PHY102 : Assignment 1

1. (Purcell 1.4) At each corner of a square is a particle with charge q. Fixed at the center of the square is a point charge of opposite sign, of magnitude Q. What value must Q have to make the total force on each of the four particles zero ? With Q set at that value, the system, in the absence of other forces, is in equilibrium. Do you think the equilibrium is stable ?

2. (Purcell 1.9) A spherical volume of radius a is filled with charge of uniform density ρ. We want to know the potential energy U of this sphere of charge, that is, the work done in assembling it. Calculate it by building the sphere up layer by layer, making use of the fact that the field outside a spherical distribution of charge is tha same as if all the charge were at the center. Express the result in terms of the total charge Q in the sphere.

3. (Purcell 1.17) A point charge q is located at the center of a cube of edge length d. What is the value of $\int \mathbf{E} \cdot d\mathbf{a}$ over one face of the cube. The charge is moved to one corner of the cube. What is the value of flux $\mathbf{E}$ through each of the faces of the cube.

4. (Purcell 1.20) Consider a distribution of charge on the form of a circular cylinder, like a long charged pipe. Prove that the field inside the pipe is zero. Prove that the field outside is the same as if the charge were all on the axis.

5. A thin spherical shell of radius a has a charge $+Q$ evenly distributed over its surface. Find the electric field both inside and outside the shell.

6. A hollow spherical shell with radius R has charge Q uniformly distributed over it. Show that the energy stored in this system is $Q^2/8\pi\epsilon_0 R$.