

1. An electron (charge  $e$ ) is buried a distance  $d$  under the surface of a glass slab. There is no other free charge in the universe. The surface of the glass is covered in water. Glass has a relative dielectric constant of 4. Water has a relative dielectric constant of 80. Using equations that we discussed in class, find the electric potential on the surface of glass.

2. 3. and 4. A collection of problems from Griffiths.

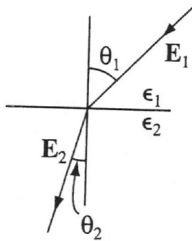


FIGURE 4.34

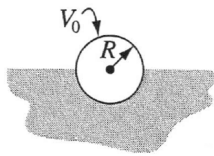


FIGURE 4.35

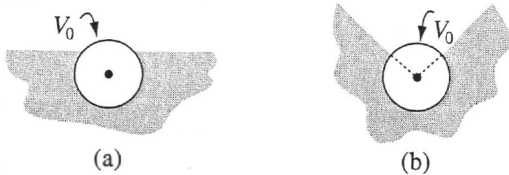


FIGURE 4.36

**Problem 4.35** A point charge  $q$  is imbedded at the center of a sphere of linear dielectric material (with susceptibility  $\chi_e$  and radius  $R$ ). Find the electric field, the polarization, and the bound charge densities,  $\rho_b$  and  $\sigma_b$ . What is the total bound charge on the surface? Where is the compensating negative bound charge located?

**Problem 4.36** At the interface between one linear dielectric and another, the electric field lines bend (see Fig. 4.34). Show that

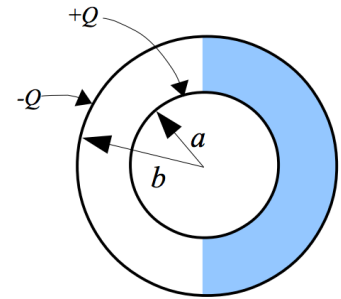
$$\tan \theta_2 / \tan \theta_1 = \epsilon_2 / \epsilon_1, \tag{4.68}$$

assuming there is no *free* charge at the boundary. [Comment: Eq. 4.68 is reminiscent of Snell's law in optics. Would a convex "lens" of dielectric material tend to "focus," or "defocus," the electric field?]

**Problem 4.39** A conducting sphere at potential  $V_0$  is half embedded in linear dielectric material of susceptibility  $\chi_e$ , which occupies the region  $z < 0$  (Fig. 4.35). *Claim:* the potential everywhere is exactly the same as it would have been in the absence of the dielectric! Check this claim, as follows:

- Write down the formula for the proposed potential  $V(r)$ , in terms of  $V_0$ ,  $R$ , and  $r$ . Use it to determine the field, the polarization, the bound charge, and the free charge distribution on the sphere.
- Show that the resulting charge configuration would indeed produce the potential  $V(r)$ .
- Appeal to the uniqueness theorem in Prob. 4.38 to complete the argument.
- Could you solve the configurations in Fig. 4.36 with the same potential? If not, explain *why*.

5. (From Jackson Chpt 4) Two concentric conducting spheres of inner and outer radii  $a$  and  $b$ , respectively, carry charges  $\pm Q$ . As always, the potential must be constant on each conductor, but the charge density is not necessarily constant. Half the empty space between the spheres is filled by a polarizable material (the light blue shaded region).



(a) The electric potential in the empty space between the spheres (the white region) can be described by a sum of orthogonal functions. Identify any  $A_l$  or  $B_l$  coefficients that must be zero.

(b) Find the electric field everywhere between the spheres (make use of the boundary conditions at a dielectric interface).

(c) Calculate the surface-charge distribution on the inner sphere.

(d) Calculate the surface bound charge,  $\sigma_b$ , induced on the surface of the dielectric at  $r = a$ .