UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

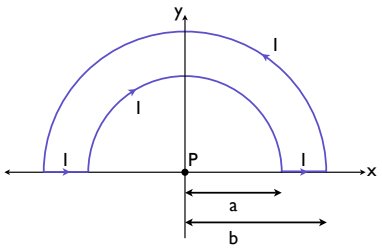
PH 102 / LeClair Summer II 2009

Problem Set 6: Magnetism

Instructions:

1. Answer all questions below. Show your work for full credit.
2. Due before the end of the day, 23 July 2009
3. Email: leclair.homework@gmail.com; hard copies: Gallalee 110 or Bevill 228.
4. You may collaborate, but everyone must turn in their own work

1. Find the magnetic field at point P due to the current distribution shown below. *Hint: Break the loop into segments, and use superposition.*



Problem 3: A current loop

2. You want to confine an electron of kinetic energy 3.0×10^4 eV by making it circle inside a solenoid of radius 0.1 m under the influence of the force exerted by the magnetic field. The solenoid has 12000 turns of wire per meter. What minimum current must you put through the wire if the electron is not to hit the wall of the solenoid?

3. Consider an electron orbiting a proton and maintained in a fixed circular path of radius $R = 5.29 \times 10^{-11}$ m by the Coulomb force. Treating the orbiting charge as a current loop, calculate the resulting torque when the system is in a magnetic field of 0.400 T directed perpendicular to the magnetic moment of the electron.

4. The electric field of a long, straight line of charge with λ coulombs per meter is

$$E = \frac{2k_e\lambda}{r}$$

where r is the distance from the wire. Suppose we move this line of charge parallel to itself at speed v. **(a)** The moving line of charge constitutes an electric current. What is the magnitude of this current? **(b)** What is the magnitude of the magnetic field produced by this current? **(c)** Show that the magnitude of the magnetic field is proportional to the magnitude of the electric field, and find the constant of proportionality.