Problem Set #1. From Newton and Maxwell, to Schrödinger.

1. The Wien displacement law states that the most wavelength of the most intense radiation from a black body is inversely proportional to the temperature,

$$\lambda_{\max} = \frac{b}{T}.$$

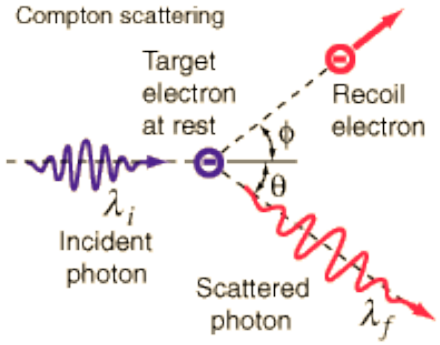
That is, the location of the peak in the blackbody radiation curve is inversely proportional to the temperature. **Derive the Wien displacement law from Planck's law for the intensity of blackbody radiation,**

$$\rho_T(\lambda)d\lambda = \frac{8\pi hc}{\lambda^5\left(e^{\frac{hc}{\lambda kT}} - 1\right)}d\lambda.$$

2. **Sketch the dependence of the kinetic energy of the electrons emitted due to the photoelectric effect versus the wavelength of the incident light for cesium metal, which has a work function of 2.14 eV. (1 electron volt is 1.60218 x 10^{-19} J) Label (a) the largest wavelength, $\lambda_{\text{threshhold}}$, at which electrons are emitted and (b) indicate the functional form of $T(\lambda)$ for $\lambda < \lambda_{\text{threshhold}}$.**

3. **What is the de Broglie wavelength of a major-league fastball. (velocity = 100 miles-per-hour; mass = 145 g.) The diameter of a baseball is 7.50 cm. What is the probability that a swing of the bat that would have made contact with the pitch misses due to quantum mechanics?**

4. In the simplest case of Compton scattering, one starts with an electron at rest and shines a light, with wavelength λ_i, on the electron. After contact, the electron and the photon that hits it scatters through an angle, θ, and emerges with a larger wavelength, $\lambda_f > \lambda_i$, as shown in the following diagram. **Derive the dependence of the wavelength on the scattering angle. What is the minimum wavelength that can be observed at a given energy? Is it possible to have a process where the frequency of the scattered photon is zero (infinite wavelength)?**



5. **I have a high-power green laser pointer (532 nm; 100 mW) that I use for astronomy. If I shine this laser pointer on you, how much momentum, per second, will be transferred to you.**