PHYS420 (Spring 2002)
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Homework # 7
(due Monday, April 1st, 2002)

Problems

By the end of this homework, chances are, you will be tired of computing the numerical value for the product hc. Here's a little suggestion-- these problems are simplified if we express the combination of hc in units of $eV \cdot nm$. That way you can work in convenient units of eV and nm: $hc = 1.986x10^{-25}\, J \cdot m = 1239.7\, eV \cdot nm$.

1. In the typical experimental photoelectric set-up, a Geissler tube (two electrodes in a evacuated glass tube) is connected to some voltage source. In this context, state the difference between the *stopping potential*, a *retarding* voltage and an *accelerating* voltage. Feel free to draw diagrams/graphs to make your point clear.

2. State and clearly explain three *classical* (i.e. Maxwell model for light) predictions regarding the photoelectric effect. Feel free to draw diagrams/graphs to make your point clear.

3. A laser beam with an intensity of 120 W/m^2 (roughly that of a small helium-neon laser) is incident on a surface of sodium. It takes a minimum energy of 2.3 eV to release an electron from sodium (the work function Φ of sodium). Assuming the electron to be confined to an area of radius equal to that of a sodium atom (0.10 nm), how long will it take, ***classically***, for the surface to absorb enough energy to release an electron?

4. State and clearly explain three *experimental* facts about the photoelectric effect. Feel free to draw diagrams/graphs to make your point clear.

5. (a) What are the energy and momentum of a photon of red light of wavelength 650 nm? (b) What is the wavelength of a photon of energy 2.40 eV? *Recall from relativity that for a massless particle, $E = pc$.*

6. The work function for tungsten metal is 4.52 eV. (a) What is the cutoff wavelength λ_c for tungsten? (b) What is the maximum kinetic energy of the electrons when radiation of wavelength 198 nm is used? (c) What is the stopping potential in this case?

7. *Extra credit problem 1*. **SMM, Chapter 2, Problem 19.**

8. *Extra credit problem 2*. Consider a photon with wavelength λ incident on an unknown metal. The most energetic electrons ejected from the metal are bent into a circular orbit of radius *R* by a magnetic field whose strength is equal to *B*. (a) Derive an expression for the work function in terms of these variables. (b) Use this expression to solve **SMM, Chapter 2, Problem 21.**