Home Assignment - 5

1. It is given that a proton is accelerated through a potential difference V, the direction of magnetic field is normal to the velocity of proton i.e. the potential energy is converted to kinetic energy.

$\Rightarrow \frac{1}{2} m_p v^2 = eV.$

$\Rightarrow v = \sqrt{\frac{2eV}{m_p}}$

If the potential difference is doubled;

$V' = 2V.$

$\therefore v = \sqrt{\frac{2e \times 2V}{m_p}}$

$\Rightarrow v' = \sqrt{2} v$

Radius of the circular path will be,

$qvB = \frac{m_p v^2}{r}.$

$\Rightarrow r = \frac{m_p v}{qB}$

$\Rightarrow r' = \frac{m_p \times \sqrt{2} v}{qB}$

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

2. Let Mass of ~~deutron~~ Proton = m

then mass of duetron (proton + neutron) = m + m = 2m.

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

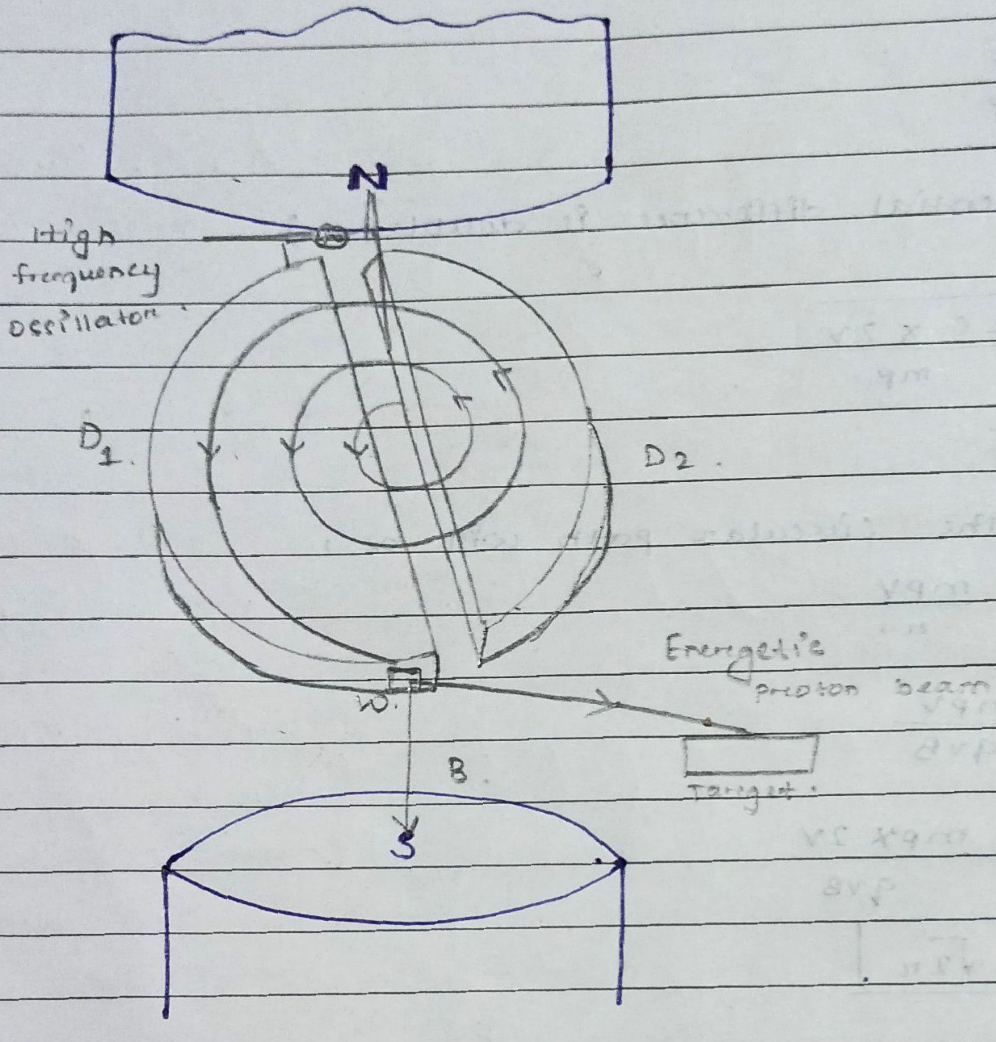
$\therefore$ Radius of Proton $= \frac{mv}{qB}$

and radius of duetron $= \frac{2m \times v}{qB}$

So, Ratio of $\frac{\text{Proton}}{\text{Deutron}} = \dfrac{\frac{mV}{qB}}{\frac{2mV}{qB}} = \frac{1}{2}$

Hence, the required ratio is 1 : 2.

3.



Principle :-

A charged particle can be accelerated to very high energies by making it pass through a moderate electric field a number of times. This can be done with the help of a perpendicular magnetic field which throws the charged particle into a circular motion, the frequency of which does not depend on the speed of the particle and the radius of the circular orbit.

Now, $F_e = F_m$

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

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

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

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

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

The frequency is independent of velocity.

4. i) Let us consider, Mass of proton = m,

charge of proton = q , ~~[illegible]~~

Mass of alpha particle = 4m

Charge of alpha particle = 2q.

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

$$\Rightarrow f \propto \frac{q}{m}.$$

For alpha particle, frequency $(F_a) \propto \frac{2q}{4m} = \frac{q}{2m}.$

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

ii) Velocity $= \frac{Bqr}{m} \Rightarrow v \propto \frac{q}{m}$

For proton, velocity, $V_p \propto \frac{q}{m}$.

For alpha particle, velocity, $V_\alpha \propto \frac{2q}{4m}$.

$\Rightarrow V_\alpha \propto \frac{q}{2m}$.

Hence, particles will not exit the Dees with same velocity. The velocity of proton is twice than the velocity of alpha particle.

5. As we know that a charged particle will experience a force when it enters a magnetic field. The magnetic field will move the charged particle in a circular path, as the force is perpendicular to the velocity of particle.

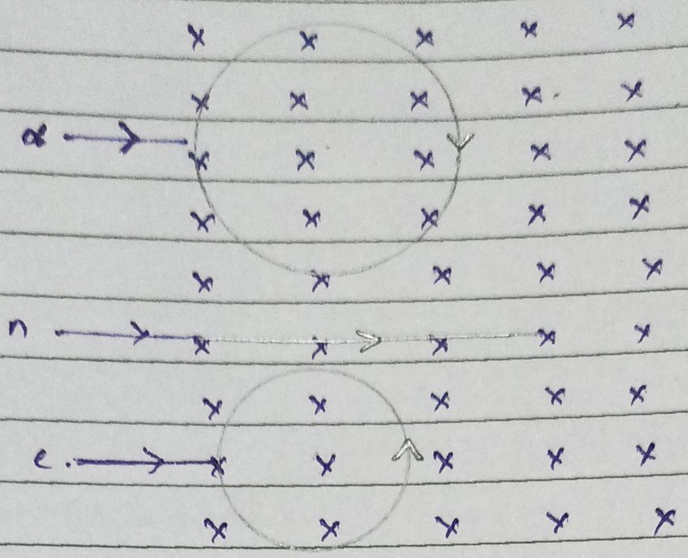
So, $r = \frac{mv}{Bq}$

$\Rightarrow r \propto \frac{m}{q}$.

→ The neutron will move along the straight line as it has no charge.

→ The electron will describe a circle of radius smaller than alpha particle in anticlockwise direction.

→. The alpha particle will move in the clockwise direction inscribing a circle.


α
n
e