P214/Homework #10 Due April 28 by 5 PM **Professor Lynn Cominsky**

Problems are from Tipler Chapter 26:

(1) 8 The north-seeking pole of a compass needle located on the magnetic equator is the end of the needle that oints toward the north, and the direction of any magnetic field $\vec{B}$ is specified as the direction that the north-seeking pole of a compass needle points when the needle is aligned in the field. Suppose that the direction of the magnetic field $\vec{B}$ were instead specified as the direction of a south-seeking pole of a compass needle aligned in the field. Would the right hand rule shown in Figure 26-2 then give the direction of the magnetic force on the moving positive charge, or would a left-hand rule be required? Explain

(2) 17 (a) Estimate the charge-to-mass ratio of a micrometeorite needed for it to "orbit" the Earth in a low-Earth orbit (400 km above the surface) under the influence of the Earth's magnetic field alone. Take the magnitude of the Earth's field to be 5×10^{-5} T and assume it perpendicular to the meteorite's velocity. Assume that the speed of meteorite is about the same as Earth's orbital speed of roughly 30 km/s. (b) If the mass of the micrometeorite is 3×10^{-10} kg, what is its charge? **NOTE: the answers in the back of the book are wrong.**

(3)28 A 10-cm length of wire carries a current of 4.0 A in the positive z direction. The force on this wire due to a uniform magnetic field $\vec{B}$ is $\vec{F} = (-0.2\ \hat{\imath} + 0.2\ \hat{\jmath})$ N If this wire is rotated so that the current flows in the positive x direction, the force on the wire is $\vec{F} = 0.2\ \hat{k}$ N. Find the magnetic field $\vec{B}$.

(4) 36 A particle of charge q and mass m has momentum $p = mv$ and kinetic energy $K = p^2/2m$. If the particle moves in a circular orbit of radius R perpendicular to a uniform magnetic field $\vec{B}$, show that (a) $p = BqR$ and (b) $K = \frac{1}{2}B^2q^2R^2/m$

(5) 54 What is the maximum torque on a 400-turn circular coil of radius 0.75 cm that carries a current of 1.6 mA and resides in a uniform magnetic field of 0.25T?

(6) 58 A rectangular 50-turn coil has sides 6-cm long and 8-cm long and carries a current I of 1.75 A. It is oriented and pivoted about the z axis, as shown in Figure 26-36. (a) If the wire in the xy plane makes an angle $\theta = 37°$ with the y-axis as shown, what angle does the unit normal $\hat{n}$ make with the x axis? (b) Write an expression for $\hat{n}$ in terms of the unit vectors $\hat{\imath}$ and $\hat{\jmath}$. (**Hint: picture this in 2D**) (c) What is the magnetic moment of the coil? (d) Find the torque on the coil when there is a uniform magnetic fields $\vec{B} = 1.5$ T $\hat{\jmath}$ (e) Find the potential energy of the coil in this field

(7) 62 A wire of length L is wound into a circular coil of N loops. Show that when this coil carries a current I, its magnetic moment has the magnitude $IL^2/4\pi N$

(8) 70 A metal strip 2-cm wide and 0.1-cm thick carries a current of 20 A in a uniform magnetic field of 2 T, as shown in Figure 26-41. The Hall voltage is measured to be 4.27 μV. (a)Calculate the drift velocity of the electrons in the strip (b) Find the number density of the charge carriers in the strip (c) Is point a or point b at the higher potential?

Problems are from Tipler Chapter 27:

(9) 4 Two wires lie in the plane of the paper and carry equal currents in opposite directions, as shown in Figure 27-42. At a point midway between the wires, the magnetic field is (a) zero (b) into the page (c) out of the page (d) toward the top or bottom of the page (e) toward one of the two wires

(10) repeat 4 Repeat the above problem with equal currents in the same direction.