Problem Set 5
Due Tuesday March 9, 2004

1. Problem 4-31

2. Problem 4-33

3. Problem 4-37

4. (Cheng) What are the boundary conditions that must be satisfied by the electric potential at an interface between two perfect dielectrics with dielectric constants ϵ_1 and ϵ_2.

5. (Cheng) Assuming the earth to be a large conducting sphere (radius $= 6.37 \times 10^3$km) surrounded by air, find (a) the capacitance of earth and (b) the maximum charge that can be placed onto earth before the air breaks down.

6. (Cheng) A capacitor consists of two concentric spherical shells of radii R_i and R_o. The space between them is filled with a dielectric of relative permittivity ϵ_r from R_i to R_b ($R_i < R_b < R_o$) and another dielectric of relative permittivity $2\epsilon_r$ from R_b to R_o.

    (a) Determine **E** and **D** everywhere in terms of an applied voltage V_0.
    (b) Determine the capacitance.

7. (Cheng) The two parallel conducting wires of a power transmission line have a radius a and are spaced at a distance d apart. The wires are at a height h above ground. Assuming the ground to be perfectly conducting and both d and h to be much large than a, find the expressions for the mutual and self capacitances per unit length.

8. (Cheng) A parallel-plate capacitor of width w, length ℓ, and separate d is partially filled with a dielectric medium of dielectric constant ϵ_r, as shown below. A battery of V_0 volts is connected between the plates.

    (a) Find **D**, **E**, and ρ_s in each region.
    (b) Find the distance x such that the electrostatic energy stored in each region is the same.