

Appendix A: Answers to Selected Problems

Ch 1: Units and Problem Solving

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|-----|--|-----|---|
| 1a. | A person of height 5 ft. 11 in. is 1.80 m tall | 12. | 196 cm ² |
| 1b. | The same person is 180 cm | 13. | 250 cm ³ |
| 2a. | 3 seconds = 1/1200 hours | 14. | 8:1, each side goes up by 2 cm, so it will change by 2 ³ |
| 2b. | 3x10 ³ ms | 15. | 3.5 × 10 ⁵¹ :1 |
| 3. | 87.5 mi/hr | 16. | 72,000 km/h |
| 4c. | if the person weighs 150 lb. this is equivalent to 668 N | 17. | 0.75 kg/s |
| 5. | Pascals (Pa), which equals N/m ² | 18. | 8 x 2 ^N cm ³ /sec; N is for each second starting with 0 seconds for 8 cm ³ |
| 6. | 168 lb., 76.2 kg | 19. | About 12 million |
| 7. | 5 mi/hr/s | 20. | About 1½ trillion (1.5×10 ¹²) |
| 8. | 15.13 m | 21. | [a] = N/kg = m/s ² |
| 9. | 11.85 m | | |
| 10. | 89,300 mm | | |
| 11. | 2025 mm ² | | |

Ch 2: Energy Conservation

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|-----|---|------|--|
| 1. | d | | |
| 2. | (discuss in class) | | |
| 3a. | 5.0 x 10 ⁵ J | 8a. | 34 m/s at B; 28 m/s at D, 40 m/s at E, 49 m/s at C and F; 0 m/s at H |
| 3b. | 3.7 x 10 ⁵ J | 8b. | 96 m |
| 3c. | Chemical bonds in the food. | 9a. | 1.7 J |
| 3d. | 70 m/s | 9b. | 1.3 m/s |
| 4a. | 5.0 x 10 ⁵ J | 9c. | 0.4 J, 0.63 m/s |
| 4b. | 108 m/s | 10a. | 1.2 m/s ² |
| 5a. | 450,000 J | 10b. | 130 J |
| 5b. | 22,500 J | 11a. | 6750 J |
| 5c. | 16,875 J | 11b. | 2.25x10 ⁵ J |
| 5d. | 21.2 m/s | 11c. | 1.5x10 ⁵ J/gallon of gas |
| 5e. | 9.18 m | 12. | 0.76 m |
| 7b. | KE = 504,600 J; U _g = 1,058,400 J;
E _{total} = 1,563,000 J | | |

Ch 3: One-Dimensional Motion (answers assume 9.8 m/s² for acceleration of gravity)

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|-----|---|------|---|
| 2. | b | 8. | 6 minutes |
| 3. | a,c,d | 9d. | 20 meters |
| 4. | a,d | 9e. | 40 meters |
| 5a. | Zyan | 9f. | 2.67 m/s |
| 5b. | Ashaan is accelerating because the distance he travels every 0.1 seconds is increasing, so the speed must be increasing | 9g. | 6 m/s |
| 5c. | Ashaan | 9h. | Between t = 15 s and t = 20 sec because your position goes from x = 30 m to x = 20 m. |
| 5d. | Zyan | 9i. | You went forwards and backwards |
| 5f. | Ashaan | 10a. | 7.7 m/s ² |
| | | 10b. | 47 m, 150 feet |

- 10c. 34 mph
- 11a. 1.22 m
- 11b. 4.9 m/s
- 11c. 2.46 m/s
- 11d. -4.9 m/s
- 12b. 1 second
- 12c. at 2 seconds
- 12d. 4m
- 13a. 250 m
- 13b. 16 m/s, -16m/s
- 13c. 14s for round trip
- 14. 6 times higher
- 15. -31m/s^2
- 16a. 23 m/s
- 16b. 3.6 seconds
- 16c. 28 m
- 16d. 45m
- 17a. 25 m/s
- 17b. 30 m
- 17c. -10m/s^2
- 18. 2m/s^2
- 19a. $v_0 = 0$
- 19b. The acceleration of gravity (9.8m/s^2)
- 19c. The acceleration of gravity (9.8m/s^2)
- 19d. 60 m
- 20a. 0.3m/s^2
- 20b. 0.5 m/s

Ch 4: Two-Dimensional and Projectile Motion (answers assume 9.8m/s^2 for acceleration of gravity)

- 7a. 13 m
- 7b. 41 degrees
- 7c. $v_y = 26\text{m/s}$; $v_x = 45\text{m/s}$
- 7d. 56 degrees, 14 m/s
- 9. 32 m
- 10a. 0.5 s
- 10b. 0.8 m/s
- 11. 105 m
- 12. $t = 0.60\text{ s}$, 1.8 m below target
- 13. 28 m.
- 14a. 3.5 s.
- 14b. 35 m; 15 m
- 15. 40 m; 9.1 m
- 16. 1.3 seconds, 7.1 meters
- 17. 50 m; $v_{0y} = 30\text{m/s}$; 50° ; on the way up
- 18. 4.4 s
- 19. 19°
- 20. 0.6 s
- 21. 2.3 m/s
- 22. 6 m
- 23. 1.4 seconds
- 24a. yes
- 24b. 18 m/s @ -46 degrees from horizontal
- 25. 22 m/s @ 62 degrees

Ch 5: Newton's Laws

- 4. Zero; weight of the hammer minus the air resistance.
- 5. 2 forces
- 6. 1 force
- 7. No
- 8. The towel's inertia resists the acceleration
- 9a. Same distance
- 9b. You go farther
- 9c. Same amount of force
- 11a. 98 N
- 11b. 98 N
- 13. 32 N
- 14. 5.7m/s^2
- 17. $F_x = 14\text{ N}$, $F_y = 20\text{ N}$
- 18. Left picture: $F = 23\text{N}$ 98° , right picture: $F = 54\text{ N}$ 5°
- 19. 3m/s^2 east
- 20. 4m/s^2 ; 22.5° NE
- 21. 0.51
- 22. 0.2
- 23. The rope will not break because his weight of 784 N is distributed between the two ropes.
- 24. Yes, because his weight of 784 N is greater than what the rope can hold.
- 25. Mass is 51 kg and weight is 82 N
- 26a. While accelerating down
- 26b. 686 N
- 26c. 826 N
- 27a. 390 N
- 27b. 490 N
- 28. 0.33
- 29. 3.6 kg
- 30. $g\sin\theta$
- 31b. 20 N
- 31c. 4.9 N
- 31d. 1.63 kg
- 31e. Eraser would slip down the wall
- 32a. 1450 N
- 32b. 5600 N
- 32c. 5700 N
- 32d. Friction between the tires and the ground
- 32e. Fuel, engine, or equal and opposite reaction
- 33b. 210 N
- 33c. Normal Force decreases as angle is increases.

- 33d. 2.8 m/s^2
 33e. 28 m/s
 33f. no
 33g. 69 N
 33h. 57 N
 33i. 40 N
 33j. 0.33
 33k. 0.09
 35a. zero
 35b. $-kx_0$
 36b. $f_1 = \mu_k m_1 g \cos\theta$; $f_2 = \mu_k m_2 g \cos\theta$
 36c. Ma
 36d. $T_A = (m_1 + m_2)(a + \mu \cos\theta)$
 and $T_B = m_2 a + \mu m_2 g \cos\theta$
 36e. Solve by using $d = 1/2at^2$ and substituting h for d
 37a. Yes, because it is static and you know the angle and m_1
 37b. Yes, T_A and the angle gives you m_1 and the angle and T_C gives you m_2 , $m_1 = T_A \cos 25^\circ / g$ and $m_2 = T_C \cos 30^\circ / g$
 38a. 3 seconds
 38d. 90 m
 42a. 1.5 N ; 2.1 N ; 0.71

Ch 6: Centripetal Forces

- 5a. 100 N
 5b. 10 m/s^2
 6a. 25 N towards her
 6b. 25 N towards you
 7a. 14.2 m/s^2
 7b. $7.1 \times 10^3 \text{ N}$
 7c. friction between the tires and the road
 8. $.0034g$
 9a. $6.2 \times 10^5 \text{ m/s}^2$
 9b. The same as a.
 10. $3.56 \times 10^{22} \text{ N}$
 11. $4.2 \times 10^{-7} \text{ N}$; very small force
 12. $g = 9.8 \text{ m/s}^2$; you'll get close to this number but not exactly due to some other small effects
 13a. $4 \times 10^{26} \text{ N}$
 13b. gravity
 13c. $2 \times 10^{41} \text{ kg}$
 14. $.006 \text{ m/s}^2$
 15a. $.765$
 15b. 4880 N
 16a. $\sim 10^{-8} \text{ N}$ very small force
 16b. Your pencil does not accelerate toward you because the frictional force on your pencil is much greater than this force.
 17a. $4.23 \times 10^7 \text{ m}$
 17b. $6.6 R_e$
 17d. The same, the radius is independent of mass
 18. $1.9 \times 10^7 \text{ m}$
 19. You get two answers for r , one is outside of the two stars one is between them, that's the one you want, $1.32 \times 10^{10} \text{ m}$ from the larger star.
 22a. $v = 28 \text{ m/s}$
 22b. v-down, a-right
 22c. f-right
 22d. Yes, 640 N

Ch 7: Momentum Conservation

8. 37.5 m/s
 9. $v_1 = 2v_2$
 10a. $24 \frac{\text{kg}\cdot\text{m}}{\text{s}}$
 10b. 0.364 m/s
 10c. $22 \frac{\text{kg}\cdot\text{m}}{\text{s}}$
 10d. 109 N
 10e. 109 N due to Newton's third law
 11. 2.0 kg , 12.5 m/s
 12. 21 m/s to the left
 13. 920 N
 14a. 90 sec
 15a. 60 m/s
 15b. $.700 \text{ sec}$
 15c. yes, 8.16 m
 16. 0.133 m/s to the left
 17a. 11000 N to the left
 17b. tree experienced same average force of 11000 N but to the right
 17c. 2500 lb.
 17d. about 2.5 "g"s of acceleration
 18a. no change
 18b. the last two cars
 19a. 0.009 s
 19b. 0.377 kg
 20a. 0.0058 m/s^2
 20b. 3.5 m/s^2
 21a. 15 m/s
 21b. 49° S of E
 22b. 1.72 m/s 8.36°

Ch 8: Energy & Force

- 6a. 7.18×10^9 J
6b. 204 m/s
7a. 34 m/s @ B; 28 m/s @ D; 40 m/s @ E; 49 m/s @ C and F; 0 m/s @ H
7b. 30 m
7c. Yes, it makes the loop!!
8a. 2.3 m/s
8c. No, the baby will not clear the hill.
9a. 29,500 J
9b. 13 m
11a. 86 m
11b. 220 m
12a. 48.5 m/s
12b. 128 N
13. 0.32 m/s each
14a. 10 m/s
14b. 52 m
15a. 1.1×10^4 N/m
15b. 2 m above the spring
16. 96%
18a. .008 m
18b. 5.12°
19. 8 m/s same direction as the cue ball and 0 m/s
20. $v_{\text{golf}} = -24.5$ m/s; $v_{\text{pool}} = 17.6$ m/s
21. 2.8 m
22a. 0.57 m/s
22b. Leonora's
22c. 617 J
23a. 19.8 m/s
23b. 8.8 m/s
23c. 39.5 m
24a. 89 kW
24b. 0.4
24c. 15.1 m/s
25. 43.8 m/s
29a. 3.15×10^5 J
29b. 18.0 m/s
29c. 2.41 m
29d. 7900 J
30a. $v_0/14$
30b. $mv_0^2/8$
30c. $7mv_0^2/392$
30d. 71%

Ch 9: Rotational Motion

- 2a. 9.74×10^{37} kg m²
2b. 1.33×10^{47} kg m²
2c. 0.5 kg m²
2d. 0.28 kg m²
2e. 0.07 kg m²
3 a. True, all rotate 2π for 86,400 sec which is 24 hours,
3b. True, $\omega = 2\pi/t$ and $t=86,400$ s
3f. True, L is the same
3g. $L = I\omega$ and $I = 2/5 mr^2$
3h. True, $K = \frac{1}{2} I\omega^2$ & $I = 2/5 mr^2$ sub-in $K = 1/5 mr^2\omega^2$
3i. True, $K = \frac{1}{2} I\omega^2$ & $I = mr^2$ sub-in $K = 1/2 mr^2\omega^2$,
4a. 250 rad
4b. 40 rad
4c. 25 rad/s
4d. Force applied perpendicular to radius allows α
4e. 0.27 kg m²,
4f. $K_5 = 84$ J and $K_{10} = 340$ J
6. Moment of inertia at the end $1/3 ML^2$ at the center $1/12 ML^2$, angular momentum, $L = I\omega$ and torque, $\tau = I\alpha$ change the in the same way
.8. Lower
9. Iron ball
10a. 200 N team
10b. 40 N
- 10c. 0.02 rad/s²
10d. 25 s
11a. Coin with the hole
11b. Coin with the hole
12a. weight
12b. 19.6 N
12c. plank's length (0.8m) left of the pivot
12d. 15.7 N m,
12e Ba. weight, Bb. 14.7 N, Bc. plank's length (0.3m) left of the pivot, Bd. 4.4 N m, Ca. weight, Cb. 13.6 N, Cc. plank's length (1.00 m) right of the pivot, Cd. 13.6 N m, f) 6.5 N m CC, g) no, net torque doesn't equal zero
13a. 7.27×10^{-6} Hz
13b. 7.27 Hz
14a. 100 Hz
14 b. 1.25×10^5 J
14c. 2500 J-s
14d. 12,500 m-N
15. 1.92 rads/sec = 0.306 rev/s
16. 2300 N
17b. 771 N, 1030 N
17c. 554 kgm²
17d. 4.81rad/sec²
18a. 300 N
18b. 240N, -22 N
18c. .092
19a. -1.28 mN

- | | |
|------------------------------------|---------------------------|
| 19b. CCW | 21a. 1411 kg |
| 20a. 2280 N | 21c. 17410 N |
| 20b. 856 n toward beam, 106 N down | 22a. -2.4 m/s^2 |
| 20c. 425 kg m^2 | 22b. 1.25 seconds |
| 20d. 3.39 rad/sec^2 | |

Ch 10: Simple Harmonic Motion

- | | |
|---|---|
| 1a. Buoyant force and gravity | 12b. 16 complete cycles but 32 times up and down, 315 complete cycles but 630 times up and down |
| 1b. $T = 6 \text{ s}, f = 1/6 \text{ Hz}$ | 12c. 0.063 s |
| 2a. $9.8 \times 10^5 \text{ N/m}$ | 13a. 24.8 J, 165 N, 413 m/s^2 |
| 2b. 0.5 mm | 13b. 11.1 m/s , 0, 0 |
| 2c. 22 Hz, no, | 13c. 6.2 J, 18.6 J, 9.49 m/s , 82.5 N, 206 m/s^2 |
| 3. $3.2 \times 10^3 \text{ N/m}$ | 13d. .169 sec, 5.9 Hz |
| 4a. 110 N/m | 14b. .245 J |
| 4d. $v(t) = (25)\cos(83t)$ | 14c. 1.40 m/s |
| 7a. 0.0038 s | 14d. 1.00 m/s |
| 7b. 0.0038 s | 14f. 2.82 N |
| 10. 4 times | 14g. 3.10 N |
| 11. 0.04 m | |
| 12a. 16 Hz | |

Ch 11: Wave Motion and Sound

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|---|--|
| 1. 390 Hz | 13. 1.9 Hz or 2.1 Hz. |
| 2a. 4 Hz | 14. 0.53 m |
| 2b. It was being driven near its resonant frequency. | 15. 2.2 m, 36 Hz; 1.1 m, 73 Hz; 0.733 m, 110 Hz; 0.55 m, 146 Hz |
| 2c. 8 Hz, 12 Hz | 16. 430 Hz; $1.3 \times 10^3 \text{ Hz}$; $2.1 \times 10^3 \text{ Hz}$; $3.0 \times 10^3 \text{ Hz}$; |
| 2d. (Note that earthquakes rarely shake at more than 6 Hz). | 17a. The tube closed at one end will have a longer fundamental wavelength and a lower frequency. |
| 5a. 7 nodes including the 2 at the ends | 17b. If the temperature increases the wavelength will not change, but the frequency will increase accordingly. |
| 5b. 3.6 Hz | 18. struck by bullet first . |
| 6. 1.7 km | 19. 80 Hz; 0.6 m |
| 7a. 1.7 cm | 20a. 0.457 m |
| 7b. 17 m | 20b. 0.914 m |
| 8a. $4.3 \times 10^{14} \text{ Hz}$ | 20c. 1.37 m |
| 8b. $2.3 \times 10^{-15} \text{ s}$ - man that electron is moving fast | 21. 2230 Hz; 2780 Hz; 2970 Hz |
| 9a. 2.828 m | 22. 498 Hz |
| 9b. 3.352 m | 23. 150 m/s |
| 9c. $L = \frac{1}{4} \lambda$ so it would be difficult to receive the longer wavelengths. | |
| 10. Very low frequency | |
| 11b. Same as closed at both ends | |

Ch 12: Electricity

-
- 11b. 1350 N
 11c. 1350 N
 12a. 1.1×10^9 N/C
 12b. 9000 N
 13. $F_g = 1.0 \times 10^{-47}$ N and $F_e = 2.3 \times 10^{-8}$ N. The electric force is 39 orders of magnitudes bigger.
 14. 1.0×10^{-4} C
 16a. down
 16b. Up 16c, 5.5×10^{11} m/s²
 16e. 2.9×10^8 m/s²
 17a. Toward the object
 17b. 3.6×10^4 N/C to the left with a force of 2.8×10^{-7} N
18. Twice as close to the smaller charge, so 2 m from $12\mu\text{C}$ charge and 1 m from $3\mu\text{C}$ charge.
 19. 0.293 N and at 42.5°
 20. 624 N/C and at an angle of -22.4° from the + *x*-axis.
 21a. 7500V
 21b. 1.5 m/s
 22a. 6.4×10^{-17} N
 22b. 1300V
 22c. 2.1×10^{-16} J
 22d. 2.2×10^7 m/s
 23b. 0.25m
 23c. $F_T = 0.022$ N
 23d. $0.37 \mu\text{C}$

Ch 13: Electric Circuits – Batteries and Resistors

- 1a. 4.5C
 1b. 2.8×10^{19} electrons
 2a. 0.11 A
 2b. 1.0 W
 2c. 2.5×10^{21} electrons
 2d. 3636 W
 3a. 192 Ω
 3b. 0.42 W
 4a. 5.4 mV
 4b. 1.4×10^{-8} A
 4c. 7.3×10^{-11} W, not a lot
 4d. 2.6×10^{-7} J
 5. left = brighter, right = longer
 6a. 224 V
 6b. 400 W by 100 Ω and 48 W by 12 Ω
 6c. 448 W
 7b. 8.3 Ω
 8. 0.5A
 10. 0.8A and the 50 Ω on the left
 11a. 0.94 A
 11b. 112 W
 11c. 0.35 A
 11d. 0.94 A
 11e. 50, 45, 75 Ω
- 11f. dimmer; total resistance increases
 11g. 45 Ω
 12a. 0.76 A
 12b. 7.0 W
 13b. 1000 W
 14a. lightbulb A
 14b. lightbulbs B,C
 14c. i. All; ii. C; iii. None
 14d. i. A dimmer, D brighter, C out
 ii. A dimmer, B,C brighter
 15a. 9.1 Ω
 15b. 29.1 Ω
 15c. 10.8 Ω
 15d. 26.8 Ω
 15e. 1.8A
 15f. 21.5V
 15g. 19.4V
 15h. 6.1V
 15i. 0.24A
 15j. 16 W hr
 16a. 3.66 Ω
 16b. 0.36A
 16c. 1.32 V
 23a. 10V

Ch 14: Magnetism

1. No: if $v = 0$ then $F = 0$; yes: $F = qE$
 4a. Into the page
 4b. Down the page
 4c. Right
 5. Both pointing away from north
 8. 7.6 T, south
 9. Down the page; 60 N
 10a. To the right, 1.88×10^4 N
 10b. 91.7 m/s
- 10c. It should be doubled
 11. East 1.5×10^4 A
 12. 0.00016 T; if CCW motion, B is pointed into the ground.
 13. 1.2×10^5 V, counterclockwise
 14a. 15 V
 14b. Counter-clockwise
 15a. 2×10^{-5} T
 15b. Into the page

- 15c. 2.8 N/m
 15d. CW
 16a. 2.42×10^8 m/s
 16b. 9.69×10^{-12} N
 16c. .0055 m
 17. E/B
 18a. 8×10^{-7} T
 18b. 1.3×10^{-6} C
 19a. 0.8 V
 19b. CCW
 19c. .064 N
 19d. .16 N/C
 19e. .13 w
 20a. 1.11×10^8 m/s
 20b. 9.1×10^{-30} N \ll 6.4×10^{-14} N
 20d. .00364 T
 20e. .173 m
 20f. 7.03×10^{16} m/s²
 20g. 3.27°
 21. 19.2 V
 22a. 8.39×10^7 m/s
 22b. 2.68×10^{-13} N, -y
 22c. 2.95×10^{17} m/s²
 22d. .00838 m
 22e. 1.68×10^6 N/C
 22f. 16,800 V
 23a. 1.2×10^{-6} T, +z
 23b. 1.5×10^{-17} N, -y
 23c. 96 N/C, -y

Ch 15: Electric Circuits—Capacitors

- 2a. 4×10^7 V
 2b. 4×10^9 J
 4a. 100 V
 4b. A greater voltage created a stronger electronic field, or as charges build up they repel each other from the plate.
 5. 21 V, note that V is squared here
 6a. 3.3 F
 6b. 54 Ω
 7a. 200 V
 7b. 5×10^{-9} F
 7c. 2.5×10^{-9} F
 8a. 6V
 8b. 0.3A
 8c. 18V
 8d. 3.6×10^{-4} C
 8e. 3.2×10^{-3} J
 8f. i) 80 μ F ii) 40 μ F iii) 120 μ F
 9a. 26.7 μ F
 9b. 166.7 μ F
 10a. 9.0×10^3 N/C
 10b. 1.4×10^{-15} N
 10c. 1.6×10^{15} m/s²
 10d. 3.3×10^{-11} s
 10e. 8.9×10^{-7} m
 10f. 5.1×10^{-30}
 11. discuss in class
 12. discuss in class
 13. 10 V
 14a. 0.43 seconds
 14b. 1.8 seconds
 14c. 4.7×10^{-4} C
 14d. No, it will asymptotically approach it
 14e. It will rise rapidly and tail off approaching asymptote of 12 V
 14f. $V_{res} = 12V$ - voltage across capacitor
 15. 128 k Ω

Ch 16: Electric Circuits—Advanced

- 1a. 4.9×10^{-5} H
 1b. -9.8×10^{-5} V
 2. Zero
 3a. Yes
 3b. No
 3c. Because they turn current flow on and off.
 4a. 0.5 V
 4b. 0.05 A
 4c. 0.05 A
 4d. 5.5 V
 4e. 8.25V
 4f. 11 \times
 5a. On
 5b. On
 5c. On, on, off, on, off, off, on, on
 6b. 10.9 μ F
 6c. 195 Ω
 6d. 169 Ω
 6e. 1.39 A
 6f. -42°
 6g. 115Hz

Ch 17: Light

- | | | | |
|------|--|------|----------------------------|
| 3. | 2200 blue wavelengths | 19e. | -1 |
| 4. | 65000 x-rays | 20a. | 6 units |
| 5. | 6×10^{14} Hz | 20b. | bigger; $M = 3$ |
| 6. | 3.3 m | 21c. | 1.5 units |
| 8b. | vacuum & air | 21d. | $\frac{2}{3}$ |
| 8c. | 1.96×10^8 m/s | 22c. | 21/4 units |
| 9. | 6.99×10^{-7} m; 5.26×10^{-7} m | 22e. | $-\frac{2}{3}$ |
| 12. | Absorbs red and green. | 23c. | 5.3 units |
| 13. | 25° | 25b. | 22.5 mm |
| 15. | 33.3° | 27. | 32 cm |
| 16a. | 49.7° | 28a. | 10.2° |
| 16b. | No such angle | 28b. | 27 cm |
| 16c. | 48.8° | 28c. | 20 cm |
| 17b. | 11.4 m | 29a. | 0.72 m |
| 17c. | 11.5 m | 31. | 54 cm, 44cm, 21 cm, 8.8 cm |
| 18. | 85 cm | 33. | 13.5° |
| 19c. | 4 units | 34. | 549 nm |

Ch 18: Fluids

- | | | | |
|------|---|------|--|
| 1. | 0.84 | 12. | .0081 |
| 2. | 1.4×10^5 kg | 13a. | 12500 J/m^3 |
| 3a. | 90% of the berg is underwater | 13b. | 184 kPa |
| 3b. | 57% | 13c. | 1.56 kW |
| 4b. | 5.06×10^{-4} N | 13d. | 2.57 kW |
| 4c. | 7.05 m/s^2 | 13e. | 11.8 A |
| 5. | 4.14 m/s | 13f. | \$12.6 |
| 6. | 40 coins | 14a. | 611 kPa |
| 7b. | upward | 14b. | 6 atm |
| 7c. | 4.5 m/s^2 | 15b. | 500,000 N |
| 7d. | Cooler air outside, so more initial buoyant force | 16a. | 27 m/s^2 , (2.7 g) upward |
| 7e. | Thin air at high altitudes weighs almost nothing, so little weight displaced. | 16b. | 1600 N |
| 8a. | At a depth of 10 cm, the buoyant force is 2.9 N | 16c. | 2200 N |
| 8d. | The bottom of the cup is 3 cm in radius | 17a. | 10 N |
| 9a. | 83,000 Pa | 17b. | 10.5 N |
| 9b. | 104 N | 17c. | 11 N |
| 9c. | 110 N | 17d. | 11 N |
| 10a. | 248 kPa | 18a. | "The Thunder Road" |
| 10b. | 591 kPa | 18b. | 2.0 m (note: here and below, you may choose differently) |
| 10c. | 1081 kPa | 18c. | 33.5 m^3 |
| | | 18e. | 3.5 million N |
| | | 18f. | 111 MPa |

Ch 19: Thermodynamics and Heat Engines

- | | | | |
|------|---|------|--------------------------------------|
| 18. | 517 m/s | 25a. | 8.34×10^{23} |
| 19. | 1.15×10^{12} K | 25b. | 6.64×10^{-27} kg |
| 21. | 40 N | 25c. | 1600 m/s |
| 22. | $\approx 10^{28}$ molecules | 25d. | 744 kPa |
| 23a. | 21,000 Pa | 25e. | 4.2×10^{20} or 0.0007 moles |
| 23b. | Decreases to 61,000 Pa | 25g. | 0.00785 m^3 |
| 23c. | 5.8 km | 26a. | 1.9 MW |
| 24a. | No | 26b. | 0.56 MW |
| 24b. | allowed by highly improbable state. More likely states are more disordered. | 26c. | 1.3 Mw |
| | | 27a. | 54% |

- 27b. 240 kW
- 27c. 890 kW
- 27d. 590 kW
- 27e. 630 kg
- 28a. 98%
- 28b. 4.0%
- 28c. 12%
- 29. 14800 J
- 30. 12,000 J
- 31b. 720 K, 300 K, 600 K

- 31c. isochoric; isobaric
- 31d. C to A; B-C
- 31e. 0.018 J
- 32b. 300 K, 1200 K
- 33a. 1753 J
- 33b. -120 J
- 33c. 80 J
- 33d. 35 J
- 33e. -100 J, 80 J, 80 J

Ch 20: Special and General Relativity

- 1. longer
- 2. $\gamma = \infty$, the universe would be a dot
- 3. 76.4 m, 76.4 m
- 5. $\gamma = 1.002$
- 6. 9.15×10^7 m/s
- 7. 2.6×10^8 m/s
- 8a. 0.659 km
- 8b. 22.4
- 8c. 4.92×10^{-5} m/s
- 8d. 14.7 km
- 9. 2900 m
- 10. 1.34×10^{-57} m
- 11. 0.303 s
- 12. 2.9×10^{-30} kg, yes harder to accelerate
- 13a. f
- 13b. c
- 14. 4.5×10^{16} J; 1.8×10^{13} softballs
- 15a. 1.568×10^{-13} J
- 15b. 3.04×10^6 J

Ch 21: Radioactivity and Nuclear Physics

- 6a. Substance A decays faster than B
- 6b. Substance B because there is more material left to decay.
- 7a. ${}^{219}_{88}\text{Ra} \rightarrow {}^{215}_{86}\text{Rn} + {}^4_2\text{He}$
- 7b. ${}^{158}_{63}\text{Eu} \rightarrow {}^{158}_{64}\text{Gd} + {}^0_{-1}\text{e}^-$
- 7c. ${}^{53}_{22}\text{Ti} \rightarrow {}^{53}_{23}\text{Va} + {}^0_{-1}\text{e}^-$
- 7d. ${}^{211}_{83}\text{Bi} \rightarrow {}^{207}_{81}\text{Tl} + {}^4_2\text{He}$
- 8a. 5×10^{24} atoms
- 8b. Decay of a lot of atoms in a short period of time
- 8c. 2.5×10^{24} atoms
- 8d. $\frac{1}{2}$
- 8e. 26.6 minutes
- 9. The one with the short half life, because half life is the rate of decay.
- 10a. Substance B = 4.6 g and substance A = 0.035 g
- 10b. substance B
- 11. 1.2 g
- 12. 125 g
- 13. 0.46 minutes
- 14. $t = 144,700$ years
- 15. 0.0155 g
- 16. 17 years
- 17. 49,000 years

Ch 22: Standard Model of Particle Physics

- 1. strange
- 2. Some type of meson
- 3. Electron, photon, tau...
- 4. Neutron, electron neutrino, Z^0
- 5. Neutron, because it doesn't have electrical charge
- 6. No, because it doesn't have electrical charge
- 7. Two anti-up quarks and an anti-down quark
- 8. Lepton number, and energy/mass conservation
- 9. Yes, W^+ , W^- , because they both have charge
- 10. The weak force because it can interact with both quarks and leptons
- 11. Yes; a,b,c,e; no; d,f
- 12. The standard model makes verifiable predictions, string theory makes few verifiable predictions.

Ch 23: Feynman Diagrams

1. Allowed: an electron and anti-electron(positron) annihilate to a photon then become an electron and anti-electron(positron) again.
2. Not allowed: electrons don't go backward though time, and charge is not conserved
3. Not allowed: lepton number is not conserved
- 4a. Allowed: two electrons exchange a photon
- 4b. Not allowed: neutrinos do not have charge and therefore cannot exchange a photon.
- 5a. Allowed: an electron and an up quark exchange a photon
- 5b. Not allowed: lepton number not conserved
6. Not allowed: quark number not conserved
7. Allowed: electron neutrino annihilates with a positron becomes a W^+ then splits to muon and muon neutrino.
8. Allowed: up quark annihilates with anti-up quark becomes Z^0 , then becomes a strange quark and anti-strange quark
9. Not allowed: charge not conserved
10. Allowed: this is a very rare interaction
11. Not allowed: electrons don't interact with gluons
12. Not allowed: neutrinos don't interact with photons
13. Allowed: the electron and the positron are exchanging virtual electron/positron pairs
14. Allowed: this is beta decay, a down quark splits into an up quark an electron and an electron neutrino via a W^- particle.
15. Allowed: a muon splits into an muon neutrino, an electron and an electron neutrino via a W^- particle.

Ch 24: Quantum Mechanics

- 1a. $6.75 \times 10^{-26} \text{ J}$, $2.253 \times 10^{-34} \text{ kgm/s}$
- 1b. $5.96 \times 10^{-20} \text{ J}$, $1.99 \times 10^{-28} \text{ kgm/s}$
- 1c. $4.90 \times 10^{-28} \text{ J}$, $1.63 \times 10^{-36} \text{ kgm/s}$
- 2a. 1.94 eV , $1.04 \times 10^{-27} \text{ kgm/s}$
- 2b. 12.7 eV , $6.76 \times 10^{-27} \text{ kgm/s}$
- 2c. 5.00 eV , $2.67 \times 10^{-21} \text{ kgm/s}$
- 3a. $.0827 \text{ nm}$
- 3b. $4.59 \times 10^{-4} \text{ nm}$
- 3c. 730 nm
4. $1.03 \times 10^{-20} \text{ m}$
- 5a. 36 nm
- 5b. no
- 5c. 380 nm , 73 nm , 36 nm , 92 nm , 39 nm , 74 nm
6. $.80 \text{ V}$
7. 480 nm
- 8a. $.124 \text{ nm}$
- 8b. $.00120 \text{ nm}$
9. $24,600 \text{ m/s}$
10. $1.84 \times 10^8 \text{ m/s}$
- 11a. $.491 \text{ m/s}$
- 11b. $3.14 \times 10^7 \text{ J}$
- 11c. 64 Mw
- 11d. 1.55 pm
12. 3.27 ev
- 14b. 15
- 14c. 182 nm , 188 nm , 206 nm , 230 nm
15. -10.3 ev , -3.82 eV , -2.29 eV , -1.83 eV
- 16a. $4.19 \times 10^7 \text{ m/s}$
- 16b. $1.70 \times 10^{-11} \text{ m}$
- 16c. 1.95^0
- 16d. $.068 \text{ m}$
- 17a. 1.89 V
- 17b. 1.60 A
- 17c. 1.25Ω
- 18a. $4.40 \times 10^{-24} \text{ kgm/s}$
- 18b. $1.17 \times 10^{-24} \text{ kgm/s}$
- 18c. $3.23 \times 10^{-24} \text{ kgm/s}$
- 18d. $3.76 \times 10^7 \text{ m/s}$
- 19a. $1.1365 \times 10^{-22} \text{ kgm/s}$
- 19b. 5.860 pm
- 19c. $^{242}\text{Cu} \rightarrow ^4\text{He} + ^{238}\text{Pu}$
- 19d. 238.0497 amu
- 19e. 17.7 cm
- 19f. $-y$
- 19g. $+y$, 34.2 N/C
- 20.
21. $10^{-11} \text{ m} = 0.10 \text{ Angstrom}$
22. $1.7 \times 10^{-34} \text{ m}$