Assignment XI, PHYS 112 (General Physics II)
Fall 2020
Due via pdf upload to OAKS prior to Friday, December 4th, at 10:00 AM

General instructions:
Please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units.

Since several people in class asked for this, here are some suggested (but ungraded) extra problems from the textbook for practice: (All problems out of Halliday, Resnick, and Walker, 10th Extended Edition, "Fundamentals of Physics"). (I chose all odd-numbered problems since the answers to those problems are in the back of the book and that's a good way to check if your practice is accurate.) No need to turn these in, but if you are looking for extra things you can work on if you want to practice problem solving some more, here's what I would advise.

Chapter 38, Questions 1,3,5,9,13
Chapter 38, Problems 1,3,7,9,13,15,17,19,25,29,43,45,47,49,51,53,67,81,83,89

There may be more material from later chapters that is worth review and/or may appear in the final exam. At the time I'm writing this (11/14), I am unsure exactly how far we will get. If requested, I can supply additional questions for review after Thanksgiving.

1. Two 85 kW radio stations broadcast at different frequencies. Station A broadcasts at a frequency of 892 kHz, and station B broadcasts at a frequency of 1410 kHz.
   a) Which station emits more photons per second? (Explain/justify your answer).
   b) Which station emits photons of higher energy?
2. What is the wavelength of a photon that has the same momentum as an electron moving with a speed of 1200 m/s? (Ignore relativistic effects).
3. The work function of Molybdenum is 4.22 eV.
   a) What is the smallest frequency that will emit a Photoelectron from Molybdenum?
   b) Will yellow light of wavelength 560 nm cause ejection of photoelectrons from Molybdenum? (Justify your answer with a calculation).
   c) What would the stopping potential be for Molybdenum illuminated with UV light of wavelength 150 nm?

4. A photoelectric experiment with Cesium yields stopping potentials for $\lambda = 435.8$ nm and $\lambda = 546.1$ nm to be 0.95 V and 0.38 V, respectively. Using these data only, find an experimental value for h and use it to find the threshold frequency and work function for Cesium.

5. I have a ping-pong ball in my office. It has a diameter of 40 mm (regulation size because that's how I roll). Let's pretend that I painted it black and it is, for our purposes, a perfect blackbody.

   a) Assume my office is kept at a constant temperature of 293K. How much energy does the ball emit in a year? (You may assume that the ball stays in thermal equilibrium at all times).

   b) What is the peak wavelength of the blackbody emission from the ping-pong ball?

6. Calculate the de Broglie wavelengths of the following:

   a) An electron with kinetic energy 13.6 eV. (Convert this to Joules!)

   b) The Earth. (Assume that the sun is stationary. You may have to google some stuff).

   c) An average Sodium atom in an ideal gas at 500 pK. (The average speed of a molecule in an ideal gas can be computed via $v_{\text{avg}} = \left(\frac{8kT}{\pi m}\right)^{1/2}$ with k the Boltzmann constant 1.38×10^{-23} J/K. A picoKelvin is 1×10^{-12} K). Sodium has an atomic mass of 22.990, which means that the mass of a Sodium atom is about $0.02299\ \text{kg}/6.022 \times 10^{23} \approx 3.82 \times 10^{-26}$ kg.

7. As noted back in the Physical Optics portion of the semester, one tends to notice diffraction effects when the physical object/obstacle is approximately the same size as the wavelength of the object. How long would it take a bowling ball (mass 5.0 kg) to roll a distance equal to its diameter (0.22 m) in order to have an observable "diffraction" phenomena as it rolls through a door of horizontal size 0.83 meters?