It is clear from eqⁿ (2) that the force working on electron is constant and its direction is always perpendicular to the direction of motion of electron. The path of motion is circular.

Centripetal force $F_c = \frac{mv^2}{r}$

m → mass of electron

r → radius of circle

$$|F_c| = |F_L|$$

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

$$\therefore r = \frac{mv}{eB} \quad \text{--- (3)}$$

eqⁿ (3) → radius of electron motion path, circle and it is constant

Electron moving in clockwise direction. If particle is positively charged, it will move anticlockwise.

Because direction of $\vec{F_L} = q(\vec{v} \times \vec{B})$ will be opposite.

Time period of electron moving in circular path

$$T = \frac{2\pi r}{v} = \frac{2\pi(mv/eB)}{v}$$

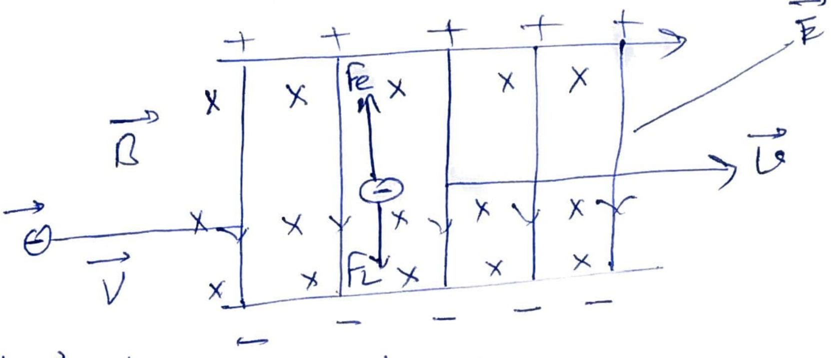
$$\therefore T = \frac{2\pi m}{eB} \quad \text{--- (4)}$$

Time period does not depend on its velocity, it depends on electron's mass, charge and magnetic field intensity.

Charged particle (or electron) with slow velocity moves in small circular path and fast moving electron moves in circular path of large radius → To maintain same T.

Motion of electron in Uniform Electric and Magnetic field in cross configuration

If uniform magnetic and electric fields acts perpendicular to each other, how particle will move?



$\vec{B}$ and $\vec{E}$ both perpendicular

If electron enters from left with velocity v, on any point two forces will act

(i) electric force $\vec{F_e} = (-) e\vec{E}$

(ii) magnetic force

(a) for electron $\vec{F_L} = (-) e(\vec{v} \times \vec{B})$

(b) for positive charged particle $\vec{F_L} = q(\vec{v} \times \vec{B})$ --- (i)

This force is opposite in direction of $\vec{F_e}$ and deflects the electron towards negatively charged plate. (and deflects positive charge towards positively charged plate)

If values of these two forces are equal, electron will move with velocity $\vec{v}$ from left to right without any deflection.

$$|F_L| = |F_e|$$

$$evB = eE \Rightarrow \therefore v = \frac{E}{B} \quad \text{--- (ii)}$$

If the velocity of charged particle is equal to ratio of electric field (E) and magnetic field (B) → then electron remains undeflected and moves with a constant velocity.

This arrangement is called → velocity selector. Only those charged particles which satisfy eqn (ii) will move forward, other particles will hit the charged plates and gets neutralized. This arrangement is used in Bain bridge mass spectrograph.

If electric field (E) and magnetic field (B) are parallel to each other, the charged particle will be deflected and its motion path will be parabolic. This arrangement is used in Thomson Parabola method for positive rays.

Motion of electron in Non-Uniform Electric field

If field is non-uniform → field lines are not parallel and also not equidistant, The motion of electron is studied by equipotential surface in this case.

Potential on each point of equipotential surface is same and force lines are perpendicular to it.

The acting force on moving electron on equi-potential surface will be normal to the equipotential surface.