Problem 4.31 A dielectric cube of side a, centered at the origin, carries a "frozen-in" polarization $\mathbf{P} = k\mathbf{r}$, where k is a constant. Find all the bound charges, and check that they add up to zero.

Problem 4.32 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?

Problem 4.33 At the interface between one linear dielectric and another the electric field lines bend (see Fig. 4.34). Show that

$$\tan \theta_2 / \tan \theta_1 = \epsilon_2/\epsilon_1,$$

Problem 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 4.21 A certain coaxial cable consists of a copper wire, radius a, surrounded by a concentric copper tube of inner radius c (Fig. 4.26). The space between is partially filled (from b out to c) with material of dielectric constant ϵ_r, as shown. Find the capacitance per unit length of this cable.

Problem 1 For the spherical conducting shells filled with two linear dielectric materials, shown in Fig.1, the potential of inner and outer shell is 0 and V_0, respectively. Determine the potential distribution in the region c<r<a.
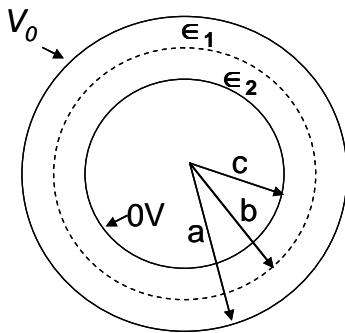
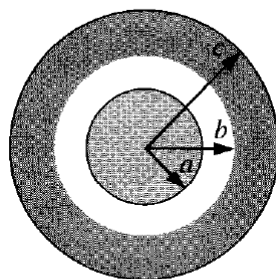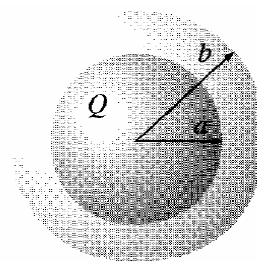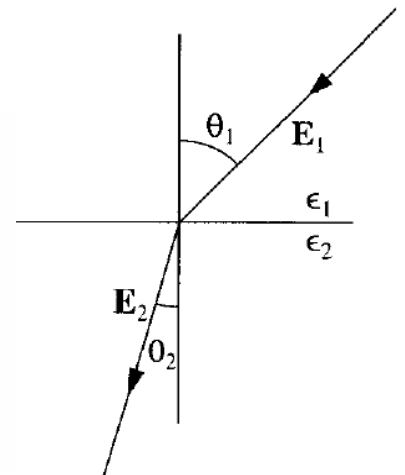

Fig.1

Figure 4.26

Figure 4.29

Figure 4.34

Problem 2 A parallel plate capacitor with plate area A cm^2 and plate separation d mm is given a charge Q C. The battery is disconnected and a parallel faced dielectric slab (dielectric constant k) of area A cm^2 thickness t mm is placed centrally between the two plates, as shown in the figure. Find out the following parameters.

Ans:

   I. Electric displacement vector ($\vec{D}$) in region 1 & 2:

  II. Electric filed vector ($\vec{E}$) in region I &2:

 III. Polarization vector ($\vec{P}$) in region 2:

 IV. Induced electric field ($\vec{E}_{induced}$) due to polarization in the dielectric slab:

  V. Capacitance

 VI. Total bound surface charges on both the surfaces of the dielectrics:

     Surface A: Surface B:

VII. Electrostatic potential energy of the capacitor: