Home Assignment -

1. A proton is accelerated through a potential difference v, subjected to a uniform magnetic field acting normal to the velocity of the proton. If the potential is doubled, how will the radius of the circular path described by the proton in the magnetic field change.

Ans The radius of the circular path by the proton in the magnetic field change can be describe as

$$r = \frac{1}{B}\sqrt{\frac{2mV}{q}}$$

b is the magnetic field.
V is the potential.

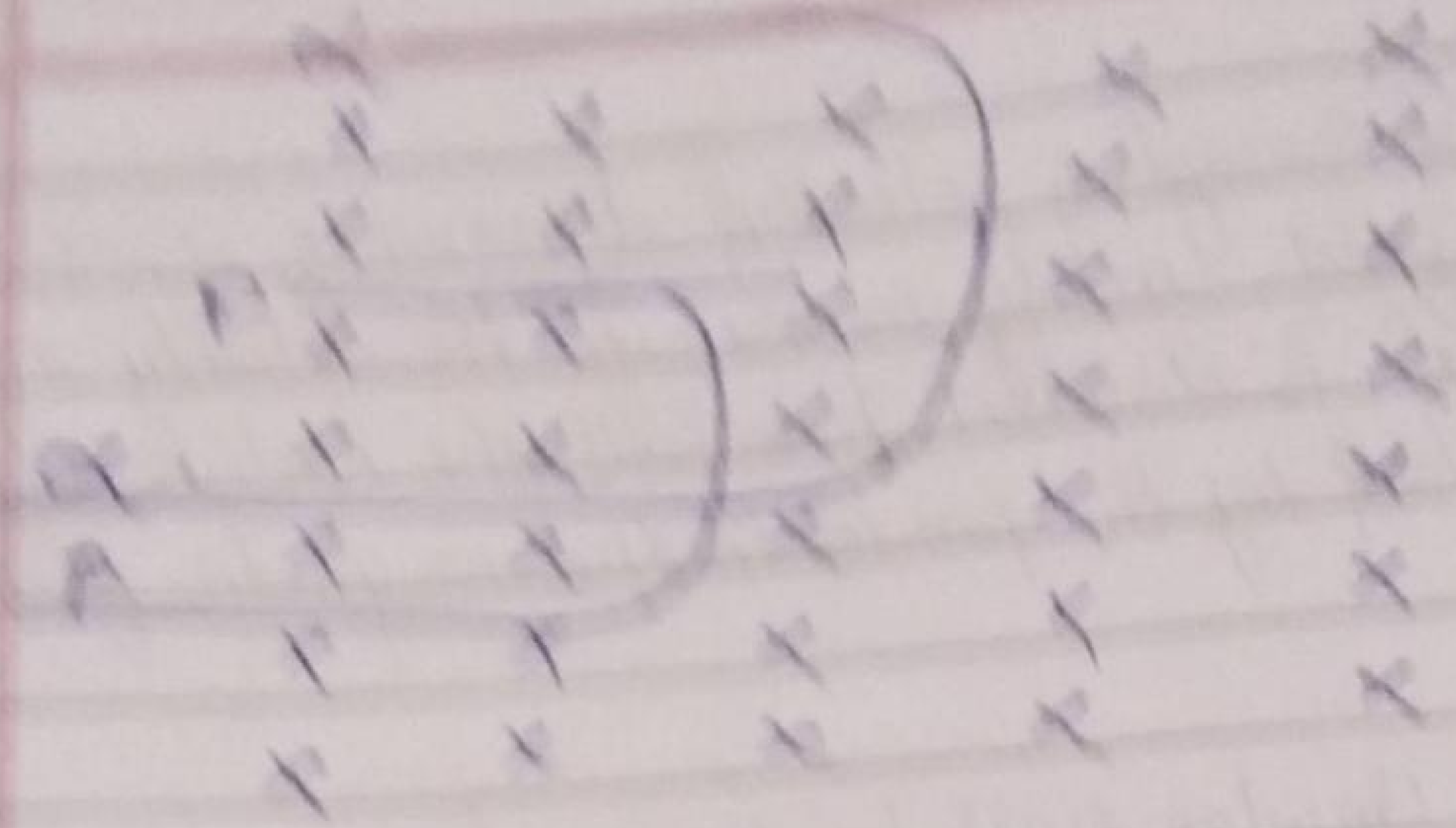
$r \propto \sqrt{V}$.

$$\frac{r'}{r} = \sqrt{\frac{2V}{V}} = \sqrt{2}.$$

$$r' = \sqrt{2}r$$

Q2. A deutron and a proton moving with the same speed enter the ~~sp~~ same magnetic field region at right angle to the direction of the field. show the trajectories followed by the two particles in the magnetic field. Find the ratio ~~and~~ of the radius of the circular paths which the two particles may describe.

Ans
$$r = \frac{mV}{qB}$$

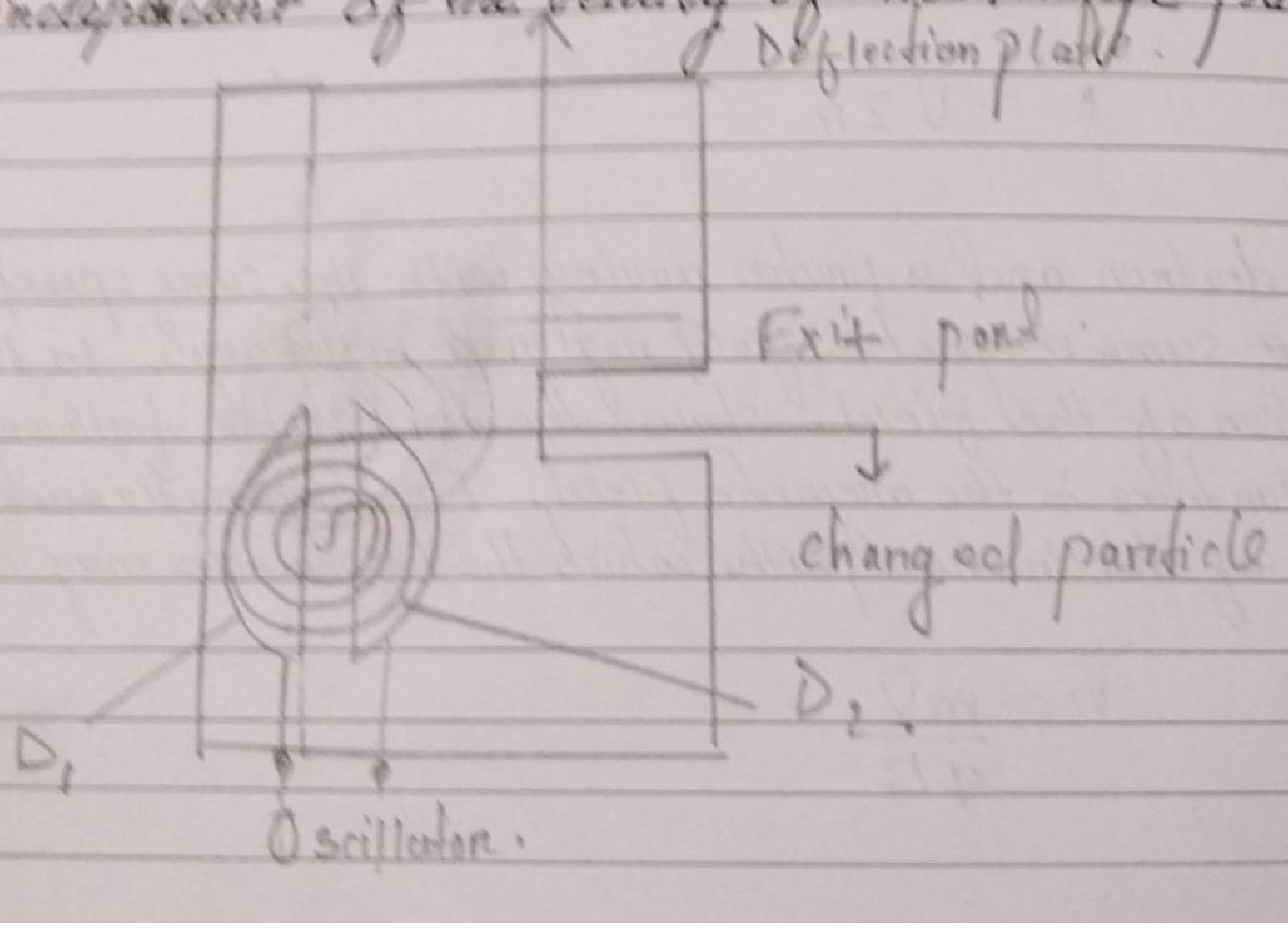


$$\frac{r_p}{r_\alpha} = \frac{(m/q)_p}{(m/q)_\alpha} = \frac{(m_p/e)}{(4m_p/2e)}$$

$$\frac{1}{2}.$$

1 : 2.

3. Draw a schematic sketch of the cyclotron. State its working principle. Show that the cyclotron frequency is independent of the velocity of the charged particle.



Working principle of Cyclotron :

The Cyclotron used crossed electric and magnetic field which increases the kinetic energy of a charged particle without changing its frequency of revolution.

$$F_c = F_m$$

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

$$\frac{v}{r} = \frac{qB}{m}.$$

$$\omega = \frac{qB}{m}$$

$$2\pi f = \frac{qB}{m}$$

$$f = \frac{qB}{2\pi m}.$$

The frequency is independent of velocity.

4. A α- particle and a proton are released from the Centre of the cyclotron and made ~~of~~ to accelerate.

a) Can both be accelerated at the same cyclotron frequency Give reason to justify ~~for~~ your answer.

b) When they are accelerate in turn, which of the two will have higher velocity at the exist slit of the dees ?

Ans (i) let us consider:

Mass of proton = m

Charge of proton = q.

Mass of alpha particle = 4m.

Charge of alpha particle = 2q.

Cyclotron frequency $v = \frac{Bq}{2\pi m}$

$$v \propto \frac{q}{m}.$$

For proton: frequency $v_p \propto \frac{q}{m}$.

For α-particle: frequency $v_a \propto \frac{2q}{4m}$

$$v_a \propto \frac{q}{2m}.$$

Thus particle will not accelerate with same cyclotron frequency. The frequency of proton is twice than the frequency of α-particle.

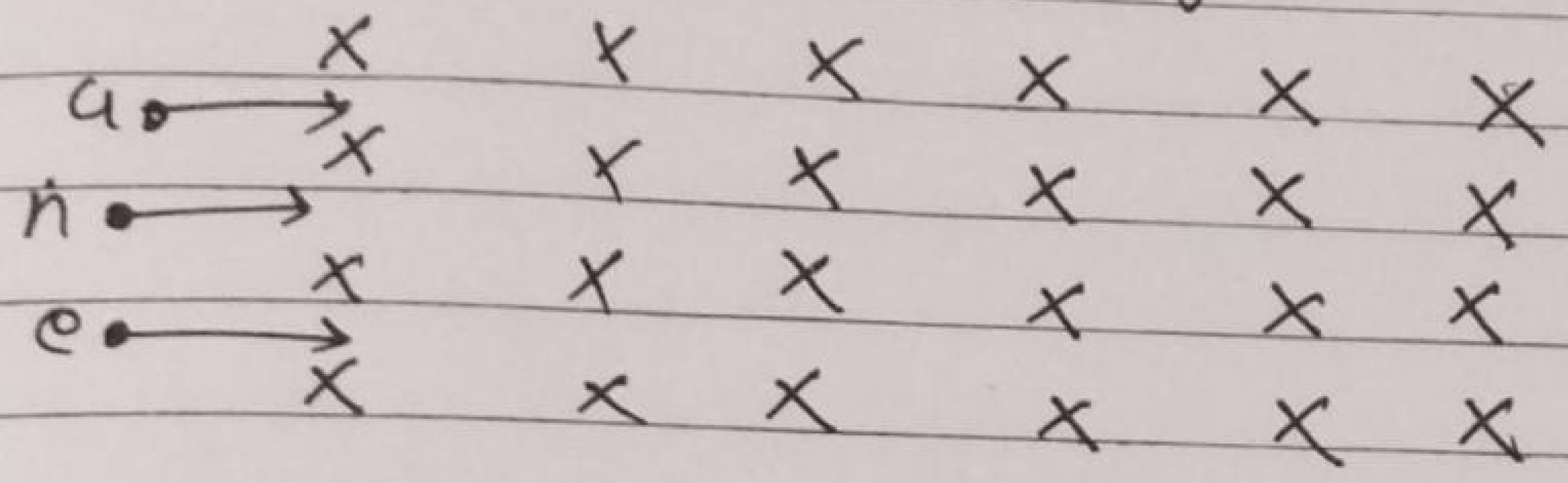
ii) Velocity $V = \frac{Bqr}{m}$ $\quad v \propto \frac{q}{m}$.

For proton: Velocity $v_p \propto \frac{q}{m}$.

For α-particle : Velocity $v_a \propto \frac{2q}{4m}$ $V_a \propto \frac{q}{2m}$.

Thus particle will not exit the dees with same velocity. The velocity of proton is twice than the velocity of α-particle.

5 A neutron, an electron and an alpha particle moving with equal velocities, enter a uniform magnetic field going to the plane of the paper as shown in the figure. Trace their paths in the field and justify your answer.



α-particle will trace circular path in clockwise direction its deviation will be in the direction $(\vec{V} \times \vec{B})$.
i.e perpendicular to the velocity of particle. neutron will pass without any deviation as magnetic field does not exert neutral particle.

Electron will trace circular path in anticlockwise direction as deviation will be in the direction opposite to $(\vec{V} \times \vec{B})$ with a smaller radius due to large charge / mass ratio as $r = \frac{mv}{qB}$.