University of Alabama
Department of Physics and Astronomy

PH 102-2 / LeClair Spring 2008

Problem Set 6: Magnetism

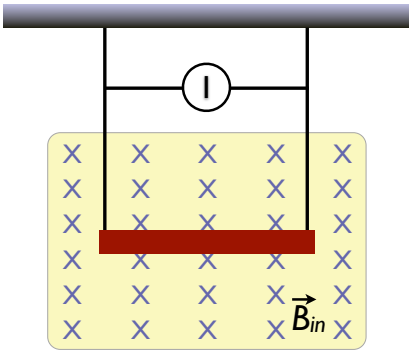
Instructions:

- Answer all questions below. Show your work for full credit.
- Due before 5pm, 3 Mar 2008
- Problem sets may turned in *via* email or hard copy
- Hard copies may be left in Dr. LeClair's mailbox (Gallalee 206) or office (Bevill 228)
- You may collaborate, but everyone must turn in their own work

1. 10 points. A wire with a weight per unit length of 0.10 N/m is suspended directly above a second wire. The top wire carries a current of 30 A and the bottom wire carries a current of 60 A. Find the distance of separation between the wires so that the top wire will be held in place by magnetic repulsion.

2. 5 points. An electron moving along the positive x axis perpendicular to a magnetic field experiences a magnetic deflection in the negative y direction. What is the direction of the magnetic field?

3. 10 points. A conductor suspended by two flexible wires as shown in the figure has a mass per unit length of 0.0400 kg/m. What current must exist in the conductor in order for the tension in the supporting wires to be zero when the magnetic field is 3.60 T into the page? What is the required direction for the current?



4. 10 points. A 40.0 cm length of wire carries a current of 20.0 A. It is bent into a loop and placed with its normal perpendicular to a magnetic field with a magnitude of 0.520 T. What is the torque on the loop if it is bent into a **(a)** equilateral triangle? What is the torque if the loop is **(b)** a square, or **(c)** a circle?

5. 5 points. A proton moving in a circular path perpendicular to a constant magnetic field takes 1.00 μs to complete one revolution. Determine the magnitude of the magnetic field.

6. 10 points. What current is required in the windings of a long solenoid that has 1000 turns uniformly distributed over a length of 0.400 m to produce at the center of the solenoid a magnetic field of magnitude of 1.00×10^{-4} T.

7. 15 points. One electron collides elastically with a second electron initially at rest. After the collision, the radii of their trajectories are 1.00 cm and 2.40 cm. The trajectories are perpendicular to a magnetic field of magnitude 0.0440 T. Determine the energy (in keV) of the incident electron.

8. 10 points. Electrons are accelerated from rest through a potential difference of 350 V. The electrons travel along a curved path because of the magnetic force exerted on them, and the radius of the path is measured to be 7.5 cm. If the magnetic field is perpendicular to the motion of the electrons, what is the magnitude of the magnetic field?

9. 10 points. A coil consists of 200 turns of wire. Each turn is a square of side 18 cm, and a uniform magnetic field directed perpendicular to the plane of the coil is turned on. If the field changes linearly (*i.e.,* uniformly) from 0 to 0.5 T in 0.80 s, w hat is the magnitude of the induced voltage in the coil while the field is changing?

10. 10 points. What is the maximum voltage induced across a coil of 4000 turns, average radius 12 cm, rotating at 30 revolutions per second in the earth's magnetic field, where the field is approximately 5×10^{-5} T?

11. 5 points. A superconducting solenoid designed for whole-body imaging by nuclear magnetic resonance is 0.9 m in diameter and 2.2 m long. The field at the center is 0.4 T. Estimate roughly the energy stored in the field of this coil, in Joules.