Physics 405
Problem Set #11: DUE Friday. 4/28/2009
Read Griffiths Chap. 5

Problem 1:

(a) Find the magnetic field a distance z above the center a square loop (length of side of the square is s) carrying constant current I.
(Hint: Use the principle of superposition to add the magnetic field vector contributions from each side of the loop; these are finite straight line-currents for which we derived the magnetic field in class)

(b) Show that in the limit $z>>s$, the magnetic field has the form

$$\mathbf{B}(z) = \frac{\mu_0}{4\pi}\left(\frac{2m}{z^3}\right)\hat{\mathbf{z}}$$

What is the magnetic moment m?

Problem 2:

Consider coaxial cable consisting of a long solid conducting cylinder of radius a surrounded by a conducting cylindrical tube of radius b . A battery is connected, and the circuit is completed so that a current **I** flows down the central cylinder and back on the surface of the outer tube.

(a) Find the magnetic field everywhere (assume the cylinders are essentially infinite in length, i.e. L>>a, L>>b)
(b) Sketch the magnitude of **B** as function of r.
(c) Show that the boundary conditions on **B** are satisfied at $r=b$.

Problem 3 Griffiths 5.14
Explain why your answer makes sense in the limit a-->0, while J(2a)-->K (a surface constant).