For this assignment... Work out the following problems on separate sheets. Staple all, including this front page, for your submission.

1) Your textbook derives an expression for the dipole field at a position $\mathbf{r}$=(R,θ,π/2)=(0,y,z). Note that in class we have been deriving an expression for the dipole magnetic field at a point $\mathbf{r}$=(x,0,z), which should produce equivalent results. Please derive step-by-step an expression for the dipole magnetic vector potential **A** and the dipole magnetic flux density **B**, as we have done in class, but filling in the following important details (each being required for full credit):

- **a.** Prove that the radial distance between your "dl" differential element and your observation point "p" is given by:

$$R = |\mathbf{r} - \mathbf{r}'| = \sqrt{r^2 - 2ar\sin\theta\cos\phi' + a^2}$$

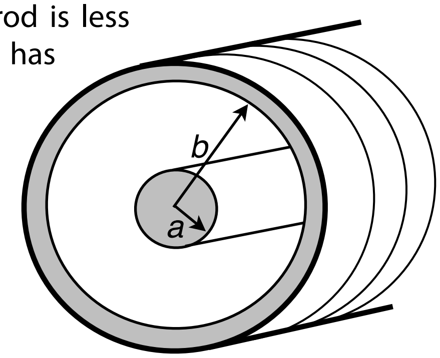
- **b.** Prove that for distances *r>>a*, the following approximation may be used for 1/R:

$$\frac{1}{R} \simeq \frac{1}{r}\left(1 + \frac{a\sin\theta\cos\phi'}{r}\right)$$

- **c.** Determine expression for **A** in terms of magnetic dipole moment.
- **d.** Determine whether the divergence of **A** is zero or nonzero.
- **e.** Determine expression for **B**.
- **f.** Compare and comment on the expression for the *electric* dipole field.

2) Cheng P.6-21.

3) A circular rod of magnetic material with permeability μ has been inserted coaxially into a <u>solenoid</u> as shown in the figure below. The radius *a* of the rod is less than the radius *b* of the coaxial solenoid. The solenoid's winding has *n* turns per unit length and carries a current *I*.



- **a.** Find **B**, **H**, and **M** inside the solenoid for regions *r<a* and *a<r<b.*
- **b.** Find equivalent magnetization current densities $\mathbf{J}_m$ and/or $\mathbf{J}_{ms}$ for the magnetized rod.

4) Cheng P.6-26.

5) Cheng P.6-30.