Physics 206b

Homework Assignment XV

This assignment will not be collected or graded, but the information covered in it is "fair game" for the final, so you'd be well advised to do it in a serious manner. Solutions will be posted shortly. I recommend that you treat the assignment as a "real" one and then compare your answers to those in the formal solution.

1. A pair of narrow slits is illuminated by a monochromatic (i.e., a single wavelength of light) source of coherent light with a wavelength of 546 nm. The slits are 3 microns apart. A screen is placed 2 meters from the pair of slits. How far from the central bright spot (n=0) will the first dark region appear on the screen? How far from the central bright spot will the next bright spot appear on the screen?
2. The work function of potassium is 2.3 eV. What is the maximum wavelength of light (in vacuum) for which potassium will emit electrons via the photoelectric effect?
3. Again taking the work function of potassium to be 2.3 eV. If a sheet of potassium is illuminated with light with a wavelength of 400 nm (just at the threshold between visible and ultraviolet), with what speed will electrons be emitted from its surface?
4. A man is walking slowly. His speed is $1\frac{m}{s}$. His mass is $80\,kg$. What is his de Broglie wavelength?
5. Consider again the experiment described in problem #1. The slit separation is the same and the distance from the slits to the screen is the same. One wishes to have the same pattern of "dark" and "light" but this time using electrons ("light" would mean many electrons while "dark" would mean few or none, in this case). If one wanted the same distance from the center to the first dark and light spots, what energy of electrons would one use? Express this energy in electron volts.
6. A beam of electrons with an energy of 20 eV passes through a small hole with a diameter of 500 nm. If the electrons are initially all traveling in the $\hat{z}$ direction, what will their approximate momentum be in the $\hat{y}$ direction after they pass through the hole?
7. The Paschen series is the set of spectral "lines" emitted from hydrogen atoms undergoing transitions terminating on the n=3 level. What are the wavelengths of the light emitted from the three most energetic transitions in the Paschen series?
8. How fast would someone need to move relative to an observer for that person's watch to appear to move at half the speed of the watch of the observer?