

Problem 5.1: Force and Torque on a dipole (Griffiths 3rd ed., Prob 4.5 & Prob. 4.9)

- (a) In Fig. 1(a), \mathbf{p}_1 and \mathbf{p}_2 are two perfect dipoles separated by a distance r . What is the torque on \mathbf{p}_1 due to \mathbf{p}_2 .
- (b) In Fig. 1(b), A dipole \mathbf{p} is at a distance r from a point charge q , and oriented so that \mathbf{p} makes an angle θ with the vector \mathbf{r} from q to \mathbf{p} . What is the force on \mathbf{p} ?

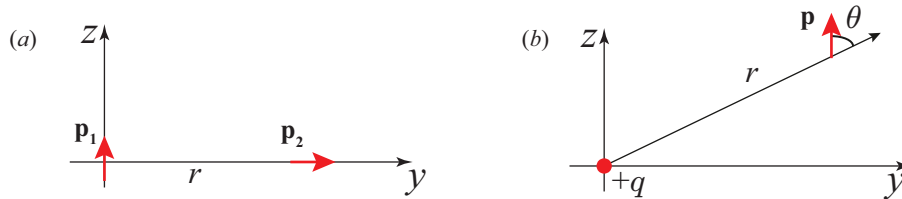


FIG. 1:

Problem 5.2: Finding electric field in the presence of dielectric (Griffiths 3rd ed., Prob 4.15)

A spherical shell with inner radius a and outer radius b is made of dielectric material with polarization $\mathbf{P} = \frac{k}{r} \hat{\mathbf{r}}$, where k is a constant r is the distance from the center (see Fig. 2). Assume no free charge anywhere.

- (a) Calculate all the bound charges.
- (b) Use Gauss's law for electric fields to calculate the electric field in all the three regions.
- (c) Use Gauss's law for electric displacement to calculate the electric field in all the three regions.

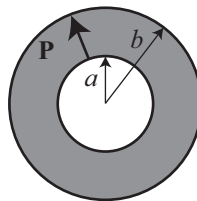


FIG. 2:

Problem 5.3: Electric potential in a dielectric material (Griffiths 3rd ed., Prob 4.20)

A sphere of linear dielectric material has embedded in it a uniform free charge density ρ . Find the potential at the center of the sphere (relative to infinity), if its radius is R and its dielectric constant is ϵ_r .

Problem 5.4: Capacitor with dielectric filling (Griffiths 3rd ed., Prob 4.21)

A certain coaxial cable consists of a copper wire, radius a , surrounded by a concentric copper tube of inner radius c . The space between is partially filled (from b out to c) with material of dielectric constant ϵ_r (see Fig. 3). Find the capacitance per unit length of the cable.

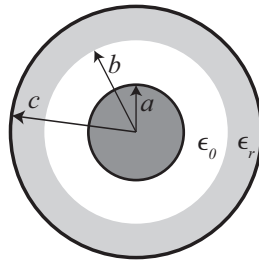


FIG. 3:

Problem 5.5: Force on a dielectric material (Griffiths 3rd ed., Prob 4.28)

Two long coaxial cylindrical metal tubes (inner radius a , outer radius b) stand vertically in a tank of dielectric oil (susceptibility χ_e , mass density ρ). The inner one is maintained at potential V and the outer one is grounded (see Fig. 4). To what height (h) does the oil rise in the space between the tubes.

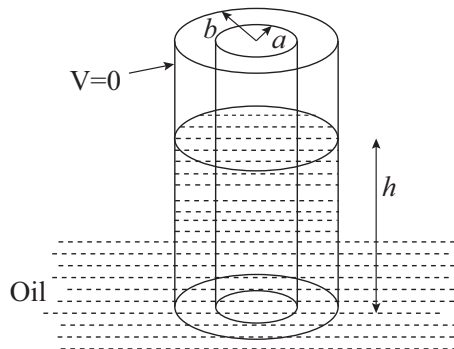


FIG. 4:

Problem 5.6: bound charges in a cubical dielectric (Griffiths 3rd ed., Prob 4.31)

A dielectric cube of side a , centered at the origin, carries a polarization $\mathbf{P} = k\mathbf{r}$. Find all the bound charges, and check that they add up to zero.