

PHYS 3320 Electricity & Magnetism I
Fall 2018
Assignment 5

1. Show that for any arbitrary shape the total bound charge

$$Q_b = \int_{\Sigma} \sigma_b dS + \int_V \rho_b dv$$

must equal 0. (Hint: think divergence theorem.)

2. A conducting sphere of radius R is surrounded by a conducting shell of radius $5R$. The region between $r=2R$ and $r=4R$ is filled with a dielectric of constant K . The rest of the volume is evacuated. The inner sphere carries a charge $+Q$, and the outer shell a charge $-Q$. Find
- the displacement field \mathbf{D} everywhere
 - the electric field \mathbf{E} everywhere
 - the polarization \mathbf{P} within the dielectric
 - the bound charges
 - the capacitance of the system. (From Physics II, capacitance is defined as $Q/\Delta V$.)
3. A half-cylinder of radius R and length L has a non-uniform polarization $\mathbf{P} = P_0(x/R)\mathbf{j}$ perpendicular to the plane surface. Find its dipole moment and the bound charge densities. The axis of the cylinder is the z -axis, and has $x>0$.
4. For any configuration of charges (ρ) and currents (\mathbf{J}) confined to a given region of space, show that $\int_V \mathbf{J} dv = d\mathbf{p}/dt$ where \mathbf{p} is the dipole moment of the charges.