Deflection of Electrons in Presence of Electric and Magnetic Field

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1 Introduction

Here we'll try to inquire about the behavior of electrons when exposed to magnetic fields.

2 Mathematical Calculations and Theories

Let's consider a beam of particles with charge q mass m moving at velocity v through vaccum. If there is a presence of a uniform electric field $\vec{E}$ and uniform magnetic field $\vec{B}$, the force on each particle is given by Lorentz Force

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

2.1 Diagram

Before moving to the actual calculation, let us see the arrangement for the magnetic deflection of the charged particles.

2.2 Derivation

The magnetic force is constant and perpendicular to $\vec{u}$. The particles will move in a circular trajectory and it's radius can be found out by equating the magnetic force to the centripetal force needed to move in a circle of radius R.

$$qvB = \frac{mv^2}{R}$$

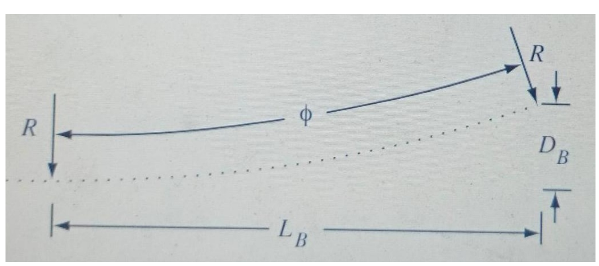

Figure 1: Arrangements for Magnetic Deflection of Charged Particles. Magnetic field is distributed uniforly over the entire distance L_B

$$R = \frac{mv}{qb}$$

The total deflection D_B can be written from the figure as

$$D_B = R - R\cos(\phi)$$

Because the angle is very small, we'll use small angle approximations to get our final results

$L_B \approx R\phi$ and $\cos(\phi) \approx 1 - \frac{\phi^2}{2}$

Substituting the values in total deflection D_B, we get

$$D_B = \left(\frac{q}{m}\right)\left(\frac{(L_B)^2}{2v}\right)B$$