QUANTUM MECHANICS I

PHYS 516

Problem Set # 3

Distributed: January 28, 2015

Due: February 4, 2015

1. Compton Wavelength: Electromagnetic radiation of frequency ν is incident on electrons at rest. Compute the change in the wavelength of the radiation scattered through an angle θ. Hint: model radiation by photons, draw a Feynman-like diagram to represent the scattering, and treat the electron relativistically.

2. Classical Radius of the Electron: Assume charge Q $(= -e)$ is uniformly distributed on the *surface* of an electron of radius r_{cl}. Compute the electric field for this particle. Compute the energy stored in this field. Equate this energy to the rest energy of the electron. What is the classical radius?

3. Length Scales: Planck's constant $\hbar, [\hbar] = ML^2T^{-1}$, will occur in any theory depending on Quantum Mechanics, the electric charge $-e$, $[e^2] = ML^3T^{-2}$ will occur in any theory depending on ElectroMagnetism, and the speed of light in vacuum, c, $[c] = LT^{-1}$, will occur in any theory depending on Special Relativity. What combination of physical constants can be used to construct a fundamental unit of length in theories that involve two of the three:

Theory	$QM \cup EM$	$QM \cup SR$	$EM \cup SR$
length	?	?	?

4. Rotors and Energies: How many *states* are there with energy $E \leq 100\frac{\hbar^2}{2I_0}$ for:

a. the rotor with fixed axis;

b. the rotor with variable axis?

5. Rotors and Partition Functions: Assume $\frac{\hbar^2}{2I_0} \ll kT$. Compute the partition function for:

a. the rotor with fixed axis.

b. the rotor with variable axis.

6. Dunham Expansions: Look up the Dunham coefficients for some diatomic molecule. Report your results by: Author(s), Source (journal or otherwise), Title, Date, Diatomic Molecule, Parameter values. Provide a brief description of what all this information means.