Problems Due Week Beginning Oct 18, 1999.

Prob2925: An electron moves at a speed v = 3 x 10^5 m/s in a region of constant magnetic field of magnitude 0.12 T The direction of the electron when it enters this region is at 40 degrees to the field, and the electron follows a helical path. When you look along the direction of the magnetic field the path is a projected circle. How far has the electron traveled along the direction of B when one projected circle has been completed?

Hint: Component of velocity parallel to field does not change.

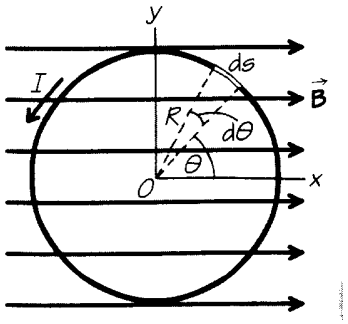
Prob2936: A 50-MeV proton, moving in the x-direction, enters a region in which there is a magnetic field. The proton experiences an acceleration of 10^{12} m/s^2 in the y-direction. What can you say about the magnetic field?

Hint: The MeV gives you kinetic energy. Convert to get velocity.

Prob2944: A current I flows through a circular wire loop of radius R that lies in the xy-plane (see fig). Consider a constant magnetic field of magnitude B that points in the x-direction. Calculate the force on an element of the loop formed by an angle dθ, located at an angle θ from the +x-axis.

Hint: Use known equations.

Prob2955: A circular wire coil of area 6 cm2 has 50 turns. When the coil is placed in a magnetic field of 0.2 T, the maximum torque is 3 x 10^{-5} N.m. (a) What is the current in the coil? (b) What work is required to rotate the coil 180 degrees in the magnetic field? Does the work depend on the initial angle?



Hint: Use equations in text.

Prob2958. (II) (a) Calculate the magnetic dipole moment of a single atom, based on the following model: One electron travels at speed 2.2 x 10^6 m/s in a circular orbit of diameter 10^{-10} m. (b) The individual atomic magnetic dipoles of magnetic materials (such as iron) are preferentially lined up to point in the same direction. If a fraction, f, of the dipoles are so aligned along the long axis (with the rest oriented randomly so that their magnetic dipole moments add vectorially to zero), what is the net magnetic dipole

moment of a piece of such material 1 cm2 in area and 10 cm long? (The material may be viewed as an array of cubes, each of which contains one atom and is 10^{-10} m on a side.) (c) What is the torque experienced by the piece of material in part (b) in a field of 10^{-3} T when the magnetic field is directed at right angles to the long axis of the material?

Hint: Use equations in text.

Prob2966: The masses of atomic ions of known charge can be precisely measured by finding the time an atom takes to complete a circular trajectory in a known magnetic field. With a magnetic field of magnitude 1 T and an apparatus capable of measuring times to an accuracy of 10^{-9} s, how accurately can the mass of an ion with charge +e be measured in 1 revolution. If the mass is to be measured to an accuracy of 10^{-30} kg, how many revolutions must be measured?

Hint: Write down an equation for the mass of the electron in terms of the period. Differentiate this to relate error in m to error in T.