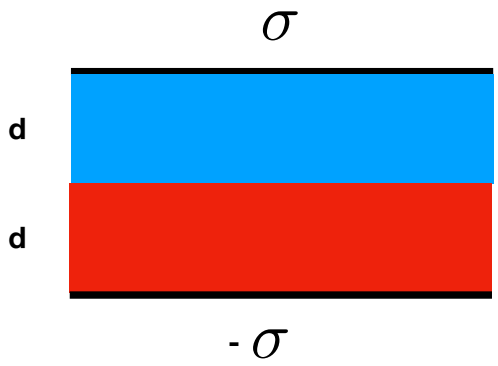
PHYSICS 321
CLASSICAL ELECTRODYNAMICS

27 Nov. 2019 Problem Set 6 These problems are due on Thursday, Dec. 6

1. *Parallel plate capacitor filled with dielectric* The space between the plates of a parallel-plate capacitor is filled with two slabs of linear dielectric material. Each slab has thickness d, so the total distance between the plates is $2d$. The upper slab has dielectric constant (ϵ_r) of 2, and the lower slab has a dielectric constant of 1.5. The free charge density on the top plate is σ and on the bottom plate it is $-\sigma$.



(a) Find the electric displacement **D** in each slab.

(b) Find the electric field **E** in each slab.

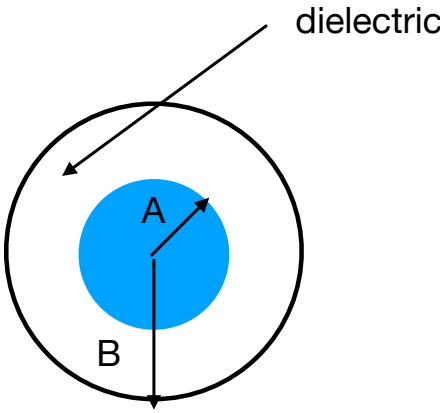
(c) Find the polarization **P** in each slab.

(d) Find the potential between the plates.

(e) Find the location and amount of all bound charge.

2. *Dielectric Shell* Find the electric field inside a dielectric shell of permitivity ϵ with inner radius A and outer radius B that is placed in a uniform electric field $\mathbf{E}_0$. Hint: use the potential in 3 regions and the boundary condition. The lecture notes have a similar problem.

3. *Cylindrical capacitor filled with dielectric*



(a) Find the capacitance per unit length of a coaxial cylindrical capacitor with inner radius A and outer radius B filled with a linear dielectric of permittivity ϵ.

(b) Find the capacitance per length if the dielectric fills only the lower half of the capacitor.

4. *Forces on Dielectrics* Two coaxial thin-walled conducting tubes with radii a and b are dipped vertically into a dielectric liquid of susceptibility χ_e and mass density ρ. If a voltage difference V_0 is applied to the tubes. The liquid rises to a. height h in the space between the tube walls.

(a) Determine h in terms of the parameters given above.

(b) Note that this is generally a small effect. For example, compute the value of h if the dielectric is water (see Table 4.2) for $a = 1.0$ cm, b=1.2cm, and $V_0 = 500$ volts.