Phys 221 – E&M I – Final Exam – May 16, 2001

1.(25 pts) An electrostatic field is given by $\vec{E} = k[2xy\,\hat{x} + (2yz + x^2)\,\hat{y} + y^2\,\hat{z}]$, where k is a constant with the appropriate units.

a) Verify that this is a possible electrostatic field.

b) Find the potential, using the *origin* as your reference point.

2.(25 pts) A sphere of radius R carries a charge density $\rho(r) = Ar$, where A is a constant.

a) Determine the electric field inside the sphere.

b) Find the net force that the "southern" hemisphere exerts on the "northern" hemisphere.

3.(25 pts) A sphere of linear dielectric material, radius R, and dielectric constant ε_r is placed in an otherwise uniform electric field $\vec{E}_0$.

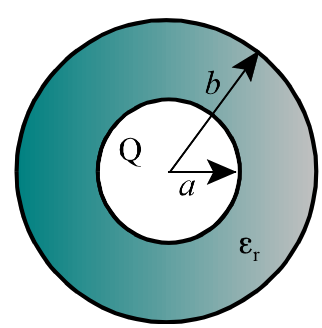
a) Determine the potential inside and outside the sphere.

b) Determine the electric field inside the sphere.

c) What is the dipole moment of the sphere? Write down the electric field outside the sphere using the dipole moment.

4.(25 pts) spherical conductor, of radius a, carries a charge Q. It is surrounded by linear dielectric material with a dielectric constant ε_r, out to a radius b.

a) Determine the electric field in all three regions,
$r < a$; $a < r < b$; $r > b$.



b) Determine the polarization in all three regions.

c) Determine the bound volume and surface charge densities.

5.(25 pts) A steady current I flows down a long cylindrical wire of radius R. The current is distributed in such a way that J is proportional to s^2 , where s is the distance from the axis.

a) Determine the constant of proportionality.

b) Find the magnetic field, both inside and outside the wire.

6.(25 pts) An infinitely long cylinder, of radius R, carries a "frozen-in" magnetization parallel to the axis. Thus $\vec{M} = As^2\hat{z}$, where A is a constant and s is the distance from the axis; there is no free current anywhere.

a) Determine all the bound currents, $\vec{J}_b$ and $\vec{K}_b$.

b) Use the bound currents to determine the magnetic field inside and outside the cylinder.