Date ______ Page ______

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 eqn (1), we get,

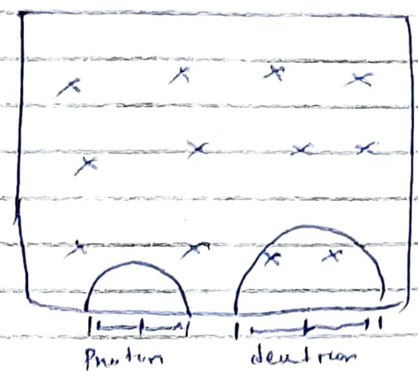
$r = \sqrt{2qVm}/qB$

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

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

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.

2.



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

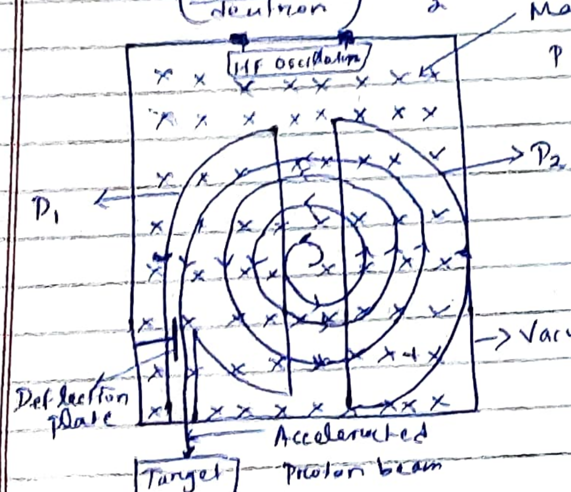
Mass of proton = m (1 proton)

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

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

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

3.



4.(i) Let mass of proton = m,

Charge of proton = q, Mass of ~~proton~~ 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,

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

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

(ii) 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 is twice than the velocity of alpha particle.

Date
Page

5. A changed particle experiences a force when it enters the magnetic field. Due to the presence of magnetic field, the changed particle will move in a circular path. This is because the force is perpendicular to the velocity of the changed particle.

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

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

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

B and v are constant.
we can write,

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

Since the neutron has no change, 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.
Therefore, the electron will move in the clockwise direction and the electron will move in the anticlockwise direction as per the Right Hand Rule.