12th July

Cyclotron

ch-4 : moving charges and magnetism

Home Assignment.

Ans 1) Potential Energy of proton is converted into K.E.

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

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

If the potential difference is doubled.

$$V' = 2V$$

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

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

now radius of the circular path will be as we know that $R \propto \sqrt{v}$

The radius will be $\sqrt{2}$ times.

$$qvB = \frac{m_p v^2}{R}$$

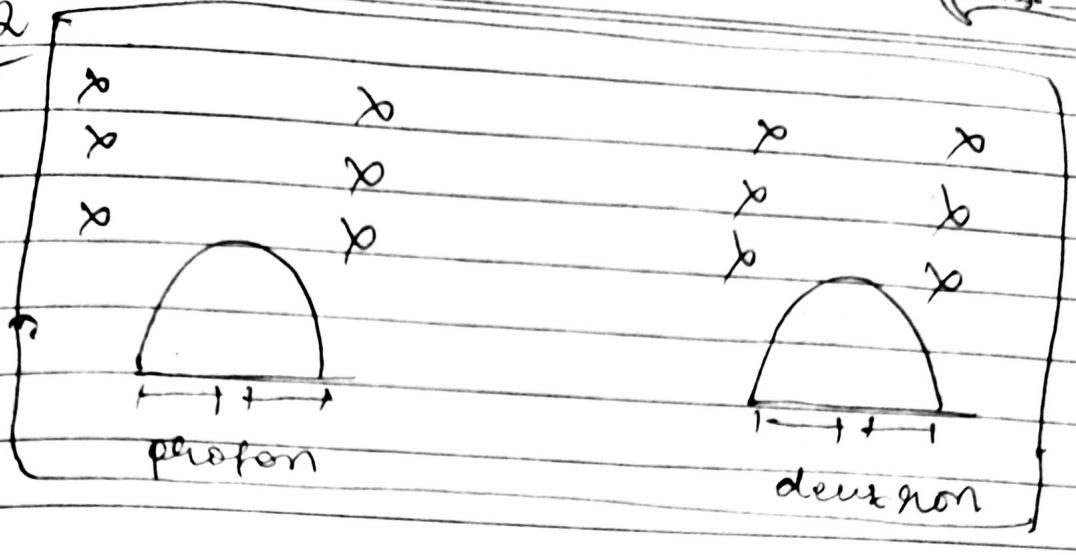
$$R = \frac{m_p v}{qvB}$$

$$R' = \frac{m_p (2v)}{qvB}$$

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

Thus the radius of the circular path described by the proton is $R' = \sqrt{2}R$

Ans 2



Mass of deutron = 2m (1 Proton + 1 neutron)

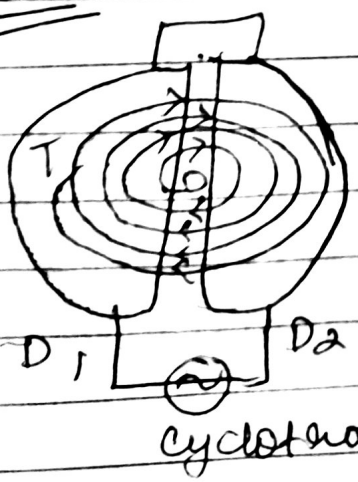
Mass of proton = m (1 proton)

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

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

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

Ans 3



cyclotron

Working principle of cyclotron:

The cyclotron uses crossed electric and magnetic fields which increases the K.E of a charged particle without changing its frequency of revolution.

such that,

$$F_c = F_m$$

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

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

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

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

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

∴ The frequency is independent of velocity.

Ans

(a) α particle

charge = 2q

mass = 4m

Cyclotron $f = \frac{B2q}{2\pi m}$

$$f \propto \frac{2q}{4m} \propto \frac{q}{2m}$$

Proton

Charge = q

mass = m

$$f' = \frac{Bq}{2\pi m}$$

$$f' \propto \frac{q}{m}$$

∴ This particle will not accelerate with same cyclotron frequency. The frequency of proton is twice than frequency of alpha particle.

(b) $v = \frac{Bqr}{m}$ ∴ $v \propto \frac{q}{m}$

$$\frac{v_\alpha}{v_p} = \frac{2q \times m}{4m \times q} = \frac{1}{2}$$

$$\boxed{v_\alpha = \frac{v_p}{2}}$$

5 Ans

A particle will trace circular path in clockwise direction as it's deviation will be in the direction.

$(\vec{V} \times \vec{B})$

that is 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 its deviation will be in the direction opposite to $(\vec{V} \times \vec{B})$ with a smaller radius due to large charge/mass ratio as $r = mv/qB$.