Electrodynamics
Spring '05
Problem Set 1

Problem 3
Jackson 6.8

The surface charge on a dielectric sphere is given by (eq. 4.58)

$$\sigma_{pol} = 3\varepsilon_0 \left(\frac{\varepsilon - \varepsilon_0}{\varepsilon + 2\varepsilon_0} \right) E_0 \sin\theta \cos\phi$$

To maintain this charge distribution there has to be a current running across the surface of the

$$\Phi_{mag} = 3\varepsilon_0 \left(\frac{\varepsilon - \varepsilon_0}{\varepsilon + 2\varepsilon_0} \right) E_0 \sin\theta \cos\phi \omega a \cos\theta$$

The magnetic potential is given as

$$\Phi_{mag} = \int \frac{j_{mag}}{|x - x'|} dS$$

Expanding 1/r as in Eq. 3.70 we get after the integration

$$\Phi_{mag} = 3\varepsilon_0 \omega a E_0 \left(\frac{\varepsilon - \varepsilon_0}{\varepsilon + 2\varepsilon_0} \right) \frac{a^2}{r^3} \frac{a^2}{5} \sin\theta \cos\phi \cos\theta$$

$$= \frac{3}{5} \varepsilon_0 \omega E_0 \left(\frac{\varepsilon - \varepsilon_0}{\varepsilon + 2\varepsilon_0} \right) \frac{a^5}{r^5} xz$$