UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

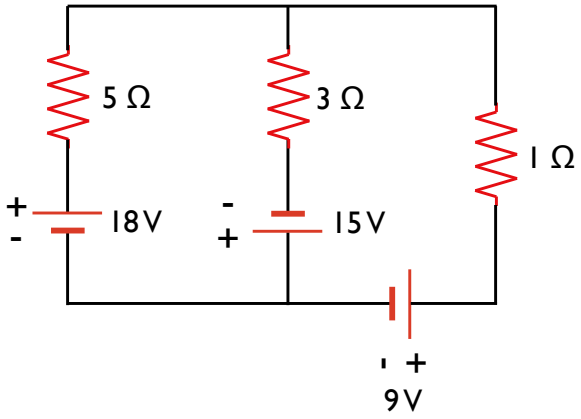
PH 102 / LeClair Summer II 2010

Problem Set 5: Misc

Instructions:

1. Answer all questions below. Show your work for full credit.
2. All problems are due Fri 23 July 2010 by the end of the day.
3. You may collaborate, but everyone must turn in their own work.

1. Find the current in the 1 Ω resistor in the circuit below.



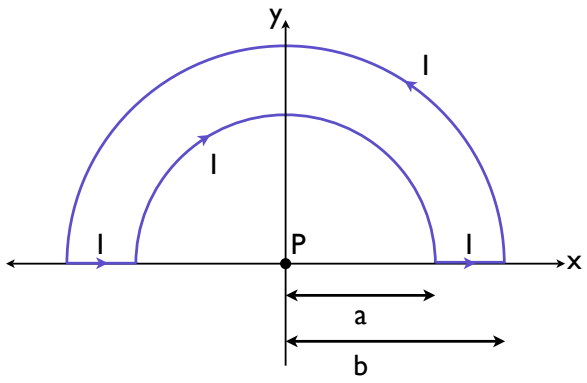
2. The electric field of a long, straight line of charge with λ coulombs per meter is

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

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.

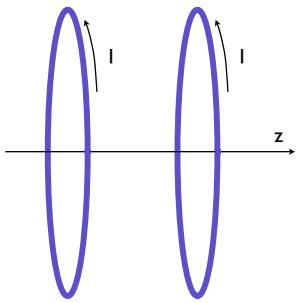
3. A 50 kV direct-current power line consists of two conductors 2 m apart. When this line is transmitting a power of 10 MW, how strong is the magnetic field halfway between the conductors?

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



5. A Helmholtz coil consists of two identical circular coils separated by a distance equal to their radius R, as shown at right. Each carries current I in the same direction. Find the field at any point along the axis between the two coils (the z axis in the figure). *Hint: The field from a single loop of radius* R *a distance* z *along the axis is:*

$$B = \frac{\mu_o I}{2} \frac{R^2}{(z^2 + R^2)^{3/2}} \quad \text{(single loop)}$$



Helmholtz Coil

6. Microphones transduce sound waves into voltages which vary in time (with the frequency of the voltage corresponding to the sound wave frequency, or pitch) and intensity (with the magnitude of the voltage corresponding to sound intensity). Describe how you could, using permanent magnets, wire, and other items, turn this voltage signal back into a sound wave (i.e., how can you construct a simple speaker?).