QUANTUM MECHANICS I

PHYS 516

Problem Set # 9
Distributed: March 8, 2013
Due: March 18, 2013

1. Ehrenfest's Theorem: Derive Ehrenfest's version of Newton's Second Law for a particle of mass m and charge q moving in an electric and magnetic field (Lorentz Force Law). Use $H = (\mathbf{p} - \frac{q}{c}\mathbf{A})^2/2m + q\Phi$. Explain: (a) what you do; (b) what this means.

2. Finite Nuclear Size Effect: Compute the change in the ground state energy (from its nonrelativistic value) of an electron in a $1S$ state around a nucleus of charge Ze. Give result in eV and as a percentage of the ground state energy.

3. New Physics: Because the $2S \to 1S$ transition is forbidden "by an $E1$ mechanism" it is possible to make very precise measurements of this energy difference. Compute *the difference* in the transition energies of a mu meson μ^- around a proton using the old, pre 2010 proton radius estimate and the newer 2012 proton radius estimate. (See *Science News* article, reverse.)