SC217: Electromagnetic Theory **Assignment 11 Nov.11**

DA-IICT, B.Tech, Sem III Autumn2019

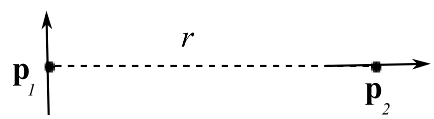
1. **A sphere of radius R, centered at the origin, carries charge density $\rho(r,\theta) = k(R - r)\cos\theta$. Find the approximate potential far from the sphere.**

2. **A dipole $\vec{\mathbf{p}}$ is at a distance r from a point charge q and oriented so that $\vec{\mathbf{p}}$ makes an angle θ with the vector $\vec{\mathbf{r}}$ from q to $\vec{\mathbf{p}}$.**

   (a) What is the force on $\vec{\mathbf{p}}$?

   (b) What is the force on q ?

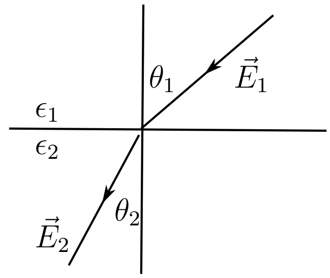
3. **$\vec{\mathbf{p}}_1$ and $\vec{\mathbf{p}}_2$ are perfect dipoles a distance r apart. $\vec{\mathbf{p}}_2$ is along $\vec{\mathbf{r}}$ while $\vec{\mathbf{p}}_1$ is orthogonal to $\vec{\mathbf{r}}$. Calculate the torque on the dipoles. Are they equal and opposite?**



4. **A sphere of radius R carries a polarization $\vec{\mathbf{P}}(\vec{\mathbf{r}}) = k\vec{\mathbf{r}}$**
   (a) Calculate the bound charges ρ_b and σ_b and the electric field caused due to them inside and outside the sphere.
   (b) Find the electric field using the Gauss' law for the displacement vector $\vec{D}$ given as $\oint_S \vec{D}\cdot\hat{n}da = Q_{f(enc)}$.

5. **A point charge q is imbedded at the center of a sphere of linear dielectric material with susceptibility χ_e and radius R. Find the electric field, the polarization, and the bound charge densities, ρ_b and σ_b. What is the total bound charge on the surface? Where is the compensating negative bound charge located?**

6. **At the interface between one linear dielectric and another the electric field lines bend. Show that $\tan\theta_2/\tan\theta_1 = \epsilon_2/\epsilon_1$ assuming there is no free charge at the boundary. Refer to fig.1 below.**



7. Suppose the field inside a large piece of dielectric is $\vec{\mathbf{E}}_0$, so that the electric displacement is $\vec{\mathbf{D}}_0 = \epsilon_0 \vec{\mathbf{E}}_0 + \vec{\mathbf{P}}$.

(a) If we have a narrow cylindrical(needle-like) cavity inside the material running parallel to $\vec{\mathbf{P}}$ find the field near the center of the cavity in terms of $\vec{\mathbf{E}}_0$ and $\vec{\mathbf{P}}$. Also find the displacement at the center of the cavity in terms of $\vec{\mathbf{D}}_0$ and $\vec{\mathbf{P}}$.

(b) Do the same for a thin wafer shaped cavity perpendicular to $\vec{\mathbf{P}}$.