**Physics 008** **Problem Set #2** **Fall 2009**

**My Lectures from :** Purcell Chapter 2
Web Notes : Lecture Notes #2
Other Notes: Fields; Coulomb Law; Gauss Law

**Purcell Problems:**

2.01 Line integrals and gradients
2.04 $\vec{E}$ and $\rho$ from $\phi$
2.08 Cylindrical charge distribution
2.12 Potential from a triangle
2.18 Potential difference
2.19 How does the charge distribute?
2.20 Potential of a sphere
2.27 Energy stored and work done
2.29 Two charged nonconducting spherical shells
2.30 Potential of a cube

**1. Energy of a radial charge distribution -** A spherically symmetric charge distribution has charge density

$$\rho = \begin{cases} \rho_0 \dfrac{r}{a} & r < a \\ 0 & r \geq a \end{cases}$$

(a) Find the electric field $\vec{E}$ everywhere
(b) Find the electrostatic potential $\phi$ everywhere
(c) Determine the energy needed to assemble the charge distribution using 2 different approaches.

**2. Electrostatic potentials**

(a) Find the electric field $\vec{E}$ from the electrostatic potential

$$\phi = \frac{\alpha z}{r}$$

where $\alpha$ is a constant and $r$ is the distance from the origin.

(b) An electrostatic potential has the form:

$$\phi = \begin{cases} -2\pi a l(x + l/4) & x < -l/2 \\ 2\pi a x^2 & -l/2 < x < l/2 \\ 2\pi a l(x - l/4) & l/2 < x \end{cases}$$

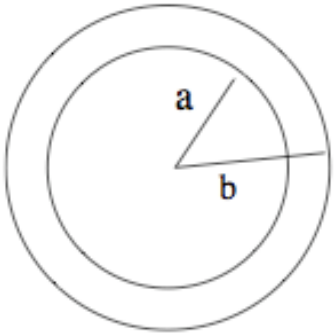
where $a$ and $l$ are constants. Find the charge distribution which gives this potential.

(c) Give the electric field of the charge distribution you found in part(b)

**3. Electric field, potential and flux -** A hollow spherical shell carries charge density

$$\rho = \frac{k}{r^2}$$

in the region $a \le r \le b$ (see figure).




(a) Find the electric field $\vec{E}$ everywhere in space.

(b) Find the potential $\phi$ everywhere in space.

(c) Calculate the flux:

i. through the concentric sphere with radius $r_1 > b$

ii. through the concentric sphere with radius $a < r_2 < b$

iii. through the concentric sphere with radius $r_3 < a$

iv. through the nonconcentric sphere with radius $r_4 = 2b$, centered at any arbitrary point on the outer surface of the shell.