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) $y = \begin{cases} 0 & 0 \le x < 100 \\ (x/10) - 10 & 100 \le x \le 1000 \\ x - 910 & 1000 < x \end{cases}$

1.1.16. $y = \begin{cases} 0.15x & 0 \le x \le 19450 \\ 0.28x - 2528.50 & 19450 < x \le 47050 \\ 0.33x - 4881 & 47050 < x \le 97620 \end{cases}$

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. $\{x \mid x \ge 3/2\}$

1.3.2. $\{x \mid x \ne -1\}$

1.3.3. $\{x \mid x \ne 1 \text{ and } x \ne -1\}$

1.3.4. $\{x \mid x < 0\}$

1.3.5. $\{x \mid x \in \mathbb{R}\}$, i.e., all x

1.3.6. $\{x \mid x \ge 0\}$

1.3.7. $\{x \mid h - r \le x \le h + r\}$

1.3.8. $\{x \mid x \ge 1 \text{ or } x < 0\}$

1.3.9. $\{x \mid -1/3 < x < 1/3\}$

1.3.10. $\{x \mid x \ge 0 \text{ and } x \ne 1\}$

1.3.11. $\{x \mid x \ge 0 \text{ and } x \ne 1\}$

1.3.12. $\mathbb{R}$

1.3.13. $\{x \mid x \ge 3\}$, $\{x \mid x \ge 0\}$

1.3.14. $A = x(500 - 2x)$, $\{x \mid 0 \le x \le 250\}$

1.3.15. $V = r(50 - \pi r^2)$, $\{r \mid 0 < r \le \sqrt{50/\pi}\}$

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, $\dfrac{-1}{3(3 + \Delta x)} \to \dfrac{-1}{9}$

2.1.4. $\dfrac{3 + 3\Delta x + \Delta x^2}{1 + \Delta x} \to 3$

2.1.5. 3.31, 3.003001, 3.0000, $3 + 3\Delta x + \Delta x^2 \to 3$

2.1.6. m

2.2.1. 10, 25/2, 20, 15, 25, 35.

2.2.2. 5, 4.1, 4.01, 4.001, $4 + \Delta t \to 4$

2.2.3. -10.29, -9.849, -9.8049, $-9.8 - 4.9\Delta t \to -9.8$

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

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. $\displaystyle\sum_{k=1}^{n} ka_k x^{k-1}$

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. $\dfrac{\sqrt{625 - x^2}}{2\sqrt{x}} - \dfrac{x\sqrt{x}}{\sqrt{625 - x^2}}$

3.3.4. $\dfrac{-1}{x^{19}\sqrt{625 - x^2}} - \dfrac{20\sqrt{625 - x^2}}{x^{21}}$

3.3.5. $f' = 4(2x - 3),\ y = 4x - 7$

3.4.1. $\dfrac{3x^2}{x^3 - 5x + 10} - \dfrac{x^3(3x^2 - 5)}{(x^3 - 5x + 10)^2}$

3.4.2. $\dfrac{2x + 5}{x^5 - 6x^3 + 3x^2 - 7x + 1} - \dfrac{(x^2 + 5x - 3)(5x^4 - 18x^2 + 6x - 7)}{(x^5 - 6x^3 + 3x^2 - 7x + 1)^2}$

3.4.3. $\dfrac{1}{2\sqrt{x}\sqrt{625 - x^2}} + \dfrac{x^{3/2}}{(625 - x^2)^{3/2}}$

3.4.4. $\dfrac{-1}{x^{19}\sqrt{625 - x^2}} - \dfrac{20\sqrt{625 - x^2}}{x^{21}}$

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. $6(x^2 + 1)^2 x$

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. $\dfrac{1}{4\sqrt{x}(5 - \sqrt{x})^{3/2}}$

3.5.9. $6 + 18x$

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

3.5.11. $-1/\sqrt{25 - x^2} - \sqrt{25 - x^2}/x^2$

3.5.12. $\dfrac{1}{2}\left(\dfrac{-169}{x^2} - 1\right) \Big/ \sqrt{\dfrac{169}{x} - x}$

3.5.13. $\dfrac{3x^2 - 2x + 1/x^2}{2\sqrt{x^3 - x^2 - (1/x)}}$

3.5.14. $\dfrac{300x}{(100 - x^2)^{5/2}}$

3.5.15. $\dfrac{1 + 3x^2}{3(x + x^3)^{2/3}}$

3.5.16. $\left(4x(x^2 + 1) + \dfrac{4x^3 + 4x}{2\sqrt{1 + (x^2 + 1)^2}}\right) \Big/ 2\sqrt{(x^2 + 1)^2 + \sqrt{1 + (x^2 + 1)^2}}$

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. $y = \dfrac{20 + 2\sqrt{5}}{5\sqrt{4 + \sqrt{5}}}x + \dfrac{3\sqrt{5}}{5\sqrt{4 + \sqrt{5}}}$

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. $\dfrac{\sin x}{2\sqrt{x}} + \sqrt{x}\cos x$

4.4.3. $-\dfrac{\cos x}{\sin^2 x}$

4.4.4. $\dfrac{(2x + 1)\sin x - (x^2 + x)\cos x}{\sin^2 x}$

4.4.5. $\dfrac{-\sin x \cos x}{\sqrt{1 - \sin^2 x}}$

4.5.1. $\cos^2 x - \sin^2 x$

4.5.2. $-\sin x \cos(\cos x)$

4.5.3. $\dfrac{\tan x + x\sec^2 x}{2\sqrt{x}\tan x}$

4.5.4. $\dfrac{\sec^2 x(1 + \sin x) - \tan x \cos x}{(1 + \sin x)^2}$

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. $\sin\theta/(\cos\theta + 1)^2$

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. $\sqrt{3}x/2 + 3/4 - \sqrt{3}\pi/6$

4.5.16. $8\sqrt{3}x + 4 - 8\sqrt{3}\pi/3$

4.5.17. $3\sqrt{3}x/2 - \sqrt{3}\pi/4$

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. $(y - \cos(x + y))/(\cos(x + y) - x)$

4.6.8. $-y^2/x^2$

4.6.9. 1

4.6.12. $y = 2x \pm 6$

4.6.13. $y = x/2 \pm 3$

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

4.6.15. $y = 7x/\sqrt{3} - 8/\sqrt{3}$

4.6.16. $y = (-y_1^{1/3}x + y_1^{1/3}x_1 + x_1^{1/3}y_1)/x_1^{1/3}$

4.6.17. $(y - y_1)/(x - x_1) = (2x_1^3 + 2x_1y_1^2 - x_1)/(2y_1^3 + 2y_1x_1^2 + y_1)$

4.7.1. 0

4.7.2. 1

4.7.3. 1/6

4.7.4. $-\infty$

4.7.5. 1/16

4.7.6. 1/3

4.7.7. 0

4.7.8. 3/2

4.7.9. $-1/4$

4.7.10. -3

4.7.11. 1/2

4.7.12. 0

4.7.13. -1

4.7.14. $-1/2$

4.7.15. 5

4.7.16. ∞

4.7.17. ∞

4.7.18. 2/7

4.7.19. 2

4.7.20. $-\infty$

4.7.21. 1

4.7.22. 0

4.7.23. ∞

4.7.24. 1/2

4.7.25. 0

4.7.26. 1/2

4.7.27. 5

4.7.28. $2\sqrt{2}$

4.7.29. $-1/2$

4.7.30. 2

4.7.31. 0

4.7.32. ∞

4.7.33. 0

4.7.34. 3/2

4.7.35. ∞

4.7.36. 5

4.7.37. $-1/2$

4.7.38. does not exist

4.7.39. ∞

4.7.40. $y = 1$ and $y = -1$

5.1.1. min at $x = 1/2$

5.1.2. min at $x = -1$, max at $x = 1$

5.1.3. max at $x = 2$, min at $x = 4$

5.1.4. min at $x = \pm 1$, max at $x = 0$.

5.1.5. min at $x = 1$

5.1.6. none

5.1.7. none

5.1.8. min at $x = 7\pi/12 + k\pi$, max at $x = -\pi/12 + k\pi$, for integer k.

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 $x = 0$

5.1.15. one

5.2.1. min at $x = 1/2$

5.2.2. min at $x = -1$, max at $x = 1$

5.2.3. max at $x = 2$, min at $x = 4$

5.2.4. min at $x = \pm 1$, max at $x = 0$.

5.2.5. min at $x = 1$

5.2.6. none

5.2.7. none

5.2.8. min at $x = 7\pi/12 + k\pi$, max at $x = -\pi/12 + k\pi$, for integer k.

5.2.9. none

5.2.10. max at $x = 0$, min at $x = \pm 11$

5.2.11. min at $x = -3/2$, neither at $x = 0$

5.2.13. min at $n\pi$, max at $\pi/2 + n\pi$

5.2.14. min at $2n\pi$, max at $(2n+1)\pi$

5.2.15. min at $\pi/2 + 2n\pi$, max at $3\pi/2 + 2n\pi$

5.3.1. min at $x = 1/2$

5.3.2. min at $x = -1$, max at $x = 1$

5.3.3. max at $x = 2$, min at $x = 4$

5.3.4. min at $x = \pm 1$, max at $x = 0$.

5.3.5. min at $x = 1$

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 $2^{-1/3}$

5.3.15. none

5.3.16. min at $n\pi$

5.3.17. max at $n\pi$, min at $\pi/2 + n\pi$

5.3.18. max at $\pi/2 + 2n\pi$, min at $3\pi/2 + 2n\pi$

5.4.1. concave up everywhere

5.4.2. concave up when $x < 0$, concave down when $x > 0$

5.4.3. concave down when $x < 3$, concave up when $x > 3$

5.4.4. concave up when $x < -1/\sqrt{3}$ or $x > 1/\sqrt{3}$, concave down when $-1/\sqrt{3} < x < 1/\sqrt{3}$

5.4.5. concave up when $x < 0$ or $x > 2/3$, concave down when $0 < x < 2/3$

5.4.6. concave up when $x < 0$, concave down when $x > 0$

5.4.7. concave up when $x < -1$ or $x > 1$, concave down when $-1 < x < 0$ or $0 < x < 1$

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

5.4.9. concave down everywhere

5.4.10. concave up on $(-\infty, (21 - \sqrt{497})/4)$ and $(21 + \sqrt{497})/4, \infty)$

5.4.11. concave up on $(0, \infty)$

5.4.12. concave down on $(2n\pi/3, (2n+1)\pi/3)$

5.4.13. concave up on $(0, \infty)$

5.4.14. concave up on $(-\infty, -1)$ and $(0, \infty)$

5.4.15. concave down everywhere

5.4.16. concave up everywhere

5.4.17. concave up on $(\pi/4 + n\pi, 3\pi/4 + n\pi)$

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. 25×25

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. $\dfrac{\sqrt{3}}{6} \times \dfrac{\sqrt{3}}{6} + \dfrac{1}{2} \times \dfrac{1}{4} - \dfrac{\sqrt{3}}{12}$

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 $k \le 2/\pi$ the ratio is $(2 - k\pi)/4$; if $k \ge 2/\pi$, 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. $h = \dfrac{750}{\pi}\left(\dfrac{2\pi^2}{750^2}\right)^{1/3}$, $r = \left(\dfrac{750^2}{2\pi^2}\right)^{1/6}$

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. 80π 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/min

6.2.12. $25\pi/144$ m/min

6.2.13. $\pi\sqrt{2}/36$ ft^3/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. $4t - t^2 + C$, $t < 2$; $t^2 - 4t + 8 + C$, $t \ge 2$

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. $\displaystyle\int_0^{2\pi} \sin t \, dt = 0$

7.3.3. net: 2π, 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) 20π
(d) 4π

8.3.9. 16π, 24π

8.3.11. $\pi h^2(3r - h)/3$

8.3.13. 2π

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. 2450π 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. $\dfrac{-1}{1 + x^2}$

9.5.5. $\dfrac{2x}{\sqrt{1 - x^4}}$

9.5.6. $\dfrac{e^x}{1 + e^{2x}}$

9.5.7. $-3x^2 \cos(x^3)/\sqrt{1 - \sin^2(x^3)}$

9.5.8. $\dfrac{2}{(\arcsin x)\sqrt{1 - x^2}}$

9.5.9. $-e^x/\sqrt{1 - e^{2x}}$

9.5.10. 0

9.5.11. $\dfrac{(1 + \ln x)x^x}{\ln 5(1 + x^{2x})\arctan(x^x)}$

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 ± 0

10.5.2. T: 9.28125 ± 0.281125; S: 9 ± 0

10.5.3. T: 60.75 ± 1; S: 60 ± 0

10.5.4. T: 1.1167 ± 0.0833; S: 1.1000 ± 0.0167

10.5.5. T: 0.3235 ± 0.0026; S: 0.3217 ± 0.000065

10.5.6. T: 0.6478 ± 0.0052; S: 0.6438 ± 0.000033

10.5.7. T: 2.8833 ± 0.0834; S: 2.9000 ± 0.0167

10.5.8. T: 1.1170 ± 0.0077; S: 1.1114 ± 0.0002

10.5.9. T: 1.097 ± 0.0147; S: 1.089 ± 0.0003

10.5.10. T: 3.63 ± 0.087; S: 3.62 ± 0.032

10.6.1. $\dfrac{(t+4)^4}{4} + C$

10.6.2. $\dfrac{(t^2-9)^{5/2}}{5} + C$

10.6.3. $\dfrac{(e^{t^2}+16)^2}{4} + C$

10.6.4. $\cos t - \dfrac{2}{3}\cos^3 t + C$

10.6.5. $\dfrac{\tan^2 t}{2} + C$

10.6.6. $\ln|t^2 + t + 3| + C$

10.6.7. $\dfrac{1}{8}\ln|1 - 4/t^2| + C$

10.6.8. $\dfrac{1}{25}\tan(\arcsin(t/5)) + C = \dfrac{t}{25\sqrt{25-t^2}} + C$

10.6.9. $\dfrac{2}{3}\sqrt{\sin 3t} + C$

10.6.10. $t\tan t + \ln|\cos t| + C$

10.6.11. $2\sqrt{e^t + 1} + C$

10.6.12. $\dfrac{3t}{8} + \dfrac{\sin 2t}{4} + \dfrac{\sin 4t}{32} + C$

10.6.13. $\dfrac{\ln|t|}{3} - \dfrac{\ln|t+3|}{3} + C$

10.6.14. $\dfrac{-1}{\sin\arctan t} + C = -\sqrt{1+t^2}/t + C$

10.6.15. $\dfrac{-1}{2(1+\tan t)^2} + C$

10.6.16. $\dfrac{(t^2+1)^{5/2}}{5} - \dfrac{(t^2+1)^{3/2}}{3} + C$

10.6.17. $\dfrac{e^t\sin t - e^t\cos t}{2} + C$

10.6.18. $\dfrac{(t^{3/2}+47)^4}{6} + C$

10.6.19. $\dfrac{2}{3(2-t^2)^{3/2}} - \dfrac{1}{(2-t^2)^{1/2}} + C$

10.6.20. $\dfrac{\ln|\sin(\arctan(2t/3))|}{9} + C = (\ln(4t^2) - \ln(9+4t^2))/18 + C$

10.6.21. $\dfrac{(\arctan(2t))^2}{4} + C$

10.6.22. $\dfrac{3\ln|t+3|}{4} + \dfrac{\ln|t-1|}{4} + C$

10.6.23. $\dfrac{\cos^7 t}{7} - \dfrac{\cos^5 t}{5} + C$

10.6.24. $\dfrac{-1}{t-3} + C$

10.6.25. $\dfrac{-1}{\ln t} + C$

10.6.26. $\dfrac{t^2(\ln t)^2}{2} - \dfrac{t^2\ln t}{2} + \dfrac{t^2}{4} + C$

10.6.27. $(t^3 - 3t^2 + 6t - 6)e^t + C$

10.6.28. $\dfrac{5+\sqrt{5}}{10}\ln(2t + 1 - \sqrt{5}) + \dfrac{5-\sqrt{5}}{10}\ln(2t+1+\sqrt{5}) + C$

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. ∞

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. π

11.2.14. 80 mph: 90.8 to 95.3 N
90 mph: 114.9 to 120.6 N
100.9 mph: 144.5 to 151.6 N

11.3.2. $\mu = 1/c$, $\sigma = 1/c$

11.3.3. $\mu = (a+b)/2$, $\sigma = \dfrac{(b-a)}{2\sqrt{3}}$

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. ≈ 3.82

11.4.8. ≈ 1.01

11.4.9. $\sqrt{1+e^2} - \sqrt{2} + \dfrac{1}{2}\ln\left(\dfrac{\sqrt{1+e^2}-1}{\sqrt{1+e^2}+1}\right) + \dfrac{1}{2}\ln(3+2\sqrt{2})$

11.5.1. $8\pi\sqrt{3} - \dfrac{16\pi\sqrt{2}}{3}$

11.5.3. $\dfrac{730\pi\sqrt{730}}{27} - \dfrac{10\pi\sqrt{10}}{27}$

11.5.4. $\pi + 2\pi e + \dfrac{1}{4}\pi e^2 - \dfrac{\pi}{4e^2} - \dfrac{2\pi}{e}$

11.5.6. $8\pi^2$

11.5.7. $2\pi + \dfrac{8\pi^2}{3\sqrt{3}}$

11.5.8. $a > b$: $2\pi b^2 + \dfrac{2\pi a^2 b}{\sqrt{a^2-b^2}}\arcsin(\sqrt{a^2-b^2}/a)$,

$a < b$: $2\pi b^2 + \dfrac{2\pi a^2 b}{\sqrt{b^2-a^2}}\ln\left(\dfrac{b}{a} + \dfrac{\sqrt{b^2-a^2}}{a}\right)$

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

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

12.2.5. undefined

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

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. πa^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. π^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. $x = t - \dfrac{\sin(t)}{2}$, $y = 1 - \dfrac{\cos(t)}{2}$

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 π.

12.5.2. $9\pi/4$

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

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. 2π

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

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

13.2.3. $\sum_{n=1}^{\infty}\frac{1}{n}$ diverges, so $\displaystyle\sum_{n=1}^{\infty} 3\frac{1}{n}$ 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. $\displaystyle\sum_{n=0}^{\infty} (n+1)x^n$

13.9.3. $\displaystyle\sum_{n=0}^{\infty} (n+1)(n+2)x^n$

13.9.4. $\displaystyle\sum_{n=0}^{\infty} \frac{(n+1)(n+2)}{2} x^n$, $R = 1$

13.9.5. $C + \displaystyle\sum_{n=0}^{\infty} \frac{-1}{(n+1)(n+2)} x^{n+2}$

13.10.1. $\displaystyle\sum_{n=0}^{\infty} (-1)^n x^{2n}/(2n)!$, $R = \infty$

13.10.2. $\displaystyle\sum_{n=0}^{\infty} x^n/n!$, $R = \infty$

13.10.3. $\displaystyle\sum_{n=0}^{\infty} (-1)^n \frac{(x-5)^n}{5^{n+1}}$, $R = 5$

13.10.4. $\displaystyle\sum_{n=1}^{\infty} (-1)^{n-1} \frac{(x-1)^n}{n}$, $R = 1$

13.10.5. $\ln(2) + \displaystyle\sum_{n=1}^{\infty} (-1)^{n-1} \frac{(x-2)^n}{n2^n}$, $R = 2$

13.10.6. $\displaystyle\sum_{n=0}^{\infty} (-1)^n(n+1)(x-1)^n$, $R = 1$

13.10.7. $1 + \displaystyle\sum_{n=1}^{\infty} \frac{1 \cdot 3 \cdot 5 \cdots (2n-1)}{n!2^n} x^n =$

$1 + \displaystyle\sum_{n=1}^{\infty} \frac{(2n-1)!}{2^{2n-1}(n-1)!\, n!} x^n$, $R = 1$

13.10.8. $x + x^3/3$

13.10.9. $\displaystyle\sum_{n=0}^{\infty} (-1)^n x^{4n+1}/(2n)!$

13.10.10. $\displaystyle\sum_{n=0}^{\infty} (-1)^n x^{n+1}/n!$

13.11.1. $1 - \dfrac{x^2}{2} + \dfrac{x^4}{24} - \dfrac{x^6}{720} + \cdots + \dfrac{x^{12}}{12!}$

13.11.2. 1000; 8

13.11.3. $x + \dfrac{x^3}{3} + \dfrac{2x^5}{15}$, error ± 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. $\displaystyle\sum_{n=0}^{\infty} \frac{(\ln(2))^n}{n!} x^n$

13.12.26. $\displaystyle\sum_{n=0}^{\infty} \frac{(-1)^n}{n+1} x^{n+1}$

13.12.27. $\displaystyle\sum_{n=0}^{\infty} \frac{2}{2n+1} x^{2n+1}$

13.12.28. $1 + x/2 + \displaystyle\sum_{n=2}^{\infty} (-1)^{n+1} \frac{1 \cdot 3 \cdot 5 \cdots (2n-3)}{2^n n!} x^n$

13.12.29. $\displaystyle\sum_{n=0}^{\infty} (-1)^n x^{2n}$

13.12.30. $\displaystyle\sum_{n=0}^{\infty} \frac{(-1)^n}{2n+1} x^{2n+1}$

13.12.31. $\pi = \displaystyle\sum_{n=0}^{\infty} (-1)^n \frac{4}{2n+1}$

14.1.6. 3, $\sqrt{26}$, $\sqrt{29}$

14.1.7. $\sqrt{14}$, $2\sqrt{14}$, $3\sqrt{14}$.

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

14.1.9. $(x-2)^2 + (y+1)^2 + (z-3)^2 = 25$.

14.1.10. $(x-3)^2 + (y+2)^2 + (z-1)^2 = 33$.

14.1.11. $(x-2)^2 + (y-1)^2 + (z+1)^2 = 16$, $(y-1)^2 + (z+1)^2 = 12$

14.2.6. $\sqrt{10}$, $\langle 0, -2 \rangle$, $\langle 2, 8 \rangle$, 2, $2\sqrt{17}$, $\langle -2, -6 \rangle$

14.2.7. $\sqrt{14}$, $\langle 0, 4, 0 \rangle$, $\langle 2, 0, 6 \rangle$, 4, $2\sqrt{10}$, $\langle -2, -4, -6 \rangle$

14.2.8. $\sqrt{2}$, $\langle 0, -2, 3 \rangle$, $\langle 2, 2, -1 \rangle$, $\sqrt{13}$, 3, $\langle -2, 0, -2 \rangle$

14.2.9. $\sqrt{3}$, $\langle 1, -1, 4 \rangle$, $\langle 1, -1, -2 \rangle$, $3\sqrt{2}$, $\sqrt{6}$, $\langle -2, 2, -2 \rangle$

14.2.10. $\sqrt{14}$, $\langle 2, 1, 0 \rangle$, $\langle 4, 3, 2 \rangle$, $\sqrt{5}$, $\sqrt{29}$, $\langle -6, -4, -2 \rangle$

14.2.11. $\langle -3, -3, -11 \rangle$, $\langle -3/\sqrt{139}, -3/\sqrt{139}, -11/\sqrt{139} \rangle$ $\langle -12/\sqrt{139}, -12/\sqrt{139}, -44/\sqrt{139} \rangle$

14.2.12. $\langle 0, 0, 0 \rangle$

14.2.13. $\mathbf{0}$; $\langle -r\sqrt{3}/2, r/2 \rangle$; $\langle 0, -12r \rangle$; where r is the radius of the clock

14.3.1. 3

14.3.2. 0

14.3.3. 2

14.3.4. -6

14.3.5. 42

14.3.6. $\sqrt{6}/\sqrt{7}$, ≈ 0.39

14.3.7. $-11\sqrt{14}\sqrt{29}/406$, ≈ 2.15

14.3.8. 0, $\pi/2$

14.3.9. $1/2$, $\pi/3$

14.3.10. $-1/\sqrt{3}$, ≈ 2.19

14.3.11. $\arccos(1/\sqrt{3}) \approx 0.96$

14.3.12. $\sqrt{5}$, $\langle 1, 2, 0 \rangle$.

14.3.13. $3\sqrt{14}/7$, $\langle 9/7, 6/7, 3/7 \rangle$.

14.3.14. $\langle 0, 5 \rangle$, $\langle 5\sqrt{3}, 0 \rangle$

14.3.15. $\langle 0, 15\sqrt{2}/2 \rangle$, $\langle 15\sqrt{2}/2, 0 \rangle$

14.3.16. Any vector of the form $\langle a, -7a/2, -2a \rangle$

14.3.17. $\langle 1/\sqrt{3}, -1/\sqrt{3}, 1/\sqrt{3}\rangle$

14.3.18. No.

14.3.19. Yes.

14.4.1. $\langle 1, -2, 1\rangle$

14.4.2. $\langle 4, -6, -2\rangle$

14.4.3. $\langle -7, 13, -9\rangle$

14.4.4. $\langle 0, -1, 0\rangle$

14.4.5. 3

14.4.6. $21\sqrt{2}/2$

14.4.7. 1

14.5.1. $(x-6) + (y-2) + (z-1) = 0$

14.5.2. $4(x+1) + 5(y-2) - (z+3) = 0$

14.5.3. $(x-1) - (y-2) = 0$

14.5.4. $-2(x-1) + 3y - 2z = 0$

14.5.5. $4(x-1) - 6y = 0$

14.5.6. $x + 3y = 0$

14.5.7. $\langle 1, 0, 3\rangle + t\langle 0, 2, 1\rangle$

14.5.8. $\langle 1, 0, 3\rangle + t\langle 1, 2, -1\rangle$

14.5.9. $t\langle 1, 1, -1\rangle$

14.5.10. $-2/5, 13/5$

14.5.12. neither

14.5.13. parallel

14.5.14. intersect at $(3, 6, 5)$

14.5.15. same line

14.5.19. $7/\sqrt{3}$

14.5.20. $4/\sqrt{14}$

14.5.21. $\sqrt{131}/\sqrt{14}$

14.5.22. $\sqrt{68}/3$

14.5.23. $\sqrt{42}/7$

14.5.24. $\sqrt{21}/6$

14.6.1. $(\sqrt{2}, \pi/4, 1)$,
$(\sqrt{3}, \pi/4, \arccos(1/\sqrt{3}))$;
$(7\sqrt{2}, 7\pi/4, 5)$,
$(\sqrt{123}, 7\pi/4, \arccos(5/\sqrt{123})$;
$(1, 1, 1)$, $(\sqrt{2}, 1, \pi/4)$; $(0, 0, -\pi)$,
$(\pi, 0, \pi)$

14.6.2. $r^2 + z^2 = 4$

14.6.3. $r\cos\theta = 0$

14.6.4. $r^2 + 2z^2 + 2z - 5 = 0$

14.6.5. $z = e^{-r^2}$

14.6.6. $z = r$

14.6.7. $\sin\theta = 0$

14.6.8. $1 = \rho\cos\phi$

14.6.9. $\rho = 2\sin\theta\sin\phi$.

14.6.10. $\rho\sin\phi = 3$

14.6.11. $\phi = \pi/4$

14.6.13. $z = mr$; $\cot\phi = m$ if $m \neq 0$, $\phi = 0$
if $m = 0$

14.6.14. A sphere with radius $1/2$, center at
$(0, 1/2, 0)$

14.6.15. $0 < \theta < \pi/2$, $0 < \phi < \pi/2$, $\rho > 0$;
$0 < \theta < \pi/2$, $r > 0$, $z > 0$

15.1.5. $\langle 3\cos t, 3\sin t, 2 - 3\sin t\rangle$

15.1.6. $\langle 0, t\cos t, t\sin t\rangle$

15.2.1. $\langle 2t, 0, 1\rangle$, $\mathbf{r}'/\sqrt{1 + 4t^2}$

15.2.2. $\langle -\sin t, 2\cos 2t, 2t\rangle$,
$\mathbf{r}'/\sqrt{\sin^2 t + 4\cos^2(2t) + 4t^2}$

15.2.3. $\langle -e^t\sin(e^t), e^t\cos(e^t), \cos t\rangle$,
$\mathbf{r}'/\sqrt{e^{2t} + \cos^2 t}$

15.2.4. $\langle \sqrt{2}/2, \sqrt{2}/2, \pi/4\rangle +$
$t\langle -\sqrt{2}/2, \sqrt{2}/2, 1\rangle$

15.2.5. $\langle 1/2, \sqrt{3}/2, -1/2\rangle +$
$t\langle -\sqrt{3}/2, 1/2, 2\sqrt{3}\rangle$

15.2.6. $2/\sqrt{5}/\sqrt{4 + \pi^2}$

15.2.7. $7\sqrt{5}\sqrt{17}/85$, $-9\sqrt{5}\sqrt{17}/85$

15.2.9. $\langle 0, t\cos t, t\sin t\rangle$, $\langle 0, \cos t -$
$t\sin t, \sin t + t\cos t\rangle$, $\mathbf{r}'/\sqrt{1 + t^2}$,
$\sqrt{1 + t^2}$

15.2.10. $\langle \sin t, 1 - \cos t, t^2/2\rangle$

15.2.11. $t = 4$

15.2.12. $\sqrt{37}$, 1

15.2.13. $\langle t^2/2, t^3/3, \sin t\rangle$

15.2.16. $(1, 1, 1)$ when $t = 1$ and $s = 0$;
$\theta = \arccos(3/\sqrt{14})$; no

15.2.17. $-6x + (y - \pi) = 0$

15.2.18. $-x/\sqrt{2} + y/\sqrt{2} + 6z = 0$

15.2.19. $(-1, -3, 1)$

15.2.20. $\langle 1/\sqrt{2}, 1/\sqrt{2}, 0\rangle + t\langle -1, 1, 6\sqrt{2}\rangle$

15.3.1. $2\pi\sqrt{13}$

15.3.2. $(-8 + 13\sqrt{13})/27$

15.3.3. $\sqrt{5}/2 + \ln(\sqrt{5} + 2)/4$

15.3.4. $(85\sqrt{85} - 13\sqrt{13})/27$

15.3.5. $\int_0^5 \sqrt{1 + e^{2t}}\, dt$

15.3.6. $2\sqrt{2}/(2 + 4t^2)^{3/2}$

15.3.7. $2\sqrt{2}/(1 + 8t^2)^{3/2}$

15.3.8. $2\sqrt{1 + 9t^2 + 9t^4}/(1 + 4t^2 + 9t^4)^{3/2}$

15.3.9. $12\sqrt{17}/289$

15.4.1. $\langle -\sin t, \cos t, 1\rangle$, $\langle -\cos t, -\sin t, 0\rangle$,
0, 1

15.4.2. $\langle -\sin t, \cos t, 2t\rangle$, $\langle -\cos t, -\sin t, 2\rangle$,
$4t/\sqrt{4t^2 + 1}$, $\sqrt{4t^2 + 5}/\sqrt{4t^2 + 1}$

15.4.3. $\langle -\sin t, \cos t, e^t\rangle$,
$\langle -\cos t, -\sin t, e^t\rangle$, $e^{2t}/\sqrt{e^{2t} + 1}$,
$\sqrt{2e^{2t} + 1}/\sqrt{e^{2t} + 1}$

15.4.4. $\langle e^t, \cos t, e^t\rangle$, $\langle e^t, -\sin t, e^t\rangle$,
$(2e^{2t} - \cos t\sin t)/\sqrt{2e^{2t} + \cos^2 t}$,
$\sqrt{2}e^t|\cos t + \sin t|/\sqrt{2e^{2t} + \cos^2 t}$

15.4.5. $\langle -3\sin t, 2\cos t, 0\rangle$, $\langle 3\cos t, 2\sin t, 0\rangle$

15.4.6. $\langle -3\sin t, 2\cos t + 0.1, 0\rangle$,
$\langle 3\cos t, 2\sin t + t/10, 0\rangle$

15.4.7. $\langle -3\sin t, 2\cos t, 1\rangle$, $\langle 3\cos t, 2\sin t, t\rangle$

15.4.8. $\langle -3\sin t, 2\cos t + 1/10, 1\rangle$,
$\langle 3\cos t, 2\sin t + t/10, t\rangle$

16.1.1. $z = y^2$, $z = x^2$, $z = 0$, lines of slope
1

16.1.2. $z = |y|$, $z = |x|$, $z = 2|x|$, diamonds

16.1.3. $z = e^{-y^2}\sin(y^2)$, $z = e^{-x^2}\sin(x^2)$,
$z = e^{-2x^2}\sin(2x^2)$, circles

16.1.4. $z = -\sin(y)$, $z = \sin(x)$, $z = 0$,
lines of slope 1

16.1.5. $z = y^4$, $z = x^4$, $z = 0$, hyperbolas

16.1.6. (a) $\{(x, y) \mid |x| \leq 3 \text{ and } |y| \geq 2\}$
(b) $\{(x, y) \mid 1 \leq x^2 + y^2 \leq 3\}$
(c) $\{(x, y) \mid x^2 + 4y^2 \leq 16\}$

16.2.1. No limit; use $x = 0$ and $y = 0$.

16.2.2. No limit; use $x = 0$ and $x = y$.

16.2.3. No limit; use $x = 0$ and $x = y$.

16.2.4. Limit is zero.

16.2.5. Limit is 1.

16.2.6. Limit is zero.

16.2.7. Limit is -1.

16.2.8. Limit is zero.

16.2.9. No limit; use $x = 0$ and $y = 0$.

16.2.10. Limit is zero.

16.2.11. Limit is -1.

16.2.12. Limit is zero.

16.3.1. $-2xy\sin(x^2 y)$, $-x^2\sin(x^2 y) + 3y^2$

16.3.2. $(y^2 - x^2 y)/(x^2 + y)^2$, $x^3/(x^2 + y)^2$

16.3.3. $2xe^{x^2 + y^2}$, $2ye^{x^2 + y^2}$

16.3.4. $y \ln(xy) + y$, $x \ln(xy) + x$

16.3.5. $-x/\sqrt{1 - x^2 - y^2}$,
$-y/\sqrt{1 - x^2 - y^2}$

16.3.6. $\tan y$, $x \sec^2 y$

16.3.7. $-1/(x^2 y)$, $-1/(xy^2)$

16.3.8. $z = -2(x - 1) - 3(y - 1) - 1$

16.3.9. $z = 1$

16.3.10. $z = 6(x - 3) + 3(y - 1) + 10$

16.3.11. $z = (x - 2) + 4(y - 1/2)$

16.3.12. $\mathbf{r}(t) = \langle 2, 1, 4 \rangle + t \langle 2, 4, -1 \rangle$

16.4.1. $4xt \cos(x^2 + y^2) + 6yt^2 \cos(x^2 + y^2)$

16.4.2. $2xy \cos t + 2x^2 t$

16.4.3. $2xyt \cos(st) + 2x^2 s$, $2xys \cos(st) + 2x^2 t$

16.4.4. $2xy^2 t - 4yx^2 s$, $2xy^2 s + 4yx^2 t$

16.4.5. x/z, $3y/(2z)$

16.4.6. $-2x/z$, $-y/z$

16.4.7. (a) $V' = (nR - 0.2V)/P$
(b) $P' = (nR + 0.6P)/2V$
(c) $T' = (3P - 0.4V)/(nR)$

16.5.1. $9\sqrt{5}/5$

16.5.2. $\sqrt{2} \cos 3$

16.5.3. $e\sqrt{2}(\sqrt{3} - 1)/4$

16.5.4. $\sqrt{3} + 5$

16.5.5. $-\sqrt{6}(2 + \sqrt{3})/72$

16.5.6. $-1/5$, 0

16.5.7. $4(x - 2) + 8(y - 1) = 0$

16.5.8. $2(x - 3) + 3(y - 2) = 0$

16.5.9. $\langle -1, -1 - \cos 1, -\cos 1 \rangle$,
$-\sqrt{2 + 2 \cos 1 + 2 \cos^2 1}$

16.5.10. Any direction perpendicular to
$\nabla T = \langle 1, 1, 1 \rangle$, for example,
$\langle -1, 1, 0 \rangle$

16.5.11. $2(x - 1) - 6(y - 1) + 6(z - 3) = 0$

16.5.12. $6(x - 1) + 3(y - 2) + 2(z - 3) = 0$

16.5.13. $\langle 2 + 4t, -3 - 12t, -1 - 8t \rangle$

16.5.14. $\langle 4 + 8t, 2 + 4t, -2 - 36t \rangle$

16.5.15. $\langle 4 + 8t, 2 + 20t, 6 - 12t \rangle$

16.5.16. $\langle 0, 1 \rangle$, $\langle 4/5, -3/5 \rangle$

16.5.18. (a) $\langle 4, 9 \rangle$ (b) $\langle -81, 2 \rangle$ or $\langle 81, -2 \rangle$

16.5.19. in the direction of $\langle 8, 1 \rangle$

16.5.20. $\nabla g(-1, 3) = \langle 2, 1 \rangle$

16.6.1. $f_{xx} = (2x^3 y - 6xy^3)/(x^2 + y^2)^3$,
$f_{yy} = (2xy^3 - 6x^3 y)/(x^2 + y^2)^3$

16.6.2. $f_x = 3x^2 y^2$, $f_y = 2x^3 y + 5y^4$,
$f_{xx} = 6xy^2$, $f_{yy} = 2x^3 + 20y^3$,
$f_{xy} = 6x^2 y$

16.6.3. $f_x = 12x^2 + y^2$, $f_y = 2xy$,
$f_{xx} = 24x$, $f_{yy} = 2x$, $f_{xy} = 2y$

16.6.4. $f_x = \sin y$, $f_y = x \cos y$, $f_{xx} = 0$,
$f_{yy} = -x \sin y$, $f_{xy} = \cos y$

16.6.5. $f_x = 3 \cos(3x) \cos(2y)$,
$f_y = -2 \sin(3x) \sin(2y)$,
$f_{xy} = -6 \cos(3x) \sin(2y)$,
$f_{yy} = -4 \sin(3x) \cos(2y)$,
$f_{xx} = -9 \sin(3x) \cos(2y)$

16.6.6. $f_x = e^{x + y^2}$, $f_y = 2ye^{x + y^2}$,
$f_{xx} = e^{x + y^2}$,
$f_{yy} = 4y^2 e^{x + y^2} + 2e^{x + y^2}$,
$f_{xy} = 2ye^{x + y^2}$

16.6.7. $f_x = \dfrac{3x^2}{2(x^3 + y^4)}$, $f_y = \dfrac{2y^3}{x^3 + y^4}$,
$f_{xx} = \dfrac{3x}{x^3 + y^4} - \dfrac{9x^4}{2(x^3 + y^4)^2}$,
$f_{yy} = \dfrac{6y^2}{x^3 + y^4} - \dfrac{8y^6}{(x^3 + y^4)^2}$,
$f_{xy} = \dfrac{-6x^2 y^3}{(x^3 + y^4)^2}$

16.6.8. $z_x = \dfrac{-x}{16z}$, $z_y = \dfrac{-y}{4z}$,
$z_{xx} = -\dfrac{16z^2 + x^2}{16^2 z^3}$,
$z_{yy} = -\dfrac{4z^2 + y^2}{16z^3}$,
$z_{xy} = \dfrac{-xy}{64z^3}$

16.6.9. $z_x = -\dfrac{y + z}{x + y}$, $z_y = -\dfrac{x + z}{x + y}$,
$z_{xx} = 2\dfrac{y + z}{(x + y)^2}$, $z_{yy} = 2\dfrac{x + z}{(x + y)^2}$,
$z_{xy} = \dfrac{2z}{(x + y)^2}$

16.7.1. minimum at $(1, -1)$

16.7.2. none

16.7.3. none

16.7.4. maximum at $(1, -1/6)$

16.7.5. none

16.7.6. minimum at $(2, -1)$

16.7.7. $f(2, 2) = -2$, $f(2, 0) = 4$

16.7.8. a cube $1/\sqrt[3]{2}$ on a side

16.7.9. $65/3 \cdot 65/3 \cdot 130/3 = 2 \cdot 65^3/27 \approx$ 20343 cubic inches.

16.7.10. It has a square base, and is one and one half times as tall as wide. If the volume is V the dimensions are $\sqrt[3]{2V/3} \times \sqrt[3]{2V/3} \times \sqrt[3]{9V/4}$.

16.7.11. $\sqrt{100/3}$

16.7.12. $|ax_0 + by_0 + cz_0 - d|/\sqrt{a^2 + b^2 + c^2}$

16.7.13. The sides and bottom should all be $2/3$ meter, and the sides should be bent up at angle $\pi/3$.

16.7.14. $(3, 4/3)$

16.7.16. $|b|$ if $b \leq 1/2$, otherwise $\sqrt{b - 1/4}$

16.7.17. $|b|$ if $b \leq 1/2$, otherwise $\sqrt{b - 1/4}$

16.7.19. $256/\sqrt{3}$

16.8.1. a cube, $\sqrt[3]{1/2} \times \sqrt[3]{1/2} \times \sqrt[3]{1/2}$

16.8.2. $65/3 \cdot 65/3 \cdot 130/3 = 2 \cdot 65^3/27$

16.8.3. It has a square base, and is one and one half times as tall as wide. If the volume is V the dimensions are $\sqrt[3]{2V/3} \times \sqrt[3]{2V/3} \times \sqrt[3]{9V/4}$.

16.8.4. $|ax_0 + by_0 + cz_0 - d|/\sqrt{a^2 + b^2 + c^2}$

16.8.5. $(0, 0, 1)$, $(0, 0, -1)$

16.8.6. $\sqrt[3]{4V} \times \sqrt[3]{4V} \times \sqrt[3]{V/16}$

16.8.7. Farthest: $(-\sqrt{2}, \sqrt{2}, 2 + 2\sqrt{2})$;
closest: $(2, 0, 0)$, $(0, -2, 0)$

16.8.8. $x = y = z = 16$

16.8.9. $(1, 2, 2)$

16.8.10. $(\sqrt{5}, 0, 0)$, $(-\sqrt{5}, 0, 0)$

16.8.11. standard \$65, deluxe \$75

16.8.12. $x = 9$, $\phi = \pi/3$

16.8.13. 35, -35

16.8.14. maximum e^4, no minimum

16.8.15. 5, $-9/2$

16.8.16. $3, 3, 3$

16.8.17. a cube of side length $2/\sqrt{3}$

17.1.1. 16

17.1.2. 4

17.1.3. $15/8$

17.1.4. $1/2$

17.1.5. $5/6$

17.1.6. $12 - 65/(2e)$.

17.1.7. $1/2$

17.1.8. $\pi/64$

17.1.9. $(2/9)2^{3/2} - (2/9)$

17.1.10. $(1 - \cos(1))/4$

17.1.11. $(2\sqrt{2}-1)/6$

17.1.12. $\pi - 2$

17.1.13. $(e^9 - 1)/6$

17.1.14. $\dfrac{4}{15} - \dfrac{\pi}{4}$

17.1.15. $1/3$

17.1.16. 448

17.1.17. $4/5$

17.1.18. 8π

17.1.19. 2

17.1.20. $5/3$

17.1.21. $81/2$

17.1.22. $2a^3/3$

17.1.23. 4π

17.1.24. $\pi/32$

17.1.25. $31/8$

17.1.26. $128/15$

17.1.27. 1800π m^3

17.1.28. $\dfrac{(e^2 + 8e + 16)}{15}\sqrt{e + 4} - \dfrac{5\sqrt{5}}{3} - \dfrac{e^{5/2}}{15} + \dfrac{1}{15}$

17.1.30. $16 - 8\sqrt{2}$

17.2.1. 4π

17.2.2. $32\pi/3 - 4\sqrt{3}\pi$

17.2.3. $(2 - \sqrt{2})\pi/3$

17.2.4. $4/9$

17.2.5. $5\pi/3$

17.2.6. $\pi/6$

17.2.7. $\pi/2$

17.2.8. $\pi/2 - 1$

17.2.9. $\sqrt{3}/4 + \pi/6$

17.2.10. $8 + \pi$

17.2.11. $\pi/12$

17.2.12. $(1 - \cos(9))\pi/2$

17.2.13. $-a^5/15$

17.2.14. 12π

17.2.15. π

17.2.16. $16/3$

17.2.17. 21π

17.2.19. 2π

17.3.1. $\bar{x} = \bar{y} = 2/3$

17.3.2. $\bar{x} = 4/5,\ \bar{y} = 8/15$

17.3.3. $\bar{x} = 0,\ \bar{y} = 3\pi/16$

17.3.4. $\bar{x} = 0,\ \bar{y} = 16/(15\pi)$

17.3.5. $\bar{x} = 3/2,\ \bar{y} = 9/4$

17.3.6. $\bar{x} = 6/5,\ \bar{y} = 12/5$

17.3.7. $\bar{x} = 14/27,\ \bar{y} = 28/55$

17.3.8. $(3/4, 2/5)$

17.3.9. $\left(\dfrac{81\sqrt{3}}{80\pi}, 0\right)$

17.3.10. $\bar{x} = \pi/2,\ \bar{y} = \pi/8$

17.3.11. $M = \displaystyle\int_0^{2\pi}\int_0^{1+\cos\theta}(2 + \cos\theta)r\,dr\,d\theta,$
$M_x = \displaystyle\int_0^{2\pi}\int_0^{1+\cos\theta}\sin\theta(2 + \cos\theta)r^2\,dr\,d\theta,$
$M_y = \displaystyle\int_0^{2\pi}\int_0^{1+\cos\theta}\cos\theta(2 + \cos\theta)r^2\,dr\,d\theta.$

17.3.12. $M = \displaystyle\int_{-\pi/2}^{\pi/2}\int_0^{\cos\theta}(r + 1)r\,dr\,d\theta,$
$M_x = \displaystyle\int_{-\pi/2}^{\pi/2}\int_0^{\cos\theta}\sin\theta(r + 1)r^2\,dr\,d\theta,$
$M_y = \displaystyle\int_{-\pi/2}^{\pi/2}\int_0^{\cos\theta}\cos\theta(r + 1)r^2\,dr\,d\theta.$

17.3.13. $M = \displaystyle\int_{-\pi/2}^{\pi/2}\int_{\cos\theta}^{1+\cos\theta} r\,dr\,d\theta + \int_{\pi/2}^{3\pi/2}\int_0^{1+\cos\theta} r\,dr\,d\theta,$
$M_x = \displaystyle\int_{-\pi/2}^{\pi/2}\int_{\cos\theta}^{1+\cos\theta} r^2\sin\theta\,dr\,d\theta + \int_{\pi/2}^{3\pi/2}\int_0^{1+\cos\theta} r^2\sin\theta\,dr\,d\theta,$
$M_y = \displaystyle\int_{-\pi/2}^{\pi/2}\int_{\cos\theta}^{1+\cos\theta} r^2\cos\theta\,dr\,d\theta + \int_{\pi/2}^{3\pi/2}\int_0^{1+\cos\theta} r^2\cos\theta\,dr\,d\theta.$

17.4.1. $\pi a\sqrt{h^2 + a^2}$

17.4.2. $\pi a^2\sqrt{m^2 + 1}$

17.4.3. $\sqrt{3}/2$

17.4.4. $\pi\sqrt{2}$

17.4.5. $\pi\sqrt{2}/8$

17.4.6. $\pi/2 - 1$

17.4.7. $\dfrac{d^2\sqrt{a^2 + b^2 + c^2}}{2abc}$

17.4.8. $8\sqrt{3}\pi/3$

17.5.1. $11/24$

17.5.2. $623/60$

17.5.3. $-3e^2/4 + 2e - 3/4$

17.5.4. $1/20$

17.5.5. $\pi/48$

17.5.6. $11/84$

17.5.7. $151/60$

17.5.8. π

17.5.10. $\dfrac{3\pi}{16}$

17.5.11. 32

17.5.12. $64/3$

17.5.13. $\bar{x} = \bar{y} = 0,\ \bar{z} = 16/15$

17.5.14. $\bar{x} = \bar{y} = 0,\ \bar{z} = 1/3$

17.6.1. $\pi/12$

17.6.2. $\pi(1 - \sqrt{2}/2)$

17.6.3. $5\pi/4$

17.6.4. 0

17.6.5. $5\pi/4$

17.6.6. $4/5$

17.6.7. $256\pi/15$

17.6.8. $4\pi^2$

17.6.9. $\dfrac{3\pi}{16}$

17.6.10. $\pi kh^2a^2/12$

17.6.11. $\pi kha^3/6$

17.6.12. $\pi^2/4$

17.6.13. $4\pi/5$

17.6.14. 15π

17.6.15. $9k\pi(5\sqrt{2} - 2\sqrt{5})/20$

17.7.1. $4\pi\sqrt{3}/3$

17.7.2. 0

17.7.3. $8/3$

17.7.4. $\dfrac{e^2 - 1}{2e^2}$

17.7.5. 36

17.7.6. $32(\sqrt{2} + \ln(1 + \sqrt{2}))/3$

17.7.7. $3\cos(1) - 3\cos(4)$

17.7.8. $\pi(1 - \cos(1))/24$

17.7.10. $(4/3)\pi abc$

18.2.1. $13\sqrt{11}/4$

18.2.2. 0

18.2.3. $3\sin(4)/2$

18.2.4. 0

18.2.5. $2e^3$

18.2.6. 128

18.2.7. $(9e - 3)/2$

18.2.8. $e^{e+1} - e^e - e^{1/e-1} + e^{1/e} + e^4/4 - e^{-4}/4$

18.2.9. $1 + \sin(1) - \cos(1)$

18.2.10. $3\ln 3 - 2\ln 2$

18.2.11. $3/20 + 10\ln(2)/7$

18.2.12. $2\ln 5 - 2\ln 2 + 15/32$

18.2.13. 1

18.2.14. 0

18.2.15. $21 + \cos(1) - \cos(8)$

18.2.16. $(\ln 29 - \ln 2)/2$

18.2.17. $2\ln 2 + \pi/4 - 2$

18.2.18. $1243/3$

18.2.19. $\ln 2 + 11/3$

18.2.20. $3\cos(1) - \cos(2) - \cos(4) - \cos(8)$

18.2.21. $-10/3$

18.3.1. no f

18.3.2. $x^4/4 - y^5/5$

18.3.3. no f

18.3.4. no f

18.3.5. $y\sin x$

18.3.6. no f

18.3.7. xyz

18.3.8. 414

18.3.9. 6

18.3.10. $1/e - \sin 3$

18.3.11. $1/\sqrt{77} - 1/\sqrt{3}$

18.4.1. 1

18.4.2. 0

18.4.3. $1/(2e) - 1/(2e^7) + e/2 - e^7/2$

18.4.4. $1/2$

18.4.5. $-1/6$

18.4.6. $(2\sqrt{3} - 10\sqrt{5} + 8\sqrt{6})/3 - 2\sqrt{2}/5 + 1/5$

18.4.7. $11/2 - \ln(2)$

18.4.8. $2 - \pi/2$

18.4.9. $-17/12$

18.4.10. 0

18.4.11. $-\pi/2$

18.4.12. 12π

18.4.13. $2\cos(1) - 2\sin(1) - 1$

18.5.1. $-1, 0$

18.5.2. $0, a + b$

18.5.3. $(2b - a)/3, 0$

18.5.4. $0, 1$

18.5.5. $-2\pi, 0$

18.5.6. $0, 2\pi$

18.6.3. $25\sqrt{21}/4$

18.6.4. $\pi\sqrt{21}$

18.6.5. $\pi(5\sqrt{5} - 1)/6$

18.6.6. $4\pi\sqrt{2}$

18.6.7. $\pi a^2/2$

18.6.8. $2\pi a(a - \sqrt{a^2 - b^2})$

18.6.9. $\pi((1 + 4a^2)^{3/2} - 1)/6$

18.6.10. $2\pi((1 + a^2)^{3/2} - 1)/3$

18.6.11. $\pi a^2 - 2a^2$

18.6.12. $\pi a^2\sqrt{1 + k^2}/4$

18.6.13. $A\sqrt{1 + a^2 + b^2}$

18.6.14. $A\sqrt{k^2 + 1}$

18.6.15. $8a^2$

18.7.1. $(0, 0, 3/8)$

18.7.2. $(11/20, 11/20, 3/10)$

18.7.3. $(0, 0, 2275/682)$

18.7.4. on center axis, $h/3$ above the base

18.7.5. 16

18.7.6. 7

18.7.7. $-\pi$

18.7.8. $-137/120$

18.7.9. $-2/e$

18.7.10. $\pi b^2(-4b^4 - 3b^2 + 6a^2b^2 + 6a^2)/6$

18.7.11. 9280 kg/s

18.7.12. $24\epsilon_0$

18.8.1. -3π

18.8.2. 0

18.8.3. -4π

18.8.4. 3π

18.8.5. $A(p(c - b) + q(a - c) + a - b)$

18.9.1. both are $-45\pi/4$

18.9.2. $a^2bc + ab^2c + abc^2$

18.9.3. $e^2 - 2e + 7/2$

18.9.4. 3

18.9.5. $384\pi/5$

18.9.6. $\pi/3$

18.9.7. 10π

18.9.8. $\pi/2$

19.1.2. $y = \arctan t + C$

19.1.3. $y = \dfrac{t^{n+1}}{n + 1} + 1$

19.1.4. $y = t\ln t - t + C$

19.1.5. $y = n\pi$, for any integer n.

19.1.6. none

19.1.7. $y = \pm\sqrt{t^2 + C}$

19.1.8. $y = \pm 1, y = (1 + Ae^{2t})/(1 - Ae^{2t})$

19.1.9. $y^4/4 - 5y = t^2/2 + C$

19.1.10. $y = (2t/3)^{3/2}$

19.1.11. $y = M + Ae^{-kt}$

19.1.12. $\dfrac{10\ln(15/2)}{\ln 5} \approx 2.52$ minutes

19.1.13. $y = \dfrac{M}{1 + Ae^{-Mkt}}$

19.1.14. $y = 2e^{3t/2}$

19.1.15. $t = -\dfrac{\ln 2}{k}$

19.1.16. $600e^{-6\ln 2/5} \approx 261$ mg; $\dfrac{5\ln 300}{\ln 2} \approx$ 41 days

19.1.17. $100e^{-200\ln 2/191} \approx$ 48 mg; $\dfrac{5730\ln 50}{\ln 2} \approx 32339$ years

19.1.18. $y = y_0 e^{t\ln 2}$

19.1.19. $500e^{-5\ln 2/4} \approx 210$ g

19.2.1. $y = Ae^{-5t}$

19.2.2. $y = Ae^{2t}$

19.2.3. $y = Ae^{-\arctan t}$

19.2.4. $y = Ae^{-t^3/3}$

19.2.5. $y = 4e^{-t}$

19.2.6. $y = -2e^{3t-3}$

19.2.7. $y = e^{1+\cos t}$

19.2.8. $y = e^2 e^{-e^t}$

19.2.9. $y = 0$

19.2.10. $y = 0$

19.2.11. $y = 4t^2$

19.2.12. $y = -2e^{(1/t)-1}$

19.2.13. $y = e^{1-t^{-2}}$

19.2.14. $y = 0$

19.2.15. $k = \ln 5, y = 100e^{-t\ln 5}$

19.2.16. $k = -12/13, y = \exp(-13t^{1/13})$

19.2.17. $y = 10^6 e^{t\ln(3/2)}$

19.2.18. $y = 10e^{-t\ln(2)/6}$

19.3.1. $y = Ae^{-4t} + 2$

19.3.2. $y = Ae^{2t} - 3$

19.3.3. $y = Ae^{-(1/2)t^2} + 5$

19.3.4. $y = Ae^{-e^t} - 2$

19.3.5. $y = Ae^t - t^2 - 2t - 2$

19.3.6. $y = Ae^{-t/2} + t - 2$

19.3.7. $y = At^2 - \dfrac{1}{3t}$

19.3.8. $y = \dfrac{c}{t} + \dfrac{2}{3}\sqrt{t}$

19.3.9. $y = A\cos t + \sin t$

19.3.10. $y = \dfrac{A}{\sec t + \tan t} + 1 - \dfrac{t}{\sec t + \tan t}$

19.4.1. $y(1) \approx 1.355$

19.4.2. $y(1) \approx 40.31$

19.4.3. $y(1) \approx 1.05$

19.4.4. $y(1) \approx 2.30$

19.5.4. $\dfrac{\omega + 1}{2\omega}e^{\omega t} + \dfrac{\omega - 1}{2\omega}e^{-\omega t}$

19.5.5. $2\cos(3t) + 5\sin(3t)$

19.5.6. $-(1/4)e^{-5t} + (5/4)e^{-t}$

19.5.7. $-2e^{-3t} + 2e^{4t}$

19.5.8. $5e^{-6t} + 20te^{-6t}$

19.5.9. $(16t - 3)e^{4t}$

19.5.10. $-2\cos(\sqrt{5}t) + \sqrt{5}\sin(\sqrt{5}t)$

19.5.11. $-\sqrt{2}\cos t + \sqrt{2}\sin t$

19.5.12. $e^{-6t}\left(4\cos t + 24\sin t\right)$

19.5.13. $2e^{-3t}\sin(3t)$

19.5.14. $2\cos(2t - \pi/6)$

19.5.15. $5\sqrt{2}\cos(10t - \pi/4)$

19.5.16. $\sqrt{2}e^{-2t}\cos(3t - \pi/4)$

19.5.17. $5e^{4t}\cos(3t + \arcsin(4/5))$

19.5.18. $(2\cos(5t) + \sin(5t))e^{-2t}$

19.5.19. $-(1/2)e^{-2t}\sin(2t)$

19.6.1. $Ae^{5t} + Bte^{5t} + (6/169)\cos t - (5/338)\sin t$

19.6.2. $Ae^{-\sqrt{2}t} + Bte^{-\sqrt{2}t} + 5$

19.6.3. $A\cos(4t) + B\sin(4t) + (1/2)t^2 + (3/16)t - 5/16$

19.6.4. $A\cos(\sqrt{2}t) + B\sin(\sqrt{2}t) - (\cos(5t) + \sin(5t))/23$

19.6.5. $e^t(A\cos t + B\sin t) + e^{2t}/2$

19.6.6. $Ae^{\sqrt{6}t} + Be^{-\sqrt{6}t} + 2 - t/3 - e^{-t}/5$

19.6.7. $Ae^{-3t} + Be^{2t} - (1/5)te^{-3t}$

19.6.8. $Ae^t + Be^{3t} + (1/2)te^{3t}$

19.6.9. $A\cos(4t) + B\sin(4t) + (1/8)t\sin(4t)$

19.6.10. $A\cos(3t) + B\sin(3t) - (1/2)t\cos(3t)$

19.6.11. $Ae^{-6t} + Bte^{-6t} + 3t^2e^{-6t}$

19.6.12. $Ae^{4t} + Bte^{4t} - t^2e^{4t}$

19.6.13. $Ae^{-t} + Be^{-5t} + (4/5)$

19.6.14. $Ae^{4t} + Be^{-3t} + (1/144) - (t/12)$

19.6.15. $A\cos(\sqrt{5}t) + B\sin(\sqrt{5}t) + 8\sin(2t)$

19.6.16. $Ae^{2t} + Be^{-2t} + te^{2t}$

19.6.17. $4e^t + e^{-t} - 3t - 5$

19.6.18. $-(4/27)\sin(3t) + (4/9)t$

19.6.19. $e^{-6t}(2\cos t + 20\sin t) + 2e^{-4t}$

19.6.20. $\left(-\dfrac{23}{325}\cos(3t) + \dfrac{592}{975}\sin(3t)\right)e^{-3t} + \dfrac{23}{325}\cos t - \dfrac{11}{325}\sin t$

19.6.21. $e^{-2t}(A\sin(5t) + B\cos(5t)) + 8\sin(2t) + 25\cos(2t)$

19.6.22. $e^{-2t}(A\sin(2t) + B\cos(2t)) + (14/195)\sin t - (8/195)\cos t$

19.7.1. $A\sin(t) + B\cos(t) - \cos t \ln|\sec t + \tan t|$

19.7.2. $A\sin(t) + B\cos(t) + \dfrac{1}{5}e^{2t}$

19.7.3. $A\sin(2t) + B\cos(2t) + \cos t - \sin t \cos t \ln|\sec t + \tan t|$

19.7.4. $A\sin(2t) + B\cos(2t) + \dfrac{1}{2}\sin(2t)\sin^2(t) + \dfrac{1}{2}\sin(2t)\ln|\cos t| - \dfrac{t}{2}\cos(2t) + \dfrac{1}{4}\sin(2t)\cos(2t)$

19.7.5. $Ae^{2t} + Be^{-3t} + \dfrac{t^3}{15}e^{2t} - \left(\dfrac{t^2}{5} - \dfrac{2t}{25} + \dfrac{2}{125}\right)\dfrac{e^{2t}}{5}$

19.7.6. $Ae^t \sin t + Be^t \cos t - e^t \cos t \ln|\sec t + \tan t|$

19.7.7. $Ae^t \sin t + Be^t \cos t - \dfrac{1}{10}\cos t(\cos^3 t + 3\sin^3 t - 2\cos t - \sin t) + \dfrac{1}{10}\sin t(\sin^3 t - 3\cos^3 t - 2\sin t + \cos t) = \dfrac{1}{10}\cos(2t) - \dfrac{1}{20}\sin(2t)$