Physics CS 36 **Spring 2012**

Set #3 - for Thurs April 26

<u>**Read Ohanian**</u> Ch. 4, Ch. 5

From Ohanian:

Ch. 4 Problems 6, 24, 33, 37.

Ch. 5 Problems 9, 11, 13, 15.

1. A beam of 8.3 MeV α-particles is directed at an aluminium foil. It is found that the Rutherford scattering formula ceases to be obeyed at scattering angles exceeding 60^o. If the α-particle is assumed to have radius of 2×10^{-15} m, find the radius of the aluminium nucleus.

2. Consider an "atom" consisting of a nucleus of mass M and an "electron" of mass m. The attractive force holding the "electron" in its orbit is given by $F(r) = -kr$, where k is a positive constant. Using Bohr's quantization condition for the angular momentum, find the quantized orbital radii and energies of the "electron", and also find the possible photon frequencies that the "electron" can emit or absorb. Discuss your answers and compare to the Bohr theory of the hydrogen atom.

3. A <u>classical</u> hydrogen atom has the electron at a radius equal to the Bohr radius ($a_0 = \hbar^2/m_e e^2$) at $t = 0$. Calculate the time τ it takes the radius to decrease to zero due to electromagnetic radiation emitted by the electron. Use the formula for power radiated, $P = \frac{2}{3}\frac{ke^2a^2}{c^3}$, where a is the acceleration. Show that $P << |E|\nu_{orbital}$ holds for most of the region of interest with E the total energy of the electron in circular orbit. Thus the decay motion is a slow inward spiral and therefore the turns of the spiral are almost circular.