac{3}{2}}{x+1} + \frac{\frac{1}{2}}{x-1} + \frac{-2x+1}{x^2+1};$
 $\frac{3}{2} \ln|x+1| + \frac{1}{2} \ln|x-1| - \ln(x^2+1) + \tan^{-1} x + c$
- 25.** $3 + \frac{1}{x+1} + \frac{2}{x-2}; 3x + \ln|x+1| + 2 \ln|x-2| + c$
- 27.** $\frac{2}{x+1} + \frac{1}{(x+1)^2}; 2 \ln|x+1| - (x+1)^{-1} + c$
- 29.** $\frac{2}{x^2+1} + \frac{1}{x}; 2 \tan^{-1} x + \ln|x| + c$
- 31.** $\frac{3}{x} + \frac{x-3}{x^2+x+1};$
 $3 \ln|x| + \frac{1}{2} \ln|x^2+x+1| - \frac{7}{\sqrt{3}} \tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + c$
- 33.** $3 + \frac{2}{x-1} + \frac{x-2}{x^2+1};$
 $3x + 2 \ln|x-1| + \frac{1}{2} \ln(x^2+1) - 2 \tan^{-1} x + c$
- 35.** $\frac{4}{x^2+1} - \frac{2}{(x^2+1)^2}$ **37.** $\frac{2}{x^2+4} - \frac{4}{(x^2+4)^2}$
- 39.** $\frac{4}{x^2+x+1} - \frac{4x+1}{(x^2+x+1)^2}$
- 41.** $\frac{1}{y} + \frac{1}{1-y}, y = \frac{ce^{at}}{1+ce^{at}}$

Exercises Section 7.5

- 3.** $\frac{1}{8(2+4x)} + \frac{1}{16} \ln|2+4x| + c$
- 5.** $\frac{2}{15}(3e^x - 2)(1+e^x)^{3/2} + c$
- 7.** $\frac{1}{8}x\sqrt{1+4x^2} - \frac{1}{16} \ln(2x + \sqrt{1+4x^2}) + c$
- 9.** $-\frac{\sqrt{3}}{12} + \frac{\pi}{9}$
- 11.** $\ln(2+\sqrt{8}) - \ln(1+\sqrt{5})$
- 13.** $\frac{-1}{x-3}\sqrt{9-(x-3)^2} - \sin^{-1}\left(\frac{x-3}{3}\right) + c$
- 15.** $\frac{1}{5} \tan^5 x - \frac{1}{3} \tan^3 x + \tan x - x + c$
- 17.** $\frac{1}{2} \ln \left| \frac{\sqrt{4+\sin x}-2}{\sqrt{4+\sin x}+2} \right| + c$
- 19.** $\frac{1}{2} \cos x^2 + \frac{1}{2} x^2 \sin x^2 + c$
- 21.** $-\frac{2}{3}(\cos x - 2)\sqrt{1+\cos x} + c$
- 23.** $\frac{1}{2} \sin x \sqrt{4+\sin^2 x} - 2 \ln(\sin x + \sqrt{4+\sin^2 x}) + c$
- 25.** $\frac{1}{4}e^{-2/x^2} + c$ **27.** $-\sqrt{4x-x^2} + 2 \cos^{-1}\left(\frac{2-x}{2}\right) + c$
- 29.** $e^x \tan^{-1}(e^x) - \frac{1}{2} \ln(1+e^{2x}) + c$

Exercises Section 7.6

- 3.** $-\frac{1}{4}$ **5.** 1 **7.** 3 **9.** 0 **11.** 1 **13.** $-\frac{1}{6}$
15. $\frac{1}{2}$ **17.** 0 **19.** 1 **21.** $-\pi$ **23.** 0 **25.** 0
27. -2 **29.** 0 **31.** 0 **33.** 0 **35.** e **37.** ∞
39. 1 **41.** e^x **43.** not indeterminate **45.** k
47. (a) $\frac{(x+1)(2+\sin x)}{x(2+\cos x)}$ (b) $\frac{x}{e^x}$ (c) $\frac{3x+1}{x-7}$ (d) $\frac{3-8x}{1+2x}$

Exercises Section 7.7

- 3.** improper **5.** not **7.** improper **9.** improper
11. $\frac{3}{2}$ **13.** diverges **15.** diverges **17.** 3
19. $2\sqrt{2}$ **21.** -1 **23.** diverges **25.** diverges
27. -1 **29.** diverges **31.** diverges **33.** π
35. diverges **37.** diverges **39.** π **41.** diverges
43. 2 **45.** diverges **47.** $r=1$ **49.** $c < 0; c > 0$
51. $\frac{x}{1+x^3} < \frac{1}{x^2}$, converges **53.** $\frac{x}{x^{3/2}-1} > \frac{1}{\sqrt{x}}$, diverges
55. $\frac{3}{x+e^x} < \frac{3}{e^x}$, converges **57.** $\frac{\sin^2 x}{1+e^x} < \frac{1}{e^x}$, converges
59. $\frac{x^2 e^x}{\ln x} > e^x$, diverges **61.** $\frac{1}{2} \ln 4 - \frac{1}{4}$
67. (a) 2 (b) 4 (c) r **69.** $\frac{1}{r}$ **71.** $e^{-1} \approx .37$

Chapter 7 Review Exercises

- 1.** $2e^{\sqrt{x}} + c$ **3.** $\frac{1}{2} \sin^{-1} x - \frac{1}{2}x\sqrt{1-x^2} + c$
5. $-\frac{1}{3}x^2 e^{-3x} - \frac{2}{9}xe^{-3x} - \frac{2}{27}e^{-3x} + c$ **7.** $\frac{1}{2} \tan^{-1} x^2 + c$
9. $\frac{1}{4} \ln(4+x^4) + c$ **11.** $\frac{1}{3}x^3 + c$
13. $\frac{1}{9} \sin 3 - \frac{1}{3} \cos 3$ **15.** $\frac{3\pi}{16}$ **17.** $\frac{2}{\pi}$
19. $4 \ln 2 - \frac{15}{16}$ **21.** $\frac{1}{3} \sin^3 x + c$
23. $\frac{1}{4} \sin^4 x - \frac{1}{6} \sin^6 x + c$ **25.** $\frac{1}{5} \tan^5 x + \frac{1}{3} \tan^3 x + c$
27. $\frac{2}{3}(\sin x)^{3/2} - \frac{2}{7}(\sin x)^{7/2} + c$ **29.** $\tan^{-1}\left(\frac{x+2}{2}\right) + c$
31. $-\frac{\sqrt{4-x^2}}{2x} + c$ **33.** $-\frac{x^2}{3}\sqrt{9-x^2} - 6\sqrt{9-x^2} + c$
35. $\frac{x^2}{3}\sqrt{x^2+9} - 6\sqrt{x^2+9} + c$
37. $3 \ln|x+1| - 2 \ln|x+2| + c$
39. $3 \ln|x| + 2 \ln|x-2| - \ln|x+2| + c$
41. $\frac{1}{5}e^x \cos 2x + \frac{2}{5}e^x \sin 2x + c$
43. $\frac{1}{3}(x^2+1)^{3/2} + c$ **45.** $\frac{\frac{4}{5}}{x-4} - \frac{\frac{4}{5}}{x+1}$
47. $\frac{3}{x} - \frac{1}{x+2} - \frac{2}{x-1}$ **49.** $\frac{1}{x+2} - \frac{4}{(x+2)^2}$
51. $\frac{1}{8}e^x(4+2e^{2x})\sqrt{4+e^{2x}} - 2 \ln(e^x + \sqrt{4+e^{2x}}) + c$
53. $\frac{1}{3} \tan x \sec^2 x + \frac{2}{3} \tan x + c$
55. $\frac{4}{3(3-x)} - \frac{4}{9} \ln \left| \frac{3-x}{x} \right| + c$

57. $-\frac{\sqrt{9+4x^2}}{x} + 2 \ln \left(x + \sqrt{\frac{9}{4} + x^2} \right) + c$
 59. $\sqrt{4-x^2} - 2 \ln \left| \frac{2+\sqrt{4-x^2}}{x} \right| + c$ 61. $\frac{3}{2}$ 63. ∞
 65. e^3 67. 1 69. diverges 71. 3 73. π
 75. diverges

CHAPTER 8**Exercises Section 8.1**

5. $1, \frac{3}{4}, \frac{5}{9}, \frac{7}{16}, \frac{9}{25}, \frac{11}{36}$ 7. $4, 2, \frac{2}{3}, \frac{1}{6}, \frac{1}{30}, \frac{1}{180}$
 9. converges to 0 11. converges to 1
 13. converges to 0 15. converges to $\frac{3}{2}$ 17. diverges
 19. converges to $\frac{1}{3}$ 21. diverges 23. converges to 0
 25. diverges 27. converges to 0 29. converges to 0
 31. diverges 33. converges to 0 39. decreasing
 41. increasing 43. decreasing
 45. decreasing, for $n \geq 9$ 47. $|a_n| < 3$ 49. $|a_n| < \frac{1}{2}$
 51. $a_{1000} \approx 2.716924$; $e \approx 2.718282$
 55. $a_n = 144 - 36\pi \approx 30.9$
 57. $3.096, 3.144, 3.194; 3.594 < 3.721; 4.376 < 4.473;$
 $5.589 > 5.33; 4.131 \times 10^{53}$ billion
 61. converges to 1 63. \sqrt{c}

Exercises Section 8.2

5. converges to $\frac{15}{4}$ 7. converges to $\frac{3}{8}$
 9. diverges 11. converges to 3
 13. diverges 15. diverges 17. converges to 1
 19. converges to $\frac{3}{2}$ 21. diverges 23. converges to 5
 25. converges to 2 27. diverges 29. converges
 31. converges 33. diverges 39. $64; 256; 4^{m-1}$
 41. $\frac{0.9}{1-0.1} = 1$ 43. $1.3589L$ 45. $1.002004008\dots$
 47. $\frac{p^2}{1-2p(1-p)} > p$ if $p > \frac{1}{2}; 0.692$
 49. $30 + 15 + \frac{15}{2} + \dots = 60$ miles 51. \$400,000
 53. $2(1-e^{-0.1}) \approx 0.19$ 55. $\frac{ce^{-r}}{1-e^{-r}}$

Exercises Section 8.3

5. diverges 7. converges 9. diverges
 11. diverges 13. diverges 15. converges
 17. converges 19. converges 21. diverges
 23. diverges 25. diverges 27. converges
 29. diverges 31. converges 33. diverges
 35. diverges 37. diverges 39. converges
 45. $p > 1$ 47. $p > 1$ 49. $\frac{1}{3 \cdot 100^3}$ 51. $\frac{6}{7 \cdot 50^7}$
 53. 6.73×10^{-696} 55. 101 57. 4
 59. (a) can't tell (b) converges (c) converges
 (d) can't tell

63. series converges for $x > 1$ 65. 1.0823, $x = 4$
 67. 1.0041, $x = 8$

Exercises Section 8.4

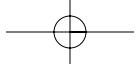
5. convergent 7. convergent 9. divergent
 11. convergent 13. convergent 15. divergent
 17. divergent 19. convergent 21. convergent
 23. divergent 25. convergent 27. divergent
 29. convergent 31. 3.61 33. -0.23 35. 1.10
 37. 3.78 39. 20,000 41. 11 43. 11
 45. $f'(k) < 0$ for $k \geq 2$
 47. positives diverge, negatives converge
 49. $\frac{\frac{3}{4}}{1+\frac{3}{4}} = \frac{3}{7}$ 51. 0.69314668

Exercises Section 8.5

5. absolutely convergent 7. divergent
 9. conditionally convergent 11. absolutely convergent
 13. divergent 15. absolutely convergent
 17. absolutely convergent 19. divergent
 21. conditionally convergent 23. absolutely convergent
 25. absolutely convergent 27. absolutely convergent
 29. conditionally convergent 31. conditionally convergent
 33. absolutely convergent 35. absolutely convergent
 37. divergent 39. absolutely convergent
 41. absolutely convergent

Exercises Section 8.6

5. $\sum_{k=0}^{\infty} 2x^k, r = 1, (-1, 1)$
 7. $\sum_{k=0}^{\infty} (-1)^k 3x^{2k}, r = 1, (-1, 1)$
 9. $\sum_{k=0}^{\infty} 2x^{3k+1}, r = 1, (-1, 1)$
 11. $\sum_{k=0}^{\infty} (-1)^k 4^{k+1} x^k, r = \frac{1}{4}, (-\frac{1}{4}, \frac{1}{4})$
 13. $\sum_{k=0}^{\infty} (-1)^k \frac{1}{2^{2k+1}} x^k, r = 4, (-4, 4)$
 15. $(-3, -1), \frac{-1}{1+x}$
 17. $(0, 1), \frac{1}{2-2x}$ 19. $(-2, 2), \frac{2}{2+x}$
 21. $\infty, (-\infty, \infty)$ 23. $4, (-4, 4)$
 25. $3, (-2, 4]$ 27. $0, \{x = -1\}$
 29. $1, [0, 2)$ 31. $1, (2, 4)$ 33. $\infty, (-\infty, \infty)$
 35. $\frac{1}{2}, [-\frac{5}{2}, -\frac{3}{2}]$ 37. $\frac{1}{4}, [-\frac{1}{4}, \frac{1}{4})$
 39. $\sum_{k=0}^{\infty} (-1)^k \frac{3}{2k+1} x^{2k+1}, r = 1$


1226 Appendix B Answers to Odd-Numbered Exercises

41. $\sum_{k=1}^{\infty} 2kx^{2k-1}, r = 1$

43. $\sum_{k=0}^{\infty} (-1)^k \frac{1}{k+1} x^{2k+2}, r = 1$

45. $\sum_{k=1}^{\infty} (-1)^{k+1} 4^{k-1} kx^{k-1}, r = \frac{1}{4}$

47. $(-\infty, \infty), \{x = 0\}$

49. $(-\infty, 0), (-\infty, 0)$

51. $(a-b, a+b), r = b$

53. r

55. $r = 1, 1.003005007\dots$

57. no x 's for which both series converge

49. $\sum_{k=0}^{\infty} (-1)^k \frac{x^{4k+2}}{(2k+1)!}; r = \infty$

51. $\sum_{k=0}^{\infty} (-1)^k \frac{9^k x^{2k}}{(2k)!}; r = \infty$

55. $\frac{98}{3}$ miles

57. $e^c \sum_{k=0}^{\infty} \frac{(x-c)^k}{k!}$

61. $1 + \sum_{k=1}^{\infty} \frac{\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right) \cdots \left(\frac{1}{2}-k+1\right)}{k!} x^k$

Exercises Section 8.7

7. $\sum_{k=0}^{\infty} (-1)^k \frac{x^{2k}}{(2k)!}, (-\infty, \infty)$

9. $\sum_{k=0}^{\infty} (-1)^k \frac{x^{2k+1}}{(2k+1)!}, (-\infty, \infty)$

11. $\sum_{k=0}^{\infty} (-1)^k \frac{x^{k+1}}{k+1}, (-1, 1]$

13. $\sum_{k=0}^{\infty} (-1)^k (k+1)x^k, (-1, 1)$

15. $\sum_{k=0}^{\infty} \frac{(x-1)^k}{k!}, (-\infty, \infty)$

17. $1 + \sum_{k=1}^{\infty} (-1)^{k+1} \frac{e^{-k}}{k} (x-e)^k, (0, 2e]$

19. $\sum_{k=0}^{\infty} (-1)^k (x-1)^k, (0, 2)$

21. $1 - \frac{1}{2}x^2 + \frac{1}{24}x^4 - \frac{1}{720}x^6 + \frac{1}{40320}x^8$

23. $1 + \frac{1}{2}(x-1) - \frac{1}{8}(x-1)^2 + \frac{1}{16}(x-1)^3 - \frac{5}{128}(x-1)^4 + \frac{7}{256}(x-1)^5 - \frac{21}{1024}(x-1)^6$

25. $e^2 \left[1 + (x-2) + \frac{1}{2}(x-2)^2 + \frac{1}{6}(x-2)^3 + \frac{1}{24}(x-2)^4 + \frac{1}{120}(x-2)^5 + \frac{1}{720}(x-2)^6 \right]$

27. $\frac{1}{2} - \frac{1}{16}(x-4) + \frac{3}{256}(x-4)^2 - \frac{5}{2048}(x-4)^3 + \frac{35}{65536}(x-4)^4$

29. $|R_n(x)| \leq \frac{|x|^{n+1}}{(n+1)!} \rightarrow 0$

31. $|R_n(x)| = \frac{1}{n+1} \left| \frac{x-1}{z} \right|^{n+1} \rightarrow 0$

33. (a) 0.04879 (b) $\frac{0.05^5}{5}$ (c) 7

35. (a) 1.0488 (b) $\frac{7(0.1)^5}{256}$ (c) 8

37. (a) 1.10517 (b) $\frac{1.5 \cdot (0.1)^5}{5!}$ (c) 6

39. e^x with $x = 2$

41. $\sin x$ with $x = \pi$

43. $\tan^{-1} x$ with $x = 1$

45. $\sum_{k=0}^{\infty} (-1)^k \frac{(2x)^k}{k!}; r = \infty$

Exercises Section 8.8

5. 0.999231634426433

7. 0.94275466553403

9. 0.818730753079365

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

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

15. 1

17. $\frac{1703}{900}$

19. $\frac{5651}{3780}$

21. $\frac{11}{30}$

23. ∞

25. 12

27. $\sqrt{2c} \approx 83,000$

29. $\frac{R}{20}$

31. no

33. too large

Exercises Section 8.9

5. $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{2}{k} \sin kx$

7. $\pi - \sum_{k=1}^{\infty} \frac{8}{(2k-1)^2 \pi} \cos[(2k-1)x]$

9. $\sum_{k=1}^{\infty} \frac{-4}{\pi(2k-1)} \sin[(2k-1)x]$

11. $3 \sin 2x$

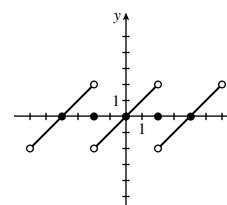
13. $\sum_{k=1}^{\infty} (-1)^k \frac{2}{k\pi} \sin k\pi x$

15. $\frac{1}{3} + \sum_{k=1}^{\infty} (-1)^k \frac{4}{k^2 \pi^2} \cos k\pi x$

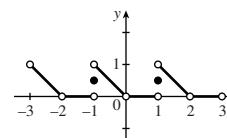
17. $\frac{1}{4} + \sum_{k=1}^{\infty} \frac{-2}{(2k-1)^2 \pi^2} \cos(2k-1)\pi x$

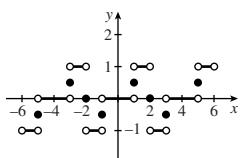
$$+ \sum_{k=1}^{\infty} (-1)^{k+1} \frac{1}{k\pi} \sin k\pi x$$

19.

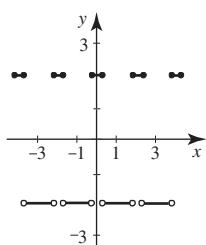
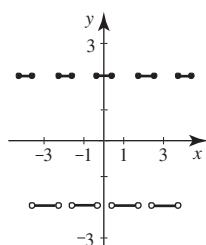
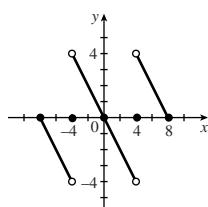
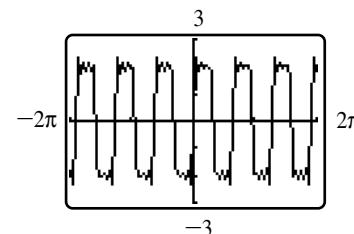
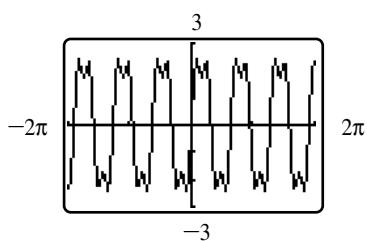
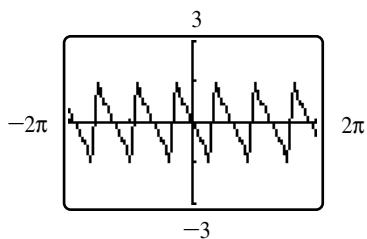
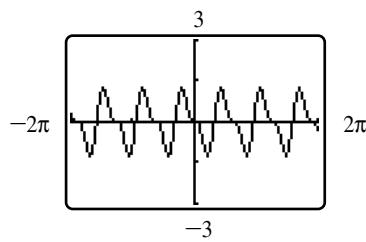


21.



23.

- 33.** odd **37.** sine
39. both **41.** both

45.**47.**

- 49.** overshoot at edges
51. $A = -1, B = 4\pi; A = 1, B = 2\pi$

Chapter 8 Review Exercises

- 1.** converges to 0 **3.** converges to 0 **5.** converges to 0
7. diverges **9.** diverges **11.** can't tell
13. diverges **15.** converges **17.** converges
19. 8 **21.** $\frac{4}{3}$ **23.** -0.40 **25.** diverges
27. converges **29.** diverges **31.** converges
33. converges **35.** converges **37.** converges
39. diverges **41.** converges **43.** converges
45. converges conditionally **47.** converges absolutely

49. $p > 1$ **51.** 1732 **53.** $\sum_{k=0}^{\infty} (-1)^k \frac{x^k}{4^{k+1}}, r = 4$

55. $\sum_{k=0}^{\infty} (-1)^k \frac{x^{2k}}{3^k}, r = \sqrt{3}$

57. $\sum_{k=0}^{\infty} (-1)^k \frac{x^{k+1}}{(k+1)4^{k+1}} + \ln 4, r = 4$ **59.** $(-1, 1)$

61. $(-1, 1]$ **63.** $(-\infty, \infty)$ **65.** $\left(\frac{5}{3}, \frac{7}{3}\right)$

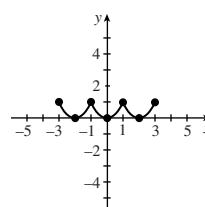
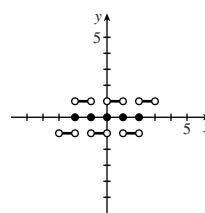
67. $\sum_{k=0}^{\infty} (-1)^k \frac{x^{2k+1}}{(2k+1)!}$

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

71. 0.1822666, 10

73. $\sum_{k=0}^{\infty} (-1)^k \frac{3^k x^{2k}}{k!}, r = \infty$ **75.** $\frac{1117}{2520}$

77. $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{4}{k\pi} \sin\left(\frac{k\pi}{2}x\right)$

79.**81.**

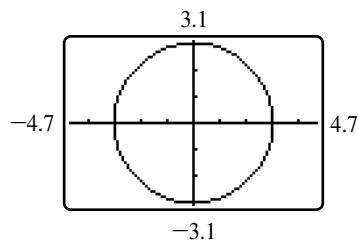
1228 Appendix B Answers to Odd-Numbered Exercises

83. $\frac{2}{3}$

85. $\frac{1+\sqrt{5}}{2}$

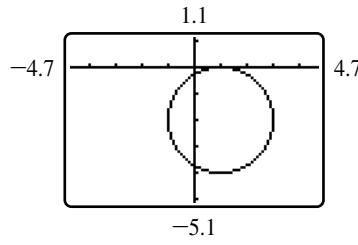
87. 2, 1.5, 1.67, 1.6, 1.625 \rightarrow 1.618...**CHAPTER 9****Exercises Section 9.1**

5.



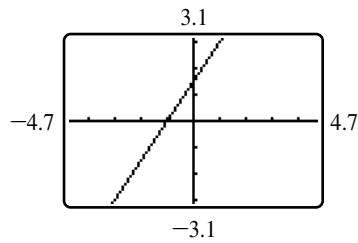
$x^2 + y^2 = 9$

7.



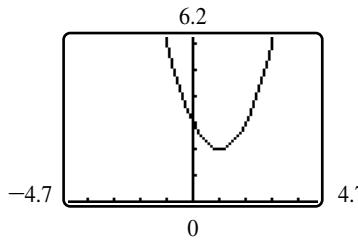
$(x - 1)^2 + (y + 2)^2 = 4$

9.



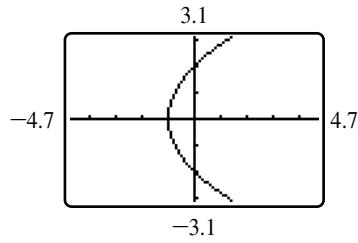
$y = \frac{3}{2}x + \frac{3}{2}$

11.



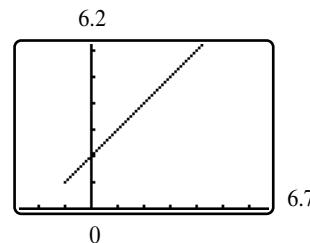
$y = x^2 - 2x + 3$

13.



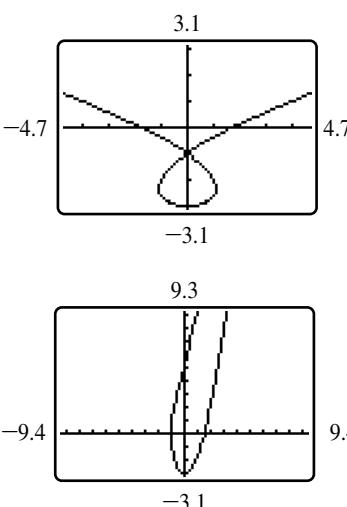
$x = \frac{1}{4}y^2 - 1$

15.

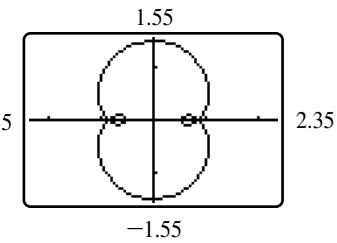


$y = x + 2, x \geq -1$

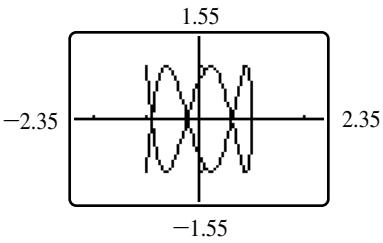
17.



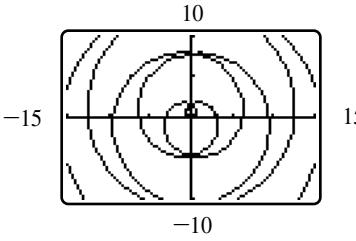
21.

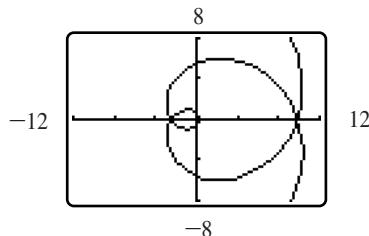
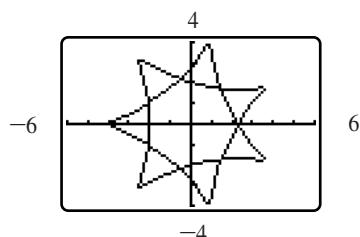
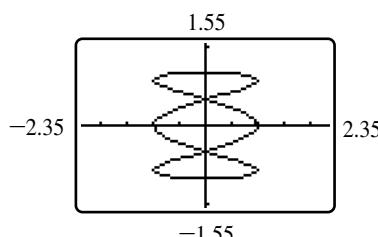
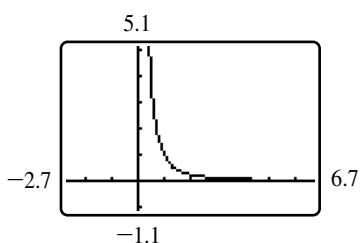


23.



25.



27.**29.****31.****33.****35.** C**37.** B**39.** A

41. $x = 3t, y = 1 + 3t, 0 \leq t \leq 1$

43. $x = -2 + 8t, y = 4 - 3t, 0 \leq t \leq 1$

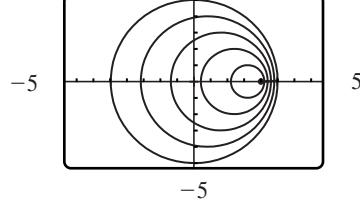
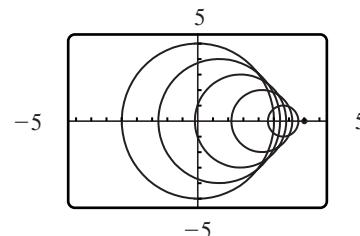
45. $x = t, y = t^2 + 1, 1 \leq t \leq 2$

47. $x = 2 - t, y = -t^2 + 4t - 2, 0 \leq t \leq 2$

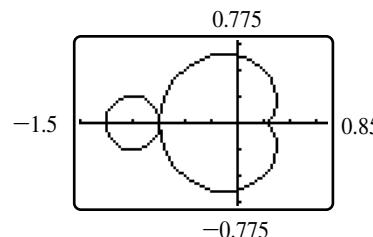
49. $x = 2 + 3 \cos t, y = 1 + 3 \sin t, 0 \leq t \leq 2\pi$

51. $(2, 3)$ and $(-3, 8)$

53. $(2, 1)$ and $(3, 0)$

55. yes, at $(250, 100)$ **57.** $y = 0$ at $t = 2, d = 0$ or $d = 5$ **59.** a circle with radius t at time t **61.****63.****65.** a cone

67. $x = 1 - 2y^2, y = \pm 2x\sqrt{1 - x^2}$

69.

Exercises Section 9.2

5. (a) -1 (b) 1 (c) undefined

7. (a) $-\frac{3}{2}$ (b) 0 (c) 0

9. (a) 2 (b) undefined (c) 0

11. $t = 1$ or -1 ; 1 and -1

13. (a) $(0, 4), (0, -4)$ (b) $(-2, 0), (2, 0)$

15. (a) $\left(\frac{\sqrt{2}}{2}, 1\right), \left(\frac{\sqrt{2}}{2}, -1\right), \left(-\frac{\sqrt{2}}{2}, 1\right), \left(-\frac{\sqrt{2}}{2}, -1\right)$
(b) $(1, 0), (-1, 0)$

17. (a) $(0, -3)$ (b) $(-1, 0)$

19. (a) $(0, 1)$ (b) $(0, -3)$

21. (a) $x'(0) = 0, y'(0) = 2$, speed = 2, up

(b) $x'\left(\frac{\pi}{2}\right) = -2, y'\left(\frac{\pi}{2}\right) = 0$, speed = 2, left

23. (a) $x'(0) = 20, y'(0) = -2$, speed = $2\sqrt{101}$, right/down

(b) $x'(2) = 20, y'(2) = -66$, speed = $\sqrt{4756}$, right/down

25. (a) $x'(0) = 5, y'(0) = 4$, speed = $\sqrt{41}$, right/up

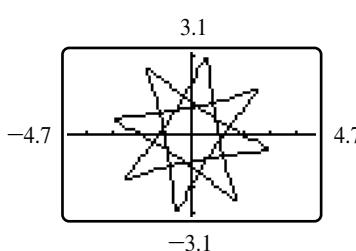
(b) $x'\left(\frac{\pi}{2}\right) = 0, y'\left(\frac{\pi}{2}\right) = -9$, speed = 9, down

27. 6π

29. $\frac{3\pi}{8}$

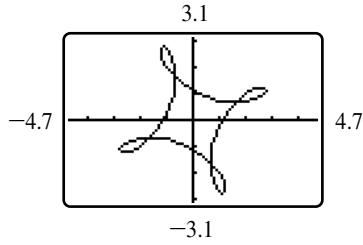
31. $\frac{4}{3}$

33. $\frac{256}{15}$

35. at $(-1, 0)$, speed is 4; at $(3, 0)$, speed is 0**37.** 5: 3,

1230 Appendix B Answers to Odd-Numbered Exercises

39. $x = 2 \cos t + \sin 3t, y = 2 \sin t + \cos 3t;$



Min/max speeds: 1, 5

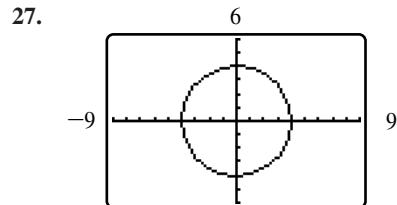
41. speed = 4, $(\tan 4t)(-\cot 4t) = -1$

Exercises Section 9.3

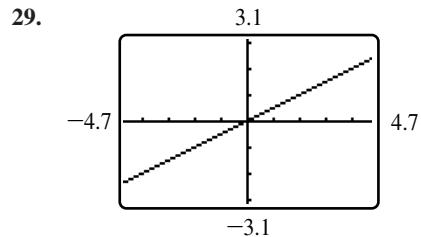
5. 19.38 7. 15.87 9. 15.69 11. 9.43
 13. 2.30 15. 2.42 17. 6.91 19. 4.4864 k
 21. 4.4569 k 23. undefined; 3.890
 25. undefined; 4.066 27. 85.8 29. 29.7 31. 85.8

Exercises Section 9.4

5. $(2, 0)$ 7. $(2, 0)$ 9. $(-3, 0)$
 11. $\left(2\sqrt{2}, -\frac{\pi}{4} + 2\pi n\right), \left(-2\sqrt{2}, \frac{3\pi}{4} + 2\pi n\right)$
 13. $\left(3, \frac{\pi}{2} + 2\pi n\right), \left(-3, \frac{3\pi}{2} + 2\pi n\right)$
 15. $(\sqrt{5}, -\tan^{-1}(\frac{1}{2}) + 2\pi n), (-\sqrt{5}, -\tan^{-1}(\frac{1}{2}) + (2n+1)\pi)$
 17. $\left(2, \frac{5\pi}{6} + 2\pi n\right), \left(-2, -\frac{\pi}{6} + 2\pi n\right)$ 19. $(1, -\sqrt{3})$
 21. $(0, 0)$ 23. $\left(3 \cos \frac{\pi}{8}, 3 \sin \frac{\pi}{8}\right) \approx (2.77, 1.15)$
 25. $(-3 \cos 1, -3 \sin 1) \approx (-1.62, -2.52)$

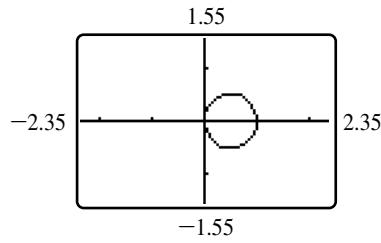


$$x^2 + y^2 = 16$$



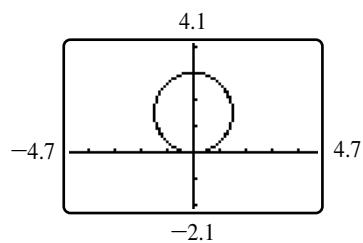
$$y = \frac{1}{\sqrt{3}}x$$

31.



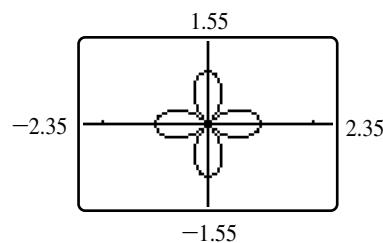
$$x^2 + y^2 = x$$

33.



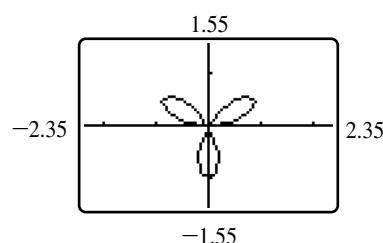
$$x^2 + y^2 = 3y$$

35.



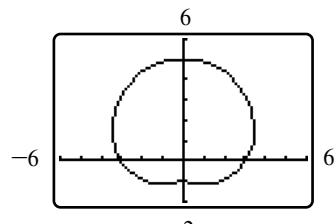
$$r = 0 \text{ at } \theta = \frac{k\pi}{4} \text{ (} k \text{ odd)} \text{, } 0 \leq \theta \leq 2\pi$$

37.

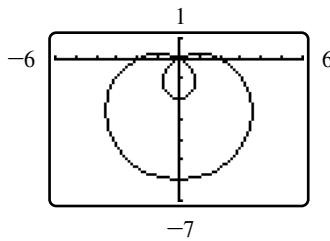


$$r = 0 \text{ at } \theta = \frac{n\pi}{3}, 0 \leq \theta \leq \pi$$

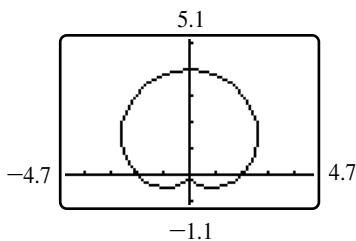
39.



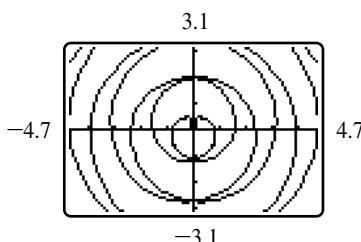
$$r > 0, 0 \leq \theta \leq 2\pi$$

41.

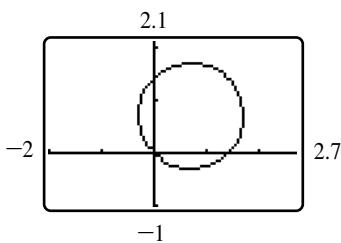
$$r = 0 \text{ at } \theta = \frac{\pi}{6} + 2\pi n, \frac{5\pi}{6} + 2\pi n; 0 \leq \theta \leq 2\pi$$

43.

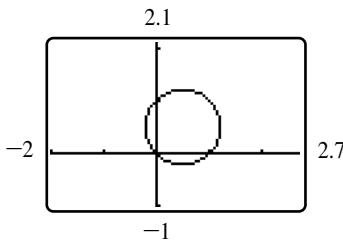
$$r = 0 \text{ at } \theta = \frac{3\pi}{2} + 2\pi n, 0 \leq \theta \leq 2\pi$$

45.

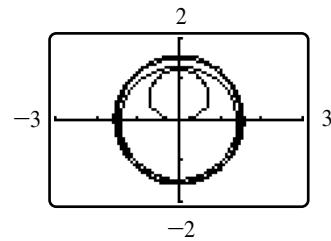
$$r = 0 \text{ at } \theta = 0, -\infty < \theta < \infty$$

47.

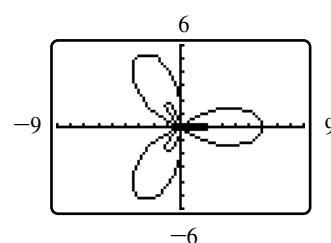
$$r = 0 \text{ at } \theta = \frac{3\pi}{4} + \pi n, 0 \leq \theta \leq \pi$$

49.

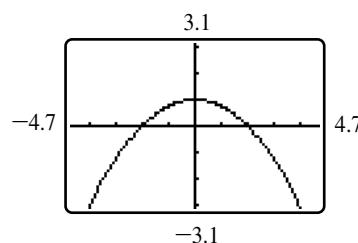
$$r = 0 \text{ at } \theta = \frac{3\pi}{4} + \pi n, 0 \leq \theta \leq \pi$$

51.

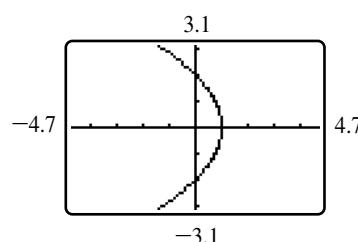
$$r = 0 \text{ at } \theta = 0, -\infty < \theta < \infty$$

53.

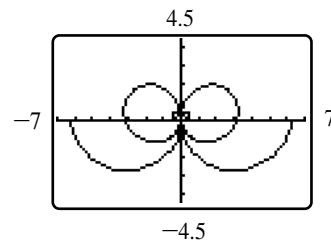
$$r = 0 \text{ at } \theta = \frac{2\pi}{9} + \frac{2\pi n}{3}, \frac{4\pi}{9} + \frac{2\pi n}{3}, 0 \leq \theta \leq 2\pi$$

55.

$$r \neq 0, -\frac{\pi}{2} < \theta < \frac{3\pi}{2}$$

57.

$$r \neq 0, -\pi < \theta < \pi$$

59.

$$r = 0 \text{ at } \theta = 0, \pm \frac{\pi}{2}, \pm \frac{3\pi}{2}$$

1232 Appendix B Answers to Odd-Numbered Exercises

61. circle, radius $\frac{a}{2}$, center $\left(\frac{a}{2}, 0\right)$

63. rose with n leaves (n odd) or $2n$ leaves (n even)

65. $r = \pm 2\sqrt{-\sec 2\theta}$ **67.** $r = 4$ **69.** $r = 3 \csc \theta$

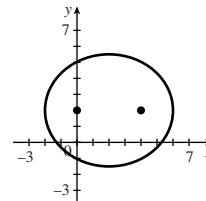
71. n wide overlapping petals on a flower when $0 \leq \theta \leq n\pi$, up to $n = 24$; graph repeats for larger domains.

75. $r_1(A) = d \cos A - \sqrt{d^2 \cos^2 A - (d^2 - h^2)}$

$$r_2(A) = d + b \left(1 - \left(\frac{A}{\sin^{-1} \left(\frac{h}{d} \right)} \right)^2 \right)$$

$$A_1 = -\sin^{-1} \left(\frac{h}{d} \right), A_2 = \sin^{-1} \left(\frac{h}{d} \right)$$

31. $\frac{(x-2)^2}{16} + \frac{(y-2)^2}{12} = 1$

**Exercises Section 9.5**

5. $\sqrt{3}$ **7.** undefined **9.** 0 **11.** 1 **13.** $\frac{1}{\sqrt{3}}$

15. $\left(\frac{\sqrt{3}}{2}, \frac{1}{2}\right), \left(-\frac{\sqrt{3}}{2}, \frac{1}{2}\right), (0, -1)$

17. $(3\sqrt{2}, -3\sqrt{2}), (-3\sqrt{2}, 3\sqrt{2})$

19. $\frac{\pi}{12}$ **21.** 0.3806 **23.** π **25.** 0.2718

27. 0.147 **29.** 24.187 **31.** 6.968 **33.** 1.927

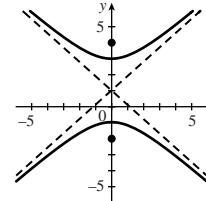
35. $(0, 0), (0.3386, -0.75), (1.6614, -0.75)$

37. $(0, 0), (1.2071, 1.2071), (-0.2071, -0.2071)$

39. 16 **41.** 6.6824 **43.** 20.0158 **45.** 31.2%

47. 62.6% **49.** $\theta = 0: 0, \theta = \frac{\pi}{3}: \sqrt{3}, \theta = \frac{2\pi}{3}: -\sqrt{3}$

33. $\frac{(y-1)^2}{4} - \frac{x^2}{5} = 1$

**Exercises Section 9.6**

5. $y = -\frac{1}{4}x^2$ **7.** $x = \frac{1}{4}y^2 + 2$ **9.** $\frac{x^2}{12} + \frac{(y-3)^2}{16} = 1$

11. $\frac{(x-4)^2}{16} + \frac{(y-1)^2}{12} = 1$ **13.** $\frac{(x-2)^2}{1} - \frac{y^2}{3} = 1$

15. $\frac{(y-4)^2}{1} - \frac{(x-2)^2}{3} = 1$

17. parabola, $(-1, -1), (-1, -\frac{7}{8})$, $y = -\frac{9}{8}$

19. ellipse, $(1, -1)$ and $(1, 5)$, $(1, 2 - \sqrt{5})$ and $(1, 2 + \sqrt{5})$

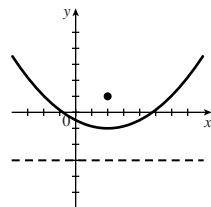
21. hyperbola, $(-2, 0)$ and $(4, 0)$, $(1 - \sqrt{13}, 0)$ and $(1 + \sqrt{13}, 0)$

23. hyperbola, $(-2, -5)$ and $(-2, 3)$, $(-2, -1 - \sqrt{20})$ and $(-2, -1 + \sqrt{20})$

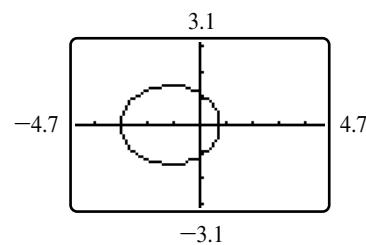
25. ellipse, $(-1, 0)$ and $(5, 0)$, $(2 - \sqrt{8}, 0)$ and $(2 + \sqrt{8}, 0)$

27. parabola, $(-1, -2), (-1, -1)$, $y = -3$

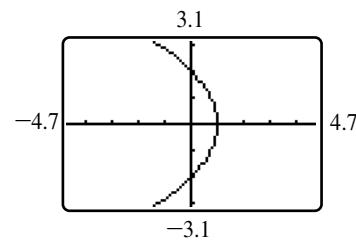
29. $y = \frac{1}{8}(x-2)^2 - 1$

**Exercises Section 9.7**

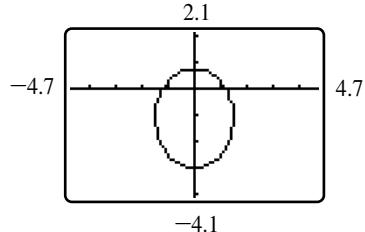
3. $r = \frac{1.2}{0.6 \cos \theta + 1}$



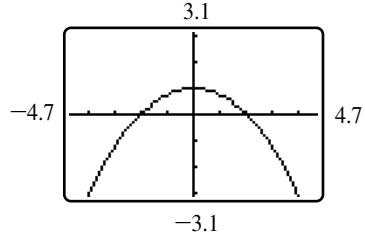
5. $r = \frac{2}{\cos \theta + 1}$



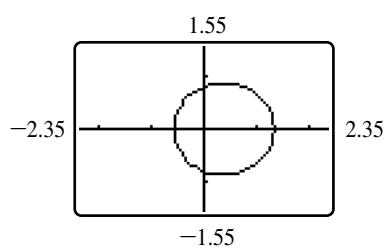
7. $r = \frac{1.2}{0.6 \sin \theta + 1}$



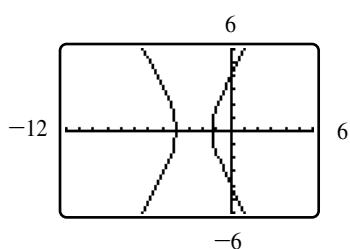
9. $r = \frac{2}{\sin \theta + 1}$



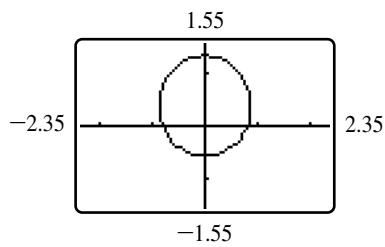
11. $r = \frac{-0.8}{0.4 \cos \theta - 1}$



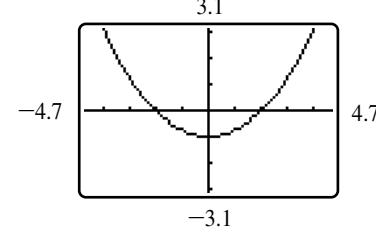
13. $r = \frac{-4}{2 \cos \theta - 1}$



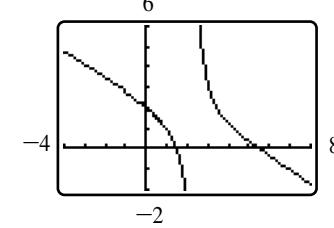
15. $r = \frac{-0.8}{0.4 \sin \theta - 1}$



17. $r = \frac{-2}{\sin \theta - 1}$

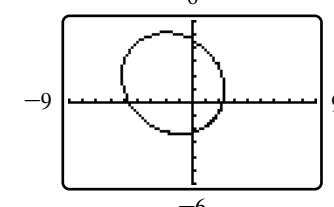


19.



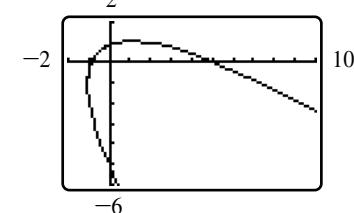
hyperbola rotated

21.



ellipse rotated

23.



parabola rotated

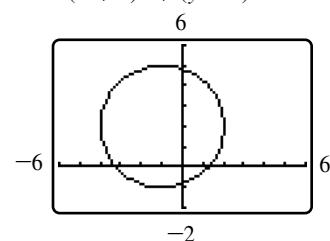
25. $x = -1 + 3 \cos t, y = 1 + 2 \sin t, 0 \leq t \leq 2\pi$

27. $x = -1 + 4 \cosh t, y = 3 \sinh t$ for the right half;
 $x = -1 - 4 \cosh t, y = 3 \sinh t$ for the left half.

29. $x = t, y = -\frac{1}{4}t^2 + 1$ 31. 2.6 times as fast

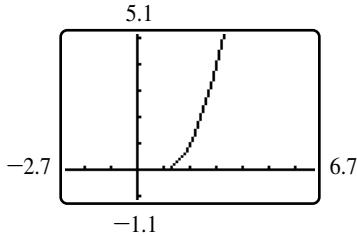
Chapter 9 Review Exercises

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

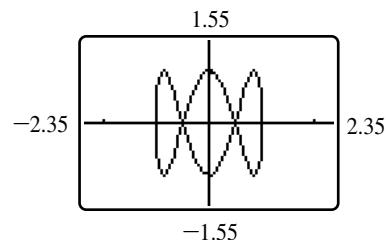


1234 Appendix B Answers to Odd-Numbered Exercises

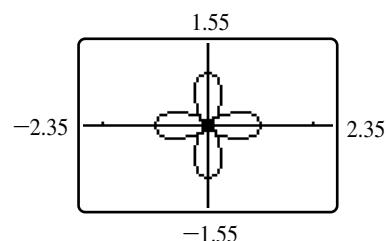
3. $y = x^2 - 2x + 1$



5.



7.



9. C 11. B 13. $x = 2 + 2t, y = 1 + 6t, 0 \leq t \leq 1$

15. (a) $\frac{1}{3}$ (b) undefined

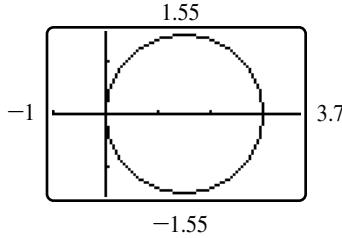
(c) undefined at $t = -1; \frac{1}{3}$ at $t = 2$

17. $x'(0) = -3, y'(0) = 2$, speed = $\sqrt{13}$, left/up

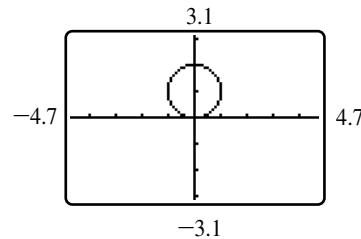
19. 6π 21. 1.9467 23. 5.249 25. 13.593

27. 128.075

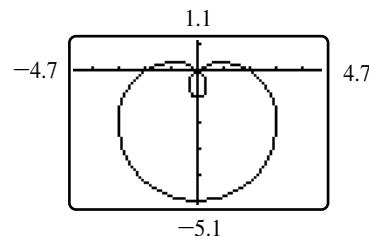
29. $x^2 + y^2 = 3x$



31.

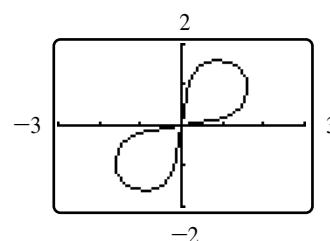
 $r = 0$ at $\theta = n\pi; 0 \leq \theta \leq \pi$

33.



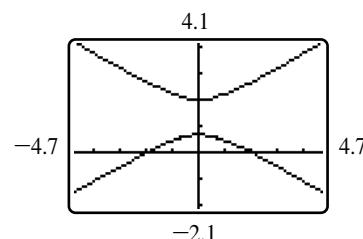
$$r = 0 \text{ at } \theta = \sin^{-1} \frac{2}{3} + 2\pi n, \pi - \sin^{-1} \frac{2}{3} + 2\pi n; \\ 0 \leq \theta \leq 2\pi$$

35.



$$r = 0 \text{ at } \theta = \frac{\pi}{2}n; 0 \leq \theta \leq \frac{\pi}{2}$$

37.



$$r \neq 0; 0 \leq \theta \leq 2\pi$$

$$\left(\theta \neq \frac{7\pi}{6}, \frac{11\pi}{6}\right)$$

39. $r = 3$ 41. $\frac{1}{\sqrt{3}}$

43. 0.157 45. 0.543

47. 2.828 49. 28.814

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

53. $\frac{(y-2)^2}{1} - \frac{(x-2)^2}{3} = 1$

55. ellipse, $(-1, -2)$ and $(-1, 8)$, $(-1, -1)$ and $(-1, 7)$

57. parabola, $(1, 4), \left(1, \frac{15}{4}\right), y = \frac{17}{4}$

59. $(0, \frac{1}{2})$

61. $r = \frac{2.4}{0.8 \cos \theta + 1}$

63. $r = \frac{2.8}{1.4 \sin \theta + 1}$

65. $x = -1 + 3 \cos t, y = 3 + 5 \sin t, 0 \leq t \leq 2\pi$