Magnetic field of a current:-

Study of magnetic fields and magnetic interactions due to moving charges.

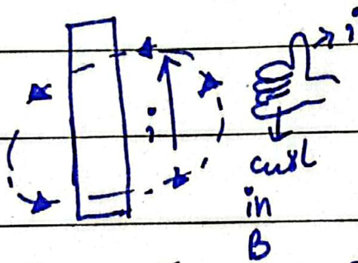
Right hand rule # 2:

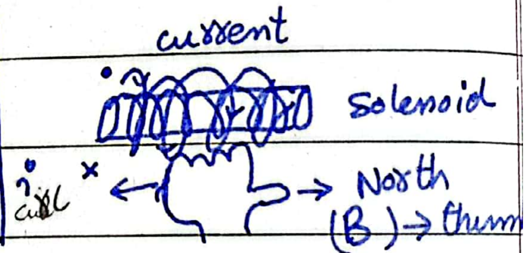
B & I
one is straight and another is curl.
i = thumb
B = curl.

i
straight thumb
↓
curl fingers
(B)

V & i are same component in drake direction

* example of current carrying wire
* example of solenoid.

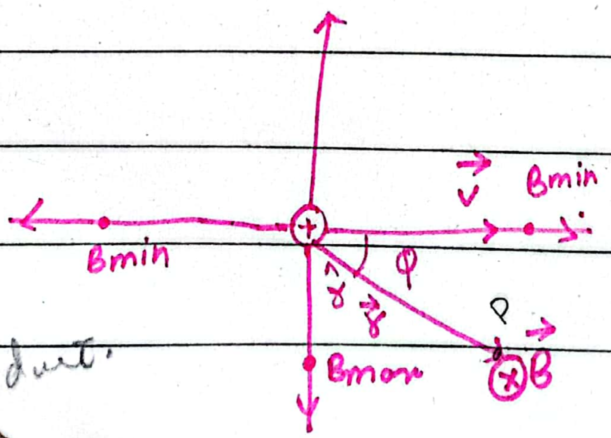




Magnetic field of a singal moving charge:-

moving charge

in 2 terms
angle
product.



• change φ would change

• to check B we can place
(i) compass n
(ii) moving

①

$q\,V$ $\quad$ $C \cdot ms^{-1}$

K $\quad$ $= \frac{Tm}{C/s} = \frac{Tm}{A}$

Date:

Day:

$K = TmA^{-1}$

$B \propto q$

$B \propto V$

$B \propto \frac{1}{r^2}$

$B \propto \sin\phi$

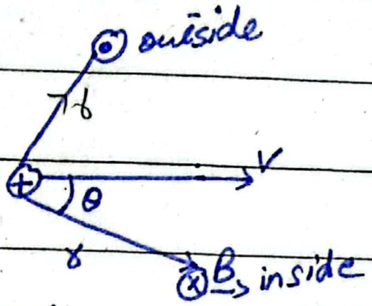
$B \propto \frac{qV\sin\phi}{r^2}$

$B = \frac{KqV\sin\phi}{r^2}$

K is magnetic constant

$K = \frac{\mu_0}{4\pi}$

$K = 10^{-7}\,TmA^{-1}$



$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$

light is electro magnetic wave.

(a $\vec{B}$ is established due to a moving charge)

In vector form:-

$$B = \frac{Kq(V\sin\phi)}{r^2}$$

$$B = \frac{Kq(\vec{V} \times \hat{r})}{r^2} \quad \hat{r} \text{ unit vector}$$

or $\frac{Kq(\vec{V} \times \vec{r})}{r^3}$

Straight thumb

Magnetic field of current:- (Biot-Savart law)

for a single moving charge q, V

for more moving charges $\rightarrow$ current $\rightarrow$ l, i

Day:

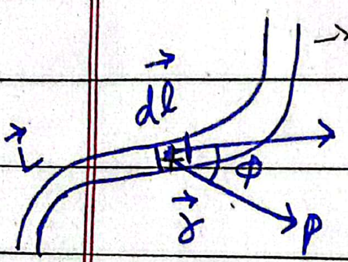
$$dB = \frac{K\,dq\,(\vec{v}\times\hat{r})}{r^2}$$

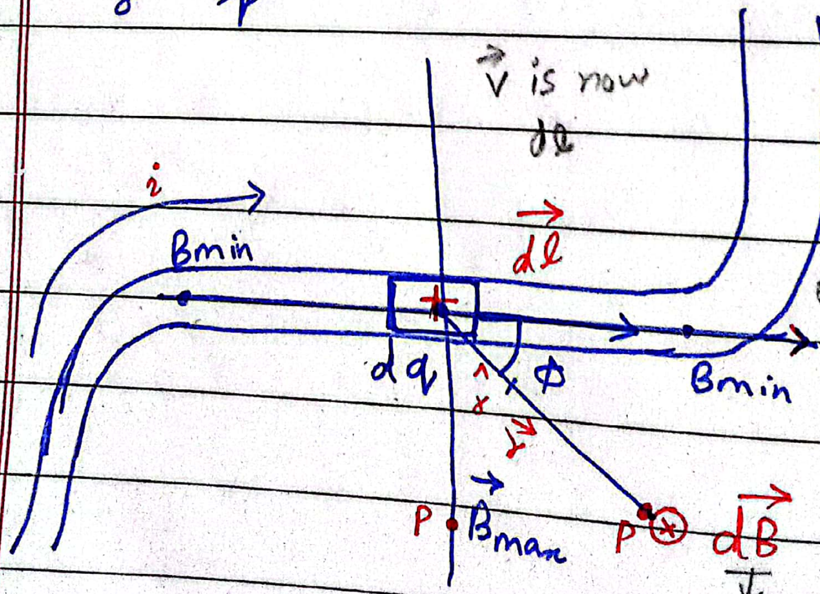
$$i = \frac{dq}{dt}, \quad \vec{v} = \frac{dl}{dt}$$

$$dB = \frac{K\,i\,dt \times \left(\frac{dl}{dt} \times \hat{r}\right)}{r^2}$$

$$\int dB = \int \frac{K\,i\,(dl \times \hat{r})}{r^2}$$

$$\vec{B} = K\,i \int \frac{dl \times \hat{r}}{r^2}$$ (Biot-savart law)





The direction of length dl is in direction of conventional current.

3)

Ampere's law:-

Drawback of Biot-Savart law:-

It is valid only for moving point charges, (ii) this discripency is removed by Ampere's law, which is highly symmetric.

Closed surface has two possible direction (i) clockwise (ii) anticlock wise.

→ integral over the closed line

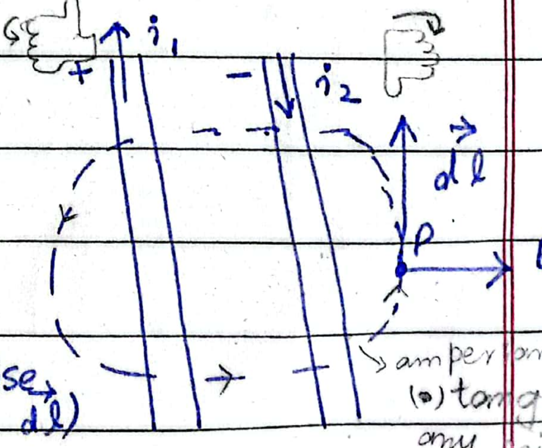
$$\oint_l \vec{B}\cdot d\vec{l} = \mu_0 i_{enc} \longrightarrow (i)$$

$\vec{B}$ ↓ on the amp loop; $d\vec{l}$ ↓ of the amperian loop; i_{enc} ↓ by amper loop

"Closed line integral of dot product of magnetic field & length of amperian loop $(d\vec{l})$ is equal to μ_0 $(4\pi \times 10^{-7})$ times current enclosed by the amperian loop."

(•) The direction of dl is same to the direction of conventional current $\vec{dl} = +\hat{i}$

The direction of Amperian loop is arbitrary. (random)



(•) tangent at any point give direction of amp loop

$$\oint_l \vec{B}\cdot d\vec{l} = \mu_0 i_{enc}$$

(for anticlockwise) $\theta = 0°$

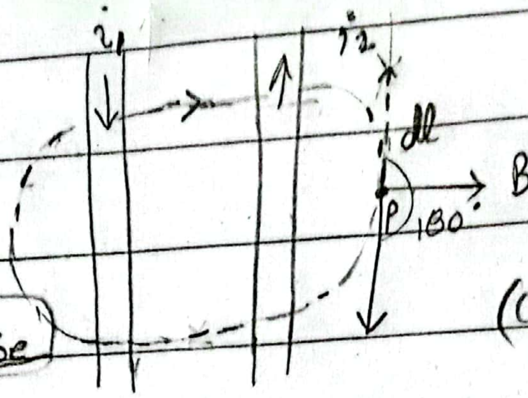
$$\oint_l B\,dl\cos\theta = \mu_0 (i_1 - i_2)$$

(anticlock wise of $\vec{dl}$)

4)

$\theta = 180$

$$-\oint_l \vec{B}\,d\vec{l} = \mu_0 \cdot (-i_1 + i_2) \quad \text{(clock wise)}$$



(comparre)

$\boxed{\text{for clockwise}}$

$\oint B \cdot dl \cos\theta = \mu_0 i_{en}$

$\oint_{\ell} B\, dl \cos 180^\circ = \mu_0 (i_2 - i_1) \Rightarrow -B\int dl = \mu_0(-i_1 + i_2)$

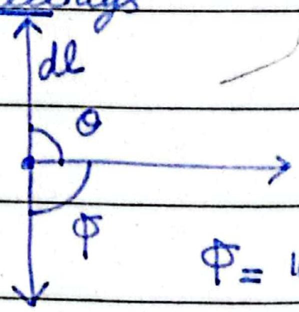
RHR-3:- b/w i & $\vec{dl}$ direction

Thumb i

curling fingers - if in direction of amp loop (positive current)

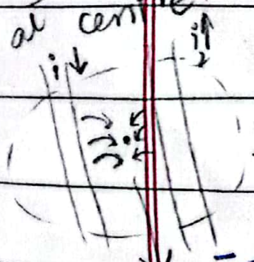
if reverse direction of amp loop (negative current)

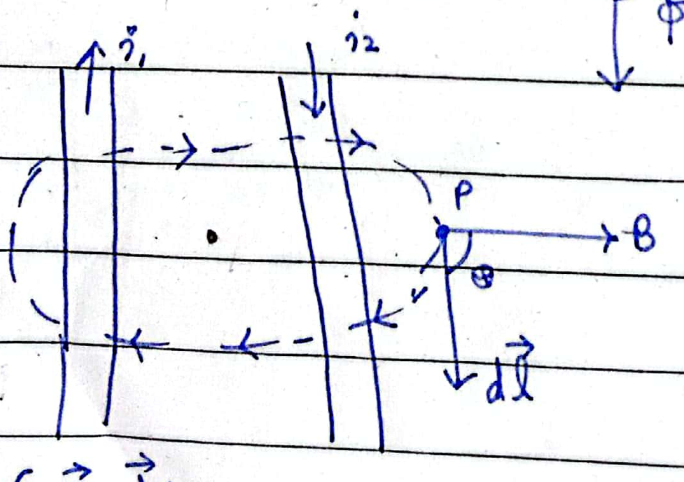
<u>Direction of $\vec{dl}$ is always arbitrary</u>. (clock wise & anticlock wise)



$\phi = 180 - \theta$

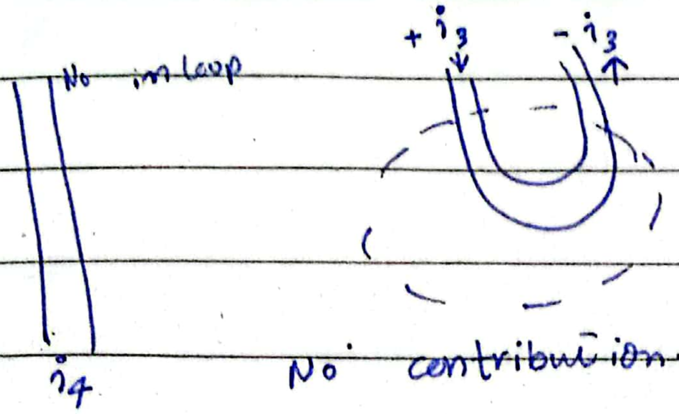
(c) at center B is reinforce





reinforce parallel

$-\oint_{dl} \vec{B} \cdot \vec{dl} = \mu_0(-i_1 + i_2)$



$+\cancel{i_3} - \cancel{i_3}$

Application of Ampere's law :-

A long straight wire :-

$$\oint_l \vec{B}\cdot\vec{dl} = \mu_0 i_{enc}$$

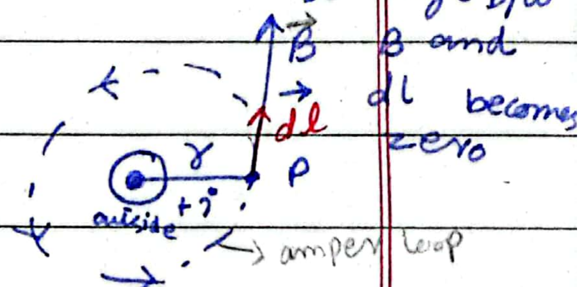
Two step
(i) angle
(ii) value of dl

$$\oint B\,dl\cos 0^\circ = \mu(+i)$$

$$B\underbrace{\oint dl}_{\text{length of amp loop}} = \mu_0(i)$$

$$B(2\pi r) = \mu_0 i$$

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



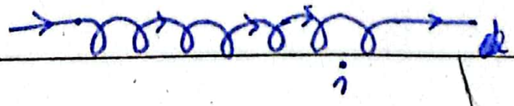
we can say dl anticlockwise so angle b/w B and dl becomes zero

لہٰذا اس میں dl کو ہم anti clock wise لیتے ہیں اس لیے $\vec{B}$ اور dl کے درمیان 0° angle ہے اور +i ہوگا۔ اگر ہم clock wise لیں تو −i آتا ہے۔

we take ampere loop in circle form because its magenetic field is like this directions mean $\vec{B}$ is in circular form we take amp loop in also circular form.

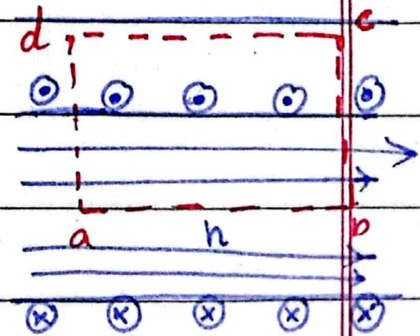
dl direction will tagent at any point on amp loop.

Solenoid :-



(i) inside $B \rightarrow$ constant
(ii) external $B \cong 0$

$$\vec{B}_{ex} \cong 0$$



$$= \oint_a^b B\,dl\cos 0^\circ + \int_b^{c} B\,dl\cos 90^\circ + \int_c^d \underbrace{B}_{0}\,dl\cos 0 + \int_d^a B\,dl\cos 90 = i_{en}\mu_0$$

Day:

Date:

$$\int_a^b B\,dl = \mu_0 i_{ence}$$

$$B\int_a^b dl = \mu_0 i_{enc}$$

$Bh = \mu_0 i_{ence} \rightarrow (i)$ $\quad$ $N \rightarrow$ no. of turns

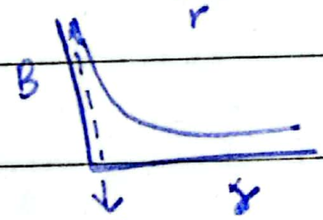
$i_{en} = Ni$ $\quad$ $\therefore n = \frac{N}{h} \Rightarrow N = nh$

$Bh = \mu_0 nh i$ (put in i)

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

$\boxed{B = \mu_0 n i}$

field is uniform inside in megnetic field.



Surface max B.

7) Teroid: (join the ends of spring)