# PHYS 2380 – Quantum Mechanics 1 – Assignment #2

## Winter 2014

1. A point source of light emits 1.0 *mW* ($10^{-3}$ *J/s*) of energy in the form of light.
   a. If the light is emitted uniformly in all directions, estimate the light energy flux in $eV/m^2 \cdot s$ at a distance of 1 m from the light source.
   b. Using a reasonable size for an atom calculate the light energy per unit time incident on the atom in *eV/s*.
   c. Given that the work function for the atom is 2.0 *eV*, how long would it take the atom to absorb enough energy to absorb this amount of energy? Assume that all the energy incident on the atom is absorbed.

2. The following involves the scattering of photons from electrons:
   a. A photon of energy E1 scatters at an angle $\phi$ from an electron that is initially at rest. Show that the energy of the scattered photon, E2, is given by: $E_2 = \dfrac{E_1}{\left(E_1/mc^2\right)\left(1-\cos\phi\right)+1}$.
   b. A student conducts a study of Compton scattering and obtains the data in the table below:

| $\Delta\lambda$ *pm* | 0.647 | 1.67 | 2.45 | 3.98 | 4.80 |
|---|---|---|---|---|---|
| $\phi$ *degrees* | 45 | 75 | 90 | 135 | 170 |

   Construct an appropriate graph from this data and use it to determine the Compton wavelength of the electron. By what percentage does it differ from the accepted value?

3. Derive the Wein displacement law from Planck's Law and calculate a value for the constant in Wein's Law to 4 significant figures. You may have to use a numerical technique. Compare your value with accepted values.

4. A 40 W incandescent bulb radiates from a tungsten filament operating at 3300 K. If the bulb radiates like a blackbody:

   a. What is, $\lambda_{\max}$, the maximum of the spectral distribution and the corresponding frequency $\nu_{\max}$.
   b. Using $\nu_{\max}$ as the average frequency of the emitted photons, about how many photons are emitted by the bulb per second.
   c. If you are looking at the bulb from 5.0 m away, how many photons enter your eye per second (the diameter of your pupil is 3.0 mm)

**Due Jan. 31st, 2014**