HW #7 Due March 4 at the beginning of class.

READING: This week we finish Ch. 20 and on Wednesday or Friday we will start Ch. 21. We are still two days behind the Course Schedule posted on Physerver. You should read any sections in Ch. 20 that you have not yet read. We are not skipping any sections although section 20-12 will only be alluded to briefly in lecture and in lab.

Please hand in the HW in two parts.

Part I: Ch. 20 Question #8, 15
Ch. 20 Problems #5, 16,29, 38, 41

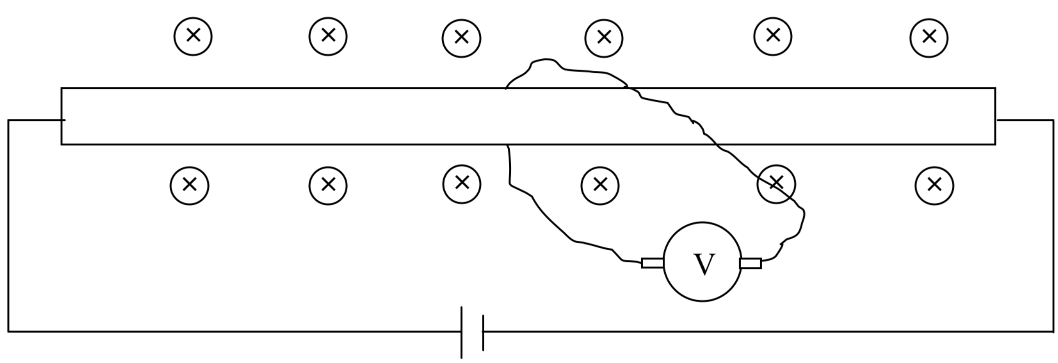
Part II: Ch. 20 Problem 43, 49, 50,
Additional Problems 1, 2, and 3

Additional Problems

1) A charged particle enters a uniform magnetic field that points from west to east.
   a) If the particle is positively charged and moving from south to north, is the magnetic force on the particle N, S, E, W, up, down, or non-existent?
   b) Same question, but now the particle is moving vertically down through the field, and it is negatively charged.
   c) Same question, but now the particle is moving from W to E, and it is negatively charged.

2) The Hall Effect –Determining whether positive or negative charge actually flows through a wire.

   Consider a strip of metal immersed in a magnetic field, as shown. A battery produces a current in the strip. The magnetic field is produced by a magnet that is not shown. A voltmeter is attached to the top and bottom of the strip.



   a) Does *conventional* current flow through the strip from left to right, or right to left?

   b) Suppose, for the sake of argument that the actual charges that move in the strip are positive. What will be the direction of the force on the moving charges, up or down?

c) The force on the moving positive charges will cause them to flow along one side of the metal strip, leaving the other side of the (neutral) strip negatively charged. The potential difference produced by this charge separation can be measured with the voltmeter. Suppose that the voltmeter reads positive if the right terminal of the meter is at a higher potential than the left side, and negative if the right side is at a lower potential. If the charges flowing in the strip are positive, will the voltmeter read a positive or a negative voltage?

d) Now suppose that negative charges move in the strip instead of positive charges. Based on the polarity of the battery, will the negative charges move from left to right or from right to left in the strip?

e) What will be the direction of the force on the negative charges, up or down (be careful!)?

f) This force will cause the negative charges to flow along one side of the strip leaving the other side positively charged. In this case, will the voltmeter read positive or negative?

g) When this experiment is performed, it is found that the voltmeter as connected reads a negative voltage, thus the charges flowing in the wire are negative. This experiment was first done by Edwin Hall around 1879 while doing work on his doctoral thesis at Johns Hopkins. Nowadays the experiment is turned around. By measuring the voltage one can determine the magnetic field strength, and a "Hall probe" is the most commonly used device for measuring magnetic field strength.

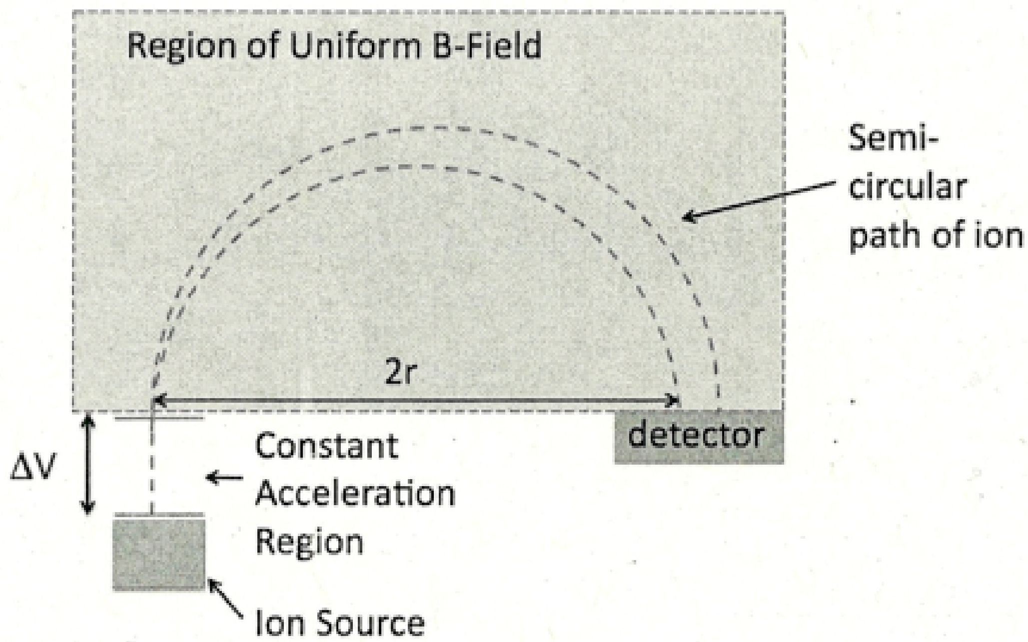
3) Instead of using a velocity selector like the mass spectrometer described in the text, the mass spectrometer shown in the diagram below accelerates ions with an electric field before they enter the uniform magnetic field. The accelerating electric field is produced in the usual way, by applying a potential difference, ΔV across two parallel plates.

a) Suppose that ions from a sample containing ^{12}C ($m = 2.00 \times 10^{-26}$ kg) and ^{14}C ($m = 2.34 \times 10^{-26}$ kg) are accelerated, from rest, through a voltage of 1.2 kV. Assume that the ions are singly ionized, i.e, they have lost a single electron so that they have a charge of $+e = +1.6 \times 10^{-19}$ C. Determine the speeds of the two different ions.

b) The moving ions follow semi-circular paths as shown. What is the direction of the magnetic field?

c) Suppose that the isotopes are separated by 1.5 mm at the detector. What is the magnetic field strength? This is a little tricky to think about, but the algebra is not that bad. Just set up the equations and follow your nose.

d) What is the radius of each isotope's orbit?


Region of Uniform B-Field
Semi-
circular
path of ion
2r
detector
ΔV
Constant
Acceleration
Region
Ion Source