PHYS 507
HANDOUT 9 - *Questions on Magnetostatic Fields in Matter*

9.1 Show that the torque exerted on a magnetic loop is given by $\mathbf{N} = \mathbf{m} \times \mathbf{B}$.

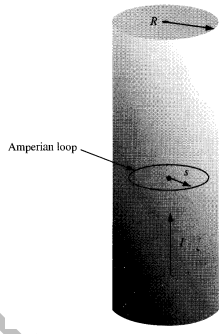
9.2 Show that the vector potential of a magnetized object is the same as would be produced by a volume current throughout the material plus a surface current on the boundary.

9.3 Find the magnetic field of a uniformly magnetized sphere.

9.4 Show that $\mathbf{J}_b = \nabla \times \mathbf{M}$.

9.5 Show that $\mathbf{H} \equiv \frac{1}{\mu_0}\mathbf{B} - \mathbf{M}$.

9.6 A long copper rod of radius *R* carries a uniformly distributed (free) current *I.* Find *H* inside and outside the rod.



9.7 A flat circular disk has a radius equal to *a*, and is uniformly charged with a surface charge density equal to σ. The disk rotates around its symmetry axis with a constant angular velocity $\boldsymbol{\omega}$. Calculate the magnetic moment of the disk.

9.8 A spherical shell has a radius equal to *a*, and carries a charge *Q* uniformly distributed on its surface. The shell rotates around its symmetry axis with a constant angular velocity $\boldsymbol{\omega}$. Calculate the magnetic moment of the disk.

9.9 A length L of a wire carries a current I. Show that if the wire is formed into a circular coil, then the maximum torque in a given magnetic field is developed when the coil has one turn only, and the maximum torque has the magnitude $N_{\max} = L^2 IB / 4\pi$.

9.10 A circular loop of wire having a radius of $8cm$ carries a current of $0.20A$. A vector of unit length and parallel to the dipole moment $\vec{\mu}$ of the loop is given by $0.6\hat{i} - 0.8\vec{j}$. If the loop is located in a uniform magnetic field given by $\vec{B} = (0.25T)\hat{i} + (0.3T)\vec{j}$. Find the torque on the loop and the potential energy of the loop.

9.11 Find the magnetic dipole moment of the loop shown in figure below. All sides have length *w*, and it carries a current *I*.