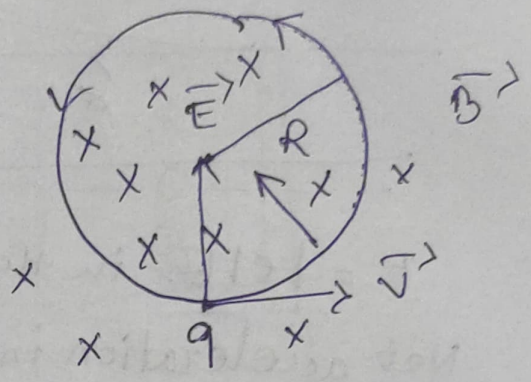
$$\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$$

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

$$\Rightarrow \boxed{R = \frac{mv}{qB}}$$

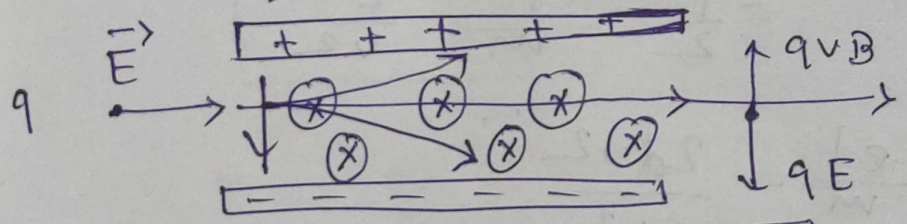


$$\omega = \frac{v}{R} = \frac{qB}{m}$$

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

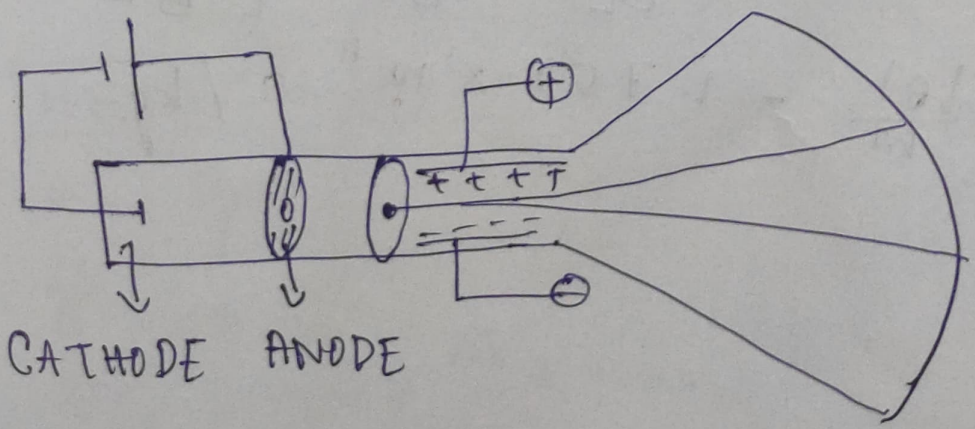
CYCLOTRON FREQUENCY

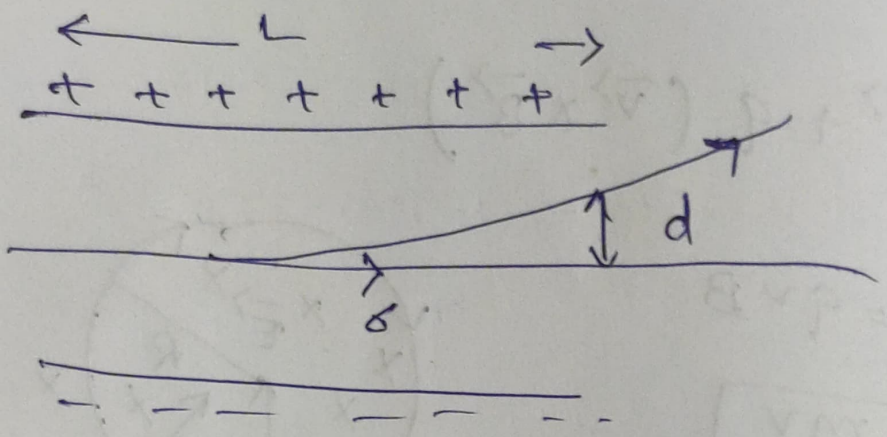
VELOCITY SELECTOR



$$qE = qvB \Rightarrow \boxed{v = \frac{E}{B}}$$

Joseph John Thomson (J. J. Thomson)





$F = |e|E$ in the upward direction

Net acceleration in upward direction $= \frac{|e|E}{m}$

Time taken ~~for~~ to propagate a length L

$= \frac{L}{v}$, $d = \frac{1}{2}at^2$

$= \frac{1}{2} \frac{|e|E}{m} \frac{L^2}{v^2}$

$\Rightarrow \frac{|e|}{m} = \frac{2dv^2}{EL^2}$

$\Rightarrow v = \frac{E}{B}$

$\Rightarrow \frac{|e|}{m} = \frac{2d}{EL^2} \cdot \frac{E^2}{B^2} = \frac{2dE}{L^2B^2}$

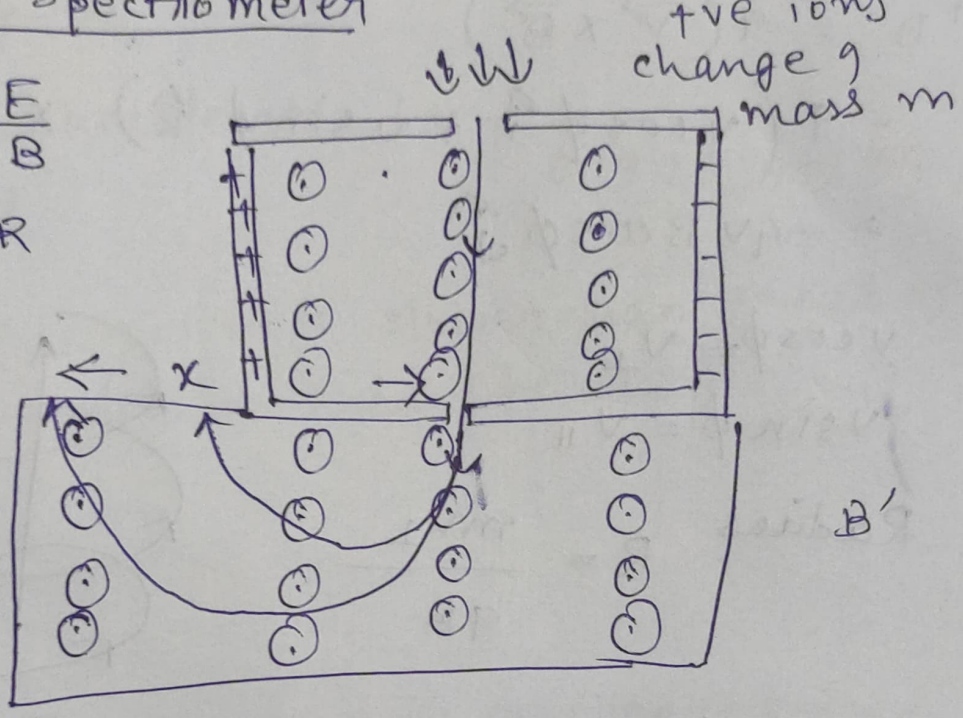
$\frac{|e|}{m} = 1.759 \times 10^{11}$ C/kg

Mass Spectrometer

$V = \frac{E}{B}$

$x = 2R$

$R = \frac{mV}{qB'}$



$$\therefore \quad x = \frac{2mV}{qB'}$$

$$x = \frac{2mE}{qBB'}$$

$q = |e|$

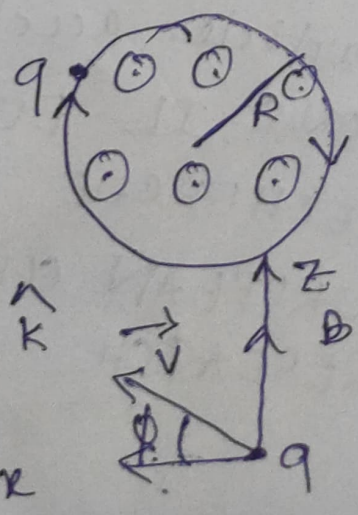
$$m = \frac{|e| B B' x}{2E}$$

HELICAL PATH

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

$\vec{B} = B\hat{k}$

$\vec{v} = v\cos\phi\,\hat{i} + v\sin\phi\,\hat{k}$



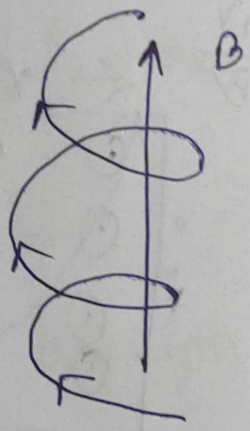
$$\vec{F}_B = q(\vec{v} \times \vec{B})$$

$$= q\left(v\cos\phi\,\hat{i} + v\sin\phi\,\hat{k}\right) \times B\,\hat{k}$$

$$= -qvB\cos\phi\,\hat{j}$$

$v\cos\phi = v_\perp$

$v\sin\phi = v_\parallel$



Radius $R = \dfrac{mv_\perp}{qB}$

complete one revolution $T = \dfrac{2\pi}{\omega} = \dfrac{2\pi R}{v_\perp}$

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

Distance moved along z direction in time $T = v_\parallel T = \dfrac{2\pi m v_\parallel}{qB}$ PITCH

Particle Accelerator

Particle accelerator CERN

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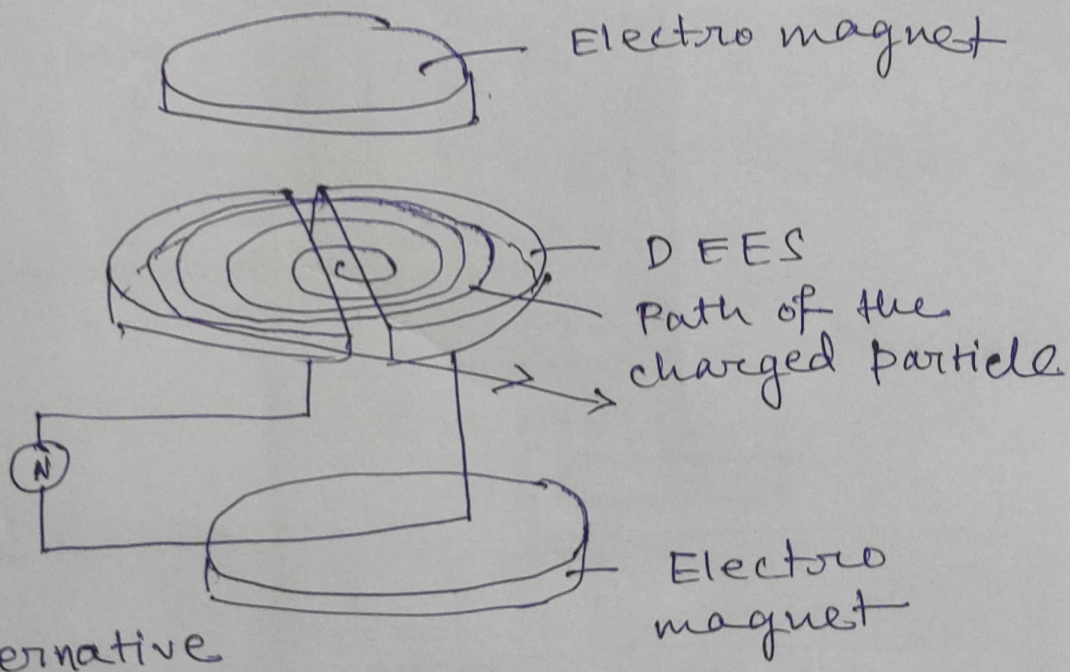
~~Proton acc~~

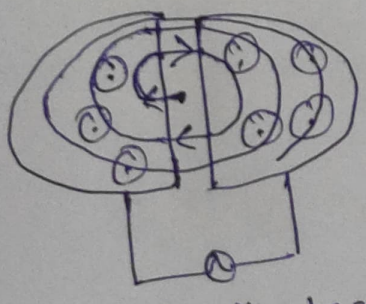
Protons accelerator to a speed] 0.999 999 990 C

(N 3.1 m/s slower than speed of light in free space)

CYCLOTRON



CYCLOTRON



Dees

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

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