

Tut-08

Problem 4.18 The space between the plates of a parallel-plate capacitor (Fig. 4.24) is filled with two slabs of linear dielectric material. Each slab has thickness a , so the total distance between the plates is $2a$. Slab 1 has a dielectric constant of 2, and slab 2 has a dielectric constant of 1.5. The free charge density on the top plate is σ and on the bottom plate $-\sigma$.

Problem 4.19 Suppose you have enough linear dielectric material, of dielectric constant ϵ_r , to *half-fill* a parallel-plate capacitor (Fig. 4.25). By what fraction is the capacitance increased when you distribute the material as in Fig. 4.25(a)? How about Fig. 4.25(b)? For a given potential difference V between the plates, find \mathbf{E} , \mathbf{D} , and \mathbf{P} , in each region, and the free and bound charge on all surfaces, for both cases.

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.

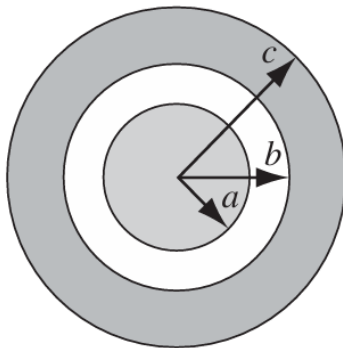


FIGURE 4.26

Problem 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 (Fig. 4.32). To what height (h) does the oil rise, in the space between the tubes?

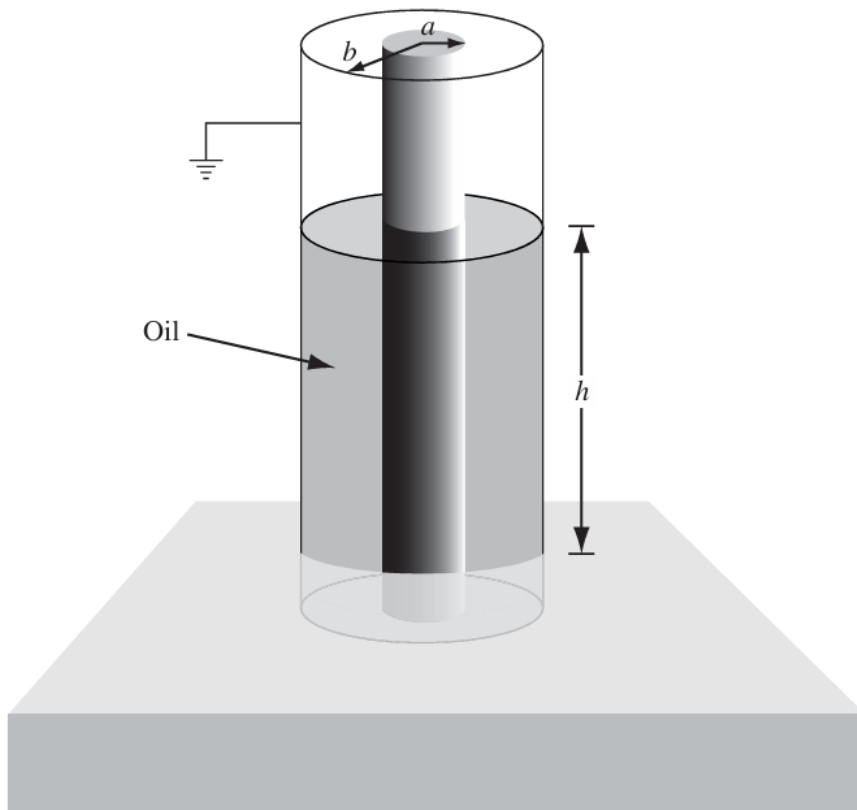


FIGURE 4.32

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

$$\tan \theta_2 / \tan \theta_1 = \epsilon_2 / \epsilon_1, \quad (4.68)$$

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?]

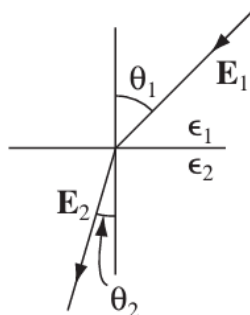


FIGURE 4.34

Problem 4.41 In a linear dielectric, the polarization is proportional to the field: $\mathbf{P} = \epsilon_0 \chi_e \mathbf{E}$. If the material consists of atoms (or nonpolar molecules), the induced dipole moment of each one is likewise proportional to the field $\mathbf{p} = \alpha \mathbf{E}$. *Question:* What is the relation between the atomic polarizability α and the susceptibility χ_e ?