Homework No. 04 (Fall 2013)

PHYS 320: Electricity and Magnetism I

Due date: Friday, 2013 Oct 11, 4.30pm

1. Consider an uniformly charged solid sphere of radius R with total charge Q. Using Gauss's law show that the electric field inside and outside the sphere is given by

$$\mathbf{E}(\mathbf{r}) = \begin{cases} \dfrac{Q}{4\pi\varepsilon_0}\dfrac{1}{R^2}\dfrac{r}{R}\,\hat{\mathbf{r}} & r < R, \\ \dfrac{Q}{4\pi\varepsilon_0}\dfrac{1}{r^2}\,\hat{\mathbf{r}} & r > R, \end{cases} \tag{1}$$

   where $\mathbf{r}$ is the radial vector with respect to the center of sphere. Plot the electric field as a function of r.

2. Consider an infinitely long and uniformly charged solid cylinder of radius R with charge per unit length λ. Using Gauss's law show that the electric field inside and outside the cylinder is given by

$$\mathbf{E}(\mathbf{r}) = \begin{cases} \dfrac{\lambda}{2\pi\varepsilon_0}\dfrac{1}{R}\dfrac{r}{R}\,\hat{\mathbf{r}} & r < R, \\ \dfrac{\lambda}{2\pi\varepsilon_0}\dfrac{1}{r}\,\hat{\mathbf{r}} & r > R, \end{cases} \tag{2}$$

   where $\mathbf{r}$ is now the radial vector transverse to the axis of the cylinder. Plot the electric field as a function of r.

3. Consider a uniformly charged solid slab of infinite extent and thickness $2R$ with charge per unit area σ. Using Gauss's law show that the electric field inside and outside the slab is given by

$$\mathbf{E}(\mathbf{r}) = \begin{cases} \dfrac{\sigma}{2\varepsilon_0}\dfrac{r}{R}\,\hat{\mathbf{r}} & r < R, \\ \dfrac{\sigma}{2\varepsilon_0}\,\hat{\mathbf{r}} & r > R, \end{cases} \tag{3}$$

   where $\mathbf{r}$ is now the vector transverse to the plane measured from the bisecting plane of the slab. Plot the electric field as a function of r.

4. Repeat Problem 1 for a uniformly charged hollow sphere of radius R with total charge Q.

5. Repeat Problem 1 for a solid sphere of radius R with total charge Q distributed inside the sphere with a charge density

$$\rho(\mathbf{r}) = br\,\theta(R - r), \tag{4}$$

   where r is the distance from the center of sphere, and $\theta(x) = 1$, if $x > 0$, and 0 otherwise.

6. Problem 2.15, Griffiths 4th edition.

7. Problem 2.16, Griffiths 4th edition.

8. Problem 2.60, Griffiths 4th edition.