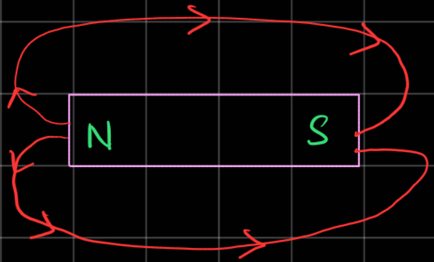
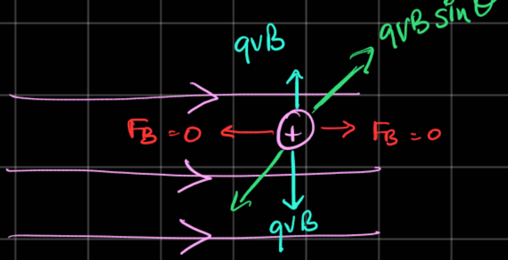
Magnetic Fields



Repel : N - N
S - S

Attract : N - S



qvB sin θ → into/out of surface

$\vec{B}$ — Magnetic Field

$\vec{F_B}$ — Magnetic Force

$\vec{F_B} = q\vec{v} \times \vec{B}$ → Cross product

↓ ↳ velocity of charge

charge

$|\vec{F_B}| = q\vec{v}\vec{B}\sin\theta$

↳ N

Force is always perpendicular to $\vec{v}$ & $\vec{B}$

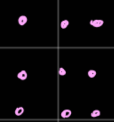
$\vec{F_B}$

- $\perp$ v & B
- $\vec{v} \neq 0$ for $\vec{F_B}$
- W = 0

work not done to move charge in magnetic field

$\vec{F_e}$

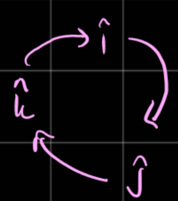
- +ve → same as $\vec{E}$
  -ve → opp. to $\vec{E}$
- charge doesn't have to move
- $W = \vec{F} \cdot \vec{s}$ to move a charge



$\vec{B}$ out of page

$\vec{B}$ into page

$\vec{B}$ → Tesla (T)



$\vec{F_B} = (+\hat{i})(-k) = -(-\hat{j}) = \hat{j}$

$v = 4 \times 10^6$ m/s

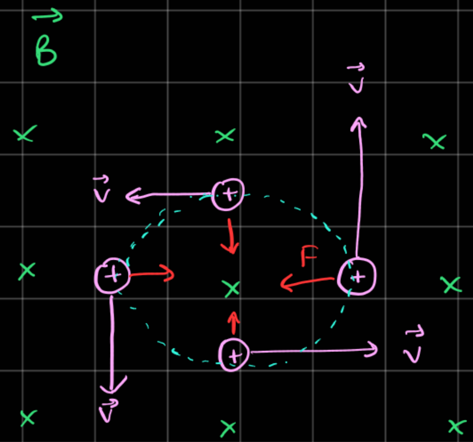
$\vec{B} = 1.7$ T

$\vec{F_B} = 8.2 \times 10^{-3}$ N

$F_B = qvB \sin\theta$

$\theta = \sin^{-1}\left(\frac{F_B}{qvB}\right)$

$=$



$F_B = qvB = ma$

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

↳ centrifugal force

Angular Speed $= \omega = 2\pi f \rightarrow$ frequency / no. of cycles

$= \frac{2\pi}{t}$ $t \rightarrow$ time taken for one cycle

$= \frac{v}{r}$ $v \rightarrow$ speed, $r \rightarrow$ radius

$= \frac{qB}{m}$ $qB \rightarrow$ charge $\times$ magnetic field, $m \rightarrow$ mass of charge

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

$\vec{B} = 0.45$ T

$r = 1.2$ m

$\omega = ?$

$v = ?$

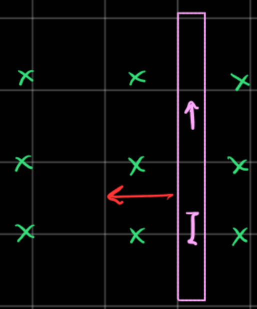
$$\omega = \frac{qB}{m} = \frac{1.6\times10^{-19}\times0.45}{\times10^{-27}}$$

$$=$$

$$v = \frac{qBR}{m} = \frac{1.6\times10^{-9}\times0.45\times1.2}{\times10^{-27}}$$

$\vec{F}_B = I\vec{L}\times\vec{B} \Rightarrow$ uniform magnetic field
wire is straight

magnitude : length
direction : current

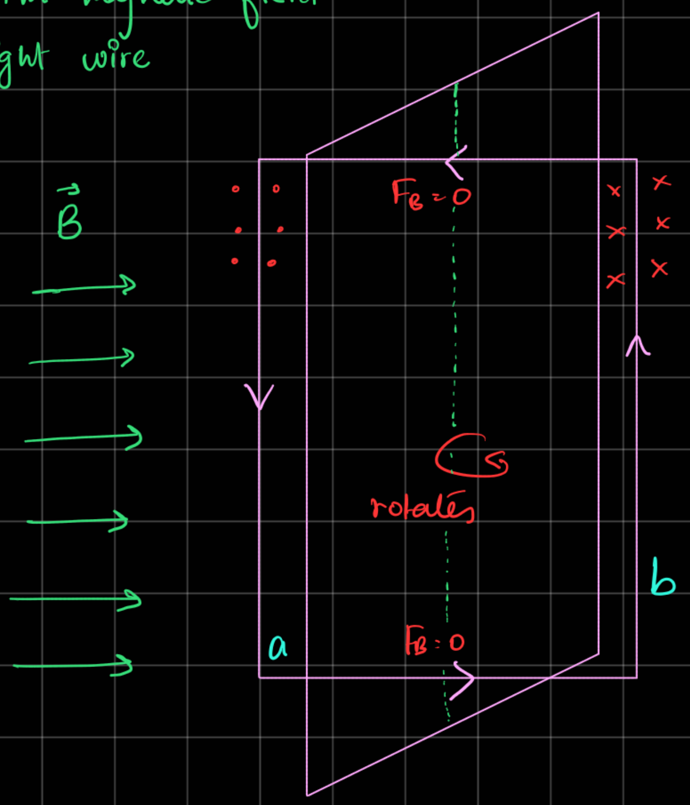


$\vec{F}_B = I\int_a^b d\vec{s}\times\vec{B} \Rightarrow$ non uniform magnetic field
non-straight wire

magnetic dipole moment $(\vec{\mu})$

$\vec{\tau} = \boxed{I\vec{A}}\times\vec{B}$

area of loop
$A = ab$
Direction : $\perp$ to loop
out of page



$\vec{\tau} = \vec{\mu}\times\vec{B}$

$\vec{U}_B = -\vec{\mu}\cdot\vec{B}$

$\mu = NIA$

↳ number of loops from same piece of wire

$$F = I\vec{L} \times \vec{B}$$

$$= 3 \times 14 \times 10^{-2} \times 0.28$$

$$= 0.1176 \text{ N}$$

$$\vec{\tau} = \vec{\mu} \times \vec{B}$$

$$= NI\vec{A} \times \vec{B}$$

$$= \left(50 \times 25 \times 10^{-3} \times \pi \times (5 \times 10^{-2})^2\right) \times (0.5)$$