classmate

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Home Assignment

9th July

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?

⇒ V = Potential difference
angle between motion of B → 90°

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

$R_1 = \frac{mv}{qB}$

$R_2 = \left(\frac{m}{qB}\right)v_2$

$R_2 = \left(\frac{m}{qB}\right)v\sqrt{2}$

$\frac{R_1}{R_2} = \frac{1}{\sqrt{2}}$

velocity

$\frac{1}{2}mv^2 = qV$ → Potential diff

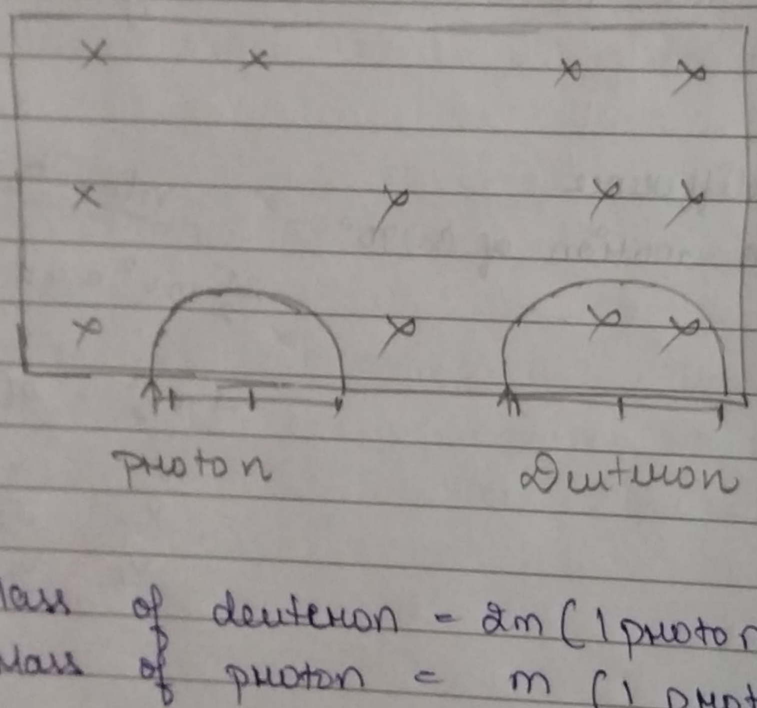
$\frac{1}{2}mv_2^2 = q(2V)$

$\frac{v_1}{v_2} = \frac{1}{\sqrt{2}}$

$v_2 = v_1\sqrt{2}$

2) A deuteron 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 followed by the two particles in the magnetic field. Find the ratio of the radii of the circular paths which the two particles may describe.

⇒



Mass of deuteron = 2m (1 proton + 1 neutron)
Mass of proton = m (1 proton)

$\therefore R(\text{proton}) = \frac{mv}{qB}$

$R(\text{deuteron}) = \frac{2m \times v}{qB}$

$\therefore \text{Ratio} \left(\frac{1\,\text{proton}}{\text{deuteron}}\right) = \frac{1}{2}$

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?

⇒ (a) let us consider: Mass of proton = m, Charge of proton = q. Mass of alpha particle = 4m

Charge of alpha particle - 2q

Cyclotron frequency,

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

For proton : Frequency, $\nu_p \propto \frac{q}{m}$

For alpha particle : Frequency,

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

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

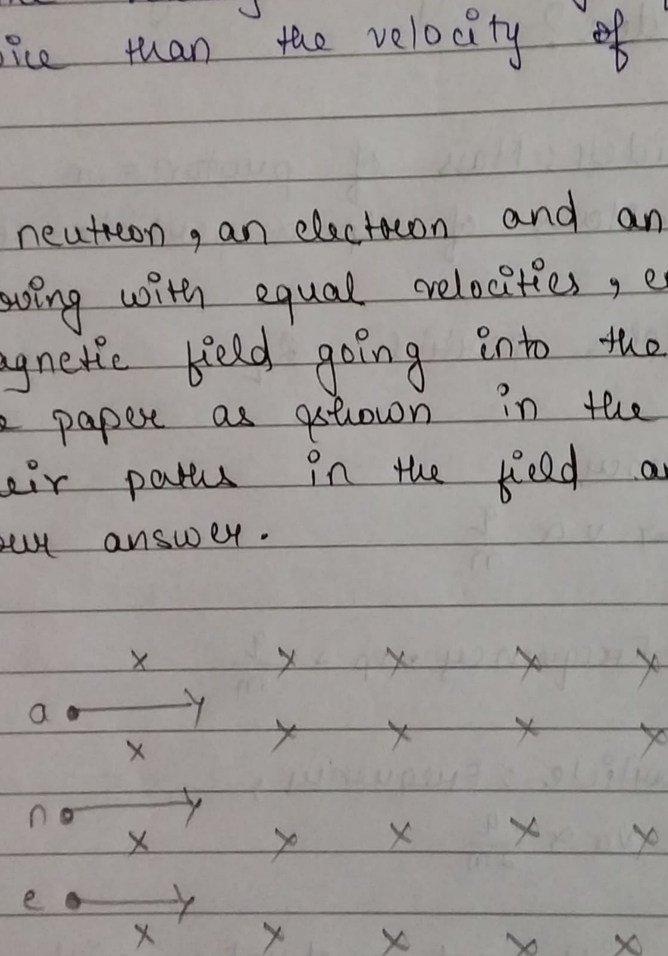
(b) Velocity, $v = \frac{Bqr}{m} \Rightarrow v \propto \frac{q}{m}$

for proton: Velocity, $v_p \propto \frac{q}{m}$

For alpha particle: Velocity,
$v_a \propto \frac{2q}{4m}$ or $v_a \propto \frac{q}{2m}$

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

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



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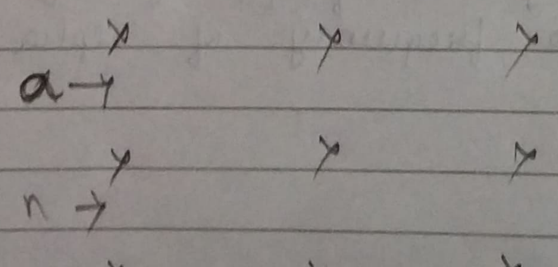

Radius of particle $\Rightarrow r = \frac{mv}{qB}$

Here, velocity and magnetic field are same,

so, $r \propto \frac{m}{q}$

$a = 4 \times$ mass of proton
$= 2 \times$ change of proton

$$R_a = \frac{4 \times mp}{2 \times p} = 2 \times \frac{mp}{p}$$

R_n = Here. charge on neutron is zero.
so, path is st-line No deflection

$$R_p = \frac{mp}{p}$$

$\boxed{R_a = 2 \times R_p}$ and neutron is straight line.