

Electricity and Magnetism

Do two of the following three problems, each on a separate sheet (or sheets). Attach each set to a provided cover sheet with your name, subject, and problem number.

Problem 1

Two very long coaxial cylindrical shells of radii a and b ($a < b$) and each of length h are kept at a fixed potential difference $\phi = V_a - V_b$. There are no other charge densities besides the ones on the shells. The electric field outside the system vanishes. Ignoring effects from the ends of the cylinders, find the surface charge densities on the two cylinders.

Problem 2

The charge density in the electron cloud of a hydrogen atom is described by the function

$$\rho(r) = - \left(\frac{e_0}{\pi a_0^3} \right) \exp \left(\frac{-2r}{a_0} \right),$$

where e_0 is the electronic charge and a_0 is a constant. Calculate the polarizability, β , of the hydrogen atom in a weak external electric field assuming that the distortion of the electron cloud may be neglected. Repeat the calculation on the assumption that the electron cloud is distributed uniformly in a sphere of radius a_0 .

Problem 3

Find the potential function, U , for two small current loops with magnetic moments m_1 and m_2 . Find the force, F , and the torque, N , on the two currents. Consider also the special case where m_1 is parallel to m_2 .