Name_____
Lab Partner(s):_____
Date Performed:_____
Date Due: February 11, 2014
Physics 111 Laboratory
Experiment #4
Magnetic Forces on an Electron Beam

Attach your fully labeled and captioned data tables for each part along with any fully labeled and captioned graphical representations of your data that you may have created to the end of this handout.

Honor Code Statement:

1. What assumptions do you need to make to perform this experiment?

2. To determine the how the magnetic force law depends on force and velocity, you made a plot of potential difference V and electron beam radius R. Starting from first principles (forces and/or work/energy), what is the *theoretical expression* for the relationship between V and R for a constant magnetic field B and how does this expression relate to the magnetic force law between force and velocity? This expression should relate all of the variables force F, electron velocity v, accelerating electric potential V and electron beam radius R. Explain your derivation in words and algebraically.

3. What is the *experimental relationship* between the magnetic force F and the velocity of the electron beam v for a constant magnetic field B using the experimental data of the accelerating potential difference V and the radius R of the electron beam? Does it support the theoretical relationship? Explain why or why not. What experimental evidence do you have to support your conclusion? What kind of curve did you use to fit the data of V and R? Why did you use this curve fit. What evidence can you use to support this choice?

4. What is the constant of proportionality from your graph of V and R? What is it supposed to be theoretically? What is your experimental value for the change-to-mass ratio of the electron? How does it compare to the accepted value? Explain any discrepancies between your experimental and theoretical values.

5. To determine the how the magnetic force law depends on force and magnetic field, you made a plot of current through the Helmholtz coils I and electron beam radius R. Starting from first principles (forces and/or work/energy), what is the *theoretical expression* for the relationship between I and R for a constant electron velocity v and how does this expression relate to the magnetic force law between force and magnetic field? This expression should relate all of the variables force F, magnetic field B, Helmholtz coil current I, and electron beam radius R. Explain your derivation in words and algebraically.

6. What is the *experimental relationship* between the magnetic force F and the magnetic field B for a constant electron speed v using the experimental data of the Helmholtz coil current I and the radius R of the electron beam? Does it support the theoretical relationship? Explain why or why not. What experimental evidence do you have to support your conclusion? What kind of curve did you use to fit the data of I and R? Why did you use this curve fit. What evidence can you use to support this choice?

7. What is the constant of proportionality from your graph of I and R? What is it supposed to be theoretically? What is your experimental value for the change-to-mass ratio of the electron? How does it compare to the accepted value? Explain any discrepancies between your experimental and theoretical values.

8. What is the *theoretical expression for the magnetic force law* in terms of the velocity v of the charges and the magnetic field B? What is your *expression for the experimental magnetic force law* using your results from questions 3 and 6? Comment on your result being sure to address any discrepancies between your theoretical and experimental results.

9. What is the average value for your charge-to-mass ratio for the electron? How does this compare to the accepted value? What are your sources of uncertainty?

10. What are your sources of uncertainty? Are these sources, as you would expect, given the assumptions you made at the beginning of the experiment? Are there things you would modify or change after having performed the experiment?