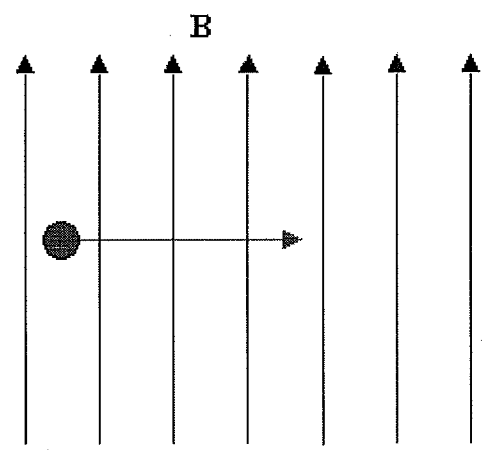
Physics 12

Section 20-4 Forces on an electric Charge Moving in a Magnetic Field

1. The force that a moving charge experiences while in a magnetic field is given by the following formula:

$$F = qvB\sin\theta$$

q is the moving charge (C)
v is the velocity of the charge (m/s)
B is the strength of the magnetic field (T)
Θ is the angle between the path of the charge and the B field



In most cases θ will be 90°

Example: A proton having a speed of 5.0×10^6 m/s in a magnetic field feels a force of 8.0×10^{-14}N towards the West when it moves vertically upwards. When moving horizontally in a Northerly direction, it feels zero force. What is the magnitude and direction of the magnetic field in this region?

$$F = qvB\sin\theta$$
$$F = qvB\sin 90$$
$$F = qvB$$

$$B = \frac{F}{qv}$$

$$B = \frac{8.0 \times 10^{-14} N}{1.6 \times 10^{-19} C \; 5.0 \times 10^{6} m/s}$$

$$B = 0.10 T$$

2. When a charge enters a uniform magnetic field, the charge experiences a force perpendicular to it motion; the resulting path is circular.

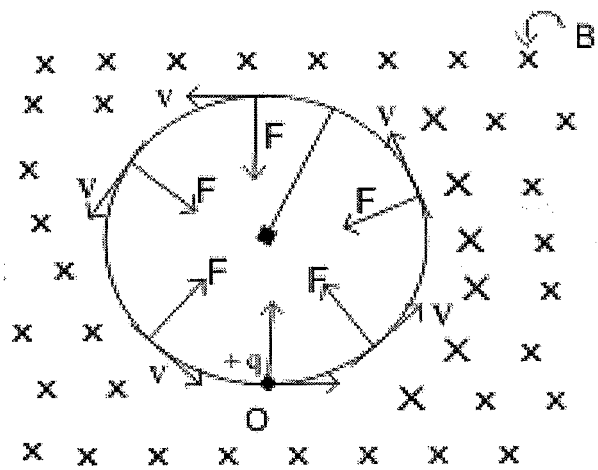


Figure 3. Motion of charged particle in uniform magnetic field

3. Using the second right hand rule shows us the direction of the force and in this case it is towards the centre.

4. The centre seeking force is constant and as a result orbits with uniform circular motion.

Example: An Electron travels at 2.0×10^{7}m/s in a plane perpendicular to a 0.010 T magnetic field. Determine the radius of curvature of the resulting path.

From Newton's second law F = ma

From uniform circular motion $F = \frac{mv^2}{r}$

$$\text{if } F = qvB$$

then

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

$$r = \frac{mv}{qB}$$

$$r = \frac{9.1 \times 10^{-31}\ \text{kg}\ 2.0 \times 10^{7}\ \text{m/s}}{1.6 \times 10^{-19} C\ 0.010 T}$$