Physics Education
Electromagnetism: F=Bqv Part 2

The equipment required to verify the relationships embodied in the equation F=Bqv is expensive and not available to many schools. As such it is an ideal experiment for simulation. The software used for the following experiment is Focus on Fields. Please read on ……

This experiment was conducted using Focus on Fields software -

Aim: To determine the relationship between the force on a charged particle moving in a magnetic field and the velocity of the charge.

Theory:

When a charge moves in a magnetic field it experiences a force given by

$$F=Bqv \ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where B = Magnetic Field Strength
q = charge
v = velocity of the charge

This force is at right angles to the velocity and so the force on the charged particle moves the charge in a circular path and the equation of the force is

$$F = \frac{mv^2}{r} \ldots\ldots\ldots\ldots\ldots 2$$

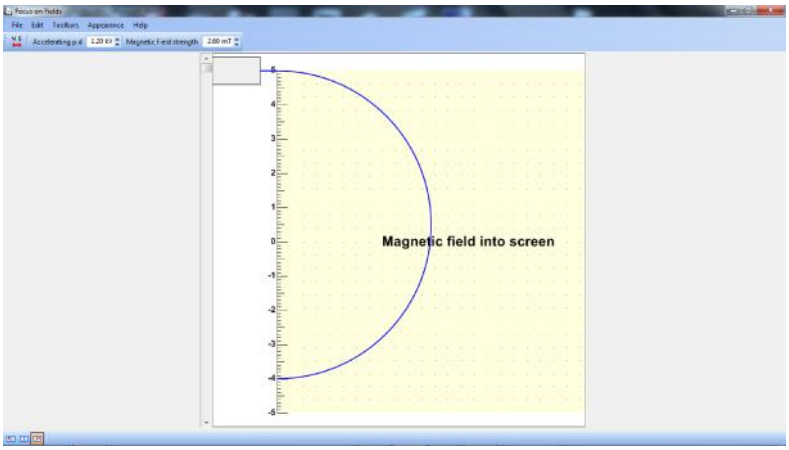
We can use this equation to determine the size of the force acting on the charged particle if we can find the velocity. For this experimental equipment we can find the velocity using the accelerating potential of the "electron gun". The electron gun accelerates a stationary charged particle to a velocity v using the equation below.

$$\frac{1}{2}mv^2 = qV \ldots\ldots\ldots\ldots\ldots 3$$

Where V = Accelerating Potential
q = charge
v = velocity of the charge
m= mass of the charge

Method :

1. Start the **Focus in Fields** software
2. Open the "**Deflection of electrons in a magnetic field"** option and examine the experiment screen as shown below



3. Starting with a magnetic field strength of 5 mT and an accelerating potential (V) of 1 kV record the radius of curvature of the path of the electron and record this value with V in the table below.
4. Using equation 3 above determine the velocity of the electron as it enters the field. Record this velocity in the table. ($q=1.6\times10^{-19}$ C and $m = 9.11 \times 10^{-31}$ kg)
5. Determine the force acting on the electron using equation 2 above and enter these values into the Force column in the table.
6. Repeat steps 4. and 5. for accelerating potentials in the range 1.0 kV to 3.0 kV and complete the table below.
7. Using the data in the table plot a graph of Force vs velocity.

Results

V	v	Radius	Force
kV	(ms^{-1})	(m)	(N)
1.0			
1.2			
1.4			
1.6			
1.8			
2.0			
2.2			
2.4			
2.6			
2.8			
3.0			

Discussion:

1. What is the shape of the line in your graph?
2. What does the slope of this graph represent?
3. Determine the value of this slope.
4. Use this value to find the charge of the electron.

Conclusion. Write a conclusion to this experiment ensuring that you address the Aim.