Problem Set 3
Due 9/23/2015
25 Points

1. Calculate the speed to which an argon atom would be accelerated if it absorbed a photon of wavelength 532 nm. Assume all of the energy from the photon is converted to kinetic energy of the atom.
2. The work function for argon is 3203 eV. Calculate the kinetic energy and the speed of the electrons ejected by light of wavelength (a) 0.1937 nm (b) 0.01937 nm.
3. Show that the total energy density of black body radiation is given by the Stefan-Boltzman law,

$$U = \frac{8\pi^5 k^4}{15h^3c^3}T^4$$

(Given: $\int_0^\infty \frac{x^3}{e^x-1}dx = \frac{\pi^4}{15}$)

4. An unnormalized wavefunction for an electron in a carbon nanotube of length L is sin(2πx/L). (For this problem, you should assume that the nanotube is laying on the x-axis from 0 to L. Also assume that the function is zero everywhere else besides on the tube.)
   a) Normalize the wavefunction. (…meaning, calculate the value of N)
   b) What is the probability of finding the electron in the range dx at L/2?
   c) What is the probability of finding the particle in the first third of the box (from x=0 to x=L/3)?
5. Two (unnormalized) wavefunctions of the hydrogen atom are:

$$\Psi(r) = (2 - \frac{r}{a_0})e^{-r/2a_0} \quad \text{and} \quad \Psi(r,\theta,\phi) = re^{-r/2a_0}\sin\theta\cos\phi$$

   a) Normalize the wavefunctions.
   b) Confirm that these wavefunctions are mutually orthogonal.
6. Evaluate the commutator $[\hat{H}, \hat{x}]$ given V(x)= ½ $k_f x^2$.