Phys 221 – E&M I – Test 2 – March 21, 2003

1. (25 pts) A point charge q is situated a distance a from the center of a grounded conducting sphere of radius R. As you know this will produce an image charge $q' = -qR/a$ at a distance b from the center of the sphere such that $ab = R^2$.

a) Find the force on the charge q in terms of the given variables q, a, and R.

b) Calculate the energy of this configuration, *i.e.*, the work necessary to bring the charge q from infinity up to the distance a from the sphere in terms of the given variables q, a, and R.

2. (25 pts) A surface charge density $\sigma(\phi)$ is glued over the surface of an infinite cylinder of radius R such that the electric potential on the surface is given by $V(\phi) = V_0 \sin(2\phi)$, where V_0 is a constant.

a) Find the electric potential $V(s,\phi)$ inside and outside the cylinder.

b) Determine the surface charge density $\sigma(\phi)$.

3. (25 pts) An uncharged (grounded) metal sphere of radius R is placed in a uniform electric field given by $\vec{E} = E_0 \hat{z}$.

a) Determine the potential inside and outside the metal sphere.

b) Determine the induced dipole moment on the metal sphere.

4. (25 pts) Three charges lie in the xy plane as shown. There is a charge q at $y = -a$, a charge q at $y = a$, and a charge $2q$ at $x = a$.

a) Calculate the monopole and dipole moments for this distribution.

b) Find the approximate potential at points far from the distribution. Give your results in spherical coordinates.

c) Find the approximate electric field at points far from the distribution. Give your results in spherical coordinates.