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Home Assignment

1) v = potential difference
Angle between motion $\theta = 90^\circ$

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

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

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

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

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

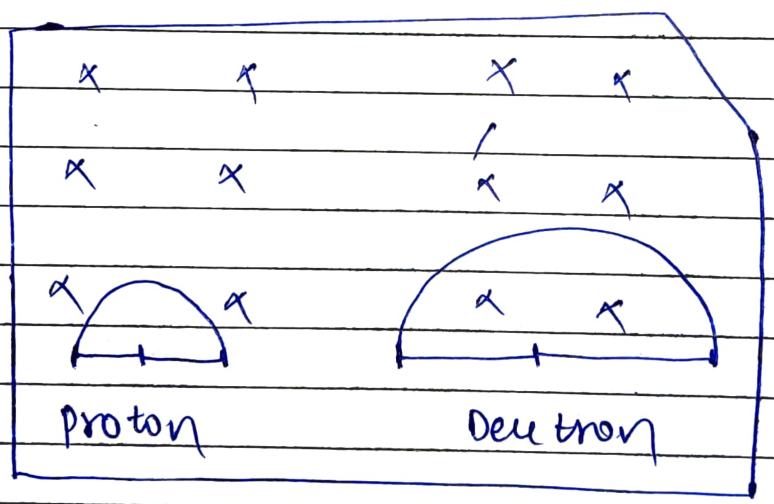
$$\frac{1}{2}mv^2 = qv$$

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

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

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

2)



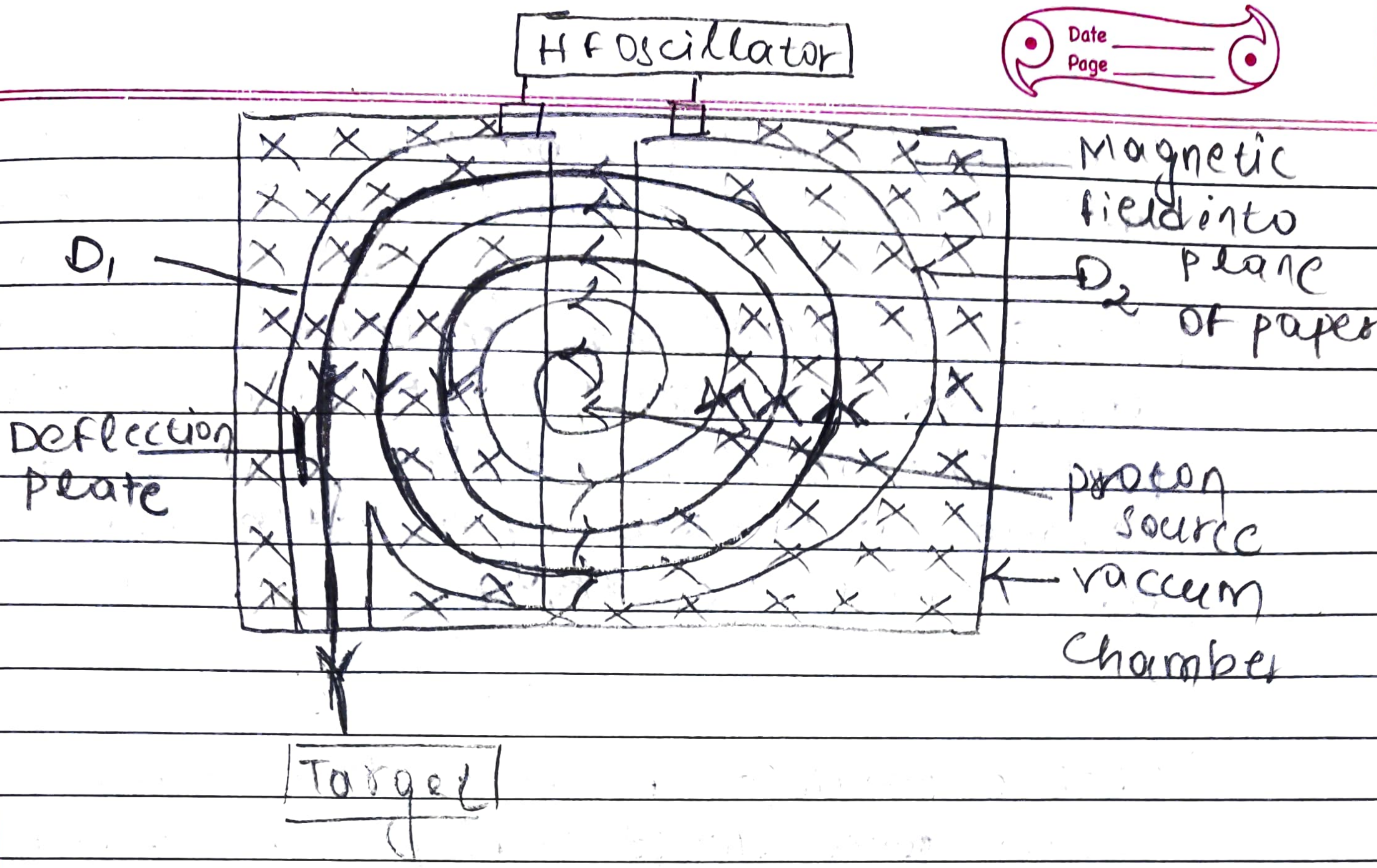
Mass of deuctron = 2m (1 proton + 1 neutron)
Mass of proton = m (1 proton)

$$R\,(\text{protron})\ \frac{mv}{qB}$$

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

$$\text{Ratio}\ \frac{\text{proton}}{\text{deutron}} = 1/2$$

3)



→ working principle of cyclotron.

i) suppose a positive ion, say a proton, eterer gap between the two dees and find dee D_1 to be negative. It gets accleatated toward ~~dee~~ dee D_1. As it enter the dee D_1, it ~~do~~ does experiance any electric field due to shielding effect of the matallic dee.

ii) The perpendicular magnetic field throws it into a circular path. At the instant the proton come out of dee D_1, it find dee D_1 ~~positive~~ positive and dee D_2 negative. It get accelatarated toward dee D_2.

iii) Thus if the frequency of the appiled voltage is kept exactly the same as the frequency of revolution of the proton, then every time the proton reaches the gap between the two dees, the electric field is reversed and proton receives a push and finally it acquires very high energy.

iv) This is called the cycloton's resonace condition. The proton follows a spiral path. The accelerated proton is ejacted through a window by a deflecting voltage and hits the target.

→ Let a particle of charge q and mass m enter ~~[illegible]~~ a region of magnetic field $\vec{B}$ with a velocity $\vec{v}$, normal to the field $\vec{B}$. The particle follows a circular path, the necessary centripal force being provided by the magnetic field.

∴ Magnetic force on charge q = centripetal force on charge q

or $qvB \sin 90° = \frac{mv^2}{r}$ or $r = \frac{mv}{qB}$

period of revolution of the charge particle is given by

$$T = \frac{2\pi r}{v} = \frac{2\pi}{v} \cdot \frac{mv}{qB} = \frac{2\pi r}{qB}$$

The frequency of revolution of the particle will be $f_c = \frac{1}{T} = \frac{qB}{2\pi m}$

Hence, this frequency is independent of both the velocity of the particle and the radius of the orbit and is called cyclotron frequency.

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4) i) As cyclotron frequency depends on both charge and mass of ion to be accelerated it is obvious the an α particle and a proton can not be accelerated at the same cycloton frequency.

ii) As, $r = \frac{mv}{qB}$

Hence, at the silt of the dees of a cycloton $v = \frac{qBR}{m}$

As $\left(\frac{q}{m}\right)_{proton} > \left(\frac{q}{m}\right)_{\alpha\text{-particle}}$, the proton will have higher velocity than alpha particle.

5) A particle will trace circular path in clockwise direction as its 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 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 $r = mv/qB$