Cyclotron

Home Assignment

1. Due to magnetic force proton moves in circular path. So, centripetal force = magnetic force

$\Rightarrow \frac{mv^2}{r} = Bqv$

$\Rightarrow r = \frac{mv}{qB}$ —— ①

we also know, kinetic energy of proton = Potential energy of proton

$\Rightarrow \frac{1}{2}mv^2 = qV$

$\Rightarrow (mv) = \sqrt{(2qVm)}$

Putting it in equ^n ① we get

$m = \sqrt{2qVm}/qB$

$\Rightarrow r = \frac{1}{B} \times \sqrt{2Vm/q}$

$\Rightarrow r \propto \frac{1}{\sqrt{V}}$

Hence, radius of path is inversely proportional to square root of potential difference.

Now if the potential difference is doubled then radius of the path becomes $\frac{1}{\sqrt{2}}$ times of the initial

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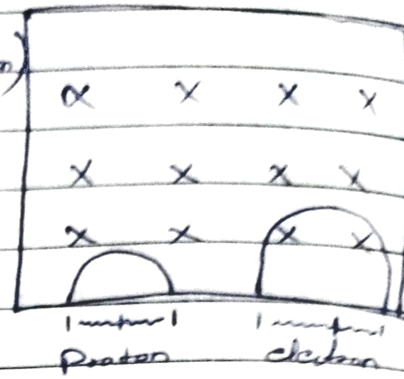
Mass of electron = 2m (1 proton + 1 neutron)



Mass of proton = m (1 proton)

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

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

$\text{Ratio}\left(\frac{\text{Proton}}{\text{electron}}\right) = \frac{1}{2}$

4-(i) Let mass of proton = m

charge of proton = q, mass of alpha particle = 4m

charge of alpha particle = 2q

cyclotron frequence, $v = \frac{Bq}{2\pi m} \Rightarrow v \propto \frac{q}{m}$

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

For alpha particle: Frequency,

$v_a \propto \frac{2q}{4m}$ or $v_a \propto \frac{q}{2m}$

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

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

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

For alpha particle: velocity,

$$V_a \propto \frac{2q}{4m} \text{ or } V_a \propto \frac{q}{2m}$$

Thus particles will not exit the with same velocity

The velocity is twice than the velocity of alpha particle

5- A charged particle experience a force when it enters the magnetic field. Due to the presence of magnetic field, the charged particle will move in a circular path. This is become the force is perpendicular to the velocity of the charged particle.

Radius of the circular path in which the charged particle is moving is given by,

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

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

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B and V are constant
we can write,

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

Since the neutron has no charge, it will move along a straight line.

The electron will follow a circular path which has a radius smaller than that of the alpha particle is more than that of the electron.