PHYS 114 - First Homework

1. According to the Bohr's theory of the atom, the electron in a hydrogen atom orbits around the nucleus in a circular orbit. The force that holds the electron in this orbit is the Coulomb force. The size of the orbit dependes on the angular momentum-the smallest possible orbit has an angular momentum $\hbar = 1.05 \times 10^{-34} J \cdot s$; the next possible orbit has angular momentum $2\hbar$, the next $3\hbar$, etc.

   (a) Calculate the radius of each of these three possible circular orbits.

   (b) In general, show that if a circular orbit has an angular momentum $n\hbar$ (where $n = 1,\ 2,\ 3,\ \cdots$), then the radius is:

$$r_n = \frac{4\pi\epsilon_0}{m_e e^2} n^2 \hbar^2 \tag{1}$$

   (c) Evaluate this radius for $n = 1$.

2. A very large flat sheet of paper carries charge uniformly distributed over its surface; the amount of charge per unit area is σ. A hole of radius R has been cut out of this paper. Find the electric field on the axis of the whole. (Hint: you can replace this configuration with a flat sheet without a whole of charge density σ and another circular sheet of radius R with a uniform charge density $-\sigma$ superimposed)(H. C. Ohanian, "Physics", Ch. 23, Pr. 28)

3. Two thin, semi-infinite rod with a uniform charge distribution of λ coulombs per meter lies along the positive x axis from $x = 0$ to $x0\infty$; a similar rod lies along the positive y axis from $y = 0$ to $y = \infty$. Calculate the electric field at a point in the $x - y$ in the first quadrant. (H. C. Ohanian, "Physics", Ch. 23, Pr. 36)

4. Consider a spherical shell of uniform charge density σ coulombs per meter square. Show that the electric field inside is zero and calculate the electric field outside the shell.