Chapter 24

A Good Thing To Know

If the distance between the diffraction gradient and the screen (L) is considerably larger than the distance between the diffraction slits, sinΘ can be substituted by Δy/L

$$\text{Thus: } m\lambda = d\sin\Theta \text{ becomes } m\lambda = d\,\frac{\Delta y}{L}$$

where Δy is the distance between fringes (light spots) and L is the distance to the screen.

1. A fifth order fringe means m = 5.

2. A third order fringe means m = 3.

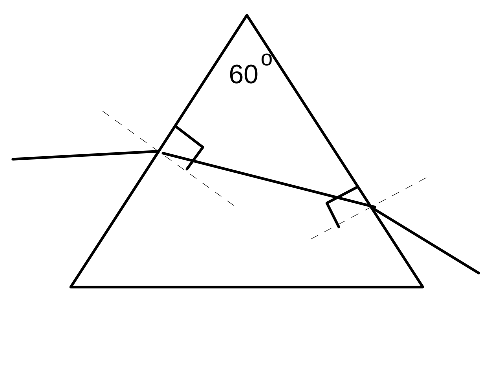
3. First, convert all the distances given to meters. List your variables and using the equation derived in the lab book on page 193, solve for wavelength and frequency.

4. Convert all distances to meters. List your variables and use the equation in A Good Thing To Know at the top of this page, to derive an equation for Δy. Then solve for Δy.

5. Use a little arithmetic to get Δy, and then solve for d. If the fourth order fringe is .048 m from the center and each dot is spaced evenly, what will be the space between each of the four dots?

6. Convert all linear measures to meters and solve for Δy for each of the given wavelengths. They want the difference between Δy.

16. You'll need to remember your geometry for this problem, and you'll have to solve it twice; once for each wavelength given. Use Snell's Law to solve for the refracted angle. Follow it to the other side and calculate the angle it makes with the prism before it refracts out to the air.



17. Use equation 24-3b on page 675 to find the angle to the middle of the central diffraction peak. Then double it to find the angle of the entire spread.

18. The angle to the first minimum is ½ the angle of the entire spread. Use equation 24-3b on page 675 to find the wavelength of the light.

19. The equation for single slit diffraction is very similar to double slit diffraction. If Δy is the distance between minima (dark spots), it is the same. If you want to find the distance between maxima, use $(m+1/2)\lambda = d\frac{\Delta y}{L}$

20. Use equation 24-3b on page 675 to find the angle to the first minimum.
The distance to the screen and Δy make a right triangle. Use the tangent of the angle to solve for Δy.
The width of the central maximum is twice Δy.

24. The width of the central maximum from a single slit diffraction goes from the first minimum on one side to the first minimum on the other; that is, it is twice the distance from the center to the first minimum.

27. Use the double slit equation substituting the distance between grating slits as d.

28. Convert 2500lines/cm to centimeters per line and then meters per line. Substitute that for *d* in the double slit equation.

32. Invert the lines per meter for the diffraction grating to get the slit width, d. Use the equation $m\lambda = d\sin\Theta$ and solve for Θ for each wavelength. For the second order, m = 2. The angular spread will be the difference between the two angles.

36. Convert 7500 lines/cm to centimeters per line and then meters per line. Substitute that for *d* and solve for Δy.

53. Use equation 24-5 on page 755. The fraction of light intensity will be I/I_o.

54. Brewster's Angle can be found on page 748, equation 24-6b.

Chapter 26

1. You have measured the shorter length, L'.
   Use equation 26-3a on page 741 and solve for L.

2. Use equation 26-1a on page 735 and solve for t.

3. Solve all 6 of these for velocity and length. Corrections for time can be found from equation 26-1 on page 805. Corrections for length can be found from equation 26-2 on page 809.

4. Let L be 100 light years and solve for L'. Keep distance units in light years.

5. Use equation 26-1a on page 735 and solve for v.

15. Corrections for mass can be found from equation 26-5 on page 743. Once you have mass, find momentum; $p = mv$.

16. Let $2m_o$ be equal to m and solve for v.

20. If $E = mc^2$, then $\Delta E = \Delta mc^2$

21. If $E = mc^2$, then $\Delta E = \Delta mc^2$. Remember to change MeV to Joules.

43. Use the equation on page 748.

Chapter 27

A Good Thing To Know

The energy of a photon can be expressed in Joules as $E = \frac{hc}{\lambda}$ or $E = hf$

The energy of a photon can be expressed in eV as $\frac{1243}{\lambda}$ where λ is in nm.

and

The energy of a photon = the work function + the KE of the electrons

$$E_p = \Phi + KE \quad \text{or} \quad E_p = W_o + KE$$

10. See section 27-3 page 758.

11. Use the equation above and solve for energy of photons from both wavelengths given.

12. You are given energy. Use energy of photon equations above and solve for wavelength. Using this wavelength and the width of an average door for *d* in the double slit equation (chapter 24) answer the question.

13. See section 27-3 page 758. Change eV to Joules.

14. See section 27-4 page 762

15. See section 27-4 page 762

17. The energy of the minimum frequency of light to cause the photoelectric effect is the same as the ionization energy of a photoelectric surface.

18. The energy of the minimum frequency of light to cause the photoelectric effect is the same as the ionization energy of a photoelectric surface.

20. a) Use the maximum wavelength and the magic number 1243 to find the work function. It will be in eV.
    b) Use the new wavelength and the magic number 1243 to find Ep. Then using equation Ep = Φ + KE, solve for the stopping voltage. All units will be eV.

22. The energy of the photon must equal the sum of the work function of the photoelectric surface and the KE of the emitted electrons.

24. Use the threshold wavelength and the magic number 1243 to find the work function in eV. In (a), use the work function you found and the wavelength to find Ep and then KE. Do the same thing for (b).

37. See equation 27-8 on page 780 to calculate the wavelength of matter.

39. This problem will take 4 steps:
   i) Calculate the momentum using the wavelength given.
   ii) From that, calculate the velocity of the electron.
   iii) Now calculate KE for the electron.
   iv) Use E = qV to calculate potential difference.

42. Each of these will take 3 steps:
   i) Convert eV to Joules and calculate the velocity of each electron.
   ii) From the velocity, calculate the momentum of each electron.
   iii) From the momentum, calculate the wavelength.

46. Use the wavelength given to calculate the momentum of the electron. From that, calculate the velocity and the kinetic energy. KE = qV.

Chapter 30

1. Use the conversion factor for atomic mass units to MeV/c^2 and kilograms is found on the inside front cover of the text and on page 918.

2. The equation for the radius of an atomic nucleus is found on page 918.

3. An alpha particle is a Helium atom minus the electrons. To find the rest mass, subtract the mass of two electrons from the mass of helium. The masses of all the elements is given in terms of atomic mass units in Appendix F pages 1064 – 1067. The masses of subatomic particles are given on the inside front cover of the text.

8. Find the radius of each atom and add them for the closest distance the two can have to "just touch." The KE of the alpha particle will be the same as it's PE when it "just touching" the americium nucleus. Use Coulomb's Law times distance, and the charges on the alpha particle americium to solve for energy.

13. See Example 30-5 on page 840.

14. See Example 30-4 on page 840.

18. The mass of the electron is included in the atomic mass of ^{3}He. Find the masses of hydrogen and ^{3}He in Appendix B pages A-12 to A-15 and subtract.

21. a) Calculate the resulting nucleus for each possibility and then consider which one has enough neutrons to be stable.
    b) If you add 11 electrons to both sides of the equation so we can use atomic masses, we find we have 2 extra electrons on the right. Subtract the mass of ^{22}Ne and 2 electrons from ^{22}Na. Masses must be expressed in atomic mass units. Then convert to KE using $931.5\frac{MeV}{c^2}$.

22. Just keep in mind that for any element X: $^{a}_{b}X$ a = #protons + neutrons, b = # protons

23. Convert the energy in MeV to the equivalent mass. Subtract that mass from the mass found in Appendix F and find an atom that also has that mass.

24. The maximum energy occurs if no neutrino is emitted.
    Calculate the mass difference in atomic mass units between ^{23}Ne and ^{23}Na and convert to MeV. That will be the KE of the electron.
    If a neutrino is emitted, it will take all the energy. The sum of the KE of the electron and the energy of the neutrino came from the mass difference in the reaction.

33. Find the masses of the isotopes in Appendix B pages A-12 to A-15 and subtract them. Convert the remaining mass to energy using the conversion factor found on page 838.

36. See equation 30-5 on page 849. Change hours to minutes or minutes to hours, but make both time increments the same.

37. a) Use the½ life and equation 30-6 on page 849 to find decay constant.
    b) Use the decay constant and the equation page 849 to find ½ life.

38. Use equation 30-3b on page 848. Use the ½ life of the isotope to find the decay constant.

39. Use equation 30-4 on page 849 and solve for $\frac{N}{N_o}$.

40. The fraction left will be $\frac{N}{N_o} = (1/2)^n$.

41. Use equation 30-3 on page 928 and solve for N.

44. a) Convert the mass given to # atoms using factor converson.
    b) Use your answer to (a) as N_o and solve for N using equation 30-4 on page 929. Convert minutes to seconds.
    c) The activity is just # of decays per second.
    d) Set $\Delta N/N$ = to 1 and solve for time.