MAGNETIC FIELD

Date

- Difference b/w magnetic & Electric Field.

1. The electric force acts in the direction of the electric field, whereas the magnetic force acts perpendicular to the magnetic field.

2. The electric force acts on a charged particle regardless of whether the particle is moving, whereas the magnetic force acts on a charge particle, only when the particle is in motion.

3. The electric force does work in displacing a charged particle, wheras the magnetic force associated with a steady magnetic field does no work when a particle is displaced.

The work done by a magnetic force on a moving charge is always ZERO.

Date ______

Units of magnetic field → $\frac{\text{Newton}}{\text{Amp}\cdot\text{meter}}$, Tesla → web/m²

$$F_B = q(v \times B)$$

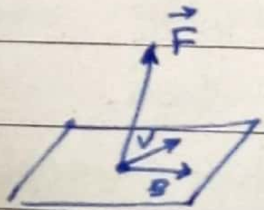
max
$\phi = 90^\circ$
$F_B = qvB$

min
$\phi = 0^\circ$
$F_B = 0$

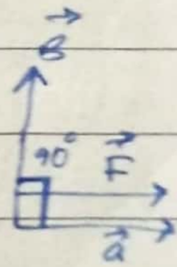
if a charge is moving along the direction of magnetic field the no force exist.

magnetic field ki direction nikaalni ho to RIGHT HAND rule se nikaalenge. Thumb ko current ki direction mei rakho phir fingers ko turn krdo jis direction mein fingers hongi who $\vec{B}$ ki direction hai.

- Force will be $\perp$ to both $\vec{B}$ & $\vec{v}$



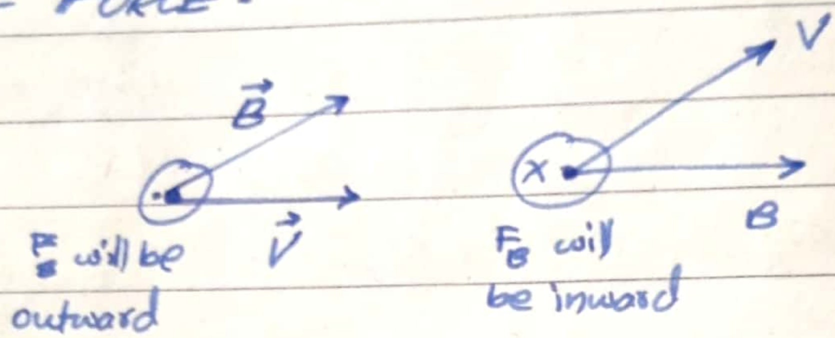
$F \perp V$
$F \perp B$
$a \perp B$
$a \cdot B = 0$



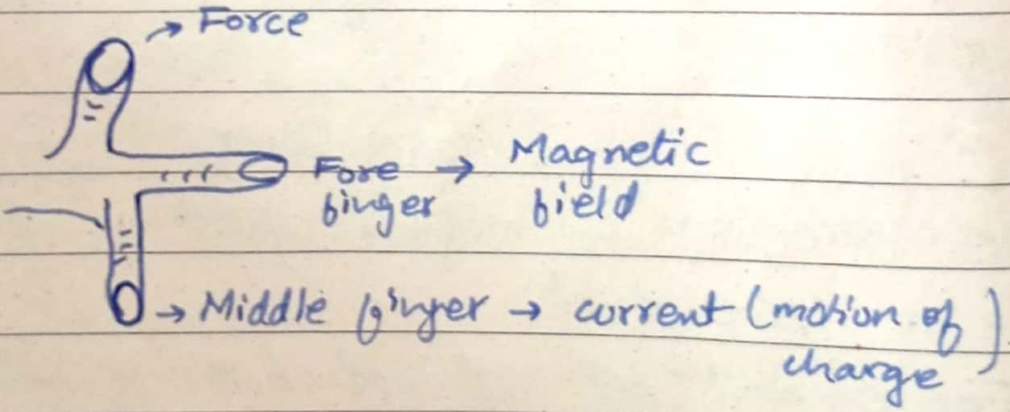
Force ki direction right hand rule se nikaalenge. $\vec{v}$ se $\vec{B}$ tak fingers turn krenge or ~~arrow~~ thumb ki direction humein force ki direction btayegi.

Date

DIRECTION OF FORCE:

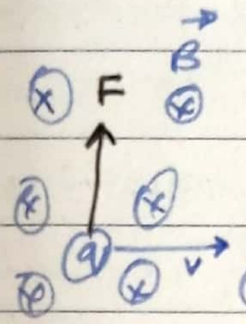


"FLEMINGS LEFT HAND RULE"



- Sabse phele forefinger ko magnetic field ki direction mein rakhna hai.
- Phir middle finger ko motion of charge ki direction mein.
- Phir thumb humein force ki direction btaa dega.

(1)



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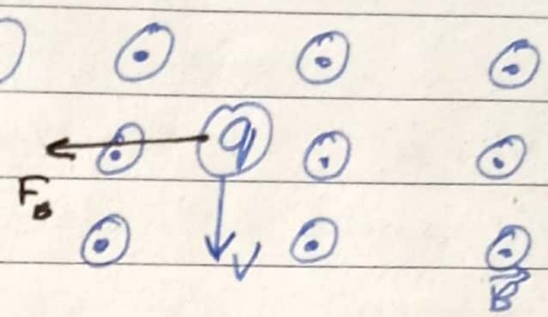

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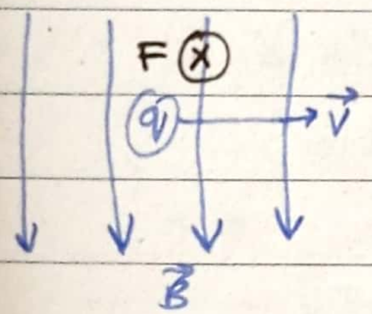

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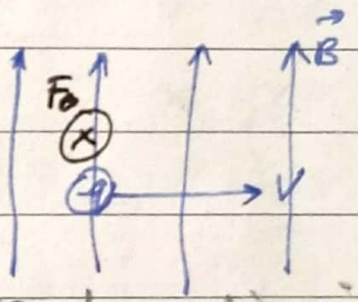
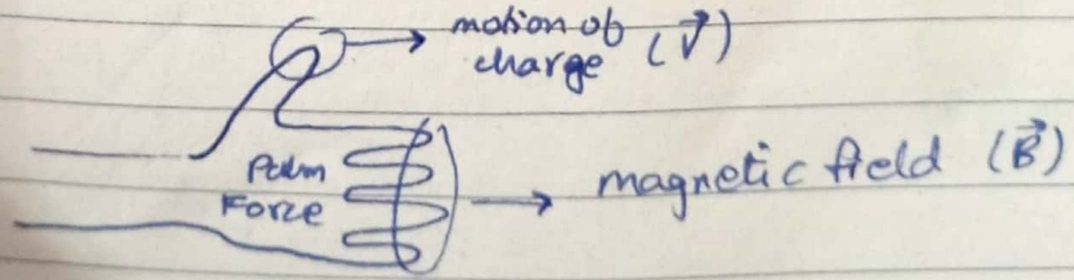


–ve charge ki waja se force ki direction opp hogai.

" RIGHT HAND PALM RULE "

Apne thum ko motion of charge (current) ki direction mein rakhenge or unglio ko $\vec{B}$ ki direction mein. Ab palm jaha push karna hoga wo force ki direction hogi..



Date

- The magnetic force cannot change the particle's speed 'v' (and thus it cannot change its kinetic energy). The force can change only the direction of $\vec{V}$, only in this sense F_B can accelerate a particle.

$$\rightarrow \quad W = 0$$

$$W_{ALL\ FORCES} = \Delta K \cdot E$$

$$0 = \Delta K \cdot E$$

$$0 = K \cdot E_f - K \cdot E_i$$

$$K \cdot E_f = K \cdot E_i$$

Speed remains constant

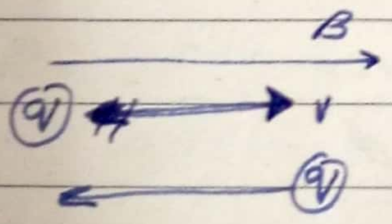
• Path Of Charge Particle In A Magnetic Field

$\because F_B = q(\vec{v} \times \vec{B})$

$= qvB\sin\theta$

Case I : when $\theta = 0°$ & or $\theta = 180°$

$\vec{v} \parallel \vec{B}$ $\qquad$ $\vec{v} \parallel -\vec{B}$

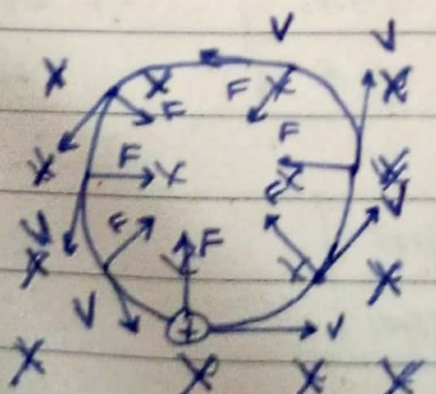


$F = qvB\sin 0$ or $qvB\sin 180$

$\boxed{F = 0}$

" Path → straight line "

Case II : $\theta = 90°$ $\quad \vec{v} \perp \vec{B}$ → Trajectory ⇒ Circle



B is inward.

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$$F_m = F_{centripetal}$$

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

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

jitni tez velocity utna ~~tez~~ bara radius or jitna kam charge utna bara radius.

$$\because \text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$T = \frac{2\pi R}{v}$$ → circumference of circle

$$T = \frac{2\pi}{\cancel{v}} \cdot \frac{m\cancel{v}}{qB}$$

$$\therefore \boxed{T = \frac{2\pi m}{qB}}$$ → Independent of Velocity

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

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Angular Frequency:

$$\omega = 2\pi f$$

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

$$\boxed{\omega = \frac{qB}{m}}$$

and $\boxed{\omega = \frac{v}{r}}$

$$R = \frac{p}{qB}$$ $p \rightarrow$ momentum $p = mv$

$$\rightarrow K.E = \frac{1}{2} m v^2$$

$$K.E = \frac{1}{2} \frac{\cancel{m} p^2}{m^{\cancel{2}}}$$

$$p = \sqrt{2mK.E}$$

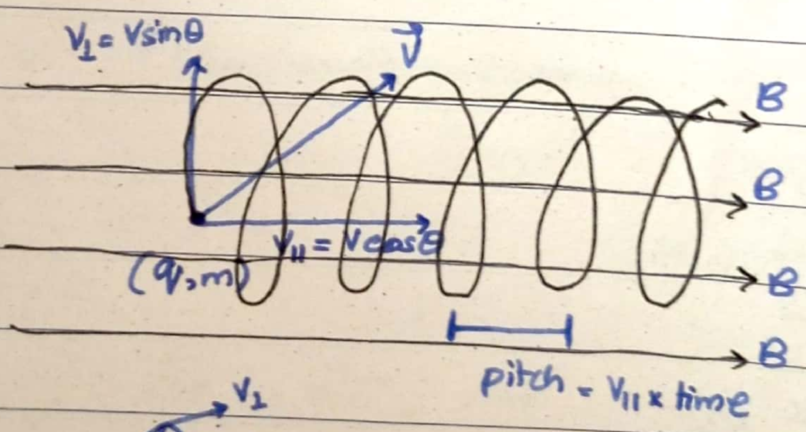
then $\boxed{R = \frac{\sqrt{2mK.E}}{qB}}$

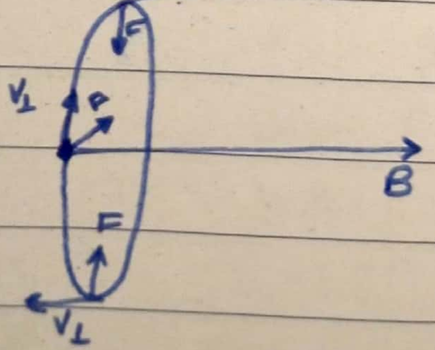
case III : When $\vec{V}$ is incled at any angle 'θ' with $\vec{B}$.

HELICAL PATH :

- $V_{\parallel}$ (parallel velocity) charge ko straight line mein chalati hai.

- $V_{\perp}$ charge ko circular motion mein ghumata hai.





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$\therefore \quad R = \frac{mV_\perp}{qB}$

$\boxed{R = \frac{mV\sin\theta}{qB}}$ → because circular motion is due to $V_\perp$.

- Time period will remain same as it has nothing to do with $\vec{V}$.

- Pitch is the horizontal period covered in time period. Yaani ek circular motion mein kitna horizontal distance covered ho.

$$\boxed{\text{Pitch} = V\cos\theta \times \frac{2\pi m}{qB}}$$

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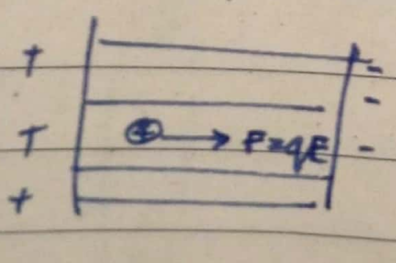
CYCLOTRON

- Machine used to accelerate charged particle to very high speed (to very high energy.) $K.E = \frac{1}{2}mV^2$.

Uses:

1) To study nuclear reactions.
2) To insert an ion in a solid
3) Used to start radioactive decay.

- To achieve highspeed we cannot use magnetic field as it doesn't change the magnitude of velocity only direction changes.



$$a = \frac{F}{m} = \frac{qE}{m}$$

$$\because V_f^2 = u^2 + 2aS$$

to agr speed barhani hai to distance b/w plates barhadenge leken)

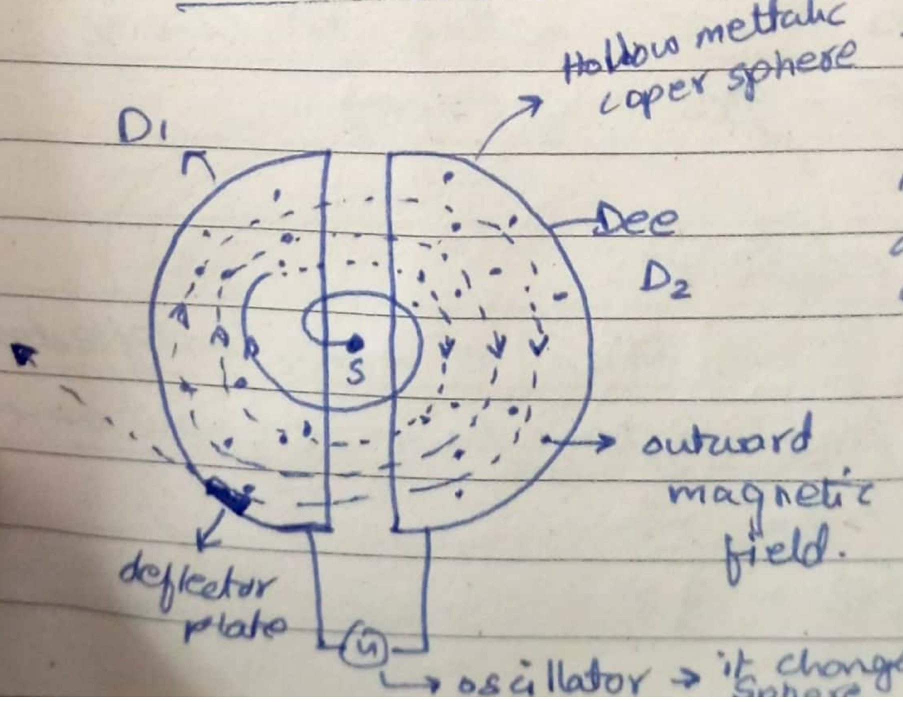
leken agr distance barhaya to machine size bcms very large AND electric field becomes weak.

distance islye barhana hai ya charge ko zyada time tak field mein islye rakhna hai taako wo jitni der rhega utni der force lagegi or jitni force utni acceleration hogi.

Frequency is the key to operation of the cyclotron is that frequency 'f' at which the proton circulates in the magnetic field must be equal to the f_{osc} of oscillator

$$f = f_{osc} \quad \text{(resonance condition)}$$

$$\boxed{f_{osc} = \frac{2\pi m}{qB}}$$



→ Inside sphere $B = 0$
inside sphere only magnetic field will act which cause circular motion.

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"LORENTZ FORCE"

Total force acting on a particle in an Electromagnetic field.

$$F_{net} = F_E + F_M$$
$$= q\vec{E} + q(\vec{V} \times \vec{B})$$

- A charge moving with a velocity 'V' in the presence of both electric Field 'E' and magnetic Field 'B' experience both an electric ~~field and~~ force 'qE' & magnetic force $q(V \times B)$. The total force is called Lorentz Force acting on charge is $\Sigma F = qE + q(V \times B)$

"VELOCITY SELECTOR :

When e^- moves undeflected from the cross field region than we must have,

$$F_B = F_E$$
$$\cancel{q}VB = \cancel{q}E$$

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

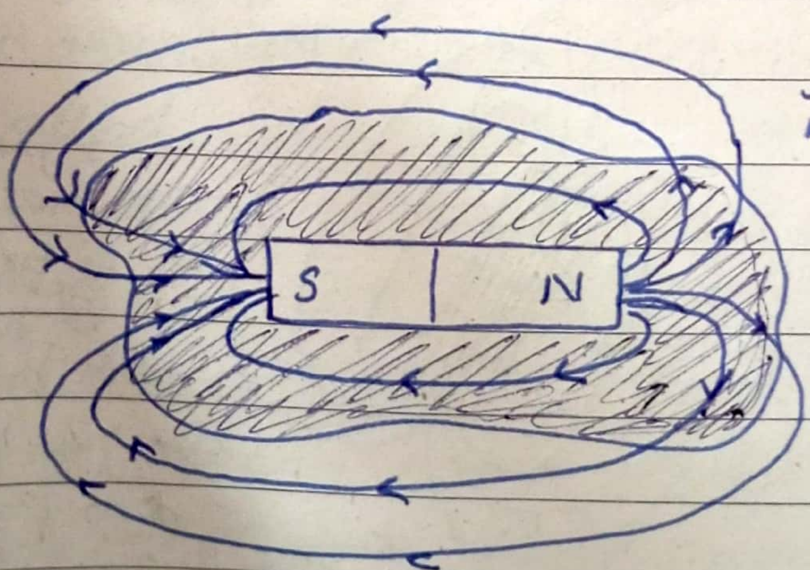
The mass spectrometer

$$\frac{m}{q} = \frac{r B_0}{V} = \frac{r B_0 B}{E} \qquad \rightarrow V = \frac{E}{B}$$

"GAUSS LAW"
In Magnetism

Magnetic Flux linked with a closed surface in magnetic field is ZERO

$$\oint \vec{B} \cdot \vec{dA} = 0 \quad \text{or} \quad \phi_B = 0$$



jitni lines of forces nikal rhi hai unti andar bhi jaarhi hai i.e why it is ZERO.

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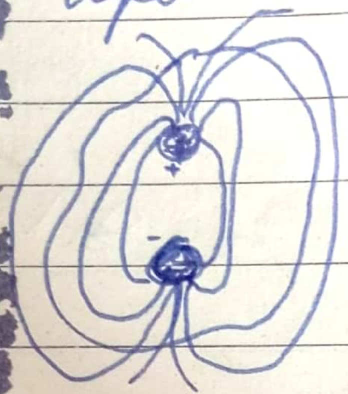
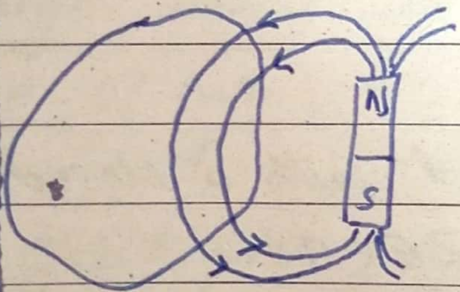
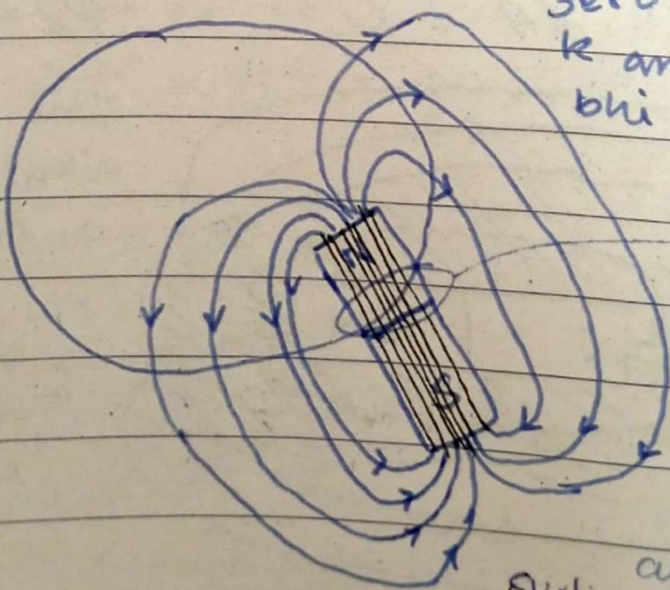
- Magnetic flux in a closed surface is some what similar to a flux in a electric dipole



- 

agr magnet baahir bhi rakha hai to bhi $\phi_B = 0$.

- is case mein bhi zero q k lines magnet k andar se hoti wi bhi jaarhi hai or



is jaga se q k lines of force 'N' ki tarf jaarhi hai to ek 'S' pole yaha par bhi ban jayega ts ab dono pole closed surface k andar aagye.

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- Bar magneti doesn't exist in monopoles.

- The difference b/w magnetic & electric flux $\phi_E = \frac{Q_{(incl)}}{\epsilon_0}$, $\phi_B = 0$ is ~~Adlt~~ only bcz

of the existence of monopoles. In electric field we can have a single charge either (-) or (+) but magnets doesn't exist in monopole they are alway dipole.

CLASSIFICATION OF MAGNET

DIAMAGNETISM:

The phenomenon in which atoms start repelling the magnetic field due to induction is called diamagnetisms. eg: H_2O & other organic material. It is not only weak but temporary also. It is independent of temperature bcz it has nothing to do with vibration of atoms. It is a universal phenomenon it exist in all materials but depends upon which one is stronger.

CamScanner

high temp less paramagnetism bcz of more vibration it is align hurdles of atoms to align
less temp causes less vibration i.e is why liquid O_2 is more paramagnetic than gas O_2.

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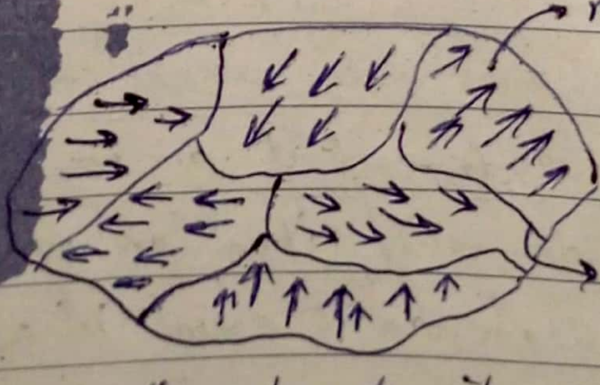
- PARAMAGNETISM :

Paramagnetic substances have a small but +ve magnetic susceptibility ($0 < \chi \ll 1$) resulting from the presence of atoms that have permanent magnetic moments.
eg : O_2, Al, Ca also weak & temporary.

DIAMAGNETISM	PARAMAGNETISM
• It repels	• It attracts
• Paired e^-	• Unpaired e^-
• Temporary dipole inducing ~~dipoles~~ to opposite direction	• permanent dipoles turning due to magnetic field.

- FERROMAGNETISM :



- By providing heat it lost all it's domains and becoms a paramagnet

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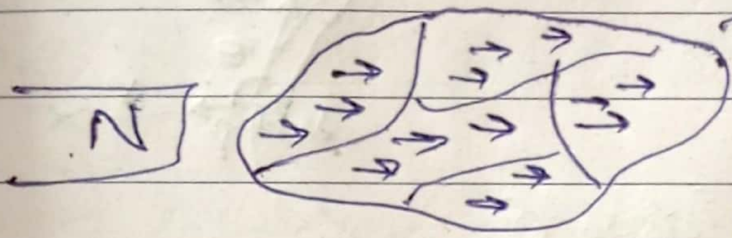
By placig an external field the domains tends to aling align to the magnetic fied



to ab saare ~~ions~~ e^- ek alignment mein aagye or ye poori ab single domain ban jayegi.

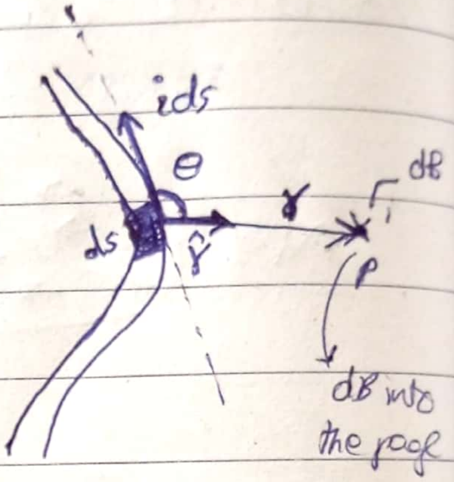
- In Paramagnent the alignment is super weak
- In Ferromagnet the alignment is perfect

- If mgnet remore there is ~~no~~ alignment comes to original position
- But here alignment remains same.

MAGNETIC FIELD DUE TO CURRENT

- BIO-SAVART LAW:

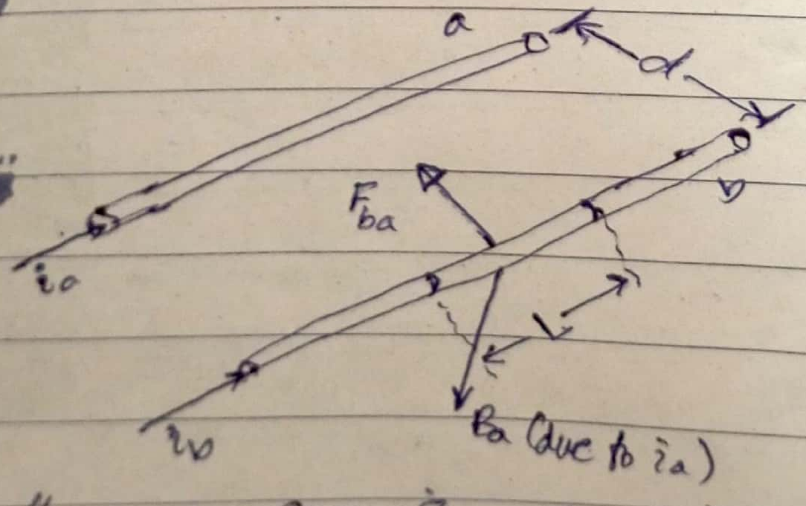
$$dB = \frac{\mu_0}{4\pi} \times \frac{i\,ds\sin\theta}{r^2}$$



θ = angle b/w the direction of $\vec{ds}$ & $\hat{r}$, a unit vector that points from ds towards P.

$\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$

- FORCE B/W TWO // CURRENTS:



Two // wires carrying current in same direction attract each other.

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B_a is the magnetic field at wire 'b' ~~due~~ ~~wire~~ produced by the current in wire 'a'.
F_{ba} is the resulting force acting on wire B bcz it carries current in $\vec{B_a}$.

- ~~Ediae~~ of e The magnitude of $\vec{B_a}$ at every point of B is

$$B_a = \frac{\mu_0 i_a}{2\pi d} \rightarrow ①$$

- force on a current carrying conductor placed in an external magnetic field is

$$F = I(L \times B)$$

therefore Force on B due to a will be,

$$F_{ba} = i_b(L \times B_a)$$

$$F_{ba} = i_b L B_a \sin 90°$$

$$\boxed{F_{ba} = \frac{\mu_0 L i_a i_b}{2\pi d}}$$ using eq ①

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- Like or parallel currents attract each other.
- Unlike or antiparallel current repels each other.

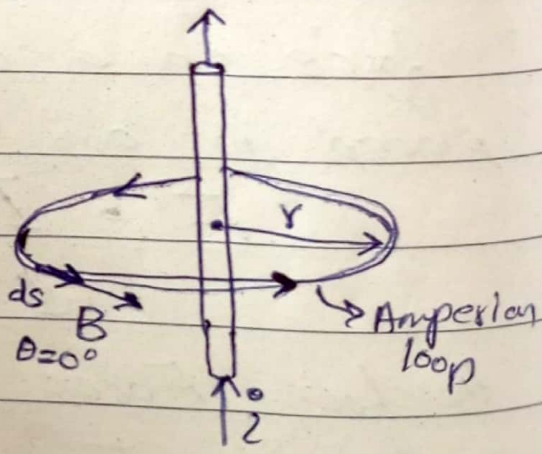
- **AMPERES LAW:**

$$\oint B \cdot ds = \mu_0 i_{(incl)}$$

or $B\, ds \cos\theta = \mu_0 i_{(incl)}$

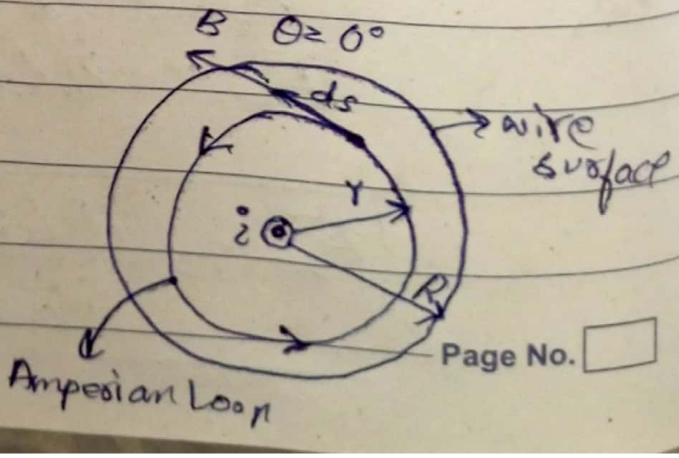
- **MAGNETIC FIELD OUTSIDE A LONG STRAIGHT WIRE:**

$$B = \frac{\mu_0 i}{2\pi r}$$



INSIDE A WIRE:

$$B = \left(\frac{\mu_0 i}{2\pi R^2}\right) r$$



Date

Thus inside the wire, the magnitude of B depends on 'r' and is zero at centere and max at $r = R$. But both eqn give different f. values at surface.

- ## SOLENOID

$B = \mu_0 n I$ → inside solenoid.

where n = no. of turns of winding

- Outside solenoid magnetic field $B \cong 0$.
  for an ideal solenoid

- ## TOROID

$$B = \frac{\mu_0 I N}{2\pi r}$$ → inside toroid

Outside toroid $B \cong 0$ (if made by an ideal solenoid)