

# A

## Selected Answers

- 1.1.1.  $(2/3)x + (1/3)$   
 1.1.2.  $y = -2x$   
 1.1.3.  $(-2/3)x + (1/3)$   
 1.1.4.  $y = 2x + 2, 2, -1$   
 1.1.5.  $y = -x + 6, 6, 6$   
 1.1.6.  $y = x/2 + 1/2, 1/2, -1$   
 1.1.7.  $y = 3/2$ ,  $y$ -intercept:  $3/2$ , no  $x$ -intercept  
 1.1.8.  $y = (-2/3)x - 2, -2, -3$   
 1.1.9. yes  
 1.1.10.  $y = 0, y = -2x + 2, y = 2x + 2$   
 1.1.11.  $y = 75t$  ( $t$  in hours); 164 minutes  
 1.1.12.  $y = (9/5)x + 32, (-40, -40)$   
 1.1.13.  $y = 0.15x + 10$   
 1.1.14.  $0.03x + 1.2$   
 1.1.15. (a)  $y = \begin{cases} 0 & 0 \leq x < 100 \\ (x/10) - 10 & 100 \leq x \leq 1000 \\ x - 910 & 1000 < x \end{cases}$

- 1.1.16.  $y = \begin{cases} 0.15x & 0 \leq x \leq 19450 \\ 0.28x - 2528.50 & 19450 < x \leq 47050 \\ 0.33x - 4881 & 47050 < x \leq 97620 \end{cases}$   
 1.1.17. (a)  $P = -0.0001x + 2$   
 (b)  $x = -10000P + 20000$   
 1.1.18.  $(2/25)x - (16/5)$   
 1.2.1. (a)  $x^2 + y^2 = 9$   
 (b)  $(x - 5)^2 + (y - 6)^2 = 9$   
 (c)  $(x + 5)^2 + (y + 6)^2 = 9$   
 1.2.2. (a)  $\Delta x = 2, \Delta y = 3, m = 3/2,$   
 $y = (3/2)x - 3, \sqrt{13}$   
 (b)  $\Delta x = -1, \Delta y = 3, m = -3,$   
 $y = -3x + 2, \sqrt{10}$   
 (c)  $\Delta x = -2, \Delta y = -2, m = 1,$   
 $y = x, \sqrt{8}$   
 1.2.6.  $(x + 2/7)^2 + (y - 41/7)^2 = 1300/49$   
 1.3.1.  $\{x \mid x \geq 3/2\}$   
 1.3.2.  $\{x \mid x \neq -1\}$   
 1.3.3.  $\{x \mid x \neq 1 \text{ and } x \neq -1\}$   
 1.3.4.  $\{x \mid x < 0\}$   
 1.3.5.  $\{x \mid x \in \mathbb{R}\}$ , i.e., all  $x$

- 1.3.6.  $\{x \mid x \geq 0\}$   
 1.3.7.  $\{x \mid h - r \leq x \leq h + r\}$   
 1.3.8.  $\{x \mid x \geq 1 \text{ or } x < 0\}$   
 1.3.9.  $\{x \mid -1/3 < x < 1/3\}$   
 1.3.10.  $\{x \mid x \geq 0 \text{ and } x \neq 1\}$   
 1.3.11.  $\{x \mid x \geq 0 \text{ and } x \neq 1\}$   
 1.3.12.  $\mathbb{R}$   
 1.3.13.  $\{x \mid x \geq 3\}, \{x \mid x \geq 0\}$   
 1.3.14.  $A = x(500 - 2x), \{x \mid 0 \leq x \leq 250\}$   
 1.3.15.  $V = r(50 - \pi r^2), \{r \mid 0 < r \leq \sqrt{50/\pi}\}$   
 1.3.16.  $A = 2\pi r^2 + 2000/r, \{r \mid 0 < r < \infty\}$   
 2.1.1.  $-5, -2.47106145, -2.4067927,$   
 $-2.400676, -2.4$   
 2.1.2.  $-4/3, -24/7, 7/24, 3/4$   
 2.1.3.  $-0.107526881, -0.11074197,$   
 $-0.1110741, \frac{-1}{3(3 + \Delta x)} \rightarrow \frac{-1}{9}$   
 2.1.4.  $\frac{3 + 3\Delta x + \Delta x^2}{1 + \Delta x} \rightarrow 3$   
 2.1.5.  $3.31, 3.003001, 3.0000,$   
 $3 + 3\Delta x + \Delta x^2 \rightarrow 3$   
 2.1.6.  $m$   
 2.2.1.  $10, 25/2, 20, 15, 25, 35.$   
 2.2.2.  $5, 4.1, 4.01, 4.001, 4 + \Delta t \rightarrow 4$   
 2.2.3.  $-10.29, -9.849, -9.8049,$   
 $-9.8 - 4.9\Delta t \rightarrow -9.8$   
 2.3.1. 7  
 2.3.2. 5  
 2.3.3. 0  
 2.3.4. undefined  
 2.3.5.  $1/6$   
 2.3.6. 0  
 2.3.7. 3  
 2.3.8. 172  
 2.3.9. 0  
 2.3.10. 2  
 2.3.11. does not exist  
 2.3.12.  $\sqrt{2}$   
 2.3.13.  $3a^2$   
 2.3.14. 512  
 2.3.15.  $-4$   
 2.3.16. 0  
 2.3.18. (a) 8, (b) 6, (c) dne, (d)  $-2$ , (e)  $-1$ ,  
 (f) 8, (g) 7, (h) 6, (i) 3, (j)  $-3/2$ ,  
 (k) 6, (l) 2  
 2.4.1.  $-x/\sqrt{169 - x^2}$   
 2.4.2.  $-9.8t$   
 2.4.3.  $2x + 1/x^2$   
 2.4.4.  $2ax + b$   
 2.4.5.  $3x^2$   
 2.4.8.  $-2/(2x + 1)^{3/2}$   
 2.4.9.  $5/(t + 2)^2$   
 2.4.10.  $y = -13x + 17$   
 2.4.11.  $-8$   
 2.5.6.  $-0.5$  or  $1.3$  or  $3.2$   
 3.1.1.  $100x^{99}$   
 3.1.2.  $-100x^{-101}$   
 3.1.3.  $-5x^{-6}$   
 3.1.4.  $\pi x^{\pi-1}$   
 3.1.5.  $(3/4)x^{-1/4}$   
 3.1.6.  $-(9/7)x^{-16/7}$   
 3.2.1.  $15x^2 + 24x$   
 3.2.2.  $-20x^4 + 6x + 10/x^3$   
 3.2.3.  $-30x + 25$

- 3.2.4.  $6x^2 + 2x - 8$   
 3.2.5.  $3x^2 + 6x - 1$   
 3.2.6.  $9x^2 - x/\sqrt{625 - x^2}$   
 3.2.7.  $y = 13x/4 + 5$   
 3.2.8.  $y = 24x - 48 - \pi^3$   
 3.2.9.  $-49t/5 + 5, -49/5$   
 3.2.11.  $\sum_{k=1}^n ka_k x^{k-1}$   
 3.2.12.  $x^3/16 - 3x/4 + 4$   
 3.3.1.  $3x^2(x^3 - 5x + 10) + x^3(3x^2 - 5)$   
 3.3.2.  $(x^2 + 5x - 3)(5x^4 - 18x^2 + 6x - 7) + (2x + 5)(x^5 - 6x^3 + 3x^2 - 7x + 1)$   
 3.3.3.  $\frac{\sqrt{625 - x^2}}{2\sqrt{x}} - \frac{x\sqrt{x}}{\sqrt{625 - x^2}}$   
 3.3.4.  $\frac{-1}{x^{19}\sqrt{625 - x^2}} - \frac{20\sqrt{625 - x^2}}{x^{21}}$   
 3.3.5.  $f' = 4(2x - 3), y = 4x - 7$   
 3.4.1.  $\frac{3x^2}{x^3 - 5x + 10} - \frac{x^3(3x^2 - 5)}{(x^3 - 5x + 10)^2}$   
 3.4.2.  $\frac{2x + 5}{x^5 - 6x^3 + 3x^2 - 7x + 1} - \frac{(x^2 + 5x - 3)(5x^4 - 18x^2 + 6x - 7)}{(x^5 - 6x^3 + 3x^2 - 7x + 1)^2}$   
 3.4.3.  $\frac{1}{2\sqrt{x}\sqrt{625 - x^2}} + \frac{x^{3/2}}{(625 - x^2)^{3/2}}$   
 3.4.4.  $\frac{-1}{x^{19}\sqrt{625 - x^2}} - \frac{20\sqrt{625 - x^2}}{x^{21}}$   
 3.4.5.  $y = 17x/4 - 41/4$   
 3.4.6.  $y = 11x/16 - 15/16$   
 3.4.8.  $y = 19/169 - 5x/338$   
 3.4.9.  $13/18$   
 3.5.1.  $4x^3 - 9x^2 + x + 7$   
 3.5.2.  $3x^2 - 4x + 2/\sqrt{x}$   
 3.5.3.  $6(x^2 + 1)^2x$   
 3.5.4.  $\sqrt{169 - x^2} - x^2/\sqrt{169 - x^2}$   
 3.5.5.  $(2x - 4)\sqrt{25 - x^2} - (x^2 - 4x + 5)x/\sqrt{25 - x^2}$   
 3.5.6.  $-x/\sqrt{r^2 - x^2}$   
 3.5.7.  $2x^3/\sqrt{1 + x^4}$   
 3.5.8.  $\frac{1}{4\sqrt{x}(5 - \sqrt{x})^{3/2}}$   
 3.5.9.  $6 + 18x$   
 3.5.10.  $\frac{2x + 1}{1 - x} + \frac{x^2 + x + 1}{(1 - x)^2}$   
 3.5.11.  $-1/\sqrt{25 - x^2} - \sqrt{25 - x^2}/x^2$   
 3.5.12.  $\frac{1}{2} \left( \frac{-169}{x^2} - 1 \right) / \sqrt{\frac{169}{x} - x}$   
 3.5.13.  $\frac{3x^2 - 2x + 1/x^2}{2\sqrt{x^3 - x^2 - (1/x)}}$   
 3.5.14.  $\frac{300x}{(100 - x^2)^{5/2}}$   
 3.5.15.  $\frac{1 + 3x^2}{3(x + x^3)^{2/3}}$   
 3.5.16.  $\left( 4x(x^2 + 1) + \frac{4x^3 + 4x}{2\sqrt{1 + (x^2 + 1)^2}} \right) / 2\sqrt{(x^2 + 1)^2 + \sqrt{1 + (x^2 + 1)^2}}$   
 3.5.17.  $5(x + 8)^4$   
 3.5.18.  $-3(4 - x)^2$   
 3.5.19.  $6x(x^2 + 5)^2$   
 3.5.20.  $-12x(6 - 2x^2)^2$   
 3.5.21.  $24x^2(1 - 4x^3)^{-3}$   
 3.5.22.  $5 + 5/x^2$   
 3.5.23.  $-8(4x - 1)(2x^2 - x + 3)^{-3}$   
 3.5.24.  $1/(x + 1)^2$   
 3.5.25.  $3(8x - 2)/(4x^2 - 2x + 1)^2$   
 3.5.26.  $-3x^2 + 5x - 1$

- 3.5.27.  $6x(2x - 4)^3 + 6(3x^2 + 1)(2x - 4)^2$   
 3.5.28.  $-2/(x - 1)^2$   
 3.5.29.  $4x/(x^2 + 1)^2$   
 3.5.30.  $(x^2 - 6x + 7)/(x - 3)^2$   
 3.5.31.  $-5/(3x - 4)^2$   
 3.5.32.  $60x^4 + 72x^3 + 18x^2 + 18x - 6$   
 3.5.33.  $(5 - 4x)/((2x + 1)^2(x - 3)^2)$   
 3.5.34.  $1/(2(2 + 3x)^2)$   
 3.5.35.  $56x^6 + 72x^5 + 110x^4 + 100x^3 + 60x^2 + 28x + 6$   
 3.5.36.  $y = 23x/96 - 29/96$   
 3.5.37.  $y = 3 - 2x/3$   
 3.5.38.  $y = 13x/2 - 23/2$   
 3.5.39.  $y = 2x - 11$   
 3.5.40.  $y = \frac{20 + 2\sqrt{5}}{5\sqrt{4 + \sqrt{5}}}x + \frac{3\sqrt{5}}{5\sqrt{4 + \sqrt{5}}}$   
 4.1.1.  $2n\pi - \pi/2$ , any integer  $n$   
 4.1.2.  $n\pi \pm \pi/6$ , any integer  $n$   
 4.1.3.  $(\sqrt{2} + \sqrt{6})/4$   
 4.1.4.  $-(1 + \sqrt{3})/(1 - \sqrt{3}) = 2 + \sqrt{3}$   
 4.1.11.  $t = \pi/2$   
 4.3.1.  $5$   
 4.3.2.  $7/2$   
 4.3.3.  $3/4$   
 4.3.4.  $1$   
 4.3.5.  $-\sqrt{2}/2$   
 4.3.6.  $7$   
 4.3.7.  $2$   
 4.4.1.  $\sin(\sqrt{x})\cos(\sqrt{x})/\sqrt{x}$   
 4.4.2.  $\frac{\sin x}{2\sqrt{x}} + \sqrt{x}\cos x$   
 4.4.3.  $-\frac{\cos x}{\sin^2 x}$   
 4.4.4.  $\frac{(2x + 1)\sin x - (x^2 + x)\cos x}{\sin^2 x}$   
 4.4.5.  $\frac{-\sin x \cos x}{\sqrt{1 - \sin^2 x}}$   
 4.5.1.  $\cos^2 x - \sin^2 x$   
 4.5.2.  $-\sin x \cos(\cos x)$   
 4.5.3.  $\frac{\tan x + x \sec^2 x}{2\sqrt{x} \tan x}$   
 4.5.4.  $\frac{\sec^2 x(1 + \sin x) - \tan x \cos x}{(1 + \sin x)^2}$   
 4.5.5.  $-\csc^2 x$   
 4.5.6.  $-\csc x \cot x$   
 4.5.7.  $3x^2 \sin(23x^2) + 46x^4 \cos(23x^2)$   
 4.5.8.  $0$   
 4.5.9.  $-6 \cos(\cos(6x)) \sin(6x)$   
 4.5.10.  $\frac{\sec \theta \tan \theta}{(1 + \sec \theta)^2} = \frac{\sin \theta}{(\cos \theta + 1)^2}$   
 4.5.11.  $5t^4 \cos(6t) - 6t^5 \sin(6t)$   
 4.5.12.  $3t^2(\sin(3t) + t \cos(3t))/\cos(2t) + 2t^3 \sin(3t) \sin(2t)/\cos^2(2t)$   
 4.5.13.  $n\pi/2$ , any integer  $n$   
 4.5.14.  $\pi/2 + n\pi$ , any integer  $n$   
 4.5.15.  $y = \sqrt{3}x/2 + 3/4 - \sqrt{3}\pi/6$   
 4.5.16.  $y = 8\sqrt{3}x + 4 - 8\sqrt{3}\pi/3$   
 4.5.17.  $y = 3\sqrt{3}x/2 - \sqrt{3}\pi/4$   
 4.5.18.  $\pi/6 + 2n\pi, 5\pi/6 + 2n\pi$ , any integer  $n$   
 4.6.1.  $x/y$   
 4.6.2.  $-(2x + y)/(x + 2y)$   
 4.6.3.  $(2xy - 3x^2 - y^2)/(2xy - 3y^2 - x^2)$   
 4.6.4.  $\sin(x)\sin(y)/(\cos(x)\cos(y))$   
 4.6.5.  $-\sqrt{y}/\sqrt{x}$   
 4.6.6.  $(y \sec^2(x/y) - y^2)/(x \sec^2(x/y) + y^2)$

- 4.6.7.  $(y - \cos(x+y))/(\cos(x+y) - x)$     4.7.21. 1  
 4.6.8.  $-y^2/x^2$     4.7.22. 0  
 4.6.9. 1    4.7.23.  $\infty$   
 4.6.12.  $y = 2x \pm 6$     4.7.24.  $1/2$   
 4.6.13.  $y = x/2 \pm 3$     4.7.25. 0  
 4.6.14.  $(\sqrt{3}, 2\sqrt{3}), (-\sqrt{3}, -2\sqrt{3}),$   
 $(2\sqrt{3}, \sqrt{3}), (-2\sqrt{3}, -\sqrt{3})$     4.7.26.  $1/2$   
 4.6.15.  $y = 7x/\sqrt{3} - 8/\sqrt{3}$     4.7.27. 5  
 4.6.16.  $y = (-y_1^{1/3}x + y_1^{1/3}x_1 + x_1^{1/3}y_1)/x_1^{1/3}$     4.7.28.  $2\sqrt{2}$   
 4.6.17.  $(y - y_1) = \frac{(2x_1^3 + 2x_1y_1^2 - x_1)}{(2y_1^3 + 2y_1x_1^2 + y_1)}(x - x_1)$     4.7.29.  $-1/2$   
 4.7.1. 0    4.7.30. 2  
 4.7.2. 1    4.7.31. 0  
 4.7.3.  $1/6$     4.7.32.  $\infty$   
 4.7.4.  $-\infty$     4.7.33. 0  
 4.7.5.  $1/16$     4.7.34.  $3/2$   
 4.7.6.  $1/3$     4.7.35.  $\infty$   
 4.7.7. 0    4.7.36. 5  
 4.7.8.  $3/2$     4.7.37.  $-1/2$   
 4.7.9.  $-1/4$     4.7.38. does not exist  
 4.7.10.  $-3$     4.7.39.  $\infty$   
 4.7.11.  $1/2$     4.7.40.  $y = 1$  and  $y = -1$   
 4.7.12. 0    5.1.1. min at  $x = 1/2$   
 4.7.13.  $-1$     5.1.2. min at  $x = -1$ , max at  $x = 1$   
 4.7.14.  $-1/2$     5.1.3. max at  $x = 2$ , min at  $x = 4$   
 4.7.15. 5    5.1.4. min at  $x = \pm 1$ , max at  $x = 0$ .  
 4.7.16.  $\infty$     5.1.5. min at  $x = 1$   
 4.7.17.  $\infty$     5.1.6. none  
 4.7.18.  $2/7$     5.1.7. none  
 4.7.19. 2    5.1.8. min at  $x = 7\pi/12 + k\pi$ , max at  
 $x = -\pi/12 + k\pi$ , for integer  $k$ .  
 4.7.20.  $-\infty$     5.1.9. none  
 5.1.10. local max at  $x = 5$   
 5.1.11. local min at  $x = 49$

- 5.1.12. local min at  $x = 0$     5.3.15. none  
 5.1.15. one    5.3.16. min at  $n\pi$   
 5.2.1. min at  $x = 1/2$     5.3.17. max at  $n\pi$ , min at  $\pi/2 + n\pi$   
 5.2.2. min at  $x = -1$ , max at  $x = 1$     5.3.18. max at  $\pi/2 + 2n\pi$ , min at  $3\pi/2 + 2n\pi$   
 5.2.3. max at  $x = 2$ , min at  $x = 4$     5.4.1. concave up everywhere  
 5.2.4. min at  $x = \pm 1$ , max at  $x = 0$ .    5.4.2. concave up when  $x < 0$ , concave  
 down when  $x > 0$   
 5.2.5. min at  $x = 1$     5.4.3. concave down when  $x < 3$ , concave  
 up when  $x > 3$   
 5.2.6. none    5.4.4. concave up when  $x < -1/\sqrt{3}$  or  
 $x > 1/\sqrt{3}$ , concave down when  
 $-1/\sqrt{3} < x < 1/\sqrt{3}$   
 5.2.7. none    5.4.5. concave up when  $x < 0$  or  $x > 2/3$ ,  
 concave down when  $0 < x < 2/3$   
 5.2.8. min at  $x = 7\pi/12 + k\pi$ , max at  
 $x = -\pi/12 + k\pi$ , for integer  $k$ .    5.4.6. concave up when  $x < 0$ , concave  
 down when  $x > 0$   
 5.2.9. none    5.4.7. concave up when  $x < -1$  or  $x > 1$ ,  
 concave down when  $-1 < x < 0$  or  
 $0 < x < 1$   
 5.2.10. max at  $x = 0$ , min at  $x = \pm 11$     5.4.8. concave down on  $((8n-1)\pi/4, (8n+3)\pi/4)$ ,  
 concave up on  $((8n+3)\pi/4, (8n+7)\pi/4)$ , for integer  $n$   
 5.2.11. min at  $x = -3/2$ , neither at  $x = 0$     5.4.9. concave down everywhere  
 5.2.13. min at  $n\pi$ , max at  $\pi/2 + n\pi$     5.4.10. concave up on  $(-\infty, (21 - \sqrt{497})/4)$   
 and  $(21 + \sqrt{497})/4, \infty)$   
 5.2.14. min at  $2n\pi$ , max at  $(2n+1)\pi$     5.4.11. concave up on  $(0, \infty)$   
 5.2.15. min at  $\pi/2 + 2n\pi$ , max at  $3\pi/2 + 2n\pi$     5.4.12. concave down on  $(2n\pi/3, (2n+1)\pi/3)$   
 5.3.1. min at  $x = 1/2$     5.4.13. concave up on  $(0, \infty)$   
 5.3.2. min at  $x = -1$ , max at  $x = 1$     5.4.14. concave up on  $(-\infty, -1)$  and  $(0, \infty)$   
 5.3.3. max at  $x = 2$ , min at  $x = 4$     5.4.15. concave down everywhere  
 5.3.4. min at  $x = \pm 1$ , max at  $x = 0$ .    5.4.16. concave up everywhere  
 5.3.5. min at  $x = 1$     5.4.17. concave up on  $(\pi/4 + n\pi, 3\pi/4 + n\pi)$   
 5.3.6. none  
 5.3.7. none  
 5.3.8. min at  $x = 7\pi/12 + n\pi$ , max at  
 $x = -\pi/12 + n\pi$ , for integer  $n$ .  
 5.3.9. max at  $x = 63/64$   
 5.3.10. max at  $x = 7$   
 5.3.11. max at  $-5^{-1/4}$ , min at  $5^{-1/4}$   
 5.3.12. none  
 5.3.13. max at  $-1$ , min at  $1$   
 5.3.14. min at  $2^{-1/3}$

- 5.4.18. inflection points at  $n\pi$ ,  $\pm \arcsin(\sqrt{2/3}) + n\pi$
- 5.4.19. up/incr:  $(3, \infty)$ , up/decr:  $(-\infty, 0)$ ,  $(2, 3)$ , down/decr:  $(0, 2)$
- 6.1.1. max at  $(2, 5)$ , min at  $(0, 1)$
- 6.1.2.  $25 \times 25$
- 6.1.3.  $P/4 \times P/4$
- 6.1.4.  $w = l = 2 \cdot 5^{2/3}$ ,  $h = 5^{2/3}$ ,  $h/w = 1/2$
- 6.1.5.  $\sqrt[3]{100} \times \sqrt[3]{100} \times 2\sqrt[3]{100}$ ,  $h/s = 2$
- 6.1.6.  $w = l = 2^{1/3}V^{1/3}$ ,  $h = V^{1/3}/2^{2/3}$ ,  $h/w = 1/2$
- 6.1.7. 1250 square feet
- 6.1.8.  $l^2/8$  square feet
- 6.1.9. \$5000
- 6.1.10. 100
- 6.1.11.  $r^2$
- 6.1.12.  $h/r = 2$
- 6.1.13.  $h/r = 2$
- 6.1.14.  $r = 5$  cm,  $h = 40/\pi$  cm,  $h/r = 8/\pi$
- 6.1.15.  $8/\pi$
- 6.1.16.  $4/27$
- 6.1.17. Go direct from  $A$  to  $D$ .
- 6.1.18. (a) 2, (b)  $7/2$
- 6.1.19.  $\frac{\sqrt{3}}{6} \times \frac{\sqrt{3}}{6} + \frac{1}{2} \times \frac{1}{4} - \frac{\sqrt{3}}{12}$
- 6.1.20. (a)  $a/6$ , (b)  $(a + b - \sqrt{a^2 - ab + b^2})/6$
- 6.1.21. 1.5 meters wide by 1.25 meters tall
- 6.1.22. If  $k \leq 2/\pi$  the ratio is  $(2 - k\pi)/4$ ; if  $k \geq 2/\pi$ , the ratio is zero: the window should be semicircular with no rectangular part.
- 6.1.23.  $a/b$
- 6.1.24.  $w = 2r/\sqrt{3}$ ,  $h = 2\sqrt{2}r/\sqrt{3}$
- 6.1.25.  $1/\sqrt{3} \approx 58\%$
- 6.1.26.  $18 \times 18 \times 36$
- 6.1.27.  $r = 5/(2\pi)^{1/3} \approx 2.7$  cm,  
 $h = 5 \cdot 2^{5/3}/\pi^{1/3} = 4r \approx 10.8$  cm
- 6.1.28.  $h = \frac{750}{\pi} \left( \frac{2\pi^2}{750^2} \right)^{1/3}$ ,  $r = \left( \frac{750^2}{2\pi^2} \right)^{1/6}$
- 6.1.29.  $h/r = \sqrt{2}$
- 6.1.30. The ratio of the volume of the sphere to the volume of the cone is  $1033/4096 + 33/4096\sqrt{17} \approx 0.2854$ , so the cone occupies approximately 28.54% of the sphere.
- 6.1.31.  $P$  should be at distance  $c\sqrt[3]{a}/(\sqrt[3]{a} + \sqrt[3]{b})$  from charge  $A$ .
- 6.1.32.  $1/2$
- 6.1.33. \$7000
- 6.1.34. There is a critical point when  $\sin\theta_1/v_1 = \sin\theta_2/v_2$ , and the second derivative is positive, so there is a minimum at the critical point.
- 6.2.1.  $1/(16\pi)$  cm/s
- 6.2.2.  $3/(1000\pi)$  meters/second
- 6.2.3.  $1/4$  m/s
- 6.2.4.  $6/25$  m/s
- 6.2.5.  $80\pi$  mi/min
- 6.2.6.  $3\sqrt{5}$  ft/s
- 6.2.7.  $20/(3\pi)$  cm/s
- 6.2.8.  $13/20$  ft/s

- 6.2.9.  $5\sqrt{10}/2$  m/s
- 6.2.10.  $75/64$  m/min
- 6.2.11.  $145\pi/72$  m/s
- 6.2.12.  $25\pi/144$  m/min
- 6.2.13.  $\pi\sqrt{2}/36$  ft<sup>3</sup>/s
- 6.2.14. tip: 6 ft/s, length: 5/2 ft/s
- 6.2.15. tip: 20/11 m/s, length: 9/11 m/s
- 6.2.16.  $380/\sqrt{3} - 150 \approx 69.4$  mph
- 6.2.17.  $500/\sqrt{3} - 200 \approx 88.7$  km/hr
- 6.2.18. 18 m/s
- 6.2.19.  $136\sqrt{475}/19 \approx 156$  km/hr
- 6.2.20.  $-50$  m/s
- 6.2.21. 68 m/s
- 6.2.22.  $3800/\sqrt{329} \approx 210$  km/hr
- 6.2.23.  $820/\sqrt{329} + 150\sqrt{57}/\sqrt{47} \approx 210$  km/hr
- 6.2.24. 4000/49 m/s
- 6.2.25. (a)  $x = a \cos\theta - a \sin\theta \cot(\theta + \beta) = a \sin\beta/\sin(\theta + \beta)$ , (c)  $\dot{x} \approx 3.79$  cm/s
- 6.3.1.  $x_3 = 1.475773162$
- 6.3.2. 2.15
- 6.3.3. 3.36
- 6.3.4. 2.19 or 1.26
- 6.4.1.  $\Delta y = 65/16$ ,  $dy = 2$
- 6.4.2.  $\Delta y = \sqrt{11/10} - 1$ ,  $dy = 0.05$
- 6.4.3.  $\Delta y = \sin(\pi/50)$ ,  $dy = \pi/50$
- 6.4.4.  $dV = 8\pi/25$
- 6.5.1.  $c = 1/2$
- 6.5.2.  $c = \sqrt{18} - 2$
- 6.5.6.  $x^3/3 + 47x^2/2 - 5x + k$
- 6.5.7.  $-\cos(2x)/2 + k$
- 7.1.1. 10
- 7.1.2.  $35/3$
- 7.1.3.  $x^2$
- 7.1.4.  $2x^2$
- 7.1.5.  $2x^2 - 8$
- 7.1.6.  $2b^2 - 2a^2$
- 7.1.7. 4 rectangles:  $41/4 = 10.25$ ,  
8 rectangles:  $183/16 = 11.4375$
- 7.1.8.  $23/4$
- 7.2.1.  $(16/3)x^{3/2} + C$
- 7.2.2.  $t^3 + t + C$
- 7.2.3.  $8\sqrt{x} + C$
- 7.2.4.  $-2/z + C$
- 7.2.5.  $(5x + 1)^3/15 + C$
- 7.2.6.  $(x - 6)^3/3 + C$
- 7.2.7.  $2x^{5/2}/5 + C$
- 7.2.8.  $-4/\sqrt{x} + C$
- 7.2.9.  $4t - t^2 + C$ ,  $t < 2$ ;  $t^2 - 4t + 8 + C$ ,  
 $t \geq 2$
- 7.2.10.  $87/2$
- 7.2.11. 2
- 7.2.12.  $3^4/4$
- 7.2.13.  $2^6/6 - 1/6$
- 7.2.14.  $x^2 - 3x$
- 7.2.15.  $2x(x^4 - 3x^2)$
- 7.2.16.  $\tan(x^2)$
- 7.2.17.  $2x \tan(x^4)$
- 7.3.1. It rises until  $t = 100/49$ , then falls. The position of the object at time  $t$  is  $s(t) = -4.9t^2 + 20t + k$ . The net distance traveled is  $-45/2$ , that is, it ends up  $45/2$  meters below where it started. The total distance traveled is  $6205/98$  meters.

- 7.3.2.  $\int_0^{2\pi} \sin t \, dt = 0$   
 7.3.3. net:  $2\pi$ , total:  $2\pi/3 + 4\sqrt{3}$   
 7.3.4. 8  
 7.3.5.  $17/3$   
 7.3.6.  $A = 18$ ,  $B = 44/3$ ,  $C = 10/3$   
 7.4.1.  $-(1-t)^{10}/10 + C$   
 7.4.2.  $x^5/5 + 2x^3/3 + x + C$   
 7.4.3.  $(x^2 + 1)^{101}/202 + C$   
 7.4.4.  $-3(1-5t)^{2/3}/10 + C$   
 7.4.5.  $(\sin^4 x)/4 + C$   
 7.4.6.  $-(100 - x^2)^{3/2}/3 + C$   
 7.4.7.  $-2\sqrt{1-x^3}/3 + C$   
 7.4.8.  $\sin(\sin \pi t)/\pi + C$   
 7.4.9.  $1/(2 \cos^2 x) = (1/2) \sec^2 x + C$   
 7.4.10.  $-\ln |\cos x| + C$   
 7.4.11. 0  
 7.4.12.  $\tan^2(x)/2 + C$   
 7.4.13.  $1/4$   
 7.4.14.  $-\cos(\tan x) + C$   
 7.4.15.  $1/10$   
 7.4.16.  $\sqrt{3}/4$   
 7.4.17.  $(27/8)(x^2 - 7)^{8/9} + C$   
 7.4.18.  $-(3^7 + 1)/14$   
 7.4.19. 0  
 7.4.20.  $f(x)^2/2$   
 8.1.1.  $8\sqrt{2}/15$   
 8.1.2.  $1/12$   
 8.1.3.  $9/2$   
 8.1.4.  $4/3$   
 8.1.5.  $2/3 - 2/\pi$   
 8.1.6.  $3/\pi - 3\sqrt{3}/(2\pi) - 1/8$

- 8.1.7.  $1/3$   
 8.1.8.  $10\sqrt{5}/3 - 6$   
 8.1.9.  $500/3$   
 8.1.10. 2  
 8.1.11.  $1/5$   
 8.1.12.  $1/6$   
 8.2.1.  $1/\pi$ ,  $5/\pi$   
 8.2.2. 0, 245  
 8.2.3. 20, 28  
 8.2.4.  $(3 - \pi)/(2\pi)$ ,  $(18 - 12\sqrt{3} + \pi)/(4\pi)$   
 8.2.5. 10/49 meters, 20/49 seconds  
 8.2.6. 45/98 meters, 30/49 seconds  
 8.2.7. 25000/49 meters, 1000/49 seconds  
 8.2.8.  $s(t) = \cos t$ ,  $v(t) = -\sin t$ ,  
 maximum distance is 1,  
 maximum speed is 1  
 8.2.9.  $s(t) = -\sin(\pi t)/\pi^2 + t/\pi$ ,  
 $v(t) = -\cos(\pi t)/\pi + 1/\pi$ ,  
 maximum speed is  $2/\pi$   
 8.2.10.  $s(t) = t^2/2 - \sin(\pi t)/\pi^2 + t/\pi$ ,  
 $v(t) = t - \cos(\pi t)/\pi + 1/\pi$   
 8.2.11.  $s(t) = t^2/2 + \sin(\pi t)/\pi^2 - t/\pi$ ,  
 $v(t) = t + \cos(\pi t)/\pi - 1/\pi$   
 8.3.5.  $8\pi/3$   
 8.3.6.  $\pi/30$   
 8.3.7.  $\pi(\pi/2 - 1)$   
 8.3.8. (a)  $114\pi/5$  (b)  $74\pi/5$  (c)  $20\pi$   
 (d)  $4\pi$   
 8.3.9.  $16\pi$ ,  $24\pi$   
 8.3.11.  $\pi h^2(3r - h)/3$   
 8.3.13.  $2\pi$   
 8.4.1.  $2/\pi$ ;  $2/\pi$ ; 0

- 8.4.2.  $4/3$   
 8.4.3.  $1/A$   
 8.4.4.  $\pi/4$   
 8.4.5.  $-1/3$ , 1  
 8.4.6.  $-4\sqrt{1224}$  ft/s;  $-8\sqrt{1224}$  ft/s  
 8.5.1.  $\approx 5, 305, 028, 516$  N-m  
 8.5.2.  $\approx 4, 457, 854, 041$  N-m  
 8.5.3.  $367, 500\pi$  N-m  
 8.5.4.  $49000\pi + 196000/3$  N-m  
 8.5.5.  $2450\pi$  N-m  
 8.5.6. 0.05 N-m  
 8.5.7.  $6/5$  N-m  
 8.5.8. 3920 N-m  
 8.5.9. 23520 N-m  
 8.5.10. 12740 N-m  
 9.5.3.  $\frac{-1}{1+x^2}$   
 9.5.5.  $\frac{2x}{\sqrt{1-x^4}}$   
 9.5.6.  $\frac{e^x}{1+e^{2x}}$   
 9.5.7.  $-3x^2 \cos(x^3)/\sqrt{1-\sin^2(x^3)}$   
 9.5.8.  $\frac{2}{(\arcsin x)\sqrt{1-x^2}}$   
 9.5.9.  $-e^x/\sqrt{1-e^{2x}}$   
 9.5.10. 0  
 9.5.11.  $\frac{(1+\ln x)x^x}{\ln 5(1+x^{2x}) \arctan(x^x)}$   
 10.1.1.  $x/2 - \sin(2x)/4 + C$   
 10.1.2.  $-\cos x + (\cos^3 x)/3 + C$   
 10.1.3.  $3x/8 - (\sin 2x)/4 + (\sin 4x)/32 + C$   
 10.1.4.  $(\cos^5 x)/5 - (\cos^3 x)/3 + C$   
 10.1.5.  $\sin x - (\sin^3 x)/3 + C$   
 10.1.6.  $x/8 - (\sin 4x)/32 + C$   
 10.1.7.  $(\sin^3 x)/3 - (\sin^5 x)/5 + C$   
 10.1.8.  $-2(\cos x)^{5/2}/5 + C$   
 10.1.9.  $\tan x - \cot x + C$   
 10.1.10.  $(\sec^3 x)/3 - \sec x + C$   
 10.2.1.  $-\ln |\csc x + \cot x| + C$   
 10.2.2.  $-\csc x \cot x/2 - (1/2) \ln |\csc x + \cot x| + C$   
 10.2.3.  $x\sqrt{x^2-1}/2 - \ln |x + \sqrt{x^2-1}|/2 + C$   
 10.2.4.  $x\sqrt{9+4x^2}/2 + (9/4) \ln |2x + \sqrt{9+4x^2}| + C$   
 10.2.5.  $-(1-x^2)^{3/2}/3 + C$   
 10.2.6.  $\arcsin(x)/8 - \sin(4 \arcsin x)/32 + C$   
 10.2.7.  $\ln |x + \sqrt{1+x^2}| + C$   
 10.2.8.  $(x+1)\sqrt{x^2+2x}/2 - \ln |x+1 + \sqrt{x^2+2x}|/2 + C$   
 10.2.9.  $-\arctan x - 1/x + C$   
 10.2.10.  $2 \arcsin(x/2) - x\sqrt{4-x^2}/2 + C$   
 10.2.11.  $\arcsin(\sqrt{x}) - \sqrt{x}\sqrt{1-x} + C$   
 10.2.12.  $(2x^2+1)\sqrt{4x^2-1}/24 + C$   
 10.3.1.  $\cos x + x \sin x + C$   
 10.3.2.  $x^2 \sin x - 2 \sin x + 2x \cos x + C$   
 10.3.3.  $(x-1)e^x + C$   
 10.3.4.  $(1/2)e^{x^2} + C$   
 10.3.5.  $(x/2) - \sin(2x)/4 + C = (x/2) - (\sin x \cos x)/2 + C$   
 10.3.6.  $x \ln x - x + C$   
 10.3.7.  $(x^2 \arctan x + \arctan x - x)/2 + C$   
 10.3.8.  $-x^3 \cos x + 3x^2 \sin x + 6x \cos x - 6 \sin x + C$   
 10.3.9.  $x^3 \sin x + 3x^2 \cos x - 6x \sin x - 6 \cos x + C$

- 10.3.10.  $x^2/4 - (\cos^2 x)/4 - (x \sin x \cos x)/2 + C$
- 10.3.11.  $x/4 - (x \cos^2 x)/2 + (\cos x \sin x)/4 + C$
- 10.3.12.  $x \arctan(\sqrt{x}) + \arctan(\sqrt{x}) - \sqrt{x} + C$
- 10.3.13.  $2 \sin(\sqrt{x}) - 2\sqrt{x} \cos(\sqrt{x}) + C$
- 10.3.14.  $\sec x \csc x - 2 \cot x + C$
- 10.4.1.  $-\ln|x-2|/4 + \ln|x+2|/4 + C$
- 10.4.2.  $-x^3/3 - 4x - 4 \ln|x-2| + 4 \ln|x+2| + C$
- 10.4.3.  $-1/(x+5) + C$
- 10.4.4.  $-x - \ln|x-2| + \ln|x+2| + C$
- 10.4.5.  $-4x + x^3/3 + 8 \arctan(x/2) + C$
- 10.4.6.  $(1/2) \arctan(x/2 + 5/2) + C$
- 10.4.7.  $x^2/2 - 2 \ln(4+x^2) + C$
- 10.4.8.  $(1/4) \ln|x+3| - (1/4) \ln|x+7| + C$
- 10.4.9.  $(1/5) \ln|2x-3| - (1/5) \ln|1+x| + C$
- 10.4.10.  $(1/3) \ln|x| - (1/3) \ln|x+3| + C$
- 10.5.1. T, S:  $4 \pm 0$
- 10.5.2. T:  $9.28125 \pm 0.281125$ ; S:  $9 \pm 0$
- 10.5.3. T:  $60.75 \pm 1$ ; S:  $60 \pm 0$
- 10.5.4. T:  $1.1167 \pm 0.0833$ ; S:  $1.1000 \pm 0.0167$
- 10.5.5. T:  $0.3235 \pm 0.0026$ ; S:  $0.3217 \pm 0.000065$
- 10.5.6. T:  $0.6478 \pm 0.0052$ ; S:  $0.6438 \pm 0.000033$
- 10.5.7. T:  $2.8833 \pm 0.0834$ ; S:  $2.9000 \pm 0.0167$
- 10.5.8. T:  $1.1170 \pm 0.0077$ ; S:  $1.1114 \pm 0.0002$
- 10.5.9. T:  $1.097 \pm 0.0147$ ; S:  $1.089 \pm 0.0003$
- 10.5.10. T:  $3.63 \pm 0.087$ ; S:  $3.62 \pm 0.032$
- 10.6.1.  $\frac{(t+4)^4}{4} + C$
- 10.6.2.  $\frac{(t^2-9)^{5/2}}{5} + C$
- 10.6.3.  $\frac{(e^t+16)^2}{4} + C$
- 10.6.4.  $\cos t - \frac{2}{3} \cos^3 t + C$
- 10.6.5.  $\frac{\tan^2 t}{2} + C$
- 10.6.6.  $\ln|t^2+t+3| + C$
- 10.6.7.  $\frac{1}{8} \ln|1-4/t^2| + C$
- 10.6.8.  $\frac{1}{25} \tan(\arcsin(t/5)) + C = \frac{t}{25\sqrt{25-t^2}} + C$
- 10.6.9.  $\frac{2}{3} \sqrt{\sin 3t} + C$
- 10.6.10.  $t \tan t + \ln|\cos t| + C$
- 10.6.11.  $2\sqrt{e^t+1} + C$
- 10.6.12.  $\frac{3t}{8} + \frac{\sin 2t}{4} + \frac{\sin 4t}{32} + C$
- 10.6.13.  $\frac{\ln|t|}{3} - \frac{\ln|t+3|}{3} + C$
- 10.6.14.  $\frac{-1}{\sin \arctan t} + C = -\sqrt{1+t^2}/t + C$
- 10.6.15.  $\frac{-1}{2(1+\tan t)^2} + C$
- 10.6.16.  $\frac{(t^2+1)^{5/2}}{5} - \frac{(t^2+1)^{3/2}}{3} + C$
- 10.6.17.  $\frac{e^t \sin t - e^t \cos t}{2} + C$
- 10.6.18.  $\frac{(t^{3/2}+47)^4}{6} + C$
- 10.6.19.  $\frac{2}{3(2-t^2)^{3/2}} - \frac{1}{(2-t^2)^{1/2}} + C$
- 10.6.20.  $\frac{\ln|\sin(\arctan(2t/3))|}{9} + C = \frac{\ln(4t^2) - \ln(9+4t^2)}{18} + C$
- 10.6.21.  $\frac{(\arctan(2t))^2}{4} + C$

- 10.6.22.  $\frac{3 \ln|t+3|}{4} + \frac{\ln|t-1|}{4} + C$
- 10.6.23.  $\frac{\cos^7 t}{7} - \frac{\cos^5 t}{5} + C$
- 10.6.24.  $\frac{-1}{t-3} + C$
- 10.6.25.  $\frac{-1}{\ln t} + C$
- 10.6.26.  $\frac{t^2(\ln t)^2}{2} - \frac{t^2 \ln t}{2} + \frac{t^2}{4} + C$
- 10.6.27.  $(t^3 - 3t^2 + 6t - 6)e^t + C$
- 10.6.28.  $\frac{5+\sqrt{5}}{10} \ln(2t+1-\sqrt{5}) + \frac{5-\sqrt{5}}{10} \ln(2t+1+\sqrt{5}) + C$
- 11.1.1. 15/2
- 11.1.2. 5
- 11.1.3. 16/5
- 11.1.5.  $\bar{x} = 45/28, \bar{y} = 93/70$
- 11.1.6.  $\bar{x} = 0, \bar{y} = 4/(3\pi)$
- 11.1.7.  $\bar{x} = 1/2, \bar{y} = 2/5$
- 11.1.8.  $\bar{x} = 0, \bar{y} = 8/5$
- 11.1.9.  $\bar{x} = 4/7, \bar{y} = 2/5$
- 11.1.10.  $\bar{x} = \bar{y} = 1/5$
- 11.1.11.  $\bar{x} = 0, \bar{y} = 28/(9\pi)$
- 11.1.12.  $\bar{x} = \bar{y} = 28/(9\pi)$
- 11.1.13.  $\bar{x} = 0, \bar{y} = 244/(27\pi) \approx 2.88$
- 11.2.1.  $\infty$
- 11.2.2. 1/2
- 11.2.3. diverges
- 11.2.4. diverges
- 11.2.5. 1
- 11.2.6. diverges
- 11.2.7. 2
- 11.2.8. diverges
- 11.2.9.  $\pi/6$
- 11.2.10. diverges, 0
- 11.2.11. diverges, 0
- 11.2.12. diverges, no CPV
- 11.2.13.  $\pi$
- 11.2.14. 80 mph: 90.8 to 95.3 N-m  
90 mph: 114.9 to 120.6 N-m  
100.9 mph: 144.5 to 151.6 N-m
- 11.3.2.  $\mu = 1/c, \sigma = 1/c$
- 11.3.3.  $\mu = (a+b)/2, \sigma = \frac{(b-a)}{2\sqrt{3}}$
- 11.3.4. 7/2
- 11.3.5. 21/2
- 11.3.9.  $r = 6$
- 11.4.1.  $(22\sqrt{22} - 8)/27$
- 11.4.2.  $\ln(2) + 3/8$
- 11.4.3.  $a + a^3/3$
- 11.4.4.  $\ln((\sqrt{2}+1)/\sqrt{3})$
- 11.4.6. 3/4
- 11.4.7.  $\approx 3.82$
- 11.4.8.  $\approx 1.01$
- 11.4.9.  $\sqrt{1+e^2} - \sqrt{2} + 1 - \ln(\sqrt{1+e^2} + 1) + \ln(\sqrt{2}+1)$
- 11.5.1.  $8\pi\sqrt{3} - \frac{16\pi\sqrt{2}}{3}$
- 11.5.3.  $\frac{730\pi\sqrt{730}}{27} - \frac{10\pi\sqrt{10}}{27}$
- 11.5.4.  $\pi + 2\pi e + \frac{1}{4}\pi e^2 - \frac{\pi}{4e^2} - \frac{2\pi}{e}$
- 11.5.6.  $8\pi^2$
- 11.5.7.  $2\pi + \frac{8\pi^2}{3\sqrt{3}}$

11.5.8.  $a > b$ :  $\frac{2\pi b^2 + 2\pi a^2 b}{\sqrt{a^2 - b^2}} \arcsin(\sqrt{a^2 - b^2}/a)$ ,  
 $a < b$ :  $\frac{2\pi b^2 + 2\pi a^2 b}{\sqrt{b^2 - a^2}} \ln\left(\frac{b}{a} + \frac{\sqrt{b^2 - a^2}}{a}\right)$

12.1.2.  $\theta = \arctan(3)$

12.1.3.  $r = -4 \csc \theta$

12.1.4.  $r^3 \cos \theta \sin^2 \theta = 1$

12.1.5.  $r = \sqrt{5}$

12.1.6.  $r^2 = \sin \theta \sec^3 \theta$

12.1.7.  $r \sin \theta = \sin(r \cos \theta)$

12.1.8.  $r = 2/(\sin \theta - 5 \cos \theta)$

12.1.9.  $r = 2 \sec \theta$

12.1.10.  $0 = r^2 \cos^2 \theta - r \sin \theta + 1$

12.1.11.  $0 = 3r^2 \cos^2 \theta - 2r \cos \theta - r \sin \theta$

12.1.12.  $r = \sin \theta$

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

12.1.22.  $(x^2 + y^2)^{3/2} = y^2$

12.1.23.  $x^2 + y^2 = x^2y^2$

12.1.24.  $x^4 + x^2y^2 = y^2$

12.2.1.  $(\theta \cos \theta + \sin \theta)/(-\theta \sin \theta + \cos \theta)$ ,  
 $(\theta^2 + 2)/(-\theta \sin \theta + \cos \theta)^3$

12.2.2.  $\frac{\cos \theta + 2 \sin \theta \cos \theta}{\cos^2 \theta - \sin^2 \theta - \sin \theta}$ ,  
 $\frac{3(1 + \sin \theta)}{(\cos^2 \theta - \sin^2 \theta - \sin \theta)^3}$

12.2.3.  $(\sin^2 \theta - \cos^2 \theta)/(2 \sin \theta \cos \theta)$ ,  
 $-1/(4 \sin^3 \theta \cos^3 \theta)$

12.2.4.  $\frac{2 \sin \theta \cos \theta}{\cos^2 \theta - \sin^2 \theta}$ ,  $\frac{2}{(\cos^2 \theta - \sin^2 \theta)^3}$

12.2.5. undefined

12.2.6.  $\frac{2 \sin \theta - 3 \sin^3 \theta}{3 \cos^3 \theta - 2 \cos \theta}$ ,  
 $\frac{3 \cos^4 \theta - 3 \cos^2 \theta + 2}{2 \cos^3 \theta (3 \cos^2 \theta - 2)^3}$

12.3.1. 1

12.3.2.  $9\pi/2$

12.3.3.  $\sqrt{3}/3$

12.3.4.  $\pi/12 + \sqrt{3}/16$

12.3.5.  $\pi a^2$

12.3.6.  $41\pi/2$

12.3.7.  $2 - \pi/2$

12.3.8.  $\pi/12$

12.3.9.  $3\pi/16$

12.3.10.  $\pi/4 - 3\sqrt{3}/8$

12.3.11.  $\pi/2 + 3\sqrt{3}/8$

12.3.12.  $1/2$

12.3.13.  $3/2 - \pi/4$

12.3.14.  $\pi/3 + \sqrt{3}/2$

12.3.15.  $\pi/3 - \sqrt{3}/4$

12.3.16.  $4\pi^3/3$

12.3.17.  $\pi^2$

12.3.18.  $5\pi/24 - \sqrt{3}/4$

12.3.19.  $7\pi/12 - \sqrt{3}$

12.3.20.  $4\pi - \sqrt{15}/2 - 7 \arccos(1/4)$

12.3.21.  $3\pi^3$

12.4.6.  $x = t - \frac{\sin(t)}{2}$ ,  $y = 1 - \frac{\cos(t)}{2}$

12.4.7.  $x = 4 \cos t - \cos(4t)$ ,  
 $y = 4 \sin t - \sin(4t)$

12.4.8.  $x = 2 \cos t + \cos(2t)$ ,  
 $y = 2 \sin t - \sin(2t)$

12.4.9.  $x = \cos t + t \sin t$ ,  
 $y = \sin t - t \cos t$

12.5.1. There is a horizontal tangent at all multiples of  $\pi$ .

12.5.2.  $9\pi/4$

12.5.3.  $\int_0^{2\pi} \frac{1}{2} \sqrt{5 - 4 \cos t} dt$

12.5.4. Four points:

$$\left(\frac{-3 - 3\sqrt{5}}{4}, \pm \sqrt{\frac{5 - \sqrt{5}}{8}}\right),$$

$$\left(\frac{-3 + 3\sqrt{5}}{4}, \pm \sqrt{\frac{5 + \sqrt{5}}{8}}\right)$$

12.5.5.  $11\pi/3$

12.5.6.  $32/3$

12.5.7.  $2\pi$

12.5.8.  $16/3$

12.5.9.  $(\pi/2, 1)$

12.5.10.  $5\pi^3/6$

12.5.11.  $2\pi^2$

12.5.12.  $(2\pi\sqrt{4\pi^2 + 1} + \ln(2\pi + \sqrt{4\pi^2 + 1}))/2$

13.1.1. 1

13.1.3. 0

13.1.4. 1

13.1.5. 1

13.1.6. 0

13.2.1.  $\lim_{n \rightarrow \infty} n^2/(2n^2 + 1) = 1/2$

13.2.2.  $\lim_{n \rightarrow \infty} 5/(2^{1/n} + 14) = 1/3$

13.2.3.  $\sum_{n=1}^{\infty} \frac{1}{n}$  diverges, so  $\sum_{n=1}^{\infty} 3\frac{1}{n}$  diverges

13.2.4.  $-3/2$

13.2.5. 11

13.2.6. 20

13.2.7.  $3/4$

13.2.8.  $3/2$

13.2.9.  $3/10$

13.3.1. diverges

13.3.2. diverges

13.3.3. converges

13.3.4. converges

13.3.5. converges

13.3.6. converges

13.3.7. diverges

13.3.8. converges

13.3.9.  $N = 5$

13.3.10.  $N = 10$

13.3.11.  $N = 1687$

13.3.12. any integer greater than  $e^{200}$

13.4.1. converges

13.4.2. converges

13.4.3. diverges

13.4.4. converges

13.4.5. 0.90

13.4.6. 0.95

13.5.1. converges

13.5.2. converges

13.5.3. converges

13.5.4. diverges

13.5.5. diverges

13.5.6. diverges

13.5.7. converges

13.5.8. diverges

13.5.9. converges

13.5.10. diverges

13.6.1. converges absolutely

13.6.2. diverges

- 13.6.3. converges conditionally  
 13.6.4. converges absolutely  
 13.6.5. converges conditionally  
 13.6.6. converges absolutely  
 13.6.7. diverges  
 13.6.8. converges conditionally  
 13.7.5. converges  
 13.7.6. converges  
 13.7.7. converges  
 13.7.8. diverges  
 13.8.1.  $R = 1, I = (-1, 1)$   
 13.8.2.  $R = \infty, I = (-\infty, \infty)$   
 13.8.3.  $R = e, I = (-e, e)$   
 13.8.4.  $R = e, I = (2 - e, 2 + e)$   
 13.8.5.  $R = 0$ , converges only when  $x = 2$   
 13.8.6.  $R = 1, I = [-6, -4]$   
 13.9.1. the alternating harmonic series  
 13.9.2.  $\sum_{n=0}^{\infty} (n+1)x^n$   
 13.9.3.  $\sum_{n=0}^{\infty} (n+1)(n+2)x^n$   
 13.9.4.  $\sum_{n=0}^{\infty} \frac{(n+1)(n+2)}{2} x^n, R = 1$   
 13.9.5.  $C + \sum_{n=0}^{\infty} \frac{-1}{(n+1)(n+2)} x^{n+2}$   
 13.10.1.  $\sum_{n=0}^{\infty} (-1)^n x^{2n}/(2n)!, R = \infty$   
 13.10.2.  $\sum_{n=0}^{\infty} x^n/n!, R = \infty$   
 13.10.3.  $\sum_{n=0}^{\infty} (-1)^n \frac{(x-5)^n}{5^{n+1}}, R = 5$

- 13.10.4.  $\sum_{n=1}^{\infty} (-1)^{n-1} \frac{(x-1)^n}{n}, R = 1$   
 13.10.5.  $\ln(2) + \sum_{n=1}^{\infty} (-1)^{n-1} \frac{(x-2)^n}{n2^n}, R = 2$   
 13.10.6.  $\sum_{n=0}^{\infty} (-1)^n (n+1)(x-1)^n, R = 1$   
 13.10.7.  $1 + \sum_{n=1}^{\infty} \frac{1 \cdot 3 \cdot 5 \cdots (2n-1)}{n!2^n} x^n =$   
 $1 + \sum_{n=1}^{\infty} \frac{(2n-1)!}{2^{2n-1}(n-1)!n!} x^n, R = 1$   
 13.10.8.  $x + x^3/3$   
 13.10.9.  $\sum_{n=0}^{\infty} (-1)^n x^{4n+1}/(2n)!$   
 13.10.10.  $\sum_{n=0}^{\infty} (-1)^n x^{n+1}/n!$   
 13.11.1.  $1 - \frac{x^2}{2} + \frac{x^4}{24} - \frac{x^6}{720} + \cdots + \frac{x^{12}}{12!}$   
 13.11.2. 1000; 8  
 13.11.3.  $x + \frac{x^3}{3} + \frac{2x^5}{15}$ , error  $\pm 1.27$ .  
 13.12.1. diverges  
 13.12.2. converges  
 13.12.3. converges  
 13.12.4. diverges  
 13.12.5. diverges  
 13.12.6. diverges  
 13.12.7. converges  
 13.12.8. converges  
 13.12.9. converges  
 13.12.10. converges  
 13.12.11. converges  
 13.12.12. converges  
 13.12.13. converges

- 13.12.14. converges  
 13.12.15. converges  
 13.12.16. converges  
 13.12.17. diverges  
 13.12.18.  $(-\infty, \infty)$   
 13.12.19.  $(-3, 3)$   
 13.12.20.  $(-3, 3)$   
 13.12.21.  $(-1, 1)$   
 13.12.22. radius is 0—it converges only when  $x = 0$   
 13.12.23.  $(-\sqrt{3}, \sqrt{3})$   
 13.12.24.  $(-\infty, \infty)$   
 13.12.25.  $\sum_{n=0}^{\infty} \frac{(\ln(2))^n}{n!} x^n$   
 13.12.26.  $\sum_{n=0}^{\infty} \frac{(-1)^n}{n+1} x^{n+1}$   
 13.12.27.  $\sum_{n=0}^{\infty} \frac{2}{2n+1} x^{2n+1}$   
 13.12.28.  $1 + x/2 +$   
 $\sum_{n=2}^{\infty} (-1)^{n+1} \frac{1 \cdot 3 \cdot 5 \cdots (2n-3)}{2^n n!} x^n$   
 13.12.29.  $\sum_{n=0}^{\infty} (-1)^n x^{2n}$   
 13.12.30.  $\sum_{n=0}^{\infty} \frac{(-1)^n}{2n+1} x^{2n+1}$   
 13.12.31.  $\pi = \sum_{n=0}^{\infty} (-1)^n \frac{4}{2n+1}$