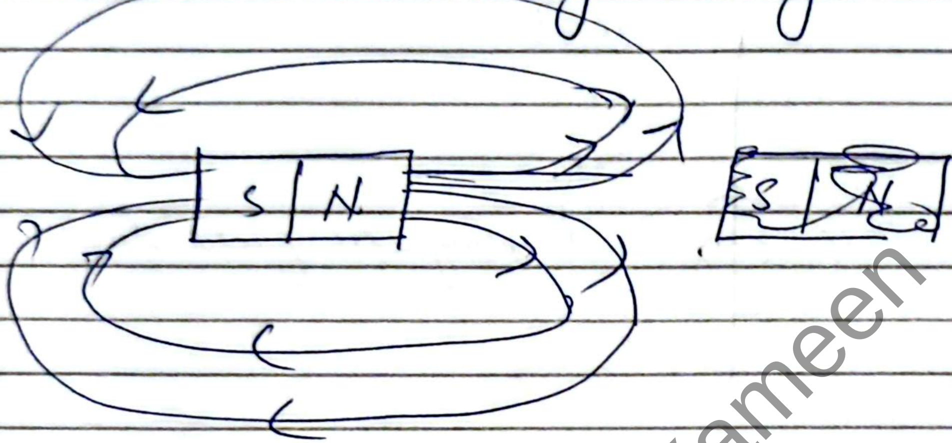
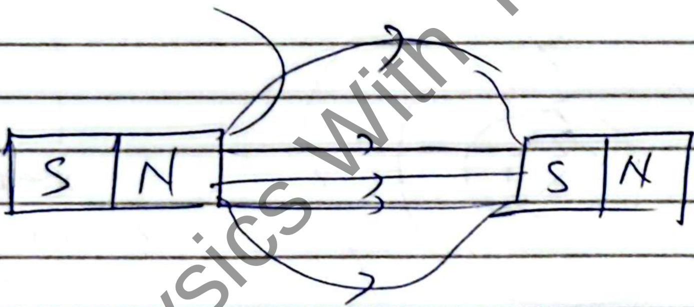
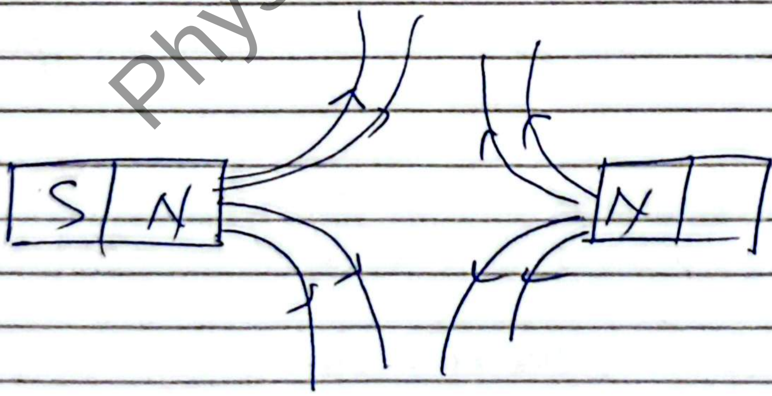
Magnetic fields

Magnetic field is due to

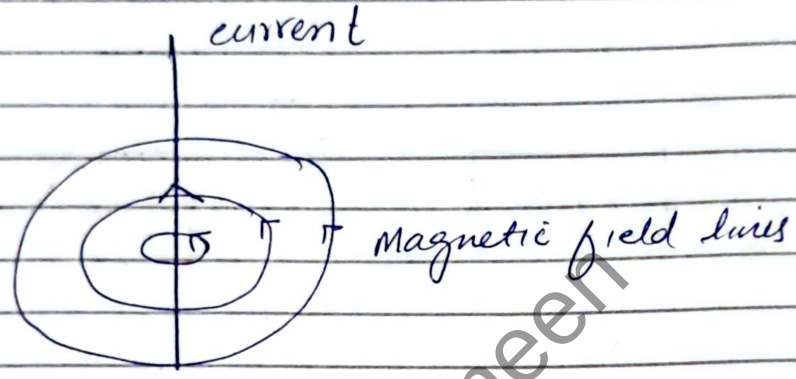
* permanent magnet
* Due to moving charges

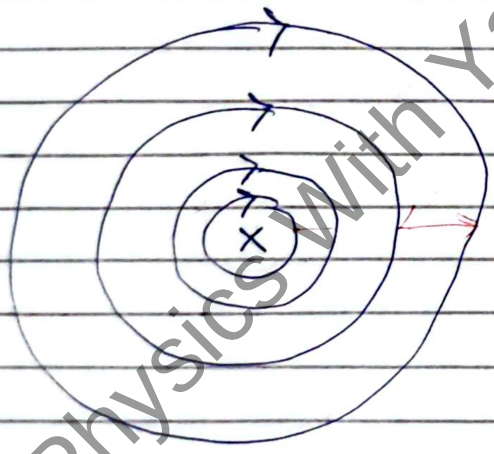






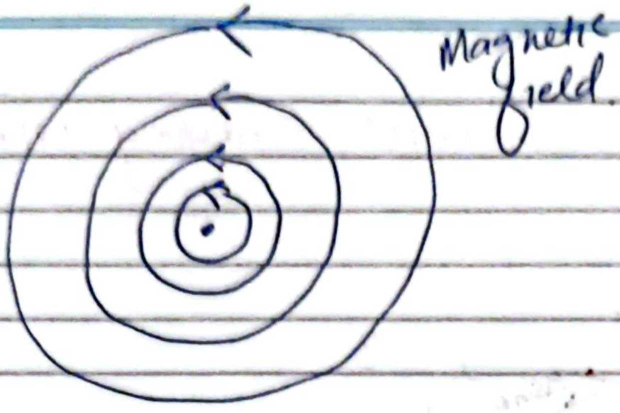
Magnetic field due to current carrying wire

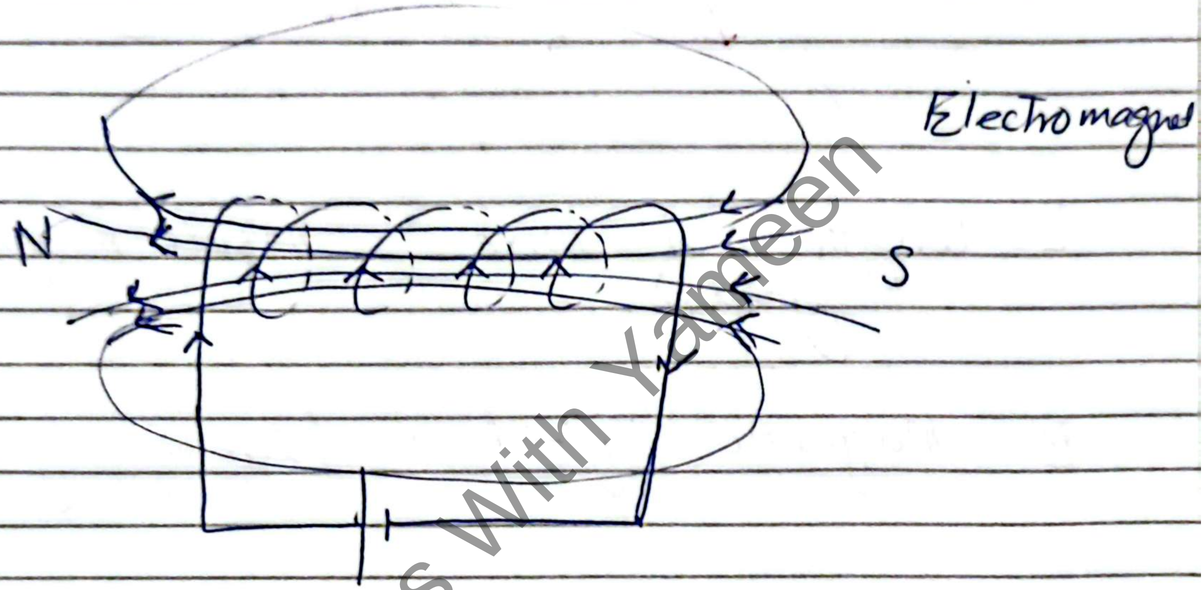




x: current inward in the page

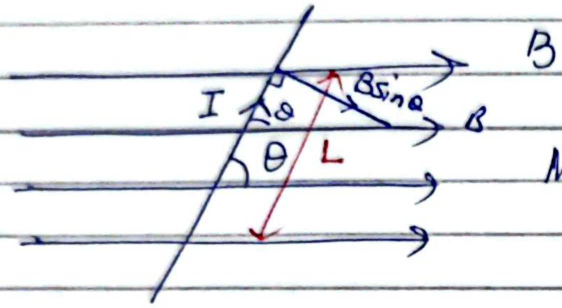
Distance between magnetic field lines should ~~decrease~~ Increase due to weakning of magnetic field as you move away from the wire





Grip the coil using your right hand fingers pointing in ~~current~~ current direction thumb will be pointing Towards North side.

Force on current carrying wire



Magnetic field

L = length of wire inside magnetic field

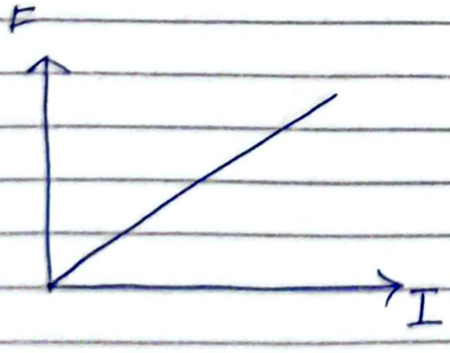
B. Magnetic field or flux density

When a wire having current I is placed inside magnetic field

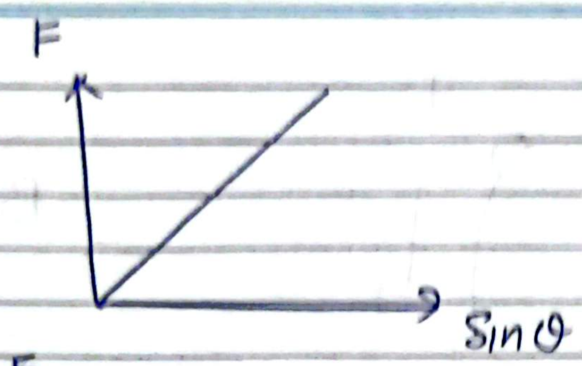
It ~~not~~ may experience force

θ : angle b/w wire and magnetic field

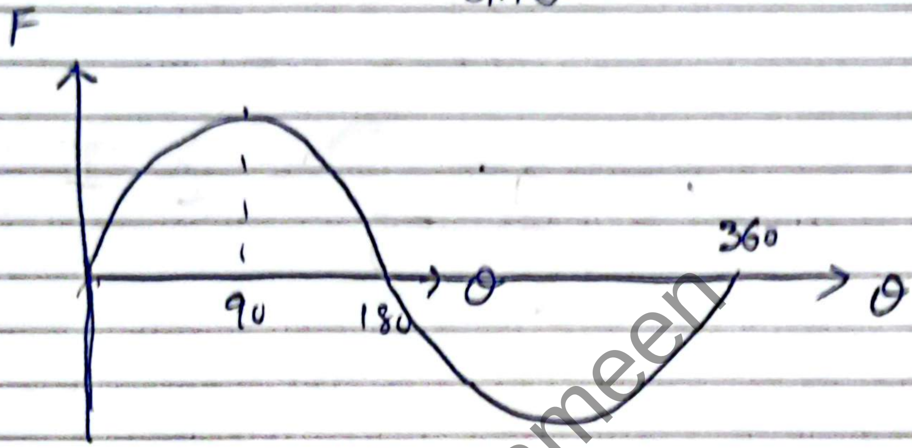
$$F = BIL\sin\theta$$



B, L, θ : constant

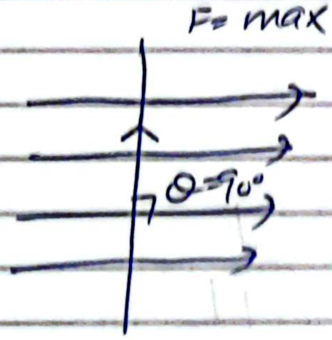


I, B, L constant



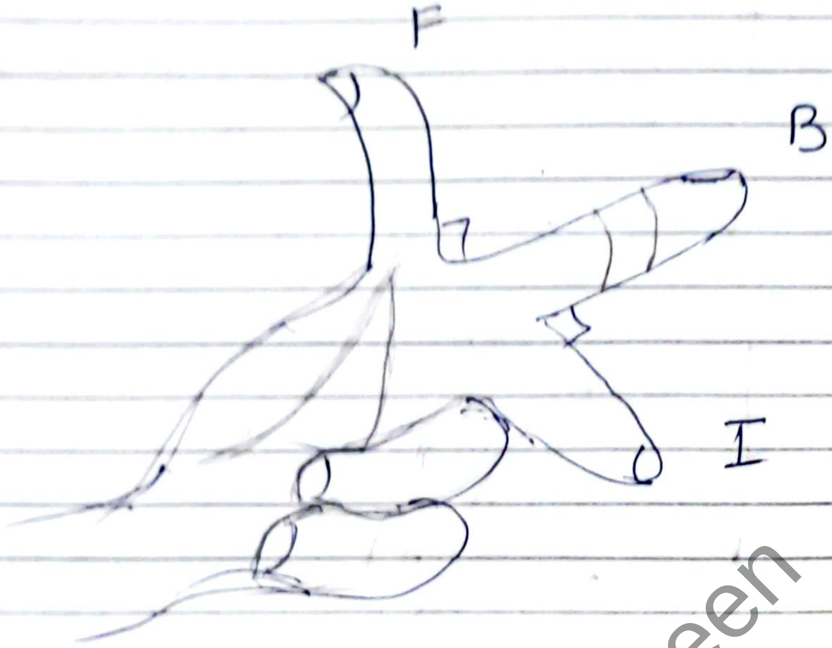
When $\theta = 90$ F is max

$F_{max} = BIL$



Direction of force?

Fleming's left hand rule



$$F = BIL \sin\theta$$

$$B = \frac{F}{IL\sin\theta}$$

$\theta = 90$

$$B = \frac{F}{IL}$$

B: Magnetic flux density

Force per unit current per unit length on a wire placed perpendicular to magnetic field

unit: Tesla (T)

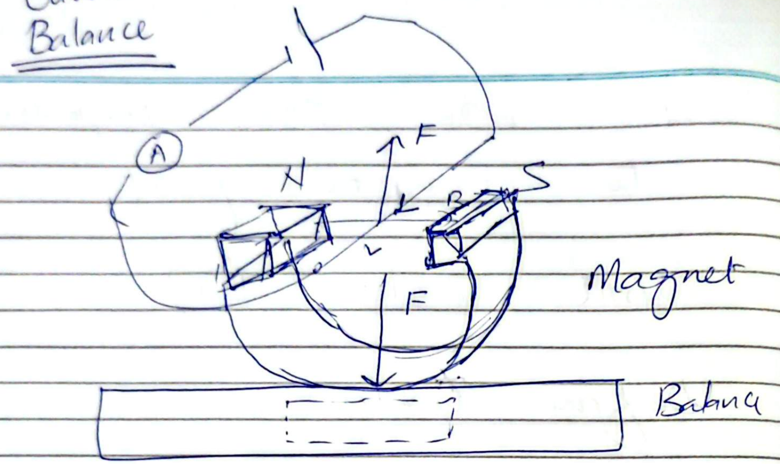
Define tesla:

$$T = N A^{-1} m^{-1}$$

Newton per Ampere per meter

If a wire of length 1 meter having current 1A placed perpendicular to field experiences 1 Newton force Then magnetic flux density is 1 tesla.

Current Balance



According to fleming's left hand r
Force on wire due to magnetic is acting upward,

By Newton's Third law

Force on magnet will be downward so balance reading will increase

Δm: increase in balance reading

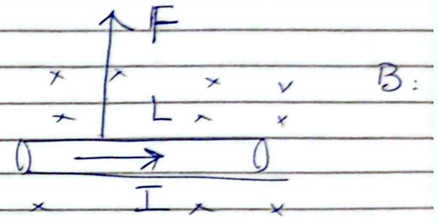
$\Delta mg = F$

$\theta = 90$

$F = BIL$

$\Delta mg = BIL$ $\qquad B = \dfrac{\Delta mg}{IL}$

Force on moving ch
inside magnetic f



$F = BIL \sin\theta$

$F = B \dfrac{Q}{t} L \sin\theta$

$F = BQ \boxed{\dfrac{L}{t}} \sin\theta$

$F = BQV \sin\theta$

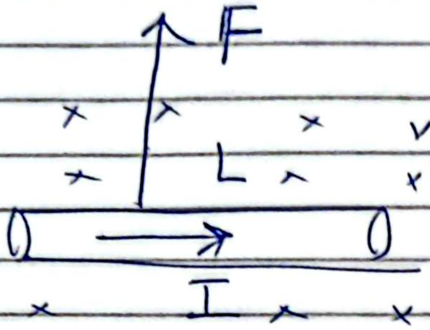
$F = Bnqv \sin\theta$

if $n = 1$

$F = Bqv \sin\theta$

$\boxed{F = qvB \sin\theta}$

Force on moving charge inside magnetic field.



B: Into the page.

$$F = BIL \sin\theta$$

$$F = B \frac{Q}{t} L \sin\theta$$

$$F = B Q \boxed{\frac{L}{t}} \sin\theta$$

$$F = BQV \sin\theta$$

Q = total charge

$$F = B n q v \sin\theta$$

If $n = 1$

$$F = Bqv \sin\theta$$

$$\boxed{F = qvB \sin\theta}$$

If a charged particle has some component of velocity perpendicular to magnetic field then it will experience force

$$\boxed{F = qvB\sin\theta}$$

q : charge

v = ~~Veloc~~ speed, velocity

B : Magnetic flux density

θ = angle b/w velocity and magnetic field.

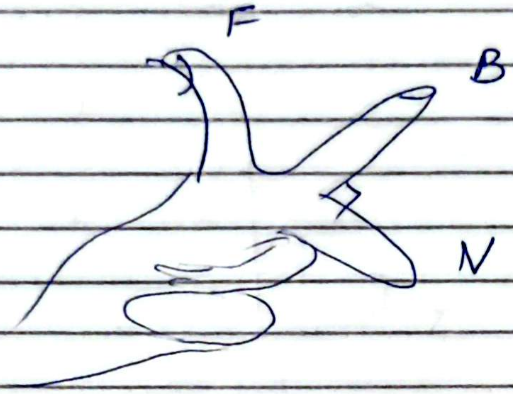
$\theta = 0°$: $F = 0$

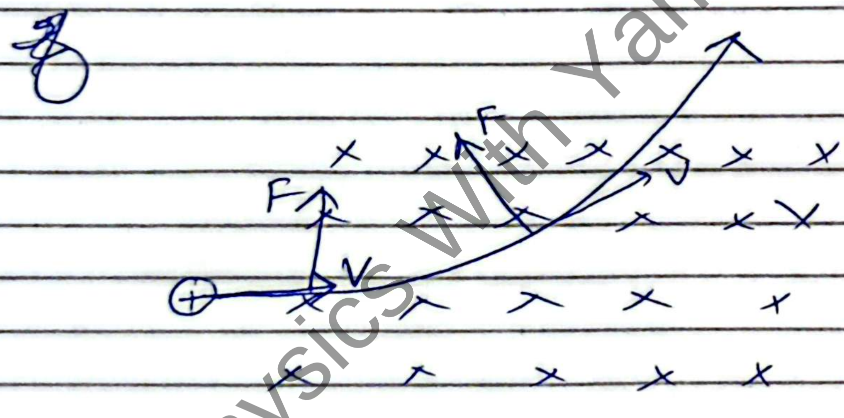
$v = 0$ $F = 0$

Direction of force?

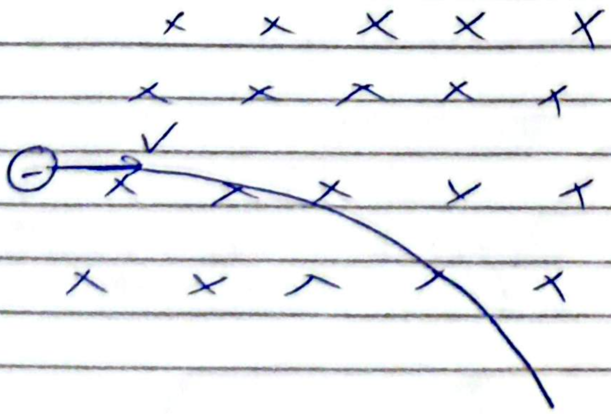
If charge is +ive

Use fleming's left hand rule

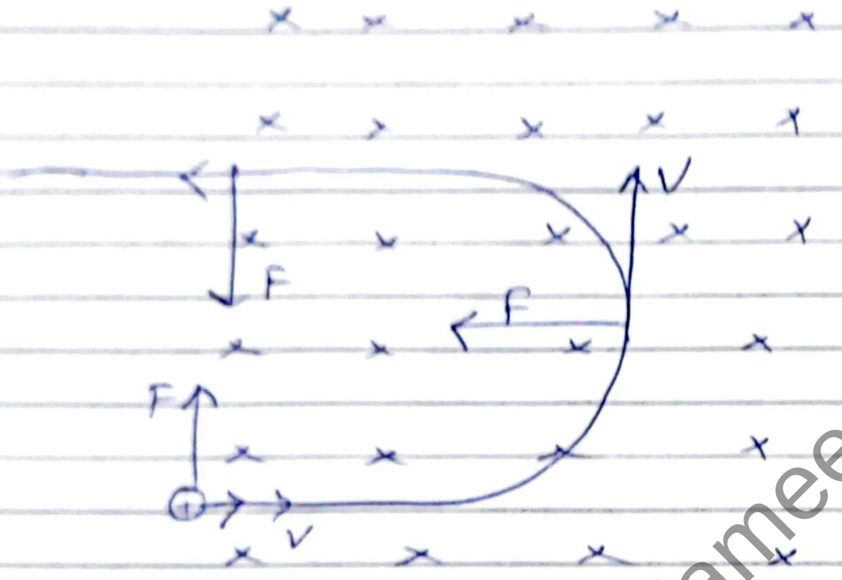


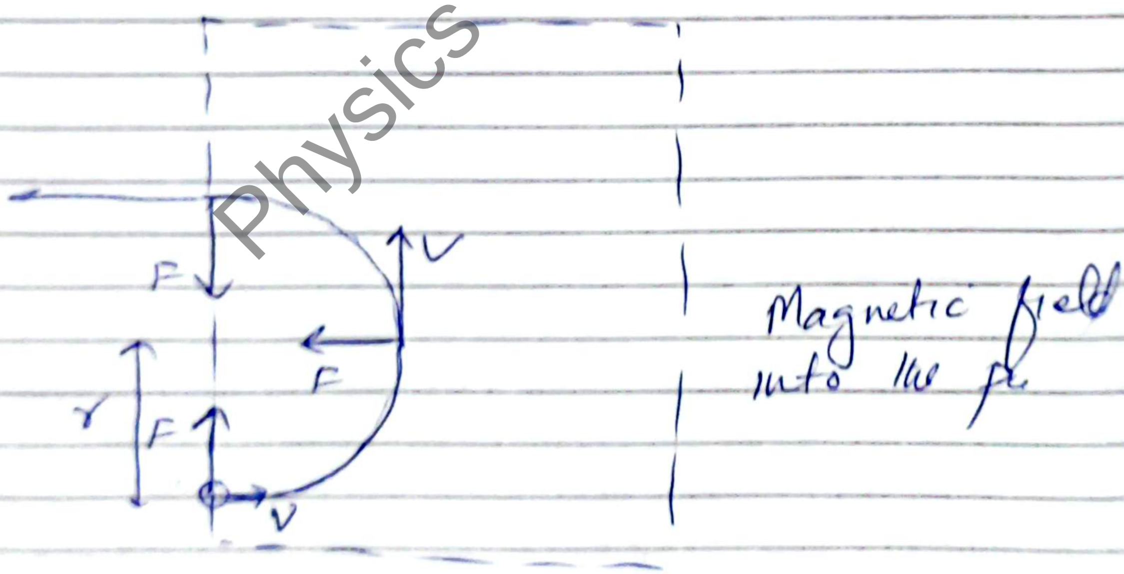


B: Into the page



assume Q to be +ive and use LHR to find F and Then opposit it





Magnetic force is centripetal force.

$$F_M = F_c$$

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

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

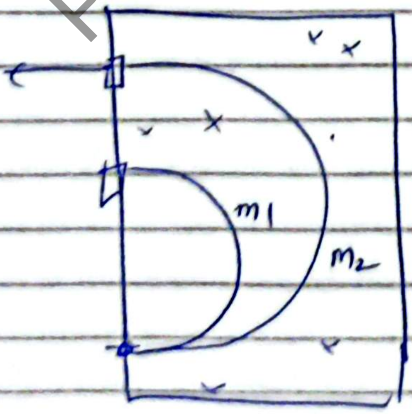
$$r \propto m$$

$$r \propto v$$

$$r \propto \frac{1}{q}$$

$$r \propto \frac{1}{B}$$

Magnetic field into the page



Charge same

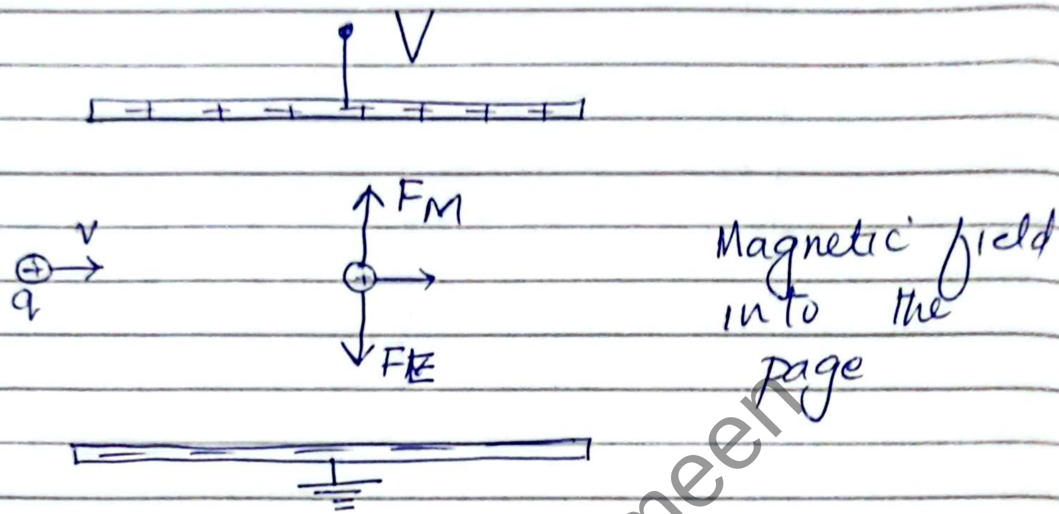
v; same

m, different

r diff

$m_2 > r_1$

Velocity Selection



Magnetic field is into the page

(+ive)
of charge particle q enters in this region

Magnetic force is up

Electric field is applied perpendicular to magnetic field so electric force is acting down

When

$$F_E = F_M$$

Charge particle will go straight undeflected

$$F_E = Eq$$

$$F_M = qvB \sin\theta \qquad \theta = 90$$

$$E\cancel{q} = \cancel{q}vB$$

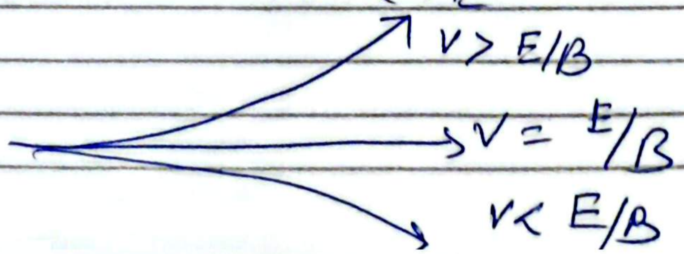
$$\boxed{v = \frac{E}{B}}$$

i) If $v > E/B$

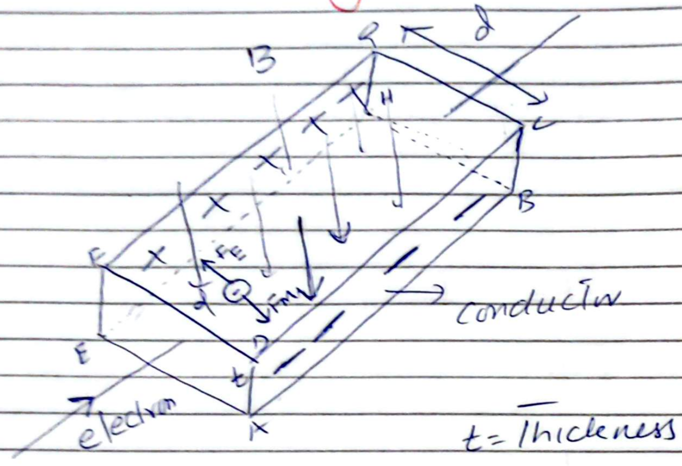
$F_M > F_E$ charge will deflect upward

If $v < E/B$

~~CRa~~ $F_M < F_E$ deflect down



Hall Voltage



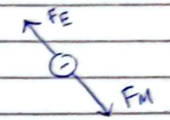
Magnetic field is applied perpendicular surface FECD

moving electrons will experience magnetic toward face ABCD

So this face becomes negative and EFGH becomes positive

Hence potential difference is established between these two faces known as hall voltage V_H

~~When~~ due hall voltage is electron will also ex electric force



When these two forces equal then electron go there will be no increase in hall vol

$$F_M = F_E$$

$$qvB = Eq$$

$$\cancel{q}vB = \frac{V_H}{d}\cancel{q}$$

$$vB = \frac{V_H}{d}$$

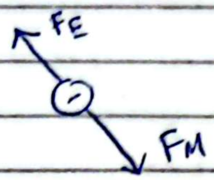
$$vBd = V_H \rightarrow (1)$$

from AS physics

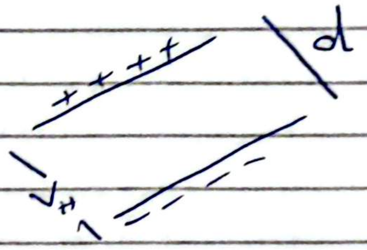
$A = dt$ area of

$I = ndtqv$

~~When~~ due hall voltage is .
electron will also experience
electric force



When these two forces become equal then electron go straight there will be no further increase in hall voltage.



$$F_M = F_E$$

$$qVB = Eq$$

$$\cancel{q}VB = \frac{V_H}{d}\cancel{q}$$

$$VB = \frac{V_H}{d}$$

$$VBd = V_H \rightarrow (1)$$

from AS physics $I = nAqV$

$A = dt$ area of EFDA

$$I = ndtqV$$

$$V = \frac{I}{ndtq}$$

put in ①

$$V_H = VBd$$

$$V_H = \frac{I\,B\cancel{d}}{n\cancel{d}tq}$$

$$\boxed{V_H = \frac{BI}{ntq}}$$

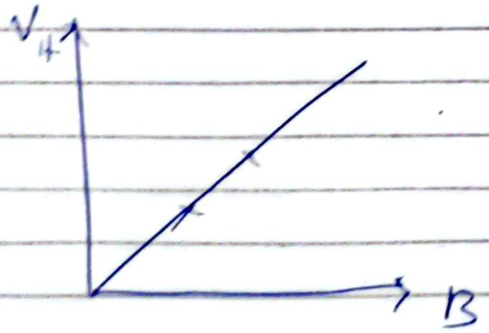
$V_H \propto I$

$V_H \propto \frac{1}{n}$

n : number of free electrons per unit Volume

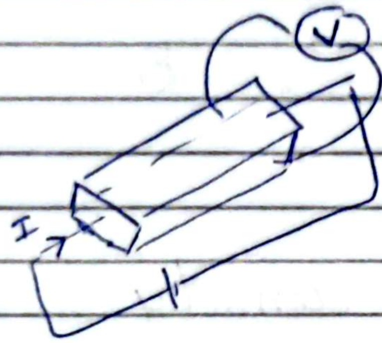
t $V_H \propto \frac{1}{t}$

$V_H \propto B$



Hall probe:

A device used to measure magnetic flux density.



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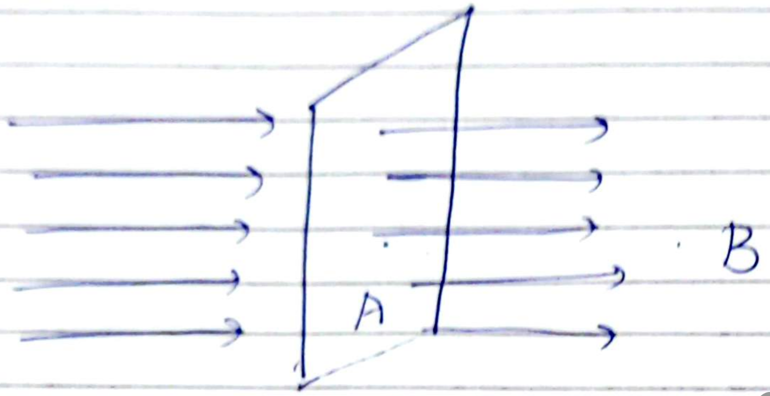
Magnetic flux



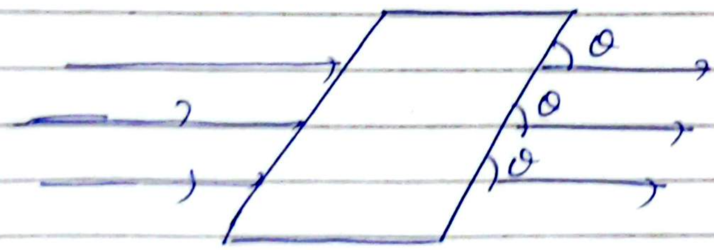
B: Magnetic flux density

A: Area held perpendicular

$$\Phi = BA$$

Φ: Magnetic flux

product of magnetic flux density and area held perpendicular to it



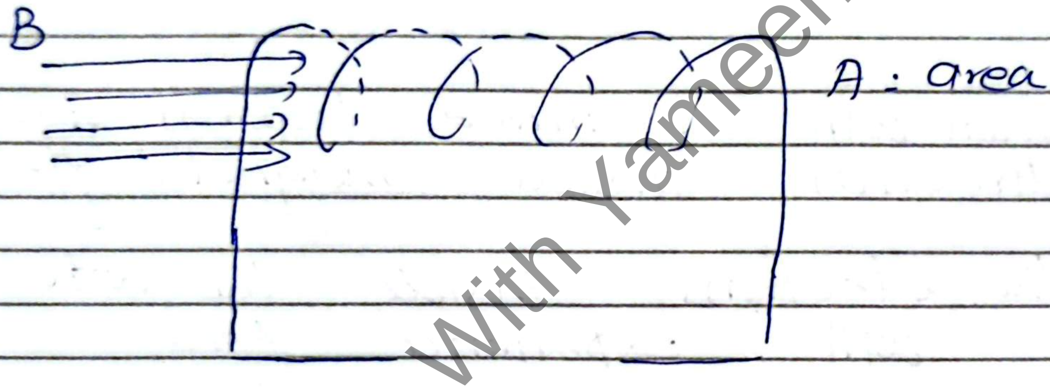
$$\Phi = BA \sin\theta$$

unit of flux

Weber (Wb)

$Wb = T\,m^2$

Magnetic flux Linkage

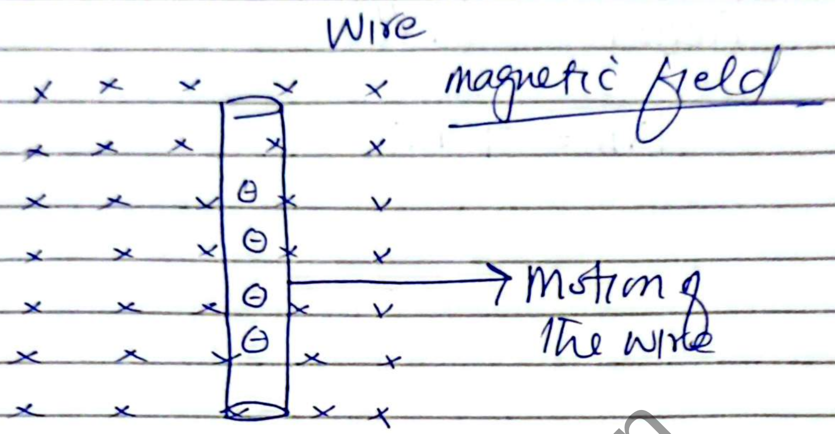


NBA is known as flux linkage

$N\Phi$ = flux Linkage

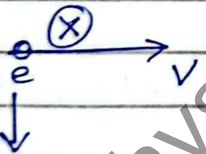
↓ number of turns

Faraday's Law



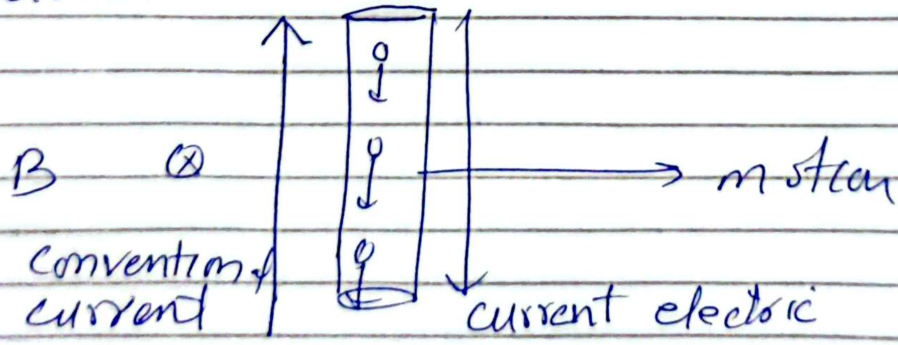
when wire is moved towards right direction inside magnetic field

the electrons inside the wire will experience force

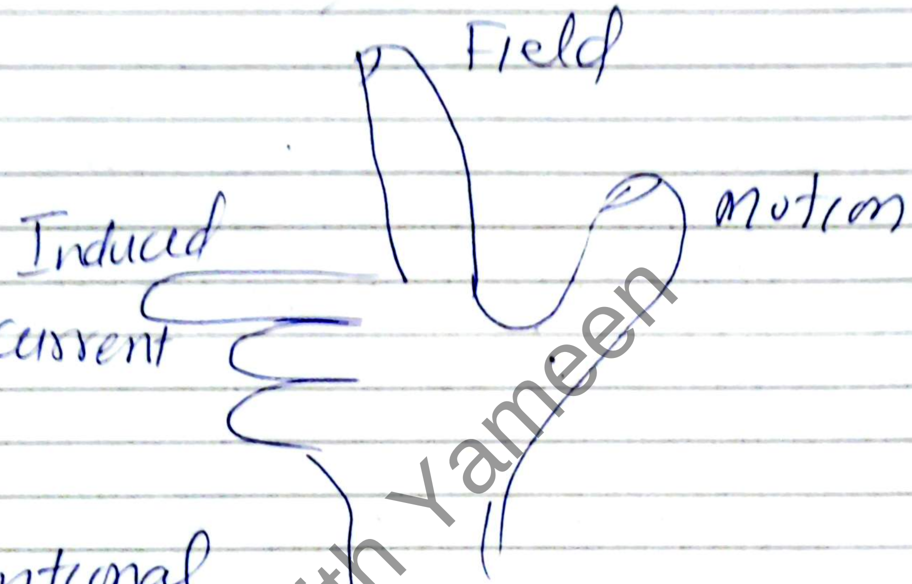


in downward direction

So electrons will start moving. current will induce.



Direction of Induced current is determined using Right hand rule.

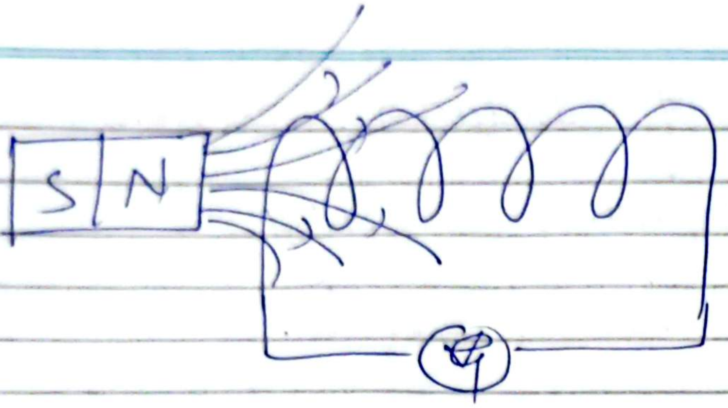


I: conventional current

Faraday Law of electromagnetic induction.

Induced emf is directly proportional to rate of change of magnetic flux Linkage

$$\mathcal{E} = \frac{\Delta(N\Phi)}{\Delta t}$$



G: Galvanometer

Factors effecting induced emf

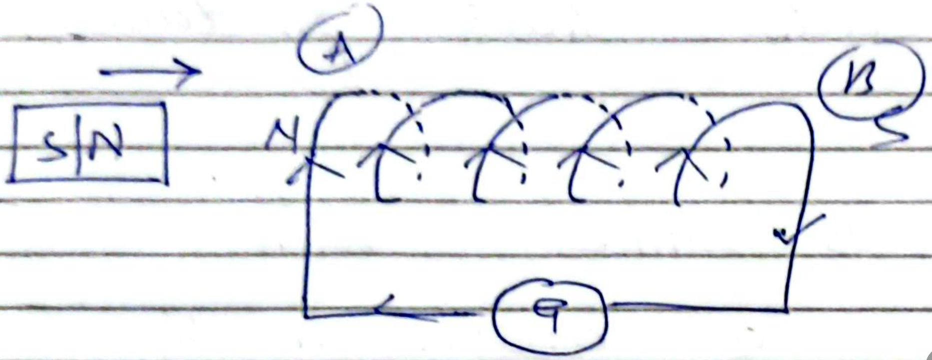
* If speed of magnet is increased emf increases

* If magnet is moved towards the coil deflection of G is on one side
If it is moved away deflection is on other side

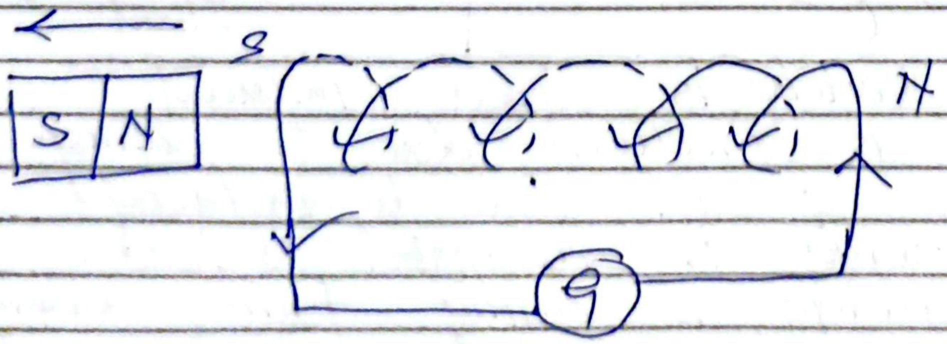
* If magnet and coil are kept stationary then no induced emf

* emf depends on relative motion of coil and magnet

Direction of induced emf.



When North pole is moved toward the coil emf is induced due to induced emf current is generated so magnetic field is generated in coil. This magnetic field opposes the magnetic field of magnet so North pole is induced on side A and south of side B.



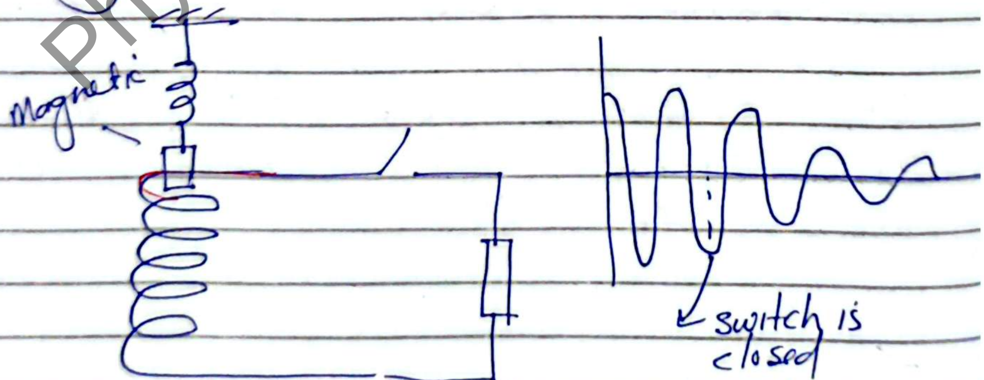
Lenz's law

Direction of induced current is such that it opposes the cause that produces it.

This is linked with law of conservation of energy

$$\mathcal{E} = -\frac{\Delta(N\phi)}{\Delta t}$$

$-$: Sign was introduced by Lenz's

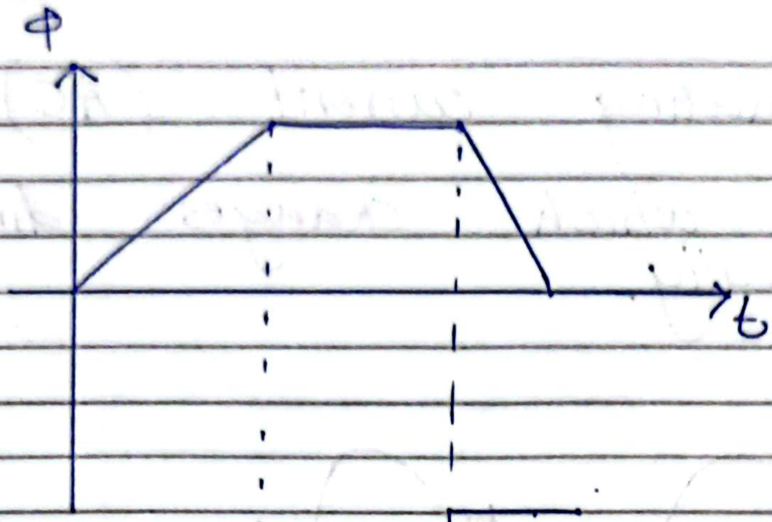


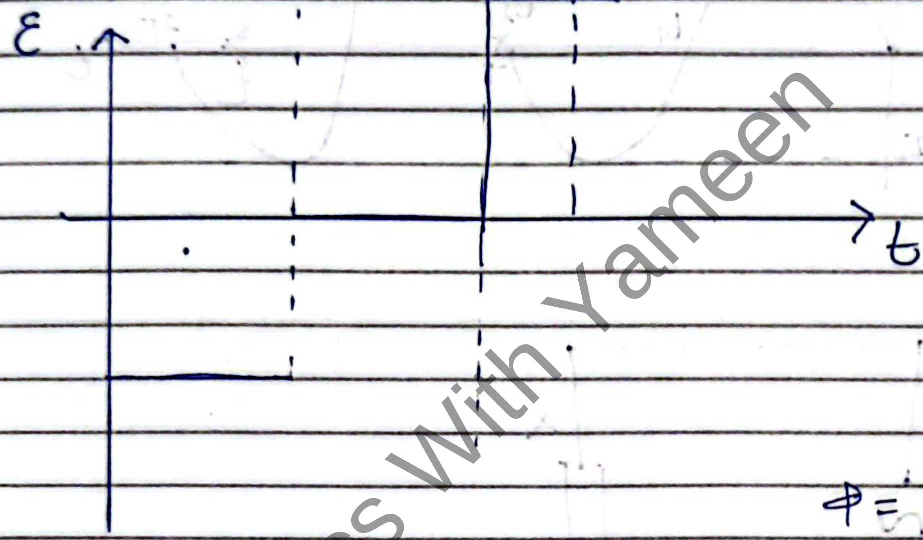
when switch is closed induced current is produced due to change in flux of coil. Due to induced current energy is decipated as heat. This energy is coming from energy of magnet. So damping is caused

$$\mathcal{E} = -\frac{\Delta(N\phi)}{\Delta t}$$

$$\mathcal{E} = -N\left(\frac{\Delta\phi}{\Delta t}\right)$$

$$\mathcal{E} = -N(\text{grad})$$

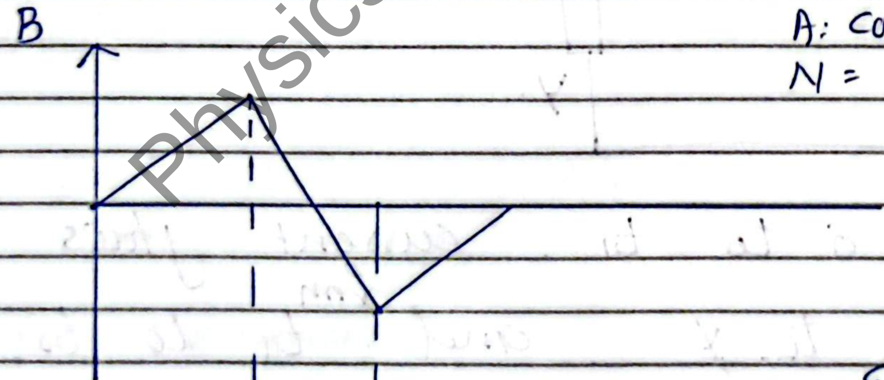




$\phi = BA$

A: constant

N = "



$$\mathcal{E} = -\frac{\Delta(N\phi)}{\Delta t}$$

$$\mathcal{E} = -NA\frac{\Delta B}{\Delta t}$$

$$\mathcal{E} \propto -\text{grad}$$