Physics 370 **Homework 9** **Due Wednesday April 11, 2018**

Reading assignment: Griffiths pages 202-204 and 210-231.

Problem 1 In this problem, we will analyze the method used by J.J. Thomson in 1897 to measure the charge/mass ratio of the electron. A beam of electrons with charge q and mass m and velocity $\vec{\mathbf{v}} = v\hat{x}$ enters a region that has a uniform electric field $\vec{\mathbf{E}} = E\hat{y}$ and a uniform magnetic field $\vec{\mathbf{B}} = B\hat{z}$. Thus the magnetic and electric fields are at right angles to each other and to the beam.

(a) Suppose that E is adjusted so that there is no deflection of the beam by the fields. What is the relation between E, v, and B?

(b) Now the electric field is turned off, and the radius of curvature R of the beam of electrons within the region is measured. In terms of E, B, and R, what is q/m?

(c) Now suppose that B is 25 gauss, and $v = 0.02c$ where c is the speed of light. Then, using the actual numerical values of q and m for the electron, what is R in meters, and E in volts/meter, for this experiment? How would these change if B were 1 Tesla?

Problem 2 (a) Find the magnetic field at the center of a square loop of side a that carries a steady current I clockwise.

(b) Find the magnetic field at the center of a regular n-sided polygon of side a that carries a steady current I clockwise.

(c) Show that your formula for part (b) reduces to the field at the center of a circular loop of radius R, in the limit $n \to \infty$.

Problem 3 Find the force on the rectangular wire loop with sides b and c, placed as shown a distance a away from an infinite straight wire carrying a current I_1 to the right. The rectangular loop carries a current I_2 clockwise.