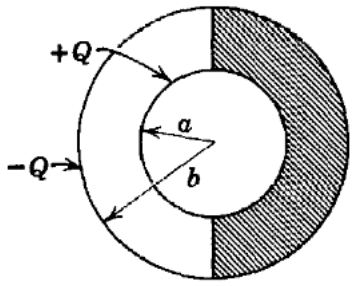
ELECTRODYNAMICS
PROBLEM SET 7
due March 16^{th}, before class

Problem 1: Dielectric fun

Two concentric conducting spheres of radii a and b carry charges $\pm Q$. The empty space between them is half-filled by a hemispherical shell of dielectric (with dielectric constant ϵ). Find the electric field everywhere between the spheres.



Problem 2: Straight from Jackson

A very long, right circular, cylindrical shell of dielectric constant ϵ and inner and outer radii a and b, respectively, is placed in a previously uniform electric field E_0 with its axis perpendicular to the field. The medium inside the cylinder is air $\epsilon \approx 1$.

a) Determine the filed in all three regions neglecting edge effects.

b) Sketch the lines of force for the case $b = 2a$.

Problem 3: Capacitances

Consider N conducting bodies in space. Since Maxwell's equations are linear, their charges and potentials are related linearly

$$Q_a = \sum_{b=1}^{N} C_{ab}\phi_b. \tag{1}$$

The constants C_{aa} are called capacitances and the non-diagonal constants C_{ab} for $a \neq b$ are called, at least by some, electrostatic induction coefficients. They depend only on the shape of the conductors (and dielectrics, if present).

a) Argue that $C_{ab} = C_{ba}$ and that $C_{aa} > 0$. Hint: write down the energy in terms of the C_{ab}.

b) In the gaussian system, what are the units for C_{ab} ? What is C for a sphere?

c) The Earth is a good conductor and approximately spherical. What is the capacitance of the Earth in "practical" units (microfarads)? If we remove all the electrons out of a gram or so of material on the Earth, what would be the potential of the Earth? What would be the electric field on the Earth's surface (in volts/cm)? Hint: you can find conversion factors for electromagnetic quantities on the back cover of textbooks. Google can probably do it too). Hint 2: I'm looking only for rough numbers here.