Practice Problems and Chapter and Unit Review Problems

Chapter 1 Review

Problems for Understanding

15. 2.6%

16. (a) 0.03%

17. (a) 11.5 Hz
(b) 11 Hz
(c) 11 Hz

Chapter 2

Practice Problems

1. –1.0 m/s

2. 1.2 m/s[N57°W]

3. (a) 0.29 m/s **(b)** 75 m or 175 m
(c) 75 m **(d)** 0.87 m/s

4. for linear segments: 2.5 m/s, –7.5 m/s, 0.0 m/s, 3.8 m/s

Chapter 2 Review

Problems for Understanding

15. (a) with respect to the ground
(b) with respect to the truck

17. (a) 17 km **(b)** 7.0 km[S]
(c) 7.0 km[N]

18. 26 km[W]

19. (a) 0.40 km [downstream]
(b) 0.53 km/h [downstream]

20. 4.35 years

21. (a) 11.4 km from Vectorville
(b) 0.571 h or 34.2 min

22. (a) uniform **(b)** non-uniform
(c) non-uniform **(d)** non-uniform
(e) uniform

24. $-2.8\ m/s^2$

25. 2.7 m/s, $0.45\ m/s^2$

26. 2.0×10^1 m[E] from the foul line

28. (1) 0 to 3.0 s, **(2)** 3.0 to 8.0 s, **(3)** 8.0 to 12 s, **(4)** 12 to 18 s

30. (a) 41 km
(b) 28 km[W28°N]
(c) 46 km/h
(d) 31 km/h[W28°N]

Chapter 3

Practice Problems

1. $8.0\ m/s^2$

2. $2.5\ m/s^2$[up]

3. 24 m/s

4. (a) 5.0 m **(b)** $1.6\ m/s^2$

5. 34 s

6. 6×10^2 m

7. 10 m/s

8. (a) 4.0×10^2 km[E28°N]
(b) W28°S

9. (a) 5.0 km **(b)** E37°S

10. 5.8 km[18° away from the horizontal from the lookout]

11. (a) 62.6 km [W11.3°N]
(b) E11.0°S

12. (a) (i) 27 km[N] **(ii)** 24 km[N12°E]
(iii) 24 km[S12°W]
(b) (i) 27 km[N] **(ii)** 24 km[N12°E]
(iii) 6.0 km[W34°N]

13. 67 km/h [W48°N]

14. 346 km/h[E30.0°N]

15. 10 m/s in direction 7° away from the normal to the boards, towards the puck's initial direction

16. (a) 8.4 m/s[N7.1°W]
(b) 5.5 m/s[N40°E]
(c) 3.6 m/s[E57°N]

17. 5.7 km/h[S42°W]

18. (a) 48 km/h[W29°N]
(b) 1.2×10^2 km/h [E29°S]

19. 5.8×10^3 m[N23°W]

20. (a) 9.2 km[N24°W]
(b) 3.1 km/h[N24°W]

21. 1.8 m/s[downstream]

22. 12 m/s[S24°W]

23. (a) N20.5°E
(b) 227 km/h[N30.0°E]
(c) 1.10 h

24. (a) 1.6×10^2 km[W18°N]
(b) 3.0×10^2 km/h[N], 2.2×10^2 km/h[W], 2.5×10^2 km/h[S]
(c) 1.3×10^2 km/h[W18°N]

25. (a) N25°E **(b)** 69 s

26. (a) 2.1 km[W54°N]
(b) S54°E
(c) 2.4 h

27. (a) 1.6 m/s[E18°S]

Chapter 3 Review

Problems for Understanding

11. 3 m/s

12. –1.9 m/s

13. (a) 17 m/s **(b)** $2.8\ m/s^2$

14. (a) 27 m **(b)** 8.0 m/s

15. (a) $-1.2\ m/s^2$ **(b)** 6.9 s

16. 1.2×10^2 m[down]

17. (a) 23 s **(b)** 550 m

18. (a) 71 km/h[SW]
(b) $3.9\ m/s^2$[SW] or $5.1 \times 10^4\ km/h^2$[SW]

19. (b) 3.6 km[S34°W]

20. (a) 6.6 km[N31°W]
(b) 4.4 km/h[N31°W]

21. (b) 7.9 m/s[NW]

22. (a) 18 km[W24°S]
(b) 14 km/h[W24°S]

23. (a) 1.3 m/s[N] **(b)** 3.7 m/s[S]

24. (a) [E26°N] **(b)** 1.7 m/s[E]
(c) 47 min

25. 4.4 m/s[N5.4°E]

26. 12 km[W24°N]

27. (a) 2.0×10^1 km[N16°E]
(b) 9.9 km/h[N16°E]

28. $0.217\ m/s^2$[S19.7°W]

29. (a) He should aim upstream at an angle 41° with respect to the river bank.
(b) 2.3 min

Unit 1 Review

34. 13 km[E13°S]

35. 64 km/h[E51°S]

36. (a) 0.50 h **(b)** 55 km[S]
(c) 110 km/h[S]

37. (i) B **(ii)** C **(iii)** A **(iv)** D

38. (a) 3.7×10^2 km **(b)** 79 km/h

39. 7.2 s

41. (a) 0.4 km **(b)** 6 min
(c) 1 km

42. $2.5\ m/s^2$[N]

43. 5.0×10^1 m

44. 9.0 s

45. 20 s

46. (i) A **(ii)** C **(iii)** E

47. (a) 5.1 km[S28°E]
(b) 1.7 m/s[S28°E]

48. 1.8 m/s[N19°E]; 8.8×10^2 s; 5.3×10^2 m downstream

49. (a) 7.4 m/s[N] **(b)** 9.5 m/s[N]
(c) 5.3 m/s[N]

50. (a) Deke **(b)** 6.2 min

51. 4.9×10^2 m

53. 59 km/h[E17°S]

54. 45 km/h[E45°S]

55. Heading[N23.5°W]; 201 m/s[N30.0°W]

56. $1.9 \times 10^4\ m/s^2$[N]

57. $6.8\ m/s^2$[NW]

58. 3.9 m/s[NE]

Chapter 4

Practice Problems

1. 23 N
2. (a) 66.722 kg (b) 656.03 N
   (c) 605.81 N
3. $W_{Earth} = 2.05 \times 10^3$ N,
   $W_{Moon} = 3.43 \times 10^2$ N
4. 3.25×10^{-2} m/s^2
5. (a) 5.89 N (b) 3.50 N; 0.595
   (c) μ_k
6. (a) 1.23×10^3 N (b) 527 N
   (c) 264 N
7. 1.95×10^2 N
8. 0.34

Chapter 4 Review

Problems for Understanding

26. 11 kg
27. 90.4 N, 205 N
28. 1.2×10^2 N
29. 62%
30. 0.87
31. 2.0×10^2 kg
32. 49 N
33. 37.5% or a 171 N reduction
34. (a) 4.4×10^3 N (b) 1.5×10^3 N
    (c) 0.25

Chapter 5

Practice Problems

1. 0.55 m/s^2[E]
2. 0.53 m/s^2[E]
3. 1.7 kg
4. 1.6 m[N]
5. (a) 5.6 m/s^2[E] (b) 2.0×10^2 m[E]
6. 0.23
7. 9.6×10^{-13} N
8. 9.3 m/s
9. –7.7 m/s^2
10. (a) 0.249 N (b) 0.00127
11. 78 N
12. (a) 58 N (b) 16 m/s^2
13. 6.7 m
14. 40 N[N30°E]
15. (a) 43 N[E] (b) 7.4 N[N]
    (c) 15 N[E] (d) 15 N[W28°S]
16. (a) 1.4×10^3 N (b) 3.9×10^2 N
17. (a) $F_x = 120$ N, $F_y = -86$ N
    (b) 3.3×10^2 N
    (c) 38 N in direction 2.3° below the horizontal
    (d) 1.5 m/s^2
18. 1.6×10^3 N, 9.1×10^2 N
19. (a) 21 N (b) 15 N
20. (a) 74 N (b) 34 N
21. negative; 5.9×10^2 N
22. down (negative); 6.9×10^2 N
23. up (positive); 5.9×10^2 N
24. 15 m/s
25. (a) 1.2 m/s^2 (b) 0.16 m/s^2
    (c) 12 s
26. 0.061
27. 0.34 m
28. 0.37
29. (a) 11.5 kg m/s[E]
    (b) 2.6×10^8 kg m/s[W]
    (c) 8.39×10^7 kg m/s[S]
    (d) 5.88×10^{-24} kg m/s[N]
30. 43.6 N·s[down]
31. 2.58×10^5 N·s[S]
32. 4.52×10^6 N[S]
33. 2.6 kg m/s[forward]
34. –38 kg m/s
35. 8.8 kg m/s[up]

Chapter 5 Review

Problems for Understanding

24. 0.4 m/s^2
25. (a) 3.8×10^2 N (b) 0.18 m/s^2
26. 50 N[E70°N]
27. (a) 0.80 m/s^2 (b) 16 N
28. (a) $v = 0$; a = –9.8 m/s^2
    (b) 3.5 m/s; –9.8m/s^2
29. (a) 1.34 m/s^2 (b) 334 N
30. 1.2 N
31. (a) 0.062 m/s^2 (b) 0.40 m/s^2
    (c) A friction force of magnitude 3.4 N operates to reduce the ideal acceleration ($a = F$/m)
32. 11 m
33. (a) 5.4 m/s[down]
    (b) 3.7×10^4 N[up]
35. (a) $a_2 = 2.5a_1$ (b) $d_2 = 2.5d_1$
36. (a) 9.00 N (b) –132 N
    (c) 141 N (d) 0.451
37. 18 kg m/s[N]
38. 1.5×10^3 kg
39. 1.20 m/s[S]
40. 6.0×10^3 m/s[forward]
41. (a) 0.023 N·s[E] (b) 0.036 N·s[S]
42. 3.8×10^3 N
43. 3.6×10^{-2} s
44. (a) 16 kg m/s[S] (b) 6.4×10^{-3} s
45. 2.5×10^4 N[E]
46. 2.9×10^4 N[backward]

Unit 2 Review

29. (a) 4.70×10^2 N (b) 178 N
    (c) 1.24×10^3 N
30. (a) 3.7×10^2 N (b) 1.9×10^2 N
31. (a) 62 N (b) 31 N
32. 4.60×10^3[E]
33. 89.7 kg
34. 0.441 m/s[E0.0121°N]
35. (b) It would accelerate in the horizontal direction.
    (c) It would have constant velocity.
    (d) It would slow down and stop.
36. 1.2×10^2 N[up]
37. (a) 2.00 (b) 2.00
38. (a) 1.5×10^4 N (b) 3.8×10^3 N
    (c) 2.5 m/s^2
    (d) 22 m/s = 81 km/h
    (e) 9.0 s
39. 2.0×10^2 N
40. (a) 6.9×10^3 N (b) 64 km/h
41. (a) 612 N (b) 437 N
    (c) 786 N (d) 612 N
42. (a) 1.7×10^2 N (b) 29 m/s
43. (a) 2.74×10^3 N[W]
    (b) 1.05×10^3 N[W]
44. 3.5×10^4 kg m/s[N]
45. (a) 6.6 kg m/s
    (b) 4.0×10^1 kg m/s
    (c) 3.0×10^3 kg m/s
46. (a) 9.6 kg m/s[N]
    (b) –17 kg m/s[N]
    (c) 17 kg m/s[S]
    (d) 2.6×10^2 N[N]
    (e) 2.6×10^2 N[S]
47. (a) 45 N (b) 42 m/s

Chapter 6

Practice Problems

1. 5.7×10^3 J; 42 m
2. 82 m
3. 2.30 m/s^2
4. 6.33 m
5. 225 N
6. 10.9 m
7. (a) 0 J
   (b) force is perpendicular to direction of motion
8. 3.00×10^2 J
9. (a) 0 J
   (b) no forces are acting so no work is done (velocity is constant)
10. (a) 0 J
    (b) the tree did not move, so Δd is zero

11. A. 180 J B. 65 J
C. 0 J D. ~230 J

14. (a) 4.1×10^3 J **(b)** -4.1×10^3 J
(c) gravity and applied force

15. raising: +126 J; lowering: −126 J

16. 1.9×10^3 J

17. 1.4×10^2 N

18. 40.0°

19. 81.1 J

20. 1.0×10^1 kg

21. 1810 J

22. 11.5 m/s

23. 4.1×10^6 m/s

24. 0.36 J; 3.6 N 6.35 kg

25. 6.35 kg

26. 3000 N; 40 M; 160 m; $d \propto v^2$

27. 87 J

28. 2.4×10^6 J

29. 4.08 m

30. 1.16 m

31. (a) 2370 J **(b)** 2370 J

32. 16.0 J

33. 1.51×10^6 J

34. (a) 1.59×10^5 J **(b)** 2.38×10^5 J

35. 5×10^2 N/m

36. (a) 0.414 m **(b)** −455 N

37. 0.0153 kg

38. 1.0 J

39. 0.30 m

40. 1.4 J

41. 1.5×10^2 W

42. 15.4 kW; 20.7 hp

43. No, the student will be 1.15 s late

44. (a) 75%
(b) into friction of moving parts

45. 25.5%

46. 19.0%

47. (a) $\text{Eff}_{\text{incand}} = 4\%$, $\text{Eff}_{\text{fl}} = 8\%$
(b) the florescent bulb heats up less than the incandescent bulb

48. 87.2%

49. (a) 66.3 J **(b)** 6.01 J **(c)** 90.9%

50. 34%

Chapter 6 Review

Problems for Understanding

15. (a) Ground pushes up, gravity pulls down, engine propels car forward, ground resists backward.
(b) The forward force (from the car's engine) does work.

16. 44 N

17. 3.50×10^2 J

18. 1.44×10^4 J

19. 6.2×10^2 J

20. 4.38 J

21. 5.0 m: 1.0×10^2 J, 13 m/s;
15.0 m: 5.8×10^2 J, 31 m/s;
25.0 m: 8.1×10^2 J, 36 m/s

22. 73°

23. the 55 kg athlete

24. (a) 3.2 m/s; 3.4×10^2 J

25. 5.0×10^1 kg

26. (a) 0.035 N **(b)** −0.025 J
(c) 0.025 J

27. (a) 16 J **(b)** 16 J

28. (a) 7.7×10^3 J **(b)** 6.7×10^3 J
(c) 9.4 m/s; 8.7 m/s
(d) infinity (no friction); 1.3×10^2 m

29. 3.2×10^2 N/m

30. 4.5×10^2 N/m

31. (a) 0.38 J **(b)** 9.6 N

Chapter 7

Practice Problems

1. 13 m/s

2. 7.7 m

3. 4.8 m

4. 5.1 m

5. $E_g = 4140$ J; $E_k = 4140$ J; $v = 5.12$ m/s

6. ball: 610 J, 22 m/s; shot: 13 J, 22 m/s

7. 1.0×10^1 m

8. 15 floors; 49.3 m/s 152 J

9. (a) 0.28 m **(b)** 1.3 m/s
(c) 17 m/s²

10. 1.4×10^3 N/m

11. 57 m/s

12. (a) 80.4 m/s **(b)** 5.98 m/s

13. (a) 39.6 cm **(b)** 16.9 J

14. (a) 469 g **(b)** 65.2 cm
(c) 61.3 cm

15. 6.59×10^3 N/m

16. 0.42 m

17. (a) 405 N/m **(b)** 44.1 m/s²

18. 11 m/s

19. 14.3 m/s

20. 7.40×10^2 J

21. (a) 11 J **(b)** 6.7 m/s
(c) 4.2 m/s

22. −7.4 J; −180 N

23. 43.1 m/s; 8.9%

24. 75 N

25. 2.7 m/s

26. 0.11 m/s[in the direction that car A was travelling]

27. 2.10 m/s[S]

28. 0.11 m/s[E]

29. -2.43×10^2 m/s

30. $v_2 = 6.32$ m/s[41.5° counterclockwise from the original direction of the first ball]; the collision is not elastic: $E_k = 12.1$ J; $E_k' = 10.2$ J

31. 1.24×10^5 kg km/h = 3.44×10^4 kg m/s[N39.5°W]; the collision was not elastic: $E_k = 3.60 \times 10^6$ kg km²/h²; $E_k' = 1.80 \times 10^6$ kg km²/h²

Chapter 7 Review

Problems for Understanding

20. 0.36 m

21. 17 J; 4.2 m/s

22. 30 m/s

23. 1.3 m/s

24. 0.77 m/s; 0.031 m

25. 5.0 m/s

26. (a) -8.7×10^2 J **(b)** −1.8 m

27. 3.1 m/s[E]

28. −2.3 m/s

29. 1.3 m/s[forward]

30. 0.17 m/s[forward]

31. (a) 0.21 m/s **(b)** 13 kg·m/s
(c) 95%

Unit 3 Review

38. 16.8 m/s

39. 31 m/s, 22 m/s, 18 m/s

40. (a) -5.8×10^3 J **(b)** 3.6
(c) yes, $\mu > 1$

41. (a) 6.1×10^3 N **(b)** 1.8×10^7 J

42. (a) 1.3×10^4 kg m/s
(b) -1.3×10^4 kg m/s
(c) -1.3×10^4 kg m/s
(d) 19 m/s

43. 260 m/s

44. (a) 780 J **(b)** It loses 780 J

45. -7.9×10^3 N

46. (a) 0.24 J **(b)** 48 J

47. (a) 0.32 m **(b)** 12 J

48. 15 kg

49. 60.0 m

50. (a) 1.46×10^4 J
(b) 1.46×10^4 J; 12.5 m/s

51. 3.1 m/s

52. (a) 0.47 m

53. (a) 6.0 N **(b)** 0.15 J **(c)** 0.023 J

54. 1.16×10^3 J. No, work is done by friction forces.
55. (a) 4.4 m/s (b) 3.5 m/s

Chapter 8

Practice Problems

1. 0.98 Hz; 1.0 s
2. 7.5 to 11 Hz
3. 29.7 s
4. 0.04 Hz; 2.5 s
5. 7.5 m/s; 0.80 s
6. 1.4×10^9 Hz
7. 3.1×10^{-4} Hz
8. (a) 8.80 Hz (b) 853 m
   (c) constant frequency
9. (a) 1.34 m (b) 0.670 m

Chapter 8 Review

Problems for Understanding

21. 0.25 Hz
22. the wavelength doubles
23. 0.4 m
24. 1.67×10^{-2} Hz; 5.72 m
25. (a) 1.4 Hz (b) 3.7 cm/s
26. 1.6 Hz
27. 680 km
28. (a) 1.2 Hz (b) 0.84 s
29. (a) 1.02 s (b) 2.56%
    (c) 225 h or 9.38 days
    (d) shorten the pendulum

Chapter 9

Practice Problems

1. (a) 3.5×10^2 m/s (b) 3.4×10^2 m/s
   (c) 3.5×10^2 m/s (d) 3.2×10^2 m/s
2. (a) 35.6 °C (b) 11.9 °C
   (c) 5.1 °C (d) −20.3 °C
3. (a) 6.2×10^2 m
4. 0.005 s
5. 2.0×10^2 m
6. (a) 5.8 s (b) 6.7×10^{-6} m
   (c) 2.8 km
7. 1.31, ice
8. 29.7°
9. 51°
10. 39.5°
11. 31.0°
12. 47.2°
13. 58.9°
14. 78.5°
15. 2.6 m
16. (a) 68 cm (b) 85 cm
17. (a) 96 cm, 160 cm
    (b) 64 cm, 96 cm
18. 19 cm, 57 cm
19. 32 cm, 96 cm
20. (a) 1.34 m (b) 64 Hz
21. 512 Hz, 768 Hz
22. (a) 64.9 Hz (b) 130 Hz, 195 Hz
23. (a) 175 Hz (b) 1.97 m
24. (b) 6.00 Hz
25. 9.0 beats
26. 251 Hz or 261 Hz
27. (a) 443 Hz

Chapter 9 Review

Problems for Understanding

40. (a) 307 m/s (b) 3.3×10^2 m/s
    (c) 343 m/s (d) 352 m/s
41. (a) 40.7 °C (b) 22.0 °C
    (c) 3.39 °C (d) −22.0 °C
42. 4.0 °C
43. 7.0×10^2 m
44. (a) 436.5 Hz or 443.5 Hz
    (b) If, as the string is tightened, the beat frequency increases, then the guitar was at 443.5 Hz, while if the beat frequency decreases, then the guitar was at 436.6 Hz.
45. (a) The human brain responds to harmonics, i.e. simple fraction ratios of pitch.
46. (a) Increases in pitch at specific, well-defined tube lengths.
    (b) $L_1 = 0.098$ m, $L_2 = 0.29$ m, $L_3 = 0.49$ m, $L_4 = 0.68$ m
47. (a) 0.38 m (b) 9.0×10^2 Hz
48. The well is less than 176 m deep.
49. 0.062 m
50. 2.8×10^3 km/h
51. 1.3×10^2 m
52. Yes, with 0.03 s to spare.
53. (a) 55° (b) 110°
54. 56°
55. 38°
56. 1.95
57. 22.8°
58. The ray exits at 30°, 5.7 cm from the bottom corner (assuming it entered 3.5 cm from the same corner).
59. 2.4×10^{-9} s
60. (a) 1.2 (b) 11° (c) 39°
61. 22°
62. 68°
63. 4 cm
64. 4.8×10^2 nm
65. 589 nm

Unit 4 Review

Problems for Understanding

39. 3.0 m/s
40. 0.167 Hz
41. 0.8 m
42. 7.14×10^9 Hz
43. 0.73 m
44. 312 Hz
45. 0.259 m
46. 382.8 Hz or 385.2 Hz
47. 2.4 s
48. 2.00 m
49. −8 °C
50. 1.60×10^8 m/s
51. 1.0×10^{-9} s
52. 1.4
53. 25°
54. 15°
55. 1.39
56. 60°
57. 38.6°
58. 0.12 m; 2.5×10^9 Hz; 4.0×10^{-10} s
59. 2.1×10^5 Hz; 1.4×10^3 m
60. 5.5×10^{16} cycles
61. 1.5×10^2 m
62. 9.4607×10^{15} m
63. 8×10^{-7} m

Chapter 10

Practice Problems

1. (a) 4.1 m, 15 m
   (b) −6.6 m/s², 4.6 m/s²
   (c) −11.3 m/s, −11.3 m/s
2. (a) 6.84 km, 18.8 km
   (b) 2.6 m/s, −1.5 m/s
   (c) −2.3 m/s, 6.4 m/s
3. 3.0×10^1 km[E], 5.2×10^1 km[N]
4. (a) 5.9 km[E34°?]
   (b) [W56°N]
5. (a) W17°S
   (b) 8.7 min
6. 15 m/s in a direction 4.9° to the shuttle
7. (a) 1.6×10^2 N[W58°S]
   (b) 2.1×10^2 N[W16°N]
   (c) 1.3×10^2 N[S50°W]
8. (a) 1.6×10^2 N[W58°S]
   (b) 2.1×10^2 N[W16°N]
   (c) 1.3×10^2 N[S50°W]
9. 1.5×10^3 N by each cable
10. (a) No (b) $> 1.7 \times 10^2$ N
11. (a) 20° (b) 0.028 m/s²
12. 4.0×10^2 N

13. (a) $> 8.3 \times 10^2$ N (b) $> 7.3 \times 10^2$ N
14. -1.9 m/s^2
15. No, the climber must limit his descent to $a = -2.5$ m/s^2
16. (a) downward (b) -1.1 m/s^2 (c) 87 N
17. 1.7×10^2 N
18. 1.8 m/s^2
19. 0.49 m/s^2; 39 N
20. 14 kg; 75 N
21. 62 kg; 1.6 m/s^2
22. 17 N
23. Both of them will rise, with $a = +1.0$ m/s^2
24. (a) 3.88 N (b) 2.04 m/s^2
25. 0.67 s
26. 2.77 s
27. (a) 5.8 m/s (b) 0.63 N
28. (a) 0.91 N (b) 1.6 m/s^2 (c) 4.9 N
29. 65 N·m
30. 4.5×10^2 N·m
31. 1.1×10^3 N
32. 9.6×10^2 N
33. (a) 4.3×10^2 N (b) 6.7×10^2 N
34. 4.4×10^2 N
35. 6.4 m/s[40.0° counterclockwise]
36. 1.16 m/s[6.1° clockwise from original direction]
37. $V_A = 34.3$km/h[S]; $V_B = 67.$km/h[E]
38. 1.4 Kg, 2.6 m/s [83° counterclockwise from the x-axis]
39. $V_2 = 6.32$ m/s[41.5° counterclockwise from the original direction of the first ball]; the collision is not elastic: $E_k = 12.1$ J; $E'_k = 10.2$ J
40. 1.24×10^5 kg km/h = 3.44×10^4 kg m/s[N39.5°W]; the collision was not elastic: $E_k = 3.60 \times 10^6$ kg km^2/h^2; $E'_k = 1.80 \times 10^6$ kg km^2/h^2
41. 261 m/s
42. The cart will stop at 0.018 m; therefore, it will not reach the end of the track.
43. 55.5 km/h = 15.4 m/s
44. 18.2 m/s
45. 3.62 m/s; 1.71 m

Chapter 10 Review

Problems for Understanding

23. (a) N36°E (b) 1.5 m/s[E] (c) 29s
24. (a) 1.0×10^2 N[E27°N] (b) 34 N[S0.61°E] (c) 1.5×10^2 N[67° counterclockwise from the x-axis]
25. 2.3×10^2 N [1.4° to the right of backward]
26. (a) No (c) 2.8 kg (d) 5.7 m/s^2
27. 3.9×10^2 N[up], 5.0×10^2 N[up]
28. (a) 8.58×10^3 N (b) 1.00×10^4 N[43.3° cw from arm]
29. 4.4 m/s[35.2° clockwise]
30. (a) 0.29 m/s[W21°N] (b) 70%

Chapter 11

Practice Problems

1. 677 m [before drop point]
2. 4.67 m/s
3. 89.6 m, 45.2 m/s [60.3° below the horizontal]
4. 0.156 m
5. 3.05 m/s
6. 0.55 m
7. 74 m
8. (a) 153 m (b) 5.00 m/s [down]
9. 85 m
10. 4.0×10^1 m
11. 18 m/s [52° below the horizontal]
12. 2.8 m/s
13. (a) 58.9 m (b) 21.0 m (c) 4.14 s
14. 33.2°; 2.39 m; 1.40 s
15. 47.0 m/s
16. 2.7×10^2 m
17. (a) 48.6 N (b) 54.2 N (c) 9.62 m/s
18. 5.9×10^3 N
19. 84 m
20. 103 m
21. 13 m/s (47 km/h)
22. 19.1 m/s (68.8 km/h)
23. 20.1°

Chapter 11 Review

Problems for Understanding

15. (a) 3.0×10^1 m (b) 3.7 s
16. 2.7×10^2 m
17. (a) 2.1 s (b) 34 m (c) 8.5 m [above the ground] (d) $v_x = 16$ m/s; $v_y = +3.8$ m/s or -3.8m/s (e) 38.2°
18. 52 m/s
19. Yes. It travels 330 m.
20. (a) 7.4 s (b) 67 m (c) 1.2×10^2 m (d) x: 34 m, y: 53 m (e) $v_x = 17$ m/s; $v_y = -23$ m/s
21. (a) 2.1 m/s (b) 1.2 m/s^2
22. (a) 1.33×10^{14} m/s^2 (b) 1.21×10^{-16} N
23. 0.33
24. 8.9 m/s
25. 33°
26. 9.90 m/s
27. 0.62
28. (a) 4.64×10^2 m/s (b) 2.0 N (for $m = 60.0$ kg) (c) Toward the centre of Earth; gravity (d) $mg = 589$ N (for $m = 60.0$ kg) (e) $N = mg - mv^2/r = 587$ N (f) $mg - N = ma_c$; because $mg > N$, there is a net acceleration toward the centre of Earth.

Chapter 12

Practice Problems

1. 3.58×10^{22} N
2. 1.99×10^{20} N
3. 5.1×10^{-3} m. This is much smaller than the radii of the bowling balls.
4. 3.61×10^{-47} N
5. 5.0×10^{24} kg
6. 0.25 m
7. $F_{Uranus} = 0.80 \times F_{Earth}$
8. 0.9 × Earth – Moon distance
9. 1.899×10^{27} kg
10. 1.472×10^{22} kg
11. 2.74×10^5 m
12. 1.02×10^3 m/s
13. (a) 6.18×10^4 s (17.2 h) (b) 7.93×10^2 m/s
14. 4×10^{41} kg $= 2 \times 10^{11} \times M_{Sun}$
15. 7.42×10^3 m/s; 8.59×10^5 m
16. 7.77×10^3 m/s; 5.34×10^3 s (89.0 min)
17. (a) 5.21×10^9 s (165 years); 5.43×10^3 m/s (b) It will complete one orbit, after its discovery, in the year 2011.

Chapter 12 Review

Problems for Understanding

22. 1/8
23. (c) F
24. (b) a/3
25. (a) 3.0×10^4 m/s (b) 6.0×10^{-3} m/s^2

26. 1.8×10^{-8} m/s^2

27. 9.03 m/s^2 = 92% of acceleration due to gravity at Earth's surface

28. 4.1×10^{36} kg = $2.0 \times 10^6 \times m_{Sun}$

29. 2.7×10^{-10} N

30. **(a)** 5.3×10^5 m
(b) 5.7×10^3 s = 95 min

31. 1.02×10^3 m/s;
2.37×10^6 s = 27.4 days

32. **(a)** Yes. **(b)** 5.69×10^{26} kg

33. **(a)** 4×10^{15} kg **(b)** 4×10^{27} kg
(c) $m_{Oort} = 700m_{Earth} = 2m_{Jupiter}$

Chapter 13

Practice Problems

1. 0.494 s

2. 17 N/m

3. **(a)** 0.253 s **(b)** 8.4 m/s
(c) 7.4 m/s

4. 8.2×10^4 N/m

5. **(a)** 71 N/m
(b) 0.897 s using k = 71.05 n/m

6. **(a)** $k = 2.2 \times 10^3$ N/m
(b) 0.98 s

7. 1.3 s

8. 4.0 m

9. 0.25 m

10. 0.88 s

Chapter 13 Review

Problems for Understanding

22. 0.245 s, 0.297 s, 0.42 s, 0.149 s, 0.181 s, 0.26 s

23. 0.48 s

24. **(a)** 0.82 J **(b)** 1.37 m/s

25. **(a)** 81 J **(b)** 8.0×10^2 N/m
(c) 0.13 s

26. 44 N/m

27. 0.21 s

28. 0.016 m

29. 0.097 m

30. 1.5 m/s

Unit 5 Review

33. 15 N[E19°S]

34. 1.4 m/s^2

35. **(a)** 7×10^3 N
(b) 9.15 × true weight

36. 17°

37. **(a)** 9.8×10^2 N **(b)** 13 km

38. **(a)** 33 m/s^2 **(b)** 23 N

39. **(a)** 21.3 m/s **(b)** 1.53 m
(c) down

40. **(a)** 4.4×10^2 N; 1 × weight
(b) 2.0×10^2 N; 0.45 × weight
(c) 4.4×10^2 N; 1 × weight
(d) 6.8×10^2 N; 1.5 × weight

41. 29 m/s

42. 4.2×10^3 m/s

43. **(a)** 4.6×10^2 m/s
(b) 7.9×10^2 m/s

44. 59.7 m

45. 44°

46. **(a)** 0.342 J **(b)** 1.45 m/s

Chapter 14

Practice Problems

1. 0.34 N

2. 0.80 m

3. 5.1×10^{-7} C

4. 0.50 N (attractive)

5. 0.17 N (repulsive)

6. 0.12 m (directly above the first proton)

7. $F_A = 1.2 \times 10^{-2}$ N[W73°S];
$F_B = 1.6 \times 10^{-2}$ N[E63°N];
$F_C = 4.6 \times 10^{-3}$ N[W36°S]

8. 8.7 N[E18°N]

9. 2.0×10^{-8} C

10. 7.9×10^{-8} C

11. 1.5×10^5 N/C (to the right)

12. 0.019 N[W]

13. 2.5×10^4 N/C (to the left)

14. -4.0×10^{-4} C

15. 3.8 N/kg[down]

16. 52 N[down]

17. 3.46 kg

18. 2.60 N/kg[down]

19. 2.60 m/s^2[toward centre]

20. -7.8×10^5 N/C (toward the sphere)

21. -1.2×10^{-5} C

22. 0.32 m

23. 5.80×10^9 electrons

24. -1.5×10^6 N/C (toward the sphere)

25. 0.080 m

26. 5.3×10^8N/C[81.4° above the +*x*-axis]

27. 1.9×10^4 N/C[86.7° above the +*x*-axis]

28. 3.4×10^6 N/C[23.7° above the −*x*-axis]

29. 2.25×10^{14} N/C (toward the negative charge)

30. 2.9×10^7 N/C[73.6° above the +*x*-axis]

31. 5.7×10^{-2} N/kg

32. 3.81×10^7 m

33. 8.09 N/kg[toward centre]

34. 5.82×10^{23} kg

35. 5.0×10^{-11} N/kg[toward centre]

36. 8.09 N/kg[toward centre]

37. 1.03×10^{26} kg

38. -4.7×10^{-2} J

39. 0.18 J

40. 5.1×10^2 m

41. 1.55×10^{-4} C. The signs of the two charges must be the same, either both positive or both negative.

42. 4.8×10^6 N/C

43. 1.5×10^{10} m

44. 2.9×10^{-5} J

45. -4.7×10^{-12} C

46. If the positive charge is placed at 0.0 cm and the negative charge is placed at 10.0 cm, there are two locations where the electric potential will be zero: 6.2 cm and 27 cm.

47. 1.1×10^6 V

48. 8.0 V

49. -2.1×10^6 V

50. 1.6×10^6 V

51. 1.4×10^{-6} C

52. 2.0 V

53. 12 J

54. -2.4×10^4 V

55. **(a)** 1.9×10^5 V
(b) 1.2×10^{-3} J
(c) A. It takes positive work to move a positive test charge to a higher potential. Since in this case, you invest positive work to move your positive test charge from B to A, A must be at a higher potential.

56. 5.3 cm and 16 cm to the right of the positive charge.

57. any point lying on a line midway between the two charges and perpendicular to the line that connects them

58. The potential is zero 3.4 cm above the origin and 24 cm below the origin.

59. If the distances of the first and second charges, q_1 and q_2, from the point of zero potential are d_1 and d_2, then d_2 must satisfy $d_2 = (-q_2/q_1)d_1$, with $q_2 > 0$. For example, if $q_2 = -8.0\mu$C, then $d_2 = 16$ cm and the charge would be located either 24 cm to the right of q_1 or 8.0 cm to the left of q_1. Other solutions can be similarly determined.

60. 4.0 cm to the right of the $-4.0\mu C$ charge.

Chapter 14 Review

Problems for Understanding

18. 9×10^3 N
19. 2.3×10^{-8} N
20. 5.6 cm
21. $F_A = 4.5 \times 10^{-2}$ N to the left; $F_B = 0.29$ N to the right; $F_C = 0.24$ N to the left
22. $F_A = 3.8$ N[N3.0°E]; $F_B = 4.4$ N[E23°S]; $F_C = 4.7$ N[W26°S]
23. $F_Q = 8.2 \times 10^{-8}$ N; $F_g = 3.6 \times 10^{-47}$ N
24. The charges on Earth (q_E) and the Moon (q_M) must satisfy $|q_E| \times |q_M| = 3.3 \times 10^{27}$ C^2, and they must have opposite signs.
25. 4.2×10^{42}
26. –57 C
27. 5.2×10^{-3} N
28. **(a)** 8.65×10^{25} kg
    (b) 8.81 N/kg
    (c) 881 N
29. $2/9\ g_{Earth} = 2.18$ N/kg
30. **(a)** 8.24×10^{-8} N
    (b) 2.19×10^6 m/s
    (c) 5.14×10^{11} N/C
    (d) 27.2 V
31. $1.86 \times 10^{-9}\ kg = 2.04 \times 10^{21} \times m_{actual}$
32. 9×10^{-5} N[W]
33. 0.51 m
34. 6.0×10^4 N/C[E37°N]
35. **(a)** -8×10^{-8} J
    (b) It loses energy.
36. -3×10^{-6} J
37. 2.8×10^2 C
38. **(a)** 4.5×10^3 V
    (b) Yes; the spheres have to be at equal potential, because the same point cannot have two different potentials.
    (c) big sphere: 52 nC; small sphere: 23 nC
39. **(a)** E = 0; $V = 2.2 \times 10^5$ V
    (b) $E = 4.3 \times 10^5$ N/C; V = 0
40. **(a)** 2.3 J **(b)** 1.2×10^6 V
    (c) X
41. **(a)** 4.0×10^5 V **(b)** R

Chapter 15

Practice Problems

1. 20.0 V
2. 0.378 J
3. 6.5×10^{-2} C
4. 40.0 V
5. 8.0 s
6. 4.23×10^3 J
7. 50 A
8. 57 s
9. 7×10^4 C
10. 2.8 A
11. 4.6×10^7 J
12. 0.133 A
13. **(a)** 9.38 A
    (b) 2.11×10^{22} elementary charges
14. 5.25×10^{20} elementary charges
15. **(a)** 3.3 A **(b)** 1.7 V
16. 2.2 Ω
17. 4.08 m
18. 1.6×10^{-6} m
19. 0.45 Ω
20. 2.4 mm
21. 16 Ω
22. 12.5 A
23. 5.0 V
24. **(a)** 9.9×10^2 C **(b)** 2.1 A
25. 11.6 Ω
26. 7.50 min
27. **(a)** 33 V, 53 V and 79 V respectively
    (b) 75 Ω **(c)** 1.6×10^2 V
28. **(a)** 91.0 V **(b)** 156 V
29. 42.0 Ω
30. **(a)** 8.00 Ω **(b)** 224 V **(c)** 32.0 Ω
31. 44.0 Ω
32. 0.667 A, 1.00 A and 1.33 A respectively; 3.00 Ω
33. $R_{coil} = 6.00\ \Omega$, $R_{bulb} = 20.0\ \Omega$, $R_S = 4.62\ \Omega$
34. $R_{unknown} = 8.00\ \Omega$, $R_S = 4.80\ \Omega$
35. **(a)** 11.2 Ω **(b)** 21.6 Ω, 30.0 Ω
36. **(a)** 38.4 Ω **(b)** 2.25 A **(c)** 91.5 V
37. **(a)** 15.4 Ω **(b)** 9.76 V **(c)** 1.02 A
38. **(a)** 14.8 V **(b)** 14.6 V
39. **(a)** 11.4 V **(b)** 11.2 V
40. **(a)** 7.3 A **(b)** 16 Ω
41. **(a)** 6.0×10^1 W **(b)** 27 W
    (c) 1.1×10^2 Ω
42. **(a)** 840 W
    (b) The power output drops to 1/4 its original value, or 210 W
43. **(a)** $P_a = 720$W, $P_b = 1.6 \times 10^3$ W
    (b) $P_a/P_b = 4/9$; $V_a/V_b = 2/3$; $P_a/P_b = (V_a/V_b)^2$
44. 1.0×10^3 W
45. **(a)** 400 W
    (b) 200 W. Increasing the resistance decreased the current for the given potential difference.
46. 48.0 V
47. 15 Ω
48. 294 W
49. 2.00×10^3 C
50. **(a)** 550 W **(b)** 5.0×10^6 J
51. 3.75 cents
52. 1.08 cents
53. **(a)** 1.4×10^2 W **(b)** 0.50 cents

Chapter 15 Review

Problems for Understanding

24. 3×10^3 Ω
25. **(a)** 12 A **(b)** 2.5×10^3 C
    (c) 3.0×10^5 J
26. 5.0×10^5 J
27. 1.77 cents
28. 37.5 Ω
29. $I_1 = 6.0$ A, $V_1 = 150$ V, $I_2 = 1.0$ A, $V_2 = 3.0 \times 10^1$ V, $I_3 = 5.0$ A, $V_3 = 3.0 \times 10^1$ V
30. 9.93 s
31. **(a)** 1.9 Ω **(b)** 1.4×10^2 Ω
    (c) 0.82 A **(d)** 98 W
32. 24.3 V, 0.517 Ω

Chapter 16

Practice Problems

1. 0.72 N[left]
2. 7.7 N[down]
3. 6.38 A[down]
4. 0.204 T[out of page]

Chapter 16 Review

Problems for Understanding

27. **(a)** 2 times increase
    (b) 9 times increase
    (c) 2 times increase

Unit 6 Review

38. 8.23×10^{-8} N
39. ±14 μC
40. 1.5×10^4 electrons
41. 1.8×10^{13} C
42. -1.0×10^4 C
43. 0.12 m
44. 9.2×10^{-26} N
45. 1.1×10^{-5} C
46. 6.2×10^{12} electrons

47. (a) 0 J (b) -8.6×10^{-7} J
(c) equipotential surfaces

48. 0.10 T

49. 1.2 A (into page)

50. (a) 14 N[up] (b) 0

51. 4.00 Ω; 1.2 A, 5.0 V

52. Series 5.00 Ω; 1.2 A, 6.2 V
Parallel 5.00 Ω, 3.8 V; 7.5 Ω; 5 A, 3.8 V

53. (a) 17 V (b) 6.5 Ω (c) 14 V

Chapter 17

Practice Problems

1. (a) 4.8×10^{-13} s (b) 1.5×10^{-13} s

2. 257 s

3. $0.94c = 2.8 \times 10^{8}$ m/s

4. 702 km

5. 0.31 m

6. (a) 1.74×10^{8} m/s
(b) The sphere's diameter appears contracted only in the direction parallel to the spacecraft's motion. Therefore, the sphere appears to be distorted.

7. 465 μg

8. 1.68×10^{-27} kg

9. $0.9987c = 2.994 \times 10^{8}$ m/s

10. 4.68×10^{-11} J

11. 1.01×10^{-10} J

12. 2.6×10^{8} m/s

13. 7.91×10^{-11} J

14. 1.64×10^{-13} J

15. 1.3×10^{9} J

16. 4.3×10^{9} kg/s

Chapter 17 Review

Problems for Understanding

18. $0.87c$

19. (a) 3.2 m (b) 1.9 m
(c) 6.8×10^{-8} s

20. (a) 2.5×10^{-27} kg (b) 1.7×10^{-27} kg

21. plot

22. 3.0×10^{2} m/s

23. (a) c (b) c (c) c

24. (a) 3.2 (b) 5.8×10^{-8} s
(c) 16 m

25. 1.2×10^{-30} kg, which is 1.3 times its rest mass

26. (a) 4.1×10^{-20} J (b) 4.1×10^{-16} J
(c) 1.3×10^{-14} J (d) 5.0×10^{-13} J
(e) (a) and (b)

27. $0.14c = 4.2 \times 10^{7}$ m/s

28. 3×10^{4} light bulbs

29. 4.8×10^{-30} kg; $m/m_o = 5.3$; $0.98c = 2.9 \times 10^{8}$ m/s

30. (a) 1.4 g (b) 29% or 0.40 g

Chapter 18

Practice Problems

1. (a) 2.40 J
(b) 1.25×10^{15} Hz
(c) UV

2. 1.26×10^{15} Hz

3. calcium

4. 275 nm $\leq \lambda \leq$ 427 nm

5. 4.28×10^{-34} kg·m/s

6. 9.44×10^{-22} kg·m/s

7. 4.59×10^{-15} m

8. 3.66×10^{25} photons

9. 1.11×10^{10} Hz; radio

10. 1.05×10^{-13} m

11. 7.80×10^{-15} m

12. 1.04×10^{-32} m

13. 2.39×10^{-41} m

14. 5.77×10^{-12} m

15. 2.19×10^{6} m/s

Chapter 18 Review

Problems for Understanding

16. (a) 1.24×10^{15} Hz

17. (a) 2.900 eV
(b) lithium

18. 1.5×10^{15} Hz

19. 2.2 eV

20. 5.8×10^{18} photons/s

21. (a) 1.2×10^{-27} kg m/s
(b) 1.3×10^{-27} kg m/s
(c) 9.92×10^{-26} kg m/s

22. 1.7×10^{17} Hz

23. 5.5×10^{-33} kg m/s

24. (a) 3.1×10^{-7} m
(b) 6.14×10^{-10} m
(c) 4.7×10^{-24} kg m/s

Chapter 19 Review

Problems for Understanding

16. (a) 4.8×10^{-10} m
(b) –1.5 eV, This is the n = 3 energy level.

17. 486 nm

18. (a) 6.9×10^{14} Hz (b) 4.4×10^{-7} m
(c) –0.54 (d) 1.3×10^{-9} m
(e) 9.5×10^{-8} m

Unit 7 Review

Problems for Understanding

26. (a) $0.14c$ (b) $0.045c$

27. (a) 9×10^{16} J (b) 3×10^{7} a

28. (a) 3.1 light-year (b) 4.7 a
(c) 6.3 a

29. (a) 1.1×10^{-13} J
(b) 1.3 × rest mass energy
(c) 2.1×10^{-30} kg or 2.3 × rest mass

30. (a) 3×10^{9} J (b) 4×10^{-8} kg

31. 1.12 eV = 1.80×10^{-19} J

32. 4.7 eV = 7.5×10^{-19} J

33. (a) 1.05×10^{15} Hz
(b) 287 nm

34. (a) 1.25 nm (b) 0.153 nm

35. (a) 2.47×10^{15} Hz
(b) 1.22×10^{-7} m
(c) Lyman

36. 486 nm

37. (a) 3.0×10^{-19} J
(b) 8.1×10^{17} photons

38. (a) 6.91×10^{14} Hz
(b) 4.34×10^{-7} m
(c) –0.544 eV = -8.70×10^{-20} J
(d) 1.32 nm
(e) 9.49×10^{-8} m
(f) UV

Chapter 20

Practice Problems

1. $0.06066 \text{ u} = 1.0073 \times 10^{-28} \text{ kg}$
2. $1.237 \times 10^{-11} \text{ J}$
3. $2.858 \times 10^{-10} \text{ J}$
4. $2.6 \times 10^{9} \text{ a}$
5. $3.5 \times 10^{3} \text{ a}$
6. $8.49 \times 10^{-8} \text{ mg}$

Chapter 20 Review

Problems for Understanding

12. **(a)** 20 p, 20 n, 18 e
    (b) 26 p, 30 n, 26 e
    (c) 17 p, 18 n, 18 e
13. **(a)** $1.4765 \times 10^{-11} \text{ J}$
    (b) $1.7927 \times 10^{-10} \text{ J}$
14. ${}^{230}_{90}\text{Th} \rightarrow {}^{4}_{2}\text{He} + {}^{226}_{88}\text{Ra}$
15. **(a)** 1/4 **(b)** 1/16
    (c) 1/4096
16. **(a)** 4.876 MeV
    (b) $v_{He} = 1.520 \times 10^{7} \text{ m/s}$; $v_{Rn} = 2.740 \times 10^{5} \text{ m/s}$
    (c) 98.1%
17. $1.19 \times 10^{-7} \text{ g}$
18. 43 min
19. $1.2 \times 10^{4} \text{ a}$
20. **(a)** 200 **(b)** 600
    (c) 25 **(d)** 775
    (e) ${}^{D}N = {}^{P}N_0\left(1 - \left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}\right)$, where ${}^{D}N$ is the number of daughter nuclei at any time t, ${}^{P}N_0$ is the number of parent nuclei at time $t = 0$, and $T_{\frac{1}{2}}$ is the half-life of the parent nucleus.
21. **(a)** $\frac{N_U}{N_{Pb}} = \frac{\left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}}{1 - \left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}}$
    (b) 4.26×10^{9} a; 3.89×10^{9} a; 2.93×10^{9} a
    (c) Since the ratios and therefore the ages differ, the rocks must not have solidified at the same time.
    (d) More than one half-life has elapsed.

Chapter 21

Practice Problems

1. $0.14168 \text{ u} = 2.3527 \times 10^{-28} \text{ kg}$; $2.114 \times 10^{-11} \text{ J}$
2. $2.818 \times 10^{-12} \text{ J}$
3. **(a)** $0.0265 \text{ u} = 4.40 \times 10^{-29} \text{ kg}$; $3.96 \times 10^{-12} \text{ J}$
   (b) $5.96 \times 10^{11} \text{ J}$

Chapter 21 Review

Problems for Understanding

20. $8.194 \times 10^{-14} \text{ J}$
21. ${}^{1}_{0}\text{n} + {}^{235}_{92}\text{U} \rightarrow {}^{90}_{37}\text{Rb} + {}^{144}_{55}\text{Cs} + 2\,{}^{1}_{0}\text{n}$

Unit 8 Review

26. **(a)** 3.96×10^{-12} J/reaction
    (b) 9.68×10^{37} reactions/s
    (c) 6.64×10^{-27} kg/reaction
    (d) 6.43×10^{11} kg/s
    (e) 9.82×10^{9} a
27. **(a)** $4.40 \times 10^{-29} \text{ kg}$
    (b) 0.6580%
    (c) $1.18 \times 10^{45} \text{ J}$
    (d) 9.59×10^{9} a
28. 88.2 N
29. 5.9 days
30. $9.580 \times 10^{-13} \text{ J}$