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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 difference 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 d can be described as :-

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

where, B = magnetic field
V = potential difference

$$\therefore \quad r \propto \sqrt{V}$$

let r be the radius when the potential difference is V and r' be the radius when the potential difference is 2V.

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

2. A deutron and a proton moving with the same speed enter the same magnetic field region at right angles to the direction of the field. Show the trajectories

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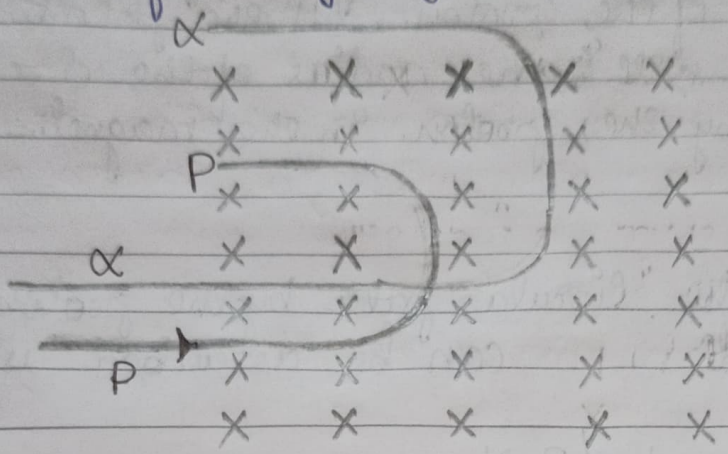
followed by the two particles in the magnetic field. Find the ratio of radii of the circular paths

ans Radius of charged particle in magnetic field.



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

$$\propto \frac{m}{q} \text{ for same } v \text{ and } B.$$

$$\frac{r_p}{r_\alpha} = \frac{(m/q)_p}{(m/q)_\alpha} = \frac{(m_p/e)}{(4m_p/2e)} = 1/2$$

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.

ans Principle :- A charged particle can be accelerated to high speeds (energies) by passing it through electric field many number of times and at the same time magnetic field makes the charged

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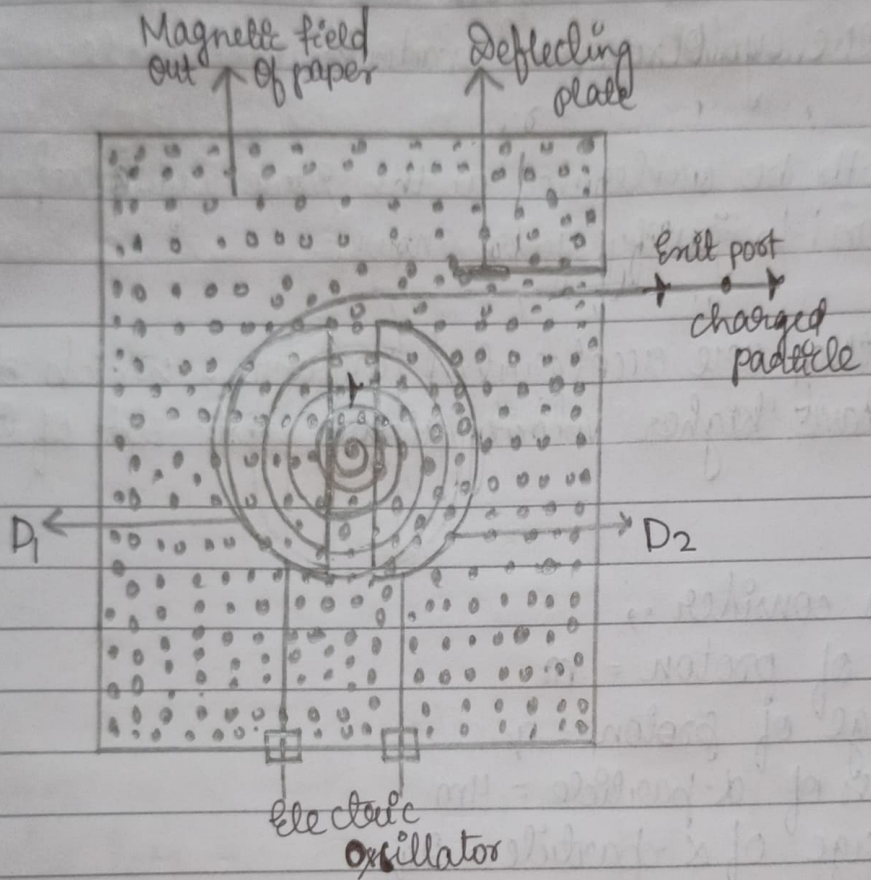
particle to move in a circular path.

The schematic sketch of cyclotron is as shown below:



$$v = \frac{qBr}{m}$$

Period of revolution, $T = \frac{2\pi r}{v}$

$$= \frac{2\pi rm}{qBr}$$

$$\Rightarrow T = \frac{2\pi m}{qB}, \quad v = 1/T = \frac{qB}{2\pi m}$$

Centripetal force, needed by the charged particle to mov

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in a circular track, is provided by the magnetic field.

4. An α-particle and a proton are released from the centre of the cyclotron and made to accelerate.

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

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

Ans (a) Let us consider.,

Mass of proton = m

charge of proton = q

Mass of α-particle = 4m

charge of α-particle = 2q

Cyclotron frequency.,

$$\nu = \frac{Bq}{2\pi m} \Rightarrow \nu \propto q/m$$

For proton.,

Frequency, $\nu_p \propto q/m$

For α-particle.,

Frequency, $\nu_\alpha \propto \frac{2q}{4m}$ or $\nu_\alpha \propto q/2m$

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

(b) Velocity, $v = \frac{Bqr}{m} \Rightarrow v \propto q/m$

For proton ..,

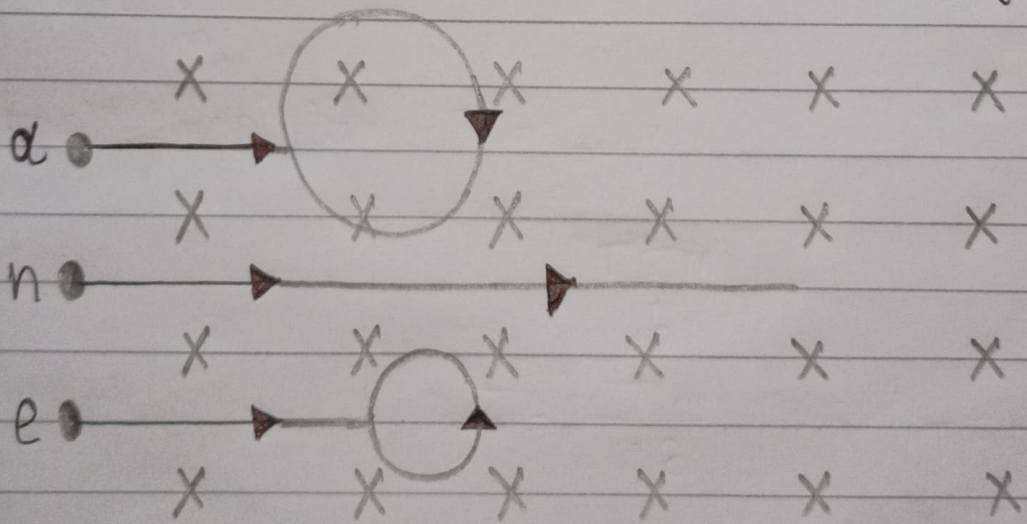
Velocity, $v_p \propto q/m$

For α-particle ..,

Velocity, $v_\alpha \propto \frac{2q}{4m}$ or $v_\alpha \propto q/2m$

Thus particles 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 α-particle moving with equal velocities, enter a uniform magnetic field going into the plane of the paper as shown in figure. Trace their paths in the field and justify your answer.



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ans = A particle will trace circular path in clockwise dir^{n} as it's 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 doesn't exert neutral particle. Electron will trace circular path in anticlockwise dir^{n} as its deviation will be in the dir^{n} opposite to $(\vec{v} \times \vec{B})$ with a smaller radius due to large charge/mass ratio as $r = mv/qB$.

Alpha-particle will move in the clockwise dir^{n}.