Answers to Odd-Numbered Problems

Chapter 1

1. (*a*) 3;
(*b*) 4;
(*c*) 3;
(*d*) 1;
(*e*) 2;
(*f*) 4;
(*g*) 2.

3. (*a*) 86,900;
(*b*) 9100;
(*c*) 0.88;
(*d*) 476;
(*e*) 0.0000362.

5. 4.6%.

7. 1.00×10^5 s.

9. 1%.

11. $(3.0 \pm 0.2) \times 10^9$ cm^2.

13. (*a*) 1 megavolt;
(*b*) 2 micrometers;
(*c*) 6 kilodays;
(*d*) 18 hectobucks;
(*e*) 700 nanoseconds.

15. (*a*) 1.5×10^{11} m;
(*b*) 1.5×10^8 km.

17. (*a*) 3.9×10^{-9} in.;
(*b*) 1.0×10^8 atoms.

19. (*a*) 9.46×10^{15} m;
(*b*) 6.31×10^4 AU.

21. Soccer; 9.4 yd, 8.6 m, 9.4%.

23. (*a*) 10^{12} protons or neutrons;
(*b*) 10^{10} protons or neutrons;
(*c*) 10^{29} protons or neutrons;
(*d*) 10^{68} protons or neutrons.

25. (*a*) 10^3;
(*b*) 10^5;
(*c*) 10^{-2};
(*d*) 10^9.

27. 500 hr.

29. 2.5 hr.

31. (*a*) 700;
(*b*) answers vary.

33. Second method.

35. 8.8 s.

37. (*a*) L/T^4, L/T^2;
(*b*) m/s^4, m/s^2.

39. 10^{-35} m.

41. 3.3×10^5 chips/cylinder.

43. 46,000 years.

45. 400 jelly beans.

47. 75 minutes.

49. 5×10^5 metric tons, 1×10^8 gal.

51. 3000 m.

53. (*a*) 0.10 nm;
(*b*) 1.0×10^5 fm;
(*c*) 1.0×10^{10} angstroms;
(*d*) 9.5×10^{25} angstroms.

55. (*a*) 3%, 3%;
(*b*) 0.7%, 0.2%.

57. 8×10^{-2} m^3.

59. 1.18×10^9 atoms/m^2.

61. 4×10^{51} kg.

Chapter 2

1. 53 m.

3. 0.57 cm/s, no, we need the distance traveled.

5. 0.14 h.

7. (*a*) 350 km;
(*b*) 78 km/h.

9. (*a*) 3.68 m/s;
(*b*) 0.

11. 38 s.

13. 1.6 min.

15. 6.00 m/s.

17. 6.1 m/s^2.

19. 6.0 m/s^2, 0.61*g*'s.

21. (*a*) 21.2 m/s;
(*b*) 2.00 m/s^2.

23. 1 m/s^2, 110 m.

25. 260 m/s^2.

27. 112 m.

29. 44*g*'s.

31. (*a*) 130 m;
(*b*) 69 m.

33. 21 m/s.

35. 6.3 s.

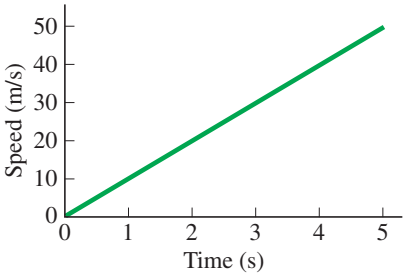
37. 0.70 m/s^2.

39. 61.8 m.

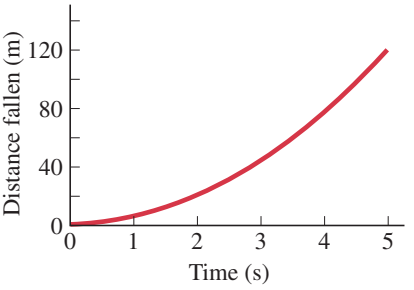
41. 17 m/s, 14 m.

43. 1.09 s.

45. (*a*)



(*b*)



49. 5.21 s.

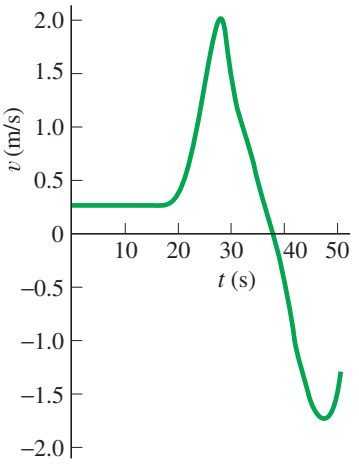
51. 12 m/s.

53. 1.6 m.

55. (*a*) 48 s;
(*b*) 90 s to 108 s;
(*c*) 0 s to 42 s, 65 s to 83 s, 90 s to 108 s;
(*d*) 65 s to 83 s.

57. (*a*) 0.3 m/s;
(*b*) 1.2 m/s;
(*c*) 0.30 m/s;
(*d*) 1.4 m/s;
(*e*) −0.95 m/s.

59.



61. 1.2 m.

63. 3.1 m.

65. (*a*) 14.4 s, no;
(*b*) no, 4.6 s.

67. (*b*) 4.8 m;
(*c*) 36 m.

69. $-20\ \text{m/s}^2$.

71. (*a*) 5.80 s;
(*b*) 41.4 m/s;
(*c*) 99.5 m.

73. She should try to stop the car.

75. 1.5 poles.

77. 30%.

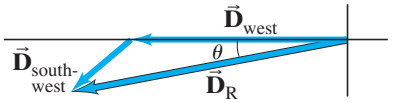
79. 245.0 km/h.

81. 23.7 s, 840 km/h.

83. (*a*) 4.3×10^6 bits;
(*b*) 67%.

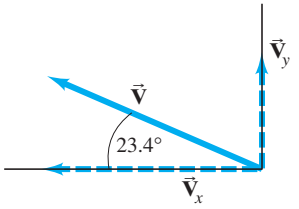
Chapter 3

1. 302 km, 13° south of west.



3. 11.70 units, −33.1°.

5. (*a*)



(*b*) −22.8 units, 9.85 units;
(*c*) 24.8 units, 23.4° above the $-x$ axis.

7. (*a*) 1.3 units, positive x direction;
(*b*) 12.3 units, positive x direction;
(*c*) 12.3 units, negative x direction.

9. (*a*) x component 24.0, y component 11.6;
(*b*) 26.7 units, 25.8°.

11. 64.6, 53.1°.

13. (*a*) 62.6, −31.0°;
(*b*) 77.5, 71.9°;
(*c*) 77.5, 251.9°.

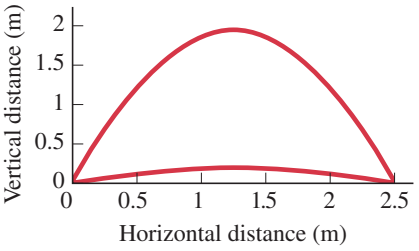
15. (−2845 m, 3589 m, 2450 m), 5190 m.

17. 3.7 m.

19. 6 times farther.

21. 14.5 m.

23. 18°, 72°.



25. 2.0 m/s.

27. (*a*) 30.8 m;
(*b*) 5.02 s;
(*c*) 136 m;
(*d*) 28.9 m/s.

29. 22.3 m.

31. 481 m.

33. (*a*) 4.0 m.s, 55° above the horizontal;
(*b*) 4.6 m;
(*c*) 9.7 m/s, 76° below the horizontal.

35. No, 0.81 m too low; 4.6 m to 34.7 m.

37. (*a*) 4.0×10^1 m/s;
(*b*) 24 m/s.

39. 1.66 m/s, 25°.

41. 23.1 s.

43. (*a*) 10.4 m/s, 17° above the horizontal;
(*b*) 10.4 m/s, 17° below the horizontal.

45. 5.31° west of south.

47. (*a*) 56°;
(*b*) 140 s.

49. 23 s, 23 m.

51. 65 km/h, 58° west of north;
65 km/h, 32° south of east.

53. Horizontal: $3.9\ \text{m/s}^2$ leftward;
vertical: $1.9\ \text{m/s}^2$ downward.

55. 0.88 s, 0.95 m.

57. $1.7\ \text{m/s}^2$.

59. (*a*) 9.96 s;
(*b*) 531 m;
(*c*) 53.2 m/s, −60.4 m/s;
(*d*) 80.5 m/s;
(*e*) 48.6° below the horizon;
(*f*) 70.9 m.

61. $v_T/\tan\theta$.

63. (*a*) 13.3 m;
(*b*) 22.1°.

65. 33 m/s.

67. 54°.

69. (*a*) 2.51 m/s, 61.4°;
(*b*) 3.60 m downstream, 6.60 m across the river.

71. (*a*) 13 m;
(*b*) 31° below the horizontal.

73. (*a*) 68 m;
(*b*) 7.3 m/s.

75. 0.51%.

Chapter 4

1. 77 N.

3. 1450 N.

5. -1.3×10^6 N, 39%, 1.3×10^6 N.

7. −3100 N.

9. 780 N, backward.

11. (*a*) 196 N, 196 N;
(*b*) 98.0 N, 294 N.

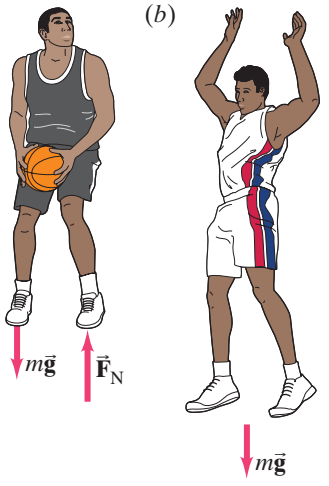
13. Descend with downward $a \geq 2.2\ \text{m/s}^2$.

15. $-2800\ \text{m/s}^2$, $280g$'s, 1.9×10^5 N.

17. (*a*) $-7.35\ \text{m/s}^2$;
(*b*) 1290 N.

19. (*a*) 7.4 m/s, downward;
(*b*) 2100 N, upward.

21. (*a*) (*b*)



23. 1410 N.

25. (*a*) 31 N (lower cord), 63 N (upper cord);
(*b*) 35 N (lower cord), 71 N (upper cord).

27. $F_{T1}/F_{T2} = 2$.

29. (*a*) $1.0 \times 10^1\ \text{m/s}^2$;
(*b*) 3.3 m/s.

31. (*a*) 23°;
(*b*) toward the windshield.

33. (*a*) $2.7\ \text{m/s}^2$;
(*b*) 0.96 s;
(*c*) 99 kg.

35. 34 N.

37. (*a*) 0.60;
(*b*) 0.53.
39. 42°.
41. 0.46.
43. 1200 N.
45. 1.4.
47. (*a*) 5.0 kg;
(*b*) 1.0×10^1 kg.
49. (*a*) 1.7 m/s^2;
(*b*) 430 N;
(*c*) 1.7 m/s^2, 220 N.
51. 1.20×10^2 N, in the direction opposite to the child's velocity.
53. 4.8 s.
55. 4.0×10^2 m.
57. (*a*) 3.67 m/s^2;
(*b*) 9.39 m/s.
59. (*a*) 2.5 m/s^2;
(*b*) 6.3 m/s.
61. -5.3 m/s^2.
63. 4.0×10^1 N.
65. -2.2 m/s^2.
67. (*a*) 1.6 m/s^2;
(*b*) 0.53.
69. 0.86 m/s^2.
71. 9.9°.
73. 73 m/s.
75. (*a*) 0.67;
(*b*) 6.1 m/s;
(*c*) 15 m/s.
77. 4.2°.
79. (*a*) 8.76×10^4 N, upward;
(*b*) 1.14×10^4 N;
(*c*) 1.14×10^4 N, downward.
81. (*a*) 45 N (10 lb);
(*b*) 37 N (8.4 lb);
(*c*) no, the fish cannot be lifted vertically by a 10-lb force.
83. 380 N (between second and last climbers), 760 N (between first and second climbers).
85. (*a*) 3.0 times her weight;
(*b*) 7.7 times his weight; Jim.
87. 23 m/s (85 km/h).
89. 4.90×10^2 N.
91. (*a*) 0.9 m/s^2;
(*b*) 0.98 m/s^2.
93. (*b*) Yes.
95. (*a*) 16 m/s;
(*b*) 13 m/s.
97. 1100 N, opposite to the velocity.

Chapter 5

1. (*a*) 1.01 m/s^2;
(*b*) 22.7 N.
3. 12 m/s.
5. 13 m/s.
7. 34 m/s.
9. 24 m/s, yes.
11. 8.5 rpm.
13. 1700 rev/day.
15. 0.210.
17. $F_A = 4\pi^2 f^2(m_A r_A + m_B r_B)$,
$F_B = 4\pi^2 f^2 m_B r_B$.
19. (*a*) 5970 N;
(*b*) 379 N;
(*c*) 29.4 m/s.
21. 930 m.
23. 59 km/h to 110 km/h.
25. $a_{tan} = 4.1$ m/s^2, $a_{rad} = 13$ m/s^2; 1.4.
27. (*a*) 0.930 m/s;
(*b*) 2.83 m/s.
29. (*a*) 24.0 kg on both;
(*b*) $w_{Earth} = 235$ N,
$w_{Planet} = 288$ N.
31. 3.94 kg, 0.06 kg.
33. 1.62 m/s^2.
35. 6.5×10^{23} kg.
37. 27.4 m/s^2.
39. (*a*) 9.78 m/s^2;
(*b*) 2.44 m/s^2.
41. 9.6×10^{17} N; 2.7×10^{-5}.
43. 2.02×10^7 m.
45. 7460 m/s.
47. 2.4 m/s^2 upward.
49. 7.05×10^3 s.
51. (*a*) 568 N;
(*b*) 568 N;
(*c*) 699 N;
(*d*) 440 N;
(*e*) 0.
53. (*a*) 59 N, away from the Moon;
(*b*) 76 N, toward the Moon.
55. 9.6 s.
57. 160 yr.
59. 84.5 min.
61. 2×10^8 yr.
63. Europa: 671×10^3 km,
Ganymede: 1070×10^3 km,
Callisto: 1880×10^3 km.
65. 5.4×10^{12} m; yes; Pluto.
67. 5.97×10^{-3} m/s^2, 3.56×10^{22} N; the Sun.
69. 28.3 m/s, 0.410 rev/s.
71. 0.18; no; the wall pushes against the riders, so by Newton's third law, they push against the wall.
73. 9.2 m/s.
75. (*a*) In circular motion, they accelerate toward each other without moving toward each other.
(*b*) 9.6×10^{29} kg.
77. Yes; $\sqrt{rg}$, where r is the radius of the vertical circle.
79. $T_{inner} = 2.0 \times 10^4$ s,
$T_{outer} = 7.1 \times 10^4$ s.
81. (*a*) 3900 m/s;
(*b*) 4.4×10^4 s.
83. 25.0 m/s.
85. (*a*) 7.6×10^6 m;
(*b*) 3.8×10^4 N;
(*c*) 1.2×10^6 m.
87. 1.21×10^6 m.
89. $0.44r$.

Chapter 6

1. 2.06×10^4 J.
3. 2300 J.
5. 1.0×10^6 J.
7. 1960 J.
9. 390 J.
11. 2 m.
13. (*a*) 2800 J;
(*b*) 2100 J.
15. 484 m/s.
17. -5.51×10^{-19} J.
19. The lighter one, $\sqrt{2}$; both the same.
21. 43 m/s.
23. 21 m/s.
25. (*a*) 3010 N;
(*b*) 7480 J;
(*c*) 5.42×10^4 J;
(*d*) -4.67×10^4 J;
(*e*) 7.51 m/s.
27. 1.01 m.
29. (*a*) 9.06×10^5 J;
(*b*) 9.06×10^5 J;
(*c*) yes.
31. 45.4 m/s.
33. 4.89 m/s.
35. 74 cm.
37. 1.4×10^5 N/m.
39. (*a*) 7.47 m/s;
(*b*) 3.01 m.

41. 52 m.
43. 12 Mg/h.
45. (*a*) 9.19×10^4 J;
(*b*) 433 N.
47. 332 J.
49. (*a*) 15.3 m/s;
(*b*) 1.03 N, upward.
51. 0.091.
53. 1.4×10^5 J.
55. (*a*) 2.8 m;
(*b*) 1.5 m;
(*c*) 1.5 m.
57. 22.0 s.
59. (*a*) 1100 J;
(*b*) 1100 W.
61. 2700 N.
63. 2.9×10^4 W, 38 hp.
65. 5.3×10^4 W.
67. 15.4 W.
69. 33 hp.
71. 610 W.
73. 14.9 m/s.
75. (*a*) $\sqrt{Fx/m}$;
(*b*) $\sqrt{3Fx/4m}$.
77. (*a*) 0.014 J;
(*b*) 0.039 J.
79. (*a*) -9.0×10^4 J;
(*b*) 8.2×10^4 N;
(*c*) -2.3×10^5 J.
81. 340 W.
83. (*a*) 1.0×10^4 J;
(*b*) 16 m/s.
85. (*a*) 42 m/s;
(*b*) 3.2×10^5 W.
87. (*b*) 420 kWh;
(*c*) 1.5×10^9 J;
(*d*) \$50, no.
89. (*a*) 8.9×10^5 J;
(*b*) 54 W, 0.072 hp;
(*c*) 360 W, 0.48 hp.
91. (*a*) 0.39 m;
(*b*) $\mu_s < 0.53$;
(*c*) 1.4 m/s.
93. 1.7×10^5 m^3.

Chapter 7

1. 0.24 kg·m/s.
3. 10.2 m/s.
5. 5.9×10^7 N, opposite the gas velocity.
7. −0.898 m/s.
9. 2500 m/s.
11. 0.99 m/s.
13. 4.9×10^6 N.
15. 2230 N, toward the pitcher.
17. (*a*) 9.0×10^1 kg·m/s;
(*b*) 1.1×10^4 N.
19. (*a*) −0.16 m/s;
(*b*) 521 N;
(*c*) astronaut: 391 J; capsule: 26 J.
21. (*a*) 290 kg·m/s eastward;
(*b*) 290 kg·m/s westward;
(*c*) 290 kg·m/s eastward;
(*d*) 340 N eastward.
23. (*a*) 5 N·s;
(*b*) 80 m/s.
25. 0.440-kg ball: 1.27 m/s, east;
0.220-kg ball: 5.07 m/s, east.
27. Tennis ball: 2.50 m/s; other ball: 5.00 m/s; both in direction of tennis ball's initial motion.
29. (*a*) 0.840 kg;
(*b*) 0.75.
31. (*a*) 1.7 m/s, in direction of initial incoming velocity;
(*b*) 1.2 kg.
33. $\sqrt{2}$.
35. Vertical: 0.15 m; horizontal: 0.90 m.
37. 21 m/s.
39. 0.84.
41. (*a*) 12.1 m/s;
(*b*) 56.4 J before, 13.7 J after.
43. (*a*) 920 m/s;
(*b*) 0.999.
45. 1.14×10^{-22} kg·m/s, 147° from the electron's momentum, 123° from the neutrino's momentum.
47. (*a*) 30°;
(*b*) $v_{\text{nucleus}} = v_{\text{target}} = v/\sqrt{3}$;
(*c*) 2/3.
49. 6.5×10^{-11} m.
51. 2.62 m.
53. $(1.2\ell,\ 0.9\ell)$ relative to back left corner.
55. $0.27R$ to the left of C.
57. 19% of the person's height along the line from shoulder to hand.
59. 4.3% of their height; no.
61. (*a*) 4.66×10^6 m from center of Earth.
63. (*a*) 5.8 m;
(*b*) 4.0 m;
(*c*) 4.2 m.
65. 0.45 m toward initial position of 85-kg person.
67. 2.0×10^1 m.
69. 8.
71. (*a*) $v'_A = 3.65$ m/s,
$v'_B = 4.45$ m/s;
(*b*) $\Delta p_A = -370$ kg·m/s,
$\Delta p_B = 370$ kg·m/s.
73. 110 km/h ≈ 70 mi/h.
75. 340 m/s.
77. (*a*) 8.6 m;
(*b*) 38 m.
79. (*a*) $v'_m = 3.98$ m/s, $v'_M = 4.42$ m/s;
(*b*) 1.62 m.
81. (*a*) 1.5×10^{21} J;
(*b*) 38,000.
83. (*a*) No;
(*b*) m_B/m_A;
(*c*) m_B/m_A;
(*d*) stays at rest.
85. $v_m = 3D\sqrt{\dfrac{k}{12m}}$, $v_{3m} = D\sqrt{\dfrac{k}{12m}}$.

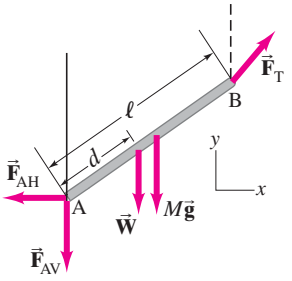
Chapter 8

1. (*a*) 0.785 rad, $\pi/4$ rad;
(*b*) 1.05 rad, $\pi/3$ rad;
(*c*) 1.57 rad, $\pi/2$ rad;
(*d*) 6.28 rad, 2π rad;
(*e*) 7.77 rad, $89\pi/36$ rad.
3. 5.3×10^3 m.
5. (*a*) 750 rad/s;
(*b*) 23 m/s;
(*c*) 4.5×10^7 bit/s.
7. (*a*) 230 rad/s;
(*b*) 4.0×10^1 m/s, 9.3×10^3 m/s^2.
9. (*a*) 0.105 rad/s;
(*b*) 1.75×10^{-3} rad/s;
(*c*) 1.45×10^{-4} rad/s;
(*d*) 0.
11. (*a*) 464 m/s;
(*b*) 185 m/s;
(*c*) 345 m/s.
13. 3.3×10^4 rpm.
15. (*a*) 1.5×10^{-4} rad/s^2;
(*b*) $a_{\text{rad}} = 1.2 \times 10^{-2}$ m/s^2,
$a_{\text{tan}} = 6.2 \times 10^{-4}$ m/s^2.
17. (*a*) −96 rad/s^2;
(*b*) 98 rev.
19. (*a*) 46 rev/min^2;
(*b*) 46 rpm.
21. 33 m.
23. (*a*) 0.53 rad/s^2;
(*b*) 13 s.
25. 1.2 m·N, clockwise.
27. $mg(\ell_2 - \ell_1)$, clockwise.

29. (*a*) 14 m·N;
(*b*) −13 m·N.
31. 0.12 kg·m^2.
33. 1.2×10^{-10} m.
35. (*a*) 7.8 m·N;
(*b*) 310 N.
37. 22 m·N.
39. (*a*) 7.0 kg·m^2;
(*b*) 0.70 kg·m^2;
(*c*) *y* axis.
41. 320 m·N; 130 N.
43. (*a*) 1.90×10^3 kg·m^2;
(*b*) 8.9×10^3 m·N.
45. 31 N.
47. (*a*) $a_A = 0.69$ m/s^2, upward;
$a_B = 0.69$ m/s^2, downward;
(*b*) 2%.
49. 125 hp.
51. 9.70 m/s.
53. (*a*) 2.6×10^{29} J;
(*b*) 2.7×10^{33} J.
55. 1.63×10^4 J.
57. $\sqrt{\frac{10}{7} g(R_0 - r_0)}$.
59. 7.27 m/s.
61. (*a*) 15 kg·m^2/s;
(*b*) −2.5 m·N.
63. $\frac{1}{2}\omega$.
65. 1.2 kg·m^2; by pulling her arms in toward the center of her body.
67. (*a*) 0.52 rad/s;
(*b*) $KE_{before} = 370$ J,
$KE_{after} = 2.0 \times 10^2$ J.
69. (*a*) 0.43 rad/s;
(*b*) 0.80 rad/s.
71. (*a*) 5×10^{-2} rad/s;
(*b*) $KE_f = 2 \times 10^4\ KE_i$.
73. (3.2×10^{-16})%.
75. 52 kg.
77. $f_{R_1} = 480$ rpm, $f_{R_2} = 210$ rpm.
79. 4.50 m/s.
81. (*a*) $\omega_R/\omega_F = N_F/N_R$;
(*b*) 4.0;
(*c*) 1.5.
83. (*a*) 3.5 m;
(*b*) 4.7 s.
85. $\dfrac{Mg\sqrt{2Rh - h^2}}{R - h}$.
87. (*a*) 4.84 J;
(*b*) $F_{4\,kg} = 26.3$ N, $F_{3\,kg} = 19.8$ N.
89. (*a*) $3g/2\ell$;
(*b*) $\frac{3}{2} g$.
91. $\ell/2$; $\ell/2$.
93. 27 h.
95. (*a*) 820 kg·m^2/s^2;
(*b*) 820 m·N;
(*c*) 930 W.

Chapter 9

1. 528 N, 120° clockwise from $\vec{\mathbf{F}}_A$.
3. (*a*) 2.3 m from vertical support;
(*b*) 4200 kg.
5. (*a*) $F_A = 1.5 \times 10^3$ N, down;
$F_B = 2.0 \times 10^3$ N, up;
(*b*) $F_A = 1.8 \times 10^3$ N, down;
$F_B = 2.6 \times 10^3$ N, up.
7. 1200 N.
9. $F_{closer} = 2900$ N, down;
$F_{farther} = 1300$ N, down.
11. (*a*) 2.3 m from the adult;
(*b*) 2.5 m from the adult.
13. $F_{left} = 260$ N, $F_{right} = 190$ N.
15. 20 N to 50 N.
17. 0.64 m to right of fulcrum rock.
19. (*a*) 410 N;
(*b*) horizontal: 410 N;
vertical: 328 N.
21. $F_A = 1.7 \times 10^4$ N,
$F_B = 7.7 \times 10^3$ N.
23. 6.0×10^1 N; the angle is small.
25. (*a*) 230 N;
(*b*) 1.0×10^2 N.
27. (*a*)



(*b*) $F_{A_{vertical}} = 9$ N,
$F_{A_{horizontal}} = 51$ N;
(*c*) 2.4 m.
29. $F_{top_{horizontal}} = 55.2$ N, right;
$F_{top_{vertical}} = 63.7$ N, up;
$F_{bottom_{horizontal}} = 55.2$ N, left;
$F_{bottom_{vertical}} = 63.7$ N, up;
31. 7.0 kg.
33. 2.4*w*.
35. 1600 N.
37. 1800 N.
39. (*b*) Yes, by $\frac{1}{24}$ of a brick length;
(*c*) $D = \sum_{i=1}^{n} \frac{\ell}{2i}$;
(*d*) 35 bricks;
41. (*a*) 1.8×10^5 N/m^2;
(*b*) 3.5×10^{-6}.
43. (*a*) 1.4×10^6 N/m^2;
(*b*) 6.9×10^{-6};
(*c*) 6.6×10^{-5} m.
45. 9.0×10^7 N/m^2, 9.0×10^2 atm.
47. 25 kg.
49. 1.7×10^{-2} J.
51. (*a*) 393 N;
(*b*) thicker.
53. (*a*) 3.7×10^{-5} m^2;
(*b*) 2.7×10^{-3} m.
55. 1.3 cm.
57. 12 m.
59. (*a*) $F_{left} = 310$ N, up;
$F_{right} = 210$ N, down;
(*b*) 0.65 m from right hand;
(*c*) 1.2 m from right hand.
61. 2.9×10^9 m·N, clockwise; no.
63. (*a*) 0.78 N;
(*b*) 0.98 N.
65. 3.5×10^{-4} m.
67. A: 230 N; B: 110 N.
69. 2.51 m.
71. 45°.
73. (*a*) 2100 N;
(*b*) 1.3.
75. 2500 N, no.
77. 2.6×10^{-4} m^2.
79. (*a*) 1.6 m;
(*b*) 1.2×10^4 N, no.
81. (4.0×10^1)°.

Chapter 10

1. 3×10^{11} kg.
3. 710 kg.
5. 0.8547.
7. (*a*) 5501 kg/m^3.
(*b*) 5497 kg/m^3, −0.07%.
9. (*a*) 6.1×10^6 N/m^2;
(*b*) 1.7×10^5 N/m^2.
11. (*a*) 4.5×10^5 N;
(*b*) 4.5×10^5 N.
13. 1.2 m.
15. 1900 kg.
17. (*a*) 7.0×10^5 N/m^2;
(*b*) 72 m.
19. 1.60×10^4 m.
21. 4.0×10^7 N/m^2.
23. 0.57.
25. (*a*) 1.5×10^5 N;
(*b*) 1.8×10^5 N.
27. Iron or steel.
29. 9.9×10^{-3} m^3.

31. 10.5%.
33. 32 bottles.
35. 0.88.
37. (*a*) $6.68 \times 10^{-2}\ \text{m}^3$;
(*b*) 1.07;
(*c*) 12%.
39. 9 N, down, 21 N, up.
41. 4.4 m/s.
43. 9.6 m/s.
45. $4.12 \times 10^{-3}\ \text{m}^3/\text{s}$.
47. $1.6 \times 10^5\ \text{N/m}^2$.
49. 1.2×10^5 N.
51. 9.7×10^4 Pa.
53. 2.5 m/s, 2.2 atm.
57. 1100 N.
59. 8.2×10^3 Pa.
61. 0.094 m.
63. (*a*) Laminar;
(*b*) 2940, turbulent.
65. 0.89 Pa/cm.
67. 2.4×10^{-2} N/m.
69. (*a*) $\gamma = F/4\pi r$;
(*b*) 1.7×10^{-2} N/m.
71. 1.5 mm.
73. (*a*) 7.6×10^{-4} N;
(*b*) 1.3 N.
75. $F_{T_{string}} = 0.71$ N, 984.2 g.
77. (*a*) $1.0 \times 10^{-3}\ \text{m}^2$;
(*b*) 4.0×10^3 J;
(*c*) 5.3×10^{-3} m;
(*d*) 80 strokes.
79. 0.6 atm.
81. 1.0 m.
83. 2×10^7 Pa.
85. $1.89 \times 10^4\ \text{m}^3$.
87. 5.29×10^{18} kg.
89. (*a*) 7.9 m/s;
(*b*) 0.22 L/s;
(*c*) 0.79 m/s.
91. 130 N.
93. $1.2 \times 10^4\ \text{N/m}^2$.
95. $3.5 \times 10^{-3}\ \text{Pa}\cdot\text{s}$.
97. 0.27 kg.
99. 68%.

Chapter 11

1. 0.84 m.
3. 560 N/m.
5. (*a*) 650 N/m;
(*b*) 2.1 cm, 2.6 Hz.
7. 0.85 kg.
9. (*a*) $A_A = 2.5$ m, $A_B = 3.5$ m;
(*b*) $f_A = 0.25$ Hz, $f_B = 0.50$ Hz;
(*c*) $T_A = 4.0$ s, $T_B = 2.0$ s.
11. ±70.7% of the amplitude.
13. 0.233 s.
15. (*a*) 2.1 m/s;
(*b*) 1.5 m/s;
(*c*) 0.54 J;
(*d*) $x = (0.15\ \text{m})\cos(4.4\pi t)$.
17. $\sqrt{3}:1$.
19. (*a*) 430 N/m;
(*b*) 4.6 kg.
21. (*a*) 0.436 s, 2.29 Hz;
(*b*) 0.157 m;
(*c*) $32.6\ \text{m/s}^2$;
(*d*) 2.26 J;
(*e*) 1.90 J.
23. 68.0 N/m, 15.6 m.
25. (*a*) $y = (0.16\ \text{m})\cos(14\,t)$;
(*b*) 0.11 s;
(*c*) 2.2 m/s;
(*d*) $31\ \text{m/s}^2$, at the release point.
27. 3.0 s.
29. (*a*) 1.8 s;
(*b*) 0.56 Hz.
31. Shorten it by 0.5 mm.
33. $\frac{1}{3}$.
35. 2.3 m/s.
37. (*a*) 1400 m/s;
(*b*) 4100 m/s;
(*c*) 5100 m/s.
39. (*a*) 1400 km;
(*b*) No; need readings from at least two other stations.
41. 4.8 N.
43. 21 m.
45. (*a*) $8.7 \times 10^9\ \text{J/m}^2\cdot\text{s}$;
(*b*) 1.7×10^{10} W.
47. $\sqrt{5}:1$.
49. 440 Hz, 880 Hz, 1320 Hz, 1760 Hz.
51. 60 Hz, fundamental or first harmonic; 120 Hz, first overtone or second harmonic; 180 Hz, second overtone or third harmonic.
53. 70 Hz.
55. (*a*) 1.2 kg;
(*b*) 0.29 kg;
(*c*) 4.6×10^{-2} kg.
57. 1.3 m/s.
59. 24°.
61. 460 Hz; $f < 460$ Hz.
63. 0.11 m.
65. Mg/k.
67. (*a*) $1.16f$;
(*b*) $0.81f$.
69. 2.6×10^{13} Hz.
71. (*a*) 1.3 Hz;
(*b*) 12 J.
73. (*a*) 3.7×10^4 N/m.
(*b*) 0.50 s.
75. 8.40×10^2 N/m.
77. 0.13 m/s, $0.12\ \text{m/s}^2$; 1.2%.
79. (*a*) 0.06 m;
(*b*) 7.1.
81. (*a*) G: 784 Hz, 1180 Hz; B: 988 Hz, 1480 Hz;
(*b*) 1.59 : 1;
(*c*) 1.26 : 1;
(*d*) 0.630 : 1.
83. 227 Hz.
85. 18 W.
87. (*a*) $\theta_{iM} = \sin^{-1}(v_{air}/v_{water})$
$= \sin^{-1}(v_i/v_r)$;
(*b*) 0.44 m.

Chapter 12

1. 430 m.
3. (*a*) 1.7 cm to 17 m;
(*b*) 1.9×10^{-5} m.
5. (*a*) 0.994 s;
(*b*) 4.52 s.
7. 33 m.
9. 62 dB.
11. 82 dB.
13. 82-dB player: 1.6×10^8;
98-dB player: 6.3×10^9.
15. (*a*) 790 W;
(*b*) 440 m.
17. (*a*) 12;
(*b*) 11 dB.
19. 130 dB.
21. (*a*) 220-W: 122 dB; 45-W: 115 dB;
(*b*) no.
23. 80 Hz, 15,000 Hz.
25. 10 octaves.
27. 87 N.
29. (*a*) 360 Hz;
(*b*) 540 Hz.
31. 260 Hz.
33. (*a*) 0.22 m;
(*b*) 1.02 m;
(*c*) $f = 440$ Hz, $\lambda = 0.78$ m.
35. 1.9%.

37. (*a*) 0.585 m;
(*b*) 858 Hz.
39. (*a*) 55 Hz;
(*b*) 190 m/s.
41. (*a*) 253 overtones;
(*b*) 253 overtones.
43. 4.2 cm, 8.2 cm, 11.9 cm, 15.5 cm, 18.8 cm, 22.0 cm.
45. $I_2/I_1 = 0.64$; $I_3/I_1 = 0.20$; $\beta_{2-1} = -2$ dB; $\beta_{3-1} = -7$ dB.
47. 28.5 kHz.
49. 347 Hz.
51. (*a*) 0.562 m;
(*b*) 0.
53. (*a*) 343 Hz;
(*b*) 1000 Hz, 1700 Hz.
55. (*a*) 8.9 beats per second;
(*b*) 38 m.
57. 4.27×10^4 Hz.
59. 3.11×10^4 Hz.
61. (*a*) Every 1.4 s;
(*b*) every 11 s.
63. 0.0821 m/s.
65. 11 km/h.
67. (*a*) 99;
(*b*) 0.58°.
69. (*a*) 36°;
(*b*) 560 m/s, 1.7.
71. 0.12 s.
73. 88 dB.
75. 14 W.
77. (*a*) 51 dB;
(*b*) 5×10^{-9} W.
79. 635 Hz.
81. $\mu_{2nd} = 0.44\mu_{lowest}$,
$\mu_{3rd} = 0.20\mu_{lowest}$,
$\mu_{4th} = 0.088\mu_{lowest}$.
83. 150 Hz, 460 Hz, 770 Hz, 1100 Hz.
85. 2.35 m/s.
87. 2.62 m.
89. 11.5 m.
91. $\frac{1}{1000}$.
93. 36 Hz, 48 Hz, 61 Hz.
95. 10^6.

Chapter 13

1. $N_{gold} = 0.548N_{silver}$.
3. (*a*) 20°C;
(*b*) 3500°F.
5. 102.0°F.
7. −40°C = −40°F.
9. 0.08 m.
11. 2.2×10^{-6} m; $\frac{1}{60}$ of the change for steel.
13. −70°C.
15. 0.98%.
17. −210°C.
19. 4.0×10^7 N/m^2.
21. −459.67°F.
23. 1.25 m^3.
25. (*a*) 0.2754 m^3;
(*b*) −63°C.
27. (*a*) 22.8 m^3;
(*b*) 2.16×10^5 Pa.
29. 1.69×10^8 Pa.
31. 7.4%.
33. 33%.
35. Actual: 0.598 kg/m^3, ideal: 0.588 kg/m^3; near a phase change.
37. 1.07 cm.
39. 55.51 mol, 3.343×10^{25} molecules.
41. 300 molecules/cm^3.
43. (*a*) 5.65×10^{-21} J;
(*b*) 3700 J.
45. 1.22.
47. 3.5×10^{-9} m/s.
49. $\sqrt{3}$.
53. $\frac{(v_{rms})_{^{235}UF_6}}{(v_{rms})_{^{238}UF_6}} = 1.004$.
55. Vapor.
57. (*a*) Vapor;
(*b*) solid.
59. 3200 Pa.
61. 18°C.
63. 0.91 kg.
65. 2.5 kg.
67. (*a*) Greater than;
(*b*) (-2.0×10^{-4})%;
(*c*) 0.603%.
69. (*b*) 4×10^{-11} mol/s;
(*c*) 0.6 s.
71. (*a*) Low;
(*b*) (2.8×10^{-2})%.
73. 18%.
75. (*a*) 1500 kg;
(*b*) 200 kg enters.
77. (*a*) Lower;
(*b*) 0.36%.
79. 910 min.
81. (*a*) 0.66×10^3 kg/m^3;
(*b*) −3.0%.
83. 2300 m.
85. (*a*) 290 m/s;
(*b*) 9.5 m/s.
87. PE/KE = 8.50×10^{-5}, yes.
89. 0.30 kg.
91. 2.4 kg.

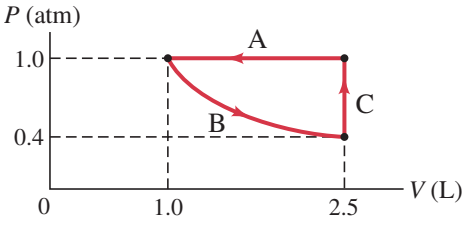
Chapter 14

1. 10.7°C.
3. 0.04 candy bars.
7. 250 kg/h.
9. 6.0×10^6 J.
11. (*a*) 3.3×10^5 J;
(*b*) 5600 s.
13. 4.0×10^2 s.
15. 42.6°C.
17. 2.3×10^3 J/kg·C°.
19. 43 C°.
21. 0.39 C°.
23. 473 kcal.
25. 7.1×10^6 J.
27. 0.18 kg.
29. (*a*) 5.2×10^5 J;
(*b*) 1.5×10^5 J.
31. 11.2 kJ/kg.
33. 2.7 g.
35. 5.2 g.
37. 93 J/s = 93 W.
39. 7.5×10^4 s.
41. 20 bulbs.
43. 3.1×10^4 s.
45. 350 Btu/h.
47. (*a*) 3.2×10^{26} W;
(*b*) 1.1×10^3 W/m^2.
49. A mixture of $\frac{1}{3}$ steam and $\frac{2}{3}$ liquid water at 100°C.
51. 2 C°.
53. 6.6×10^3 kcal.
55. 4.0×10^2 m/s.
57. 450°C.
59. 0.14 C°.
61. 1.43×10^3 m/s, toward the Earth.
63. 19 min.
65. (*a*) 3.4 W;
(*b*) 2.3 C°/s;
(*c*) no, $T > 8000$°C in less than an hour;
(*d*) 86°C;
(*e*) conduction, convection, evaporation.
67. (*a*) 3.6×10^7 J;
(*b*) 63 min.

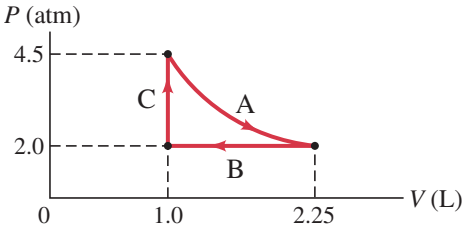
Chapter 15

1. (*a*) 0;
(*b*) 4.30×10^3 J.

3.



5.



7. (*a*) 0;
(*b*) 2630 J;
(*c*) rise.

9. −78 K.

13. (*a*) −82 J;
(*b*) 27 J;
(*c*) 55 J;
(*d*) 28 J;
(*e*) 16 J.

15. 170 W.

17. (*a*) 1.4×10^7 J;
(*b*) 3500 Cal.

19. 25.8%.

21. 8.8%.

23. 10°C decrease in the low-temperature reservoir.

25. 1.7×10^{13} J/h.

27. 1800 W.

29. 420°C.

31. 0.15.

33. 6.5.

35. (*a*) 1.0×10^3 J;
(*b*) 1.0×10^3 J;
(*c*) 230 J at 0°C, 390 J at −15°C.

37. 78 L.

39. -1.9×10^3 J/K.

41. -1.22×10^6 J/K.

43. 4×10^4 J/K.

45. 0.64 J/K.

47. 1.1 J/K.

49. (*a*) $\frac{1}{12}$;
(*b*) $\frac{1}{12}$.

51. (*a*)

(r = red, o = orange, g = green)

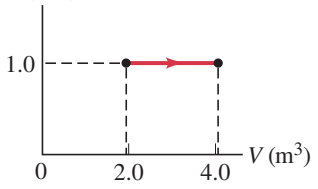
Macrostate	Microstates	Number of microstates
3 r, 0 o, 0 g	r r r	1
2 r, 1 o, 0 g	r r o r o r o r r	3
2 r, 0 o, 1 g	r r g r g r g r r	3
1 r, 2 o, 0 g	r o o o r o o o r	3
1 r, 0 o, 2 g	r g g g r g g g r	3
1 r, 1 o, 1 g	r o g r g o o r g o g r g r o g o r	6
0 r, 3 o, 0 g	o o o	1
0 r, 2 o, 1 g	g o o o g o o o g	3
0 r, 1 o, 2 g	o g g g o g g g o	3
0 r, 0 o, 3 g	g g g	1

(*b*) $\frac{1}{27}$;
(*c*) $\frac{1}{9}$.

53. 70 m^2, yes.

55. 1.5×10^7 W.

57. (*a*) 2.2×10^5 J;
(*b*) 3.6×10^5 J;
(*c*)



59. 86°C.

61. (*a*) 7.7%;
(*b*) the large volume of "fuel" (ocean water) available.

63. \$0.43/h.

65. (*a*) 44°C;
(*b*) 4.3×10^{-2} J/K.

67. 60 K.

69. (*a*) 13 km^3/day, possibly;
(*b*) 73 km^2.

71. (*a*) 0.281;
(*b*) 1.01×10^5 W, 2.1×10^9 J, 4.9×10^5 kcal.

73. (*a*) 0.22 kg;
(*b*) 4.5 days.

75. 4.6×10^6 J.

77. (*a*) −4°C;
(*b*) 29%.

Chapter 16

1. 2.7×10^{-3} N.

3. 2.2×10^4 N.

5. (1.9×10^{-13})%.

7. 3.76 cm.

9. -4.6×10^8 C, 0.

11. $F_{left} = 120$ N, to the left;
$F_{center} = 560$ N, to the right;
$F_{right} = 450$ N, to the left.

13. 2.1×10^{12} electrons.

15. $10.1 \dfrac{kQ^2}{\ell^2}$, at 61°.

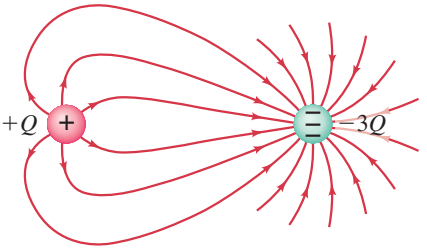
17. (*a*) 88.8×10^{-6} C, 1.2×10^{-6} C;
(*b*) 91.1×10^{-6} C, -1.1×10^{-6} C.

19. 3.94×10^{-16} N, west.

21. 6.30×10^6 N/C, upward.

23. 1.33×10^{14} m/s^2, opposite to the field.

25.



27. 5.97×10^{-10} N/C, south.

29. Upper right corner,
$E = 3.76 \times 10^4$ N/C, at 45.0°.

31. $\dfrac{4kQxa}{(x^2 - a^2)^2}$, to the left.

33. 3.7×10^7 N/C, 330°.

35. $E_A = 3.0 \times 10^6$ N/C, at 90°;
$E_B = 7.8 \times 10^7$ N/C, at 56°; yes.

37. (*a*) 5×10^{-10} N;
(*b*) 7×10^{-10} N;
(*c*) 6×10^{-5} N.

39. (*a*) -1.1×10^5 N·m^2/C;
(*b*) 0.

41. 8.3×10^{-10} C.

43. (*a*) $k \dfrac{Q}{r^2}$;
(*b*) 0;
(*c*) $k \dfrac{Q}{r^2}$;
(*d*) The shell causes the field to be 0 in the shell material. The charge polarizes the shell.

45. 4.0×10^9 C.

47. 6.8×10^5 C, negative.

49. 1.0×10^7 electron charges.

51. 5.2×10^{-11} m.

53. 4.3 m.

55. 0.14 N, rightward.

57. 8.2×10^{-7} C, positive.

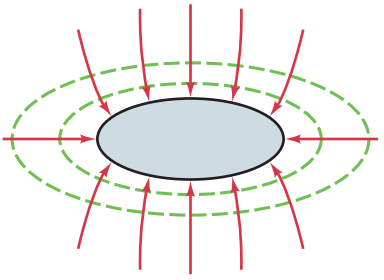
59. (*a*) 4×10^{10} particles,
(*b*) 4×10^{-5} kg.

61. 9.90×10^6 N/C, downward.

63. $x = d\left(\sqrt{2} + 1\right) \approx 2.41d$.
65. $QE\ell$, counterclockwise.
67. 8.94×10^{-19}.

Chapter 17

1. 5.0×10^{-4} J.
3. -1.0 V.
5. 4030 V, plate B.
7. 5.78 V.
9. -4.25×10^{4} V.
11. -157 V.
13. 9.0×10^{5} m/s.
15. 3000 V; only a small amount of charge was transferred.
17.



19. 2.8×10^{-9} C.
21. (*a*) 5.8×10^{5} V;
(*b*) 9.2×10^{-14} J.
23. 9.15×10^{6} m/s.
25. (*a*) 18 cm from − charge, on opposite side from + charge;
(*b*) 1.6 cm from − charge, toward + charge, and 8.0 cm from − charge, away from + charge.
27. (*a*) 1.6×10^{4} V;
(*b*) 9.9×10^{4} V/m, 64°.
29. 4.2×10^{6} V.
31. (*a*) 27 V;
(*b*) 2.2×10^{-18} J, or 14 eV;
(*c*) -2.2×10^{-18} J, or -14 eV;
(*d*) 2.2×10^{-18} J, or 14 eV.
33. (*a*) 6.6×10^{-3} V;
(*b*) 4.6×10^{-3} V;
(*c*) -4.6×10^{-3} V.
35. 2.6×10^{-6} F.
37. 6.00×10^{-5} C.
39. 6.3×10^{-7} F.
41. 0.24 m^2.
43. 9×10^{-16} m, no.
45. $V_{2.50\,\mu F} = V_{6.80\,\mu F} = 611$ V,
$Q_{2.50\,\mu F} = 1.53 \times 10^{-3}$ C,
$Q_{6.80\,\mu F} = 4.16 \times 10^{-3}$ C.
47. 4.7×10^{-11} F.
49. 9.5 V.
51. 4.20×10^{-9} F, 0.247 m^2.
53. 9.6×10^{-5} F.
55. (*a*) 9×10^{-12} F;
(*b*) 8×10^{-11} C;
(*c*) 200 V/m;
(*d*) 4×10^{-10} J;
(*e*) capacitance, charge, work done.
57. 1.0×10^{-7} J/m^3.
59. 1110100.
61. 43,690.
63. (*a*) 65,536;
(*b*) 16,777,216;
(*c*) 16,777,216.
65. (*b*) 56 Hz.
67. $+2.0 \times 10^{5}$ V/m to -2.0×10^{5} V/m.
69. Yes, 1.3×10^{-12} V.
71. (*a*) Multiplied by 2;
(*b*) multiplied by 2.
73. Alpha particle, 2.
75. Left: $-6.85kQ/\ell$, top: $-3.46kQ/\ell$, right: $-5.15kQ/\ell$.
77. (*a*) 17 cm from − charge, on opposite side from + charge;
(*b*) 1.1 cm from − charge, toward + charge, and 8.1 cm from − charge, away from + charge.
79. (*a*) 31 J;
(*b*) 5.9×10^{5} W.
81. 1.8 J.
83. 3.7×10^{-10} C.
85. (*a*) 6.4×10^{-11} C;
(*b*) 6.4×10^{-11} C;
(*c*) 18 V;
(*d*) 2×10^{-10} J.
87. (*a*) 3.6×10^{3} m/s.
(*b*) 2.8×10^{3} m/s.
89. 1.7×10^{6} V.
91. 1.3×10^{-6} C.
93. 16°.
95. (*a*) 0.32 μm^2;
(*b*) 59 megabytes.

Chapter 18

1. 1.00×10^{19} electrons/s.
3. 6.2×10^{-11} A.
5. 1200 V.
7. (*a*) 28 A;
(*b*) 8.4×10^{4} C.
9. (*a*) 8.9 Ω;
(*b*) 1.2×10^{4} C.
11. (*a*) 4.8 A;
(*b*) 6.6 A.
13. 5.1×10^{-2} Ω.
15. Yes, for length 4.0 mm.
17. 2.0 V.
19. (*a*) 3.8×10^{-4} Ω;
(*b*) 1.5×10^{-3} Ω;
(*c*) 6.0×10^{-3} Ω.
21. 18C°.
23. 2400°C.
25. $R_{carbon} = 1.42$ kΩ,
$R_{Nichrome} = 1.78$ kΩ.
27. 0.72 W.
29. 31 V.
31. 1.7×10^{5} C.
33. (*a*) 950 W;
(*b*) 15 Ω;
(*c*) 9.9 Ω.
35. (*a*) 1.1 A;
(*b*) 110 Ω.
37. 0.046 kWh; 6.6 cents per month.
39. 2.8×10^{6} J.
41. 24 bulbs.
43. 1.5 m; power increases 36× and could start a fire.
45. (*a*) 7.2 A;
(*b*) 1.7 Ω.
47. 0.12 A.
49. (*a*) Infinite resistance;
(*b*) 96 Ω.
51. (*a*) 930 V;
(*b*) 3.9 A.
53. (*a*) 3300 W;
(*b*) 9.7 A.
55. 6.0×10^{-10} m/s.
57. 2.2 A/m^2, north.
59. 32 m/s (possible delay between nerve stimulation and generation of action potential).
61. 9.8 h.
63. 6.22 A.
65. 2.4×10^{-4} m.
67. $3200 per hour per meter.
69. 4.2×10^{-3} m.
71. (*a*) 33 Hz;
(*b*) 0.990 A;
(*c*) $V = (33.6 \sin 210t)$ V.
73. 2.25 Ω.
75. (*b*) As large as possible.
77. (*a*) 7.4 hp;
(*b*) 220 km.
79. 1.7×10^{-4} m.
81. 32% increase.

83. (*a*) $I_A = 0.33\ \text{A},\ I_B = 3.3\ \text{A}$;
(*b*) $R_A = 360\ \Omega,\ R_B = 3.6\ \Omega$;
(*c*) $Q_A = 1.2 \times 10^3\ \text{C}$,
$Q_B = 1.2 \times 10^4\ \text{C}$;
(*d*) $E_A = E_B = 1.4 \times 10^5\ \text{J}$;
(*e*) Bulb B.

85. (*a*) $4 \times 10^6\ \text{J}$;
(*b*) $2 \times 10^4\ \text{m}$.

87. (*a*) 12 W;
(*b*) 4.6 W.

89. $1.34 \times 10^{-4}\ \Omega$.

91. $f = 1 - \dfrac{V}{V_0}$.

Chapter 19

1. (*a*) 5.92 V;
(*b*) 5.99 V.

3. 0.034 Ω; 0.093 Ω.

5. (*a*) 330 Ω;
(*b*) 8.9 Ω.

7. 2.

9. Connect 18 resistors in series; then measure voltage across 7 consecutive series resistors.

11. 0.3 Ω.

13. 560 Ω, 0.020.

15. 32 Ω.

17. 140 Ω.

19. $\frac{13}{8}R$.

21. 4.8 kΩ.

23. 55 V.

25. 0.35 A.

27. 0.

29. (*a*) 34 V;
(*b*) 85-V battery: 82 V;
45-V battery: 43 V.

31. $I_1 = 0.68\ \text{A}$, left; $I_2 = 0.33\ \text{A}$, left.

33. (*a*) $\mathscr{E}/R$;
(*b*) R.

35. 0.71 A.

37. 3 parallel sets, each with 100 cells in series.

39. $3.71 \times 10^{-6}\ \text{F}$.

41. $2.0 \times 10^{-9}\ \text{F}$, yes.

43. $1.90 \times 10^{-8}\ \text{F}$ in parallel,
$1.7 \times 10^{-9}\ \text{F}$ in series.

45. 2 : 1.

47. In parallel, 750 pF.

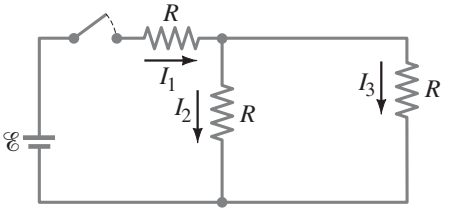
49. 29.3 μF, 5.7 μF.

51. (*a*) $\frac{3}{5}C$;
(*b*) $Q_1 = Q_2 = \frac{1}{5}CV,\ Q_3 = \frac{2}{5}CV,$
$Q_4 = \frac{3}{5}CV;\ V_1 = V_2 = \frac{1}{5}V,$
$V_3 = \frac{2}{5}V,\ V_4 = \frac{3}{5}V$.

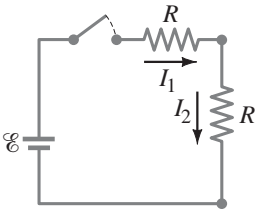
53. $1.0 \times 10^6\ \Omega$.

55. $7.4 \times 10^{-3}\ \text{s}$.

57. (*a*) $I_1 = \dfrac{2\mathscr{E}}{3R},\ I_2 = I_3 = \dfrac{\mathscr{E}}{3R}$



(*b*) $I_1 = I_2 = \dfrac{\mathscr{E}}{2R},\ I_3 = 0$;



(*c*) $\frac{1}{2}\mathscr{E}$.

59. (*a*) $2.9 \times 10^{-5}\ \text{A}$;
(*b*) $8.8 \times 10^6\ \Omega$.

61. Add 710 Ω in series with ammeter, 29 Ω/V.

63. $9.60 \times 10^{-4}\ \text{A}$, 4.8 V;
current: +20%, voltage: −20%.

65. 9.8 V.

67. Put 9.0 kΩ in series with the body.

69. $\frac{1}{4}C,\ \frac{2}{5}C,\ \frac{3}{5}C,\ \frac{3}{4}C,\ C,\ \frac{4}{3}C,\ \frac{5}{3}C,$
$\frac{5}{2}C,\ 4C$.

71. $9.2 \times 10^4\ \Omega$.

73. (*a*) 3.6 Ω;
(*b*) 14 W.

77. 600 cells; $0.54\ \text{m}^2$, 4 banks in parallel, each containing 150 cells in series.

79. (*a*) 6.0 Ω;
(*b*) 2.2 V.

81. 11 V.

83. 100 Ω.

87. 9.0 Ω.

89. $Q_{12\,\mu\text{F}} = 1.0 \times 10^{-4}\ \text{C}$,
$Q_{48\,\mu\text{F}} = 4.1 \times 10^{-4}\ \text{C}$.

91. (*a*) $1.9 \times 10^{-4}\ \text{J}$;
(*b*) $4.0 \times 10^{-5}\ \text{J}$;
(*c*) $Q_a = 16\ \mu\text{C};\ Q_b = 3.3\ \mu\text{C}$.

93. $Q_1 = \dfrac{C_1C_2}{C_2 + C_1}V_0,$

$Q_2 = \dfrac{C_2^2}{C_2 + C_1}V.$

95. (*a*) In parallel;
(*b*) 7.7 pF to 35 pF.

97. $Q_1 = 11\ \mu\text{C},\ V_1 = 11\ \text{V}$;
$Q_2 = 13\ \mu\text{C},\ V_2 = 6.3\ \text{V}$;
$Q_3 = 13\ \mu\text{C},\ V_3 = 5.2\ \text{V}$.

Chapter 20

1. (*a*) 5.8 N/m;
(*b*) 3.3 N/m.

3. 1.3 N.

5. 27°.

7. (*a*) South pole;
(*b*) 3.86 A;
(*c*) $8.50 \times 10^{-2}\ \text{N}$.

9. $5.6 \times 10^{-14}\ \text{N}$, north.

11. 0.24 T.

13. (*a*) To the right;
(*b*) downward;
(*c*) into the page.

15. (*a*) $6.0 \times 10^5\ \text{m/s}$;
(*b*) $3.6 \times 10^{-2}\ \text{m}$;
(*c*) $3.8 \times 10^{-7}\ \text{s}$.

17. 0.59 m.

19. $r_{\text{proton}}/r_{\text{electron}} = 42.8$.

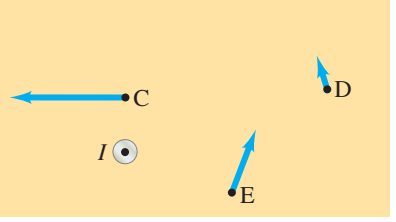
21. $1.97 \times 10^{-6}\ \text{m}$.

23. (*a*) Sign determines polarity but not magnitude of Hall emf.
(*b*) 0.56 m/s.

25. $2.9 \times 10^{-4}\ \text{T}$, about 5.8 times larger.

27. $7.8 \times 10^{-2}\ \text{N}$, toward other wire.

29.

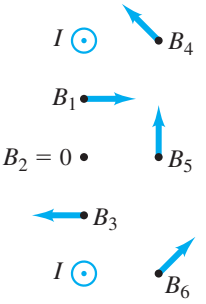


31. $5.1 \times 10^{-6}\ \text{N}$, toward wire.

33. $3.8 \times 10^{-5}\ \text{T}$, 17° below horizontal.

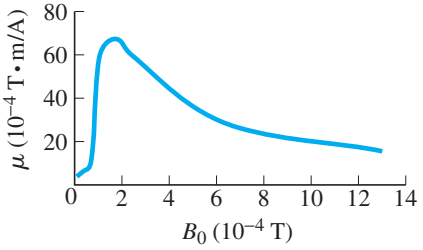
35. (*a*) $(2.0 \times 10^{-5}\ \text{T/A})(I - 25\ \text{A})$;
(*b*) $(2.0 \times 10^{-5}\ \text{T/A})(I + 25\ \text{A})$.

37.



39. 15 A, downward.

41. Closer wire: 4.4×10^{-2} N/m, attract; farther wire: 2.2×10^{-2} N/m, repel.
43. 4.66×10^{-5} T.
45. 1.19 A.
47. 0.12 N, south.
49. (*c*) No; inversely as distance from center of toroid: $B \propto 1/R$.
51. 1.18 T.
53. 69.7 μA.
55. 1.87×10^{6} V/m; perpendicular to velocity and magnetic field, and in opposite direction to magnetic force on protons.
57. 1.3×10^{-3} m; 6.5×10^{-4} m.
59. ${}^{2}_{1}$H nucleus or ${}^{4}_{2}$He nucleus.
61. 0.5 T.
63.



65. 2.7×10^{-2} T, upward.
67. 0.30 N, northerly, 68° above horizontal.
69. 7.7×10^{-6} N.
71. 1.1×10^{-6} m/s, west.
73. $\dfrac{2\mu_0 I}{\pi \ell}$, to the left.
75. They will exit above or below second tube; 52°.
77. -2.1×10^{-20} J.
79. $r = 5.3 \times 10^{-5}$ m, $p = 3.3 \times 10^{-4}$ m.
81. 1.9×10^{-3} T.
83. $\dfrac{5.0mg}{\ell B}$, to the left.
85. (*a*) Negative;
(*b*) $\dfrac{qB_0(d^2 + \ell^2)}{2d}$.
87. 1.2 A; downward.
89. (*a*) M: 5.8×10^{-4} N/m, upward; N: 3.4×10^{-4} N/m, at 300°; P: 3.4×10^{-4} N/m, at 240°;
(*b*) 1.75×10^{-4} T, at −14°.
91. 49×10^{-6} T, $B_{\text{wire}} \approx 0.06 B_{\text{Earth}}$.

Chapter 21

1. 560 V.
3. Counterclockwise.
5. 0.20 V.
7. (*a*) 1.0×10^{-2} Wb;
(*b*) 48°;
(*c*) 6.7×10^{-3} Wb.
9. (*a*) 1.73×10^{-2} V;
(*b*) 0.114 V/m, downward.
11. (*a*) 0;
(*b*) clockwise;
(*c*) counterclockwise;
(*d*) clockwise.
13. 0.65 mV, east or west.
15. (*a*) Magnetic force on current in moving bar, $B^2\ell^2 v/R$;
(*b*) $B^2\ell^2 v^2/R$.
17. (*a*) 0.17 V;
(*b*) 7.1×10^{-3} A;
(*c*) 7.5×10^{-4} N, to the right.
19. 5.23 C.
21. (*a*) 810 V;
(*b*) double the rotation frequency.
23. 17 rotations per second.
25. 92 V.
27. 1.71×10^{4} turns.
29. $I_S = 0.21 I_P$.
31. (*a*) 6.2 V;
(*b*) step-down.
33. 450 V, 56 A.
35. 6×10^{9} m.
37. 55 MW.
39. 6.9 V.
41. 0.10 H.
43. (*a*) 1.5×10^{-2} H;
(*b*) 75 turns.
45. 46 m, 21 km; 0.70 kΩ.
47. 23 J.
49. 5×10^{15} J.
51. 3.7.
53. (*a*) 2.3;
(*b*) 4.6;
(*c*) 6.9.
55. 3300 Hz.
57. $1.6 \times 10^{4}\ \Omega$, 1.47×10^{-2} A.
59. (*a*) 7400 Ω;
(*b*) 0.38 A.
61. (*a*) $3.6 \times 10^{4}\ \Omega$;
(*b*) $3.7 \times 10^{4}\ \Omega$.
63. 205 Ω.
65. 270 Hz; the voltages are out of phase.
67. (*a*) 1.77×10^{-2} A;
(*b*) −12.6°;
(*c*) $V_R = 117$ V, $V_C = 26.1$ V.
69. 3.6×10^{5} Hz.
71. (*a*) 1.3×10^{-7} F;
(*b*) 37 A.
73. (*a*) 0.032 H;
(*b*) 0.032 A;
(*c*) 16 μJ.
75. 6.01×10^{-3} J.
77. Coil radius = 1.5 cm, 10,000 turns.
79. 200 kV.
81. (*a*) 41 kV;
(*b*) 31 MW;
(*c*) 1.0 MW;
(*d*) 30 MW.
85. Put a 98-mH inductor in series with it.
87. 82 V.
89. 93 mH.
91. 2.

Chapter 22

1. 1.1×10^{5} V/m/s.
3. 1.7×10^{15} V/m/s.
5. 2.4×10^{-13} T.
7. 90.0 kHz, 2.33 V/m, along the horizontal north–south line.
9. 1.25 s.
11. 4.20×10^{-7} m, violet visible light.
13. 2.00×10^{10} Hz.
15. (*a*) 1.319×10^{-2} m;
(*b*) 2.5×10^{18} Hz.
17. 4.0×10^{16} m.
19. 9600 wavelengths; 3.54×10^{-15} s.
21. 1.6×10^{6} revolutions/s.
23. 3.02×10^{7} s.
25. 5.7 W/m^2, 46 V/m.
27. 4.51×10^{-6} J.
29. 3.80×10^{26} W.
31. 7.3×10^{-7} N/m^2; 7.3×10^{-11} N away from bulb.
33. 400 m^2.
35. 0.16 m.
37. Channel 2: 5.56 m, Channel 51: 0.434 m.
39. 1.5×10^{-12} F.
41. (*a*) 1.3×10^{-6} H;
(*b*) 9.9×10^{-11} F.
43. 6.25×10^{-4} V/m; 1.04×10^{-9} W/m^2.
45. 10 ns.
47. 1.36 s; inside.
49. 5.00×10^{2} s.
51. 13 V/m, 4.4×10^{-8} T.
53. (*a*) 1.2×10^{-10} J;
(*b*) 8.7×10^{-6} V/m, 2.9×10^{-14} T.

55. 61 km.

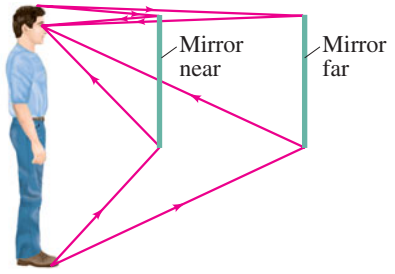
57. (*a*) 2.8×10^{-3} J/s;
(*b*) 1.0 V/m;
(*c*) 1.0 V;
(*d*) 2.0×10^{-2} V.

59. 6×10^{10} W.

61. 35 kW.

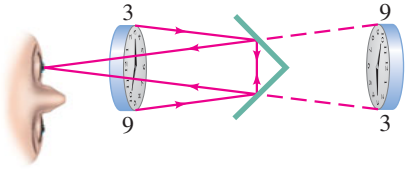
Chapter 23

1.



3. 11°.

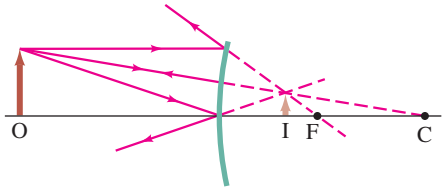
5.



7. 4.0×10^{-6} m^2.

9. 10.5 cm.

11. (*a*) $d_i \approx -5$ cm;



(*b*) $d_i = -5.3$ cm;
(*c*) 1.0 mm.

13. −6.8 m.

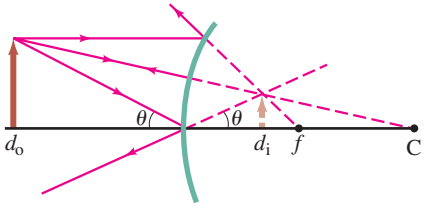
15. 5.7 m.

17. 2.0 cm behind ball's front surface; virtual; upright.

19. 1.0 m.

21. (*a*) Concave;
(*b*) upright, virtual, and magnified;
(*c*) 1.40 m.

23.



25. 1.31.

27. 1.62.

29. 50.1°.

31. 38.6°.

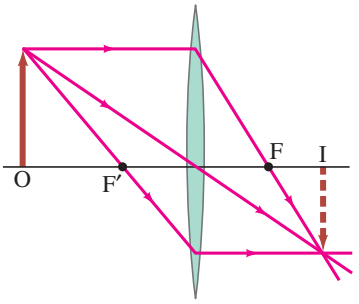
33. 81.9°.

35. 61.0°, crown glass.

37. At least 93.5 cm away.

39. (*a*) 1.4;
(*b*) no;
(*c*) 1.9.

41. (*a*) ~500 mm;



(*b*) 478 mm.

43. (*a*) 3.08 D, converging;
(*b*) −0.148 m, diverging.

45. (*a*) 106 mm;
(*b*) 109 mm;
(*c*) 117 mm;
(*d*) 513 mm.

47. (*a*) 37 cm behind lens;
(*b*) +2.3×.

49. $d_i = -6.67$ cm behind lens, virtual and upright, $h_i = 0.534$ mm.

51. (*a*) 70.0 mm;
(*b*) 30.0 mm.

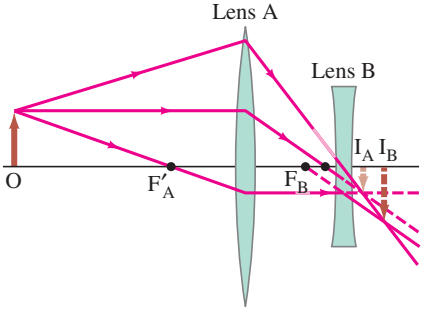
53. 64 cm.

55. 21.3 cm or 64.7 cm from object.

57. 0.105 m; 5.8 m.

59. 18.5 cm beyond second lens; −0.651× (inverted).

61. (*a*) 10 cm beyond second lens;
(*b*) −1.0×;
(*c*)



63. −29 cm.

65. 9.0 cm.

67. 0.34 m.

69. 1.25 s.

71. 6.04 m.

73. 1.58, light flint glass.

75. (*a*) Convex;
(*b*) 25 cm behind mirror;
(*c*) −110 cm;
(*d*) −220 cm.

77. 67°.

79. 9 cm, 12 cm.

81. $n \geq 1.60$.

83. (*a*) −0.33 mm;
(*b*) −0.47 mm;
(*c*) −0.98 mm.

85. Left: converging; right: diverging.

89. 6.0 cm from object, between it and lens.

Chapter 24

1. 5.4×10^{-7} m.

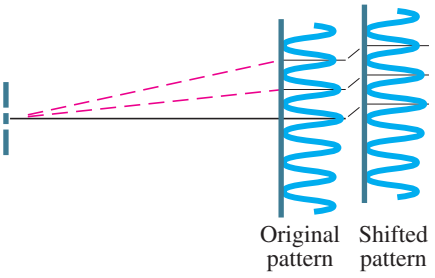
3. 6.3×10^{-7} m, 4.8×10^{14} Hz.

5. 17° and 64°.

7. 1.5×10^{-4} m.

9. 3.1 cm.

11.



13. 2.2×10^{-3} m.

15. 14 mm.

17. 570 nm.

19. 0.23°.

21. 1.8°.

23. 1.0×10^{-6} m.

25. 7.38×10^{-2} m.

27. (*a*) λ;
(*b*) 400 nm.

29. 3.4×10^{-6} m.

31. Entire pattern is shifted, with central maximum at 28.0° to the normal.

33. 330 nm.

35. 556 nm.

37. 490 nm, 610 nm, 640 nm, 650 nm.

39. $(3.0 \times 10^1)°$.
41. Second order.
43. 7140 slits/cm.
45. 0.878 cm.
47. 230 nm.
49. 9 lenses.
51. 33 dark bands.
53. 110 nm; 230 nm.
55. 482 nm.
57. 691 nm.
59. 1.004328.
61. 57.3°.
63. 48.1%.
65. No; for diamond, $\theta_p = 59.4°$.
67. 61.2°.
69. 36.9°; 48.8°; 53.1°.
71. 28° relative to first polarizer.
73. (*a*) 1.3×10^{-4} m;
(*b*) 3.9×10^{-7} m.
75. H: 13.7°; Ne: 13.5°; Ar: 14.5°.
77. 480 nm.
79. $\lambda_2 > 600$ nm overlaps with $\lambda_3 < 467$ nm.
81. (*a*) 82 nm;
(*b*) 130 nm.
83. 4.8×10^4 m.
85. 3.19×10^{-5} m.
87. 580 nm.
89. 0.6 m.
91. 658 nm; 782 slits/cm.
93. 400 nm, 600 nm.
95. (*a*) 0;
(*b*) 0.11;
(*c*) 0.

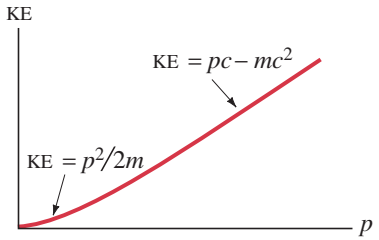
Chapter 25

1. *f*/8.
3. 3.00 mm to 46 mm.
5. 110 mm; 220 mm.
7. 5.1 m to infinity.
9. 16 mm.
11. *f*/2.5.
13. 1.1 D.
15. (*a*) −1.2 D;
(*b*) 35 cm.
17. −8.3 D; −7.1 D.
19. (*a*) 2.0 cm;
(*b*) 1.9 cm.
21. 18.4 cm, 1.00 m.
23. 1.6×.
25. 6.2 cm from lens, 4.0×.
27. (*a*) 3.6×;
(*b*) 14 mm;
(*c*) 6.9 cm.
29. 4 cm toward contract.
31. −29×; 85 cm.
33. 25 cm.
35. −22×.
37. −110×.
39. Objective: 1.09 m;
eyepiece: 0.9 cm.
41. 3.0 m.
43. $(4.0 \times 10^2)\times$.
45. 520×.
47. (*a*) $(9.00 \times 10^2)\times$;
(*b*) eyepiece: 1.8 cm;
objective, 0.300 cm;
(*c*) 0.306 cm from objective.
49. (*a*) 14 cm;
(*b*) 130×.
51. (*a*) Converging;
(*b*) 281 cm.
53. $(1.54 \times 10^{-5})°$.
55. 1.7×10^{11} m.
57. 1.0×10^4 m.
59. 8.5 cm, 6.2×10^{-6} rad (distance of 2.4 km).
61. (*a*) 53.8°;
(*b*) 0.19 nm.
63. (*a*) 1×;
(*b*) 1× (at back of body) to 2.7× (at front of body).
65. $\frac{1}{6}$ s.
67. (*a*) 1.8×10^4 m;
(*b*) 23″; atmospheric effects and aberrations in the eye.
69. 0.82 mm.
71. 8.2.
73. −0.75 D (upper part),
+2.0 D (lower part).
75. (*a*) −2.8×;
(*b*) +5.5-D lens.
77. +3.9 D.
79. 4.8×10^3 C°/min.
81. −15×.
83. 0.4 m.
85. 110 m.
87. 2 m.
89. −8.4 cm.

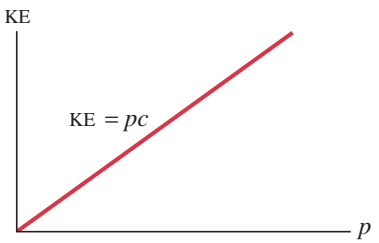
Chapter 26

1. 83.9 m.
3. 351 ly.
5. 0.70*c*.
7. (*a*) 0.141*c*;
(*b*) 0.140*c*.
9. (*a*) 6.92 m, 1.35 m;
(*b*) 13.9 s;
(*c*) 0.720*c*;
(*d*) 13.9 s.
11. (*a*) 3.6 yr;
(*b*) 7.0 yr.
13. $(6.97 \times 10^{-8})\%$.
15. 0.9716*c*.
17. (*a*) −1.1%;
(*b*) −34%.
19. 0.95*c*.
21. 8.209×10^{-14} J, 0.512 MeV.
23. 1000 kg.
25. 5.36×10^{-13} kg.
27. 1.6 GeV/*c*.
29. (*a*) 5.4 GeV;
(*b*) 5.4 GeV/*c*.
31. 0.866*c*, 0.886 MeV/*c*.
33. 9.0×10^{13} J; 9.2×10^9 kg.
35. 1.30 MeV/c^2.
37. 0.333*c*.
39. (*a*) 0.866*c*;
(*b*) 0.745*c*.
41. (*a*) 1.8×10^{19} J;
(*b*) −1.7%.
43. $\dfrac{2m}{\sqrt{1 - v^2/c^2}}$; 0;
$\left(\dfrac{1}{\sqrt{1 - v^2/c^2}} - 1\right)2mc^2$.
47. 0.69*c*.
49. (*a*) 0.959*c*;
(*b*) 0.36*c*.
51. 0.962*c*.
53. 0.3*c*.
55. (*a*) 0.66*c*;
(*b*) 6.5 yr.
57. 0.91*c*.
59. 1.022 MeV.
61. 0.79 MeV.
63. (*a*) 4×10^9 kg/s;
(*b*) 4×10^7 yr;
(*c*) 1×10^{13} yr.
67. 5.38×10^{-12} kg; $(1.5 \times 10^{-8})\%$.

69. (*a*)



(*b*)



71. $0.981c$.

73. 1.7×10^{21} J; $\sim 20\times$ greater.

75. (*a*) 15 m;
(*b*) 42 min.

77. (*a*) $0.986c$;
(*b*) $(1 - 5 \times 10^{-7})c$.

79. Yes, in barn's reference frame, if his speed is $\geq 0.639c$; no, in boy's reference frame.

81. 8.0×10^{-8} s.

Chapter 27

1. 6.2×10^{4} C/kg.

3. 5 electrons.

5. (*a*) 10.6 μm, far infrared;
(*b*) 940 nm, near infrared;
(*c*) 0.7 mm, microwave.

7. 5.4×10^{-20} J, 0.34 eV.

9. 9.35×10^{-6} m.

11. 2.7×10^{-19} J to 5.0×10^{-19} J, 1.7 eV to 3.1 eV.

13. 1.14×10^{-27} kg·m/s.

17. 7.2×10^{14} Hz.

19. 429 nm.

21. (*a*) 2.3 eV;
(*b*) 0.85 V.

23. 0.92 eV; 5.7×10^{5} m/s.

25. (*a*) 0.78 eV;
(*b*) no ejected electrons.

27. 3.32 eV.

31. (*a*) 2.43×10^{-12} m;
(*b*) 1.32×10^{-15} m.

33. 2.62 MeV.

35. 212 MeV; 5.86×10^{-15} m.

37. 1.592 MeV, 7.81×10^{-13} m.

39. 4.7×10^{-12} m.

41. 1840.

43. (*a*) 4×10^{-10} m;
(*b*) 1×10^{-10} m;
(*c*) 3.9×10^{-11} m.

45. 6.4×10^{-12} m; yes; much less than 5 cm; no.

47. 22 V.

49. (*a*) Absorption; final state; largest energy photon;
(*b*) emission, initial state;
(*c*) absorption, final state.

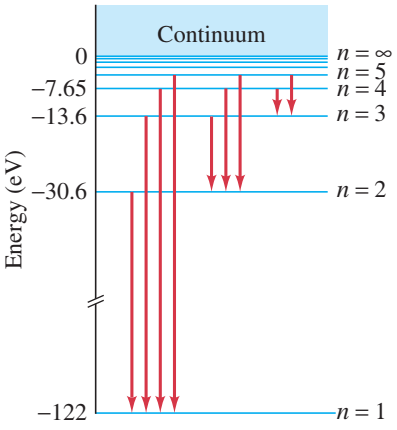
51. $n = 5$ to $n' = 3$.

53. (*a*) 486 nm;
(*b*) 103 nm;
(*c*) 434 nm.

55. 91.2 nm.

57. Yes; from $n = 1$ to $n = 3$.

59.



61. −0.544 eV.

63. Yes; $(7.30 \times 10^{-3})c$, $1/\gamma = 0.99997$.

65. 1.20×10^{29} m, -4.22×10^{-97} J.

67. 3.28×10^{15} Hz.

69. 4.4×10^{26} photons/s.

71. 5.5×10^{18} photons/s.

73. (*a*) 1.7 eV;
(*b*) 3.0 eV.

75. 0.34 MeV for both.

77. 4.0×10^{-14} m.

79. 4.40×10^{-40}; yes.

81. 0.32 V.

83. 4.0×10^{-7} W/m^2; 1.7×10^{-2} V/m.

85. 8.2×10^{-10} m.

87. 3.5×10^{-12} m.

89. 1200 m/s.

91. Paschen series, level 4.

93. 1.8×10^{11} C/kg.

95. $E_n = -\dfrac{2.84 \times 10^{165}\ \text{J}}{n^2}$,
$r_n = n^2(5.16 \times 10^{-129}\ \text{m})$;
not apparent.

Chapter 28

1. 4.5×10^{-7} m.

3. 5.3×10^{-11} m.

5. 7×10^{-8} eV.

7. 3.00×10^{-10} eV/c^2.

9. Electron: 1.5×10^{-3} m;
baseball: 9.7×10^{-33} m;
$\Delta x_{\text{electron}}/\Delta x_{\text{baseball}} = 1.5 \times 10^{29}$.

11. 7700 m/s; 1.7×10^{-4} eV.

13. 5.53×10^{-10} m.

15. $\ell = 0,\ 1,\ 2,\ 3,\ 4,\ 5$.

17. 14 electrons.

19. (*a*) $(1, 0, 0, -\frac{1}{2})$, $(1, 0, 0, +\frac{1}{2})$, $(2, 0, 0, -\frac{1}{2})$, $(2, 0, 0, +\frac{1}{2})$, $(2, 1, -1, -\frac{1}{2})$, $(2, 1, -1, +\frac{1}{2})$;
(*b*) $(1, 0, 0, -\frac{1}{2})$, $(1, 0, 0, +\frac{1}{2})$, $(2, 0, 0, -\frac{1}{2})$, $(2, 0, 0, +\frac{1}{2})$, $(2, 1, -1, -\frac{1}{2})$, $(2, 1, -1, +\frac{1}{2})$, $(2, 1, 0, -\frac{1}{2})$, $(2, 1, 0, +\frac{1}{2})$, $(2, 1, 1, -\frac{1}{2})$, $(2, 1, 1, +\frac{1}{2})$, $(3, 0, 0, -\frac{1}{2})$, $(3, 0, 0, +\frac{1}{2})$, $(3, 1, -1, -\frac{1}{2})$.

21. $12\hbar$, or 3.65×10^{-34} J·s.

23. $n \geq 4$; $3 \leq \ell \leq n - 1$; $m_s = -\frac{1}{2}, +\frac{1}{2}$.

25. (*a*) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$;
(*b*) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^4$;
(*c*) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2$.

27. (*a*) 5;
(*b*) −0.544 eV;
(*c*) $\sqrt{6}\,\hbar$, 2;
(*d*) −2, −1, 0, 1, 2.

31. $n = 3$, $\ell = 2$.

33. 4.36×10^{-11} m; 1×10^{-9} m.

37. 1.798×10^{-10} m.

39. 6.12×10^{-11} m; partial shielding by $n = 2$ shell.

41. 0.017 J, 5.5×10^{16} photons.

43. 634 nm.

45. $n \geq 7$, $\ell = 6$, $m_\ell = 2$.

47. $L_{\max} = \sqrt{30}\,\hbar$, $L_{\min} = 0$.

49. 5.275×10^{-27} kg·m/s, 1.257×10^{-7} m.

51. 5.75×10^{-13} m, 115 keV.

53. 22 electrons.

57. $L_{\text{Bohr}} = 2\hbar$; $L_{\text{qm}} = 0$ or $\sqrt{2}\,\hbar$.

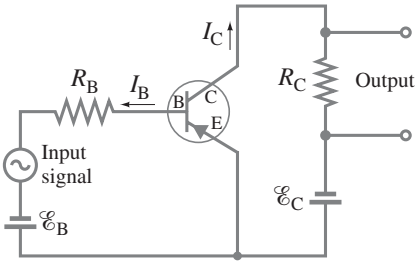
59. 3.7×10^{-37} m.

61. $\Delta p_{\text{electron}}/\Delta p_{\text{proton}} = 0.0234$.

63. 1.95×10^{-35} m/s; yes; 10^{34} s.
65. Copper.

Chapter 29

1. 5.1 eV.
3. HN: 110 pm, CN: 150 pm, NO: 133 pm.
5. 4.6 eV.
9. 1.10×10^{-10} m.
11. 5.22×10^{-4} m.
13. (*a*) 680 N/m;
(*b*) 2.1×10^{-6} m.
15. 0.315 nm.
17. 2.0 eV.
19. $\lambda \leq 1.7\ \mu$m.
21. 1.2×10^{6} electrons.
23. 3×10^{6}.
25. 1.7 eV.
27. 14 V.
29. 7.3 mA.
31. (*a*) 5.1 mA;
(*b*) 3.6 mA.
33.



35. 0.65 V.
37. (*a*) 130;
(*b*) 8700.
39. (*a*) 3.1×10^{4} K;
(*b*) 930 K.
41. (*a*) −5.3 eV;
(*b*) 4.4 eV.
43. 1.94×10^{-46} kg·m^2.
45. 6.03×10^{-4} eV.
47. $\lambda \leq 3.5 \times 10^{-7}$ m.
49. Yes; 1.11×10^{-6} m.
51. 980 J/mol.

Chapter 30

1. 0.149 u.
3. 0.855%.
5. 3727 MeV/c^2.
7. (*a*) 180 m;
(*b*) 3.5×10^{4}.
9. 30 MeV.
11. 6.0×10^{26} nucleons; no; all nucleons have about the same mass.
13. 550 MeV.
15. 7.699 MeV/nucleon.
17. 12.42 MeV.
19. $^{23}_{11}$Na: 8.113 MeV/nucleon;
$^{24}_{11}$Na: 8.063 MeV/nucleon.
21. (*b*) Yes, binding energy is positive.
25. 0.782 MeV.
27. (*a*) β^- emitter;
(*b*) $^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + \beta^- + \bar{\nu}$, 5.515 MeV.
29. 2.822 MeV.
31. α: 6.114 MeV; β^{-1}: 0.2259 MeV.
33. 10.8 MeV.
35. For both: $\text{KE}_{\text{max}} = 0.9612$ MeV, $\text{KE}_{\text{min}} = 0$.
37. $\text{KE}_{\text{recoil}} = 0.0718$ MeV, $Q = 4.27$ MeV.
39. 1.2 h.
41. 2.5×10^{9} decays/s.
43. (*a*) 3.60×10^{12} decays/s;
(*b*) 3.58×10^{12} decays/s;
(*c*) 1.34×10^{9} decays/s.
45. 7 α particles; 4 β^- particles.
47. 0.91 g.
49. (*a*) 1.38×10^{-13} s^{-1};
(*b*) 3.73×10^{7} decays/min.
51. 86 decays/s.
53. 1.78×10^{9} yr.
55. 7900 yr.
57. 15.8 d.
59. $N_D = N_0\left(1 - e^{-\lambda t}\right)$.
61. 2.6×10^{4} yr.
63. 41 yr.
65. 3.0×10^{-14} m, 4.2× nuclear radius.
67. $^{40}_{19}$K: 0.16 mg; $^{39}_{19}$K: 1.3 g.
69. 2.71×10^{-11} g.
71. (*a*) 4.6×10^{15} decays/s;
(*b*) 1.24×10^{4} decays/s.
73. (*a*) 0.002603 u, 2.425 MeV/c^2;
(*b*) 0, 0;
(*c*) −0.090739 u, −84.52 MeV/c^2;
(*d*) 0.043930 u, 40.92 MeV/c^2;
(*e*) $\Delta \geq 0$ for $0 \leq Z \leq 8$ and $Z \geq 85$;
$\Delta < 0$ for $9 \leq Z \leq 84$;
$\Delta \geq 0$ for $0 \leq A \leq 15$ and $A \geq 218$;
$\Delta < 0$ for $16 \leq A < 218$.
75. 0.2 decays/s.
77. (*a*) 180 m;
(*b*) 13 km.
79. (*a*) There would be no atoms—just neutrons;
(*b*) 0.083%.
81. 1.1×10^{11} yr.
83. 13 decays/s.
85. (*b*) 98.2%.

Chapter 31

1. $^{28}_{13}$Al; β^-; $^{28}_{14}$Si.
3. Yes, $Q > 0$.
5. 18.000937 u.
7. (*a*) Yes;
(*b*) 20.4 MeV.
9. 4.730 MeV.
11. $\text{n} + {}^{14}_{7}\text{N} \rightarrow {}^{14}_{6}\text{C} + \text{p}$, 0.626 MeV.
13. (*a*) He picks up a neutron from C;
(*b*) $^{11}_{6}$C;
(*c*) 1.856 MeV; exothermic.
15. 5.702 MeV released.
17. 126.5 MeV.
19. 1/1100.
21. (*a*) 5 neutrons;
(*b*) 171.1 MeV.
23. 1100 kg.
25. 260 MeV; about 30% > fission energy released.
27. 300 eV.
31. (*a*) a: 6.03×10^{23} MeV/g;
b: 4.89×10^{23} MeV/g;
c: 2.11×10^{24} MeV/g;
(*b*) 5.13×10^{23} MeV/g;
a: 0.851; b: 1.05; c: 0.243.
33. 0.39 g.
35. 5.6×10^{3} kg/h.
37. 2.46×10^{9} J; 50× > gasoline.
39. 7000 rads.
41. 144 rads.
43. (*a*) 1.0 rad, or 0.010 Gy;
(*b*) 1.0×10^{10} protons.
47. 5.61×10^{-10} kg.
49. 9.78×10^{16} e$^-$.
51. (*a*) 2×10^{-7} Sv/yr,
2×10^{-5} rem/yr;
$(2 \times 10^{-4}) \times$ allowed dose;
(*b*) 2×10^{-6} Sv/yr,
2×10^{-4} rem/yr;
$(2 \times 10^{-3}) \times$ allowed dose.
53. 7.041 m; radio wave.
55. (*a*) $^{12}_{6}$C;
(*b*) 5.702 MeV.
57. 1.0043 : 1.
59. 6.6×10^{-2} rem/yr.

61. (*a*) $^{226}_{88}\text{Ra} \rightarrow {}^{4}_{2}\text{He} + {}^{222}_{86}\text{Rn}$;
(*b*) 4.871 MeV;
(*c*) 190.6 MeV/c for both;
(*d*) 8.78×10^{-2} MeV.

63. (*a*) 3.7×10^{26} W;
(*b*) 3.5×10^{38} protons/s;
(*c*) 1.1×10^{11} yr.

65. 8×10^{12} J.

67. (*a*) 3700 decays/s;
(*b*) 4.0×10^{-4} Sv/yr;
11% of background.

69. 7.274 MeV.

71. 990 kg.

73. (*a*) $^{141}_{54}\text{Xe}$;
(*b*) 2 neutrons escape or are absorbed, 1 causes another fission;
(*c*) 176.0 MeV.

75. Most to least dangerous: C > B > A.

Chapter 32

1. 5.59 GeV.

3. 1.3×10^{7} Hz.

5. 2.0 T.

7. Alpha particles;
$\lambda_\alpha \approx d_{\text{nucleon}}$, $\lambda_\text{p} \approx 2d_{\text{nucleon}}$.

9. 0.9 MeV/rev.

13. 33.9 MeV.

15. 1879.2 MeV.

17. 67.5 MeV.

19. 1.32×10^{-15} m.

21. 1.3×10^{-12} m.

23. First, second, and fourth will not happen.

25. (*a*) 37.8 MeV;
(*b*) $\text{KE}_\text{p} = 5.4$ MeV,
$\text{KE}_{\pi^-} = 32.4$ MeV.

27. 9×10^{-3} MeV.

29. 7.5×10^{-21} s.

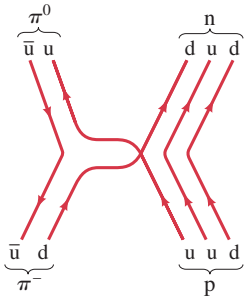
31. (*a*) 700 eV;
(*b*) 150 MeV.

33. 8×10^{-27} s.

35. (*a*) udd;
(*b*) $\bar{\text{u}}\bar{\text{d}}\bar{\text{d}}$;
(*c*) uds;
(*d*) $\bar{\text{u}}\bar{\text{d}}\bar{\text{s}}$.

37. $\text{c}\bar{\text{u}}$.

39.



41. 16 GeV; 7.8×10^{-17} m.

43. (*a*) 1.022 MeV;
(*b*) 1876.6 MeV.

45. 1.2×10^{10} m, 4.0×10^{1} s.

47. (*a*) Possible, strong interaction;
(*b*) possible, strong interaction;
(*c*) possible, strong interaction;
(*d*) not possible; charge is not conserved;
(*e*) possible, weak interaction.

49. 10^{-18} m corresponds to 200 GeV.

51. 64 fundamental fermions.

53. (*b*) 10^{29} K.

55. 798.7 MeV.

57. 9.3×10^{10} eV;
1.3×10^{-17} m, 0.99995c.

59. (*a*) π^0;
(*b*) $\bar{\nu}_\mu$.

63. 10^{-25} s.

Chapter 33

1. 3.1 ly.

3. Less than; by a factor of 2.

5. 2×10^{-3} kg/m^3.

7. 4.2×10^{-2} rad, or 2.4°;
about 4.5× Moon's width.

9. 1.83×10^{9} kg/m^3;
3.33×10^{5} times larger.

11. (*a*) 0.018″;
(*b*) $(5.0 \times 10^{-6})°$.

13. 280 yr.

15. $D_1/D_2 = 0.13$.

17. 3×10^{14} m.

19. 540°.

21. 3.1×10^{-16} m.

23. 2.1×10^{8} ly.

25. (*a*) 0.3 nm;
(*b*) 3.2 nm.

27. 0.058c.

29. 9×10^{9} ly.

31. 6.8×10^{7} ly.

33. 1.1×10^{-3} m.

35. 6 nucleons/m^3.

37. (*a*) 10^{-5} s;
(*b*) 10^{-7} s;
(*c*) 10^{-4} s.

39. 0.2 rev/s.

41. A: T increases, L doesn't change, size decreases.
B: T unchanged, L decreases, size decreases.
C: T decreases, L increases, size increases.

43. 1.7×10^{25} W.

45. 400 ly; $r_{\text{Sun}}/d_{\text{Earth–Sun}} = 2 \times 10^{7}$, $r_{\text{Sun}}/d_{\text{Galaxy}} = 4 \times 10^{-3}$.

47. (*a*) $(9 \times 10^{-6})°$;
(*b*) 4 m.

49. (*a*) 13.93 MeV;
(*b*) 4.71 MeV;
(*c*) 5.46×10^{10} K.

51. $t_\text{P} = 5.38 \times 10^{-44}$ s.