CHIRANJIB DASH.

CLASS:- XII-DB, 9882

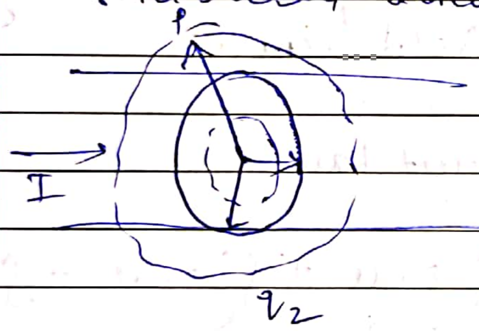
PHYSICS HOMEWORK



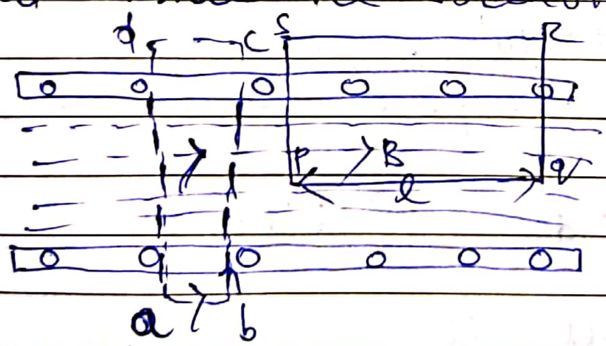
## Application of Ampere's law to find the magnetic field of solenoid & Toroid.

1) Ampere circuital law state that the line integral of magnetic field is always equal to $\mu$ times I

e.g:- Consider a long straight wire of a circular cross section with radius a carrying steady current I which is uniformly distributed across the cross section.




2) a) Field inside the solenoid




$$\oint_{pqrs} \vec{B}\cdot\vec{dl} = \int_{pq} \vec{B}\cdot\vec{dl} + \int_{qr} \vec{B}\cdot\vec{dl} + \int_{rs} \vec{B}\cdot\vec{dl} + \int_{sp} \vec{B}\cdot\vec{dl} \quad \text{--- (i)}$$

$\int_{pq} \vec{B}\cdot\vec{dl} = \int B\,dl = Bl$ (pq = l say)

$\int_{qr} \vec{B}\cdot\vec{dl} = \int_{sp} \vec{B}\cdot\vec{dl} = \int B\,dl \cos 90° = 0$

$\int_{rs} \vec{B}\cdot\vec{dl} = 0$

from eq(i)

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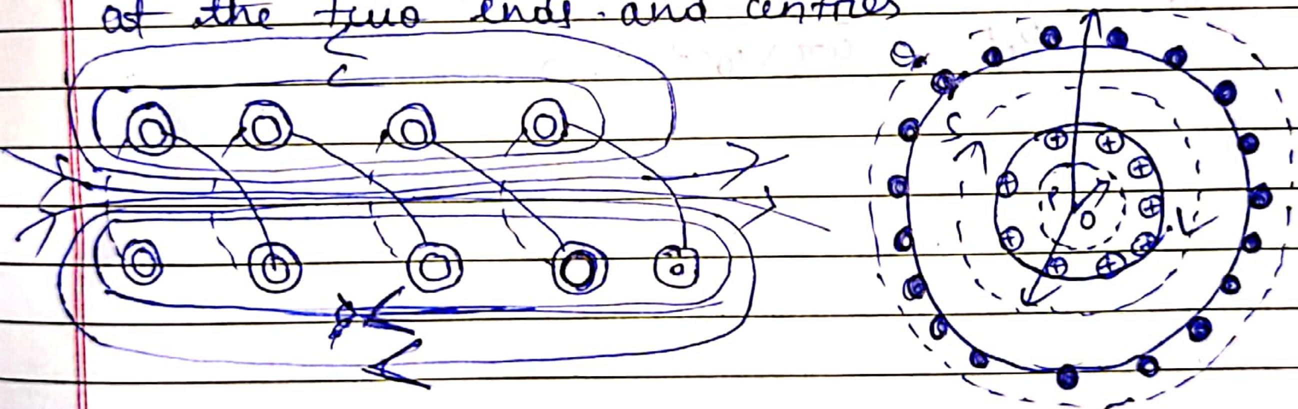
$\oint_{PQRS} \vec{B}\cdot\vec{dl} = \int_{PQ} \vec{B}\cdot\vec{dl} = Bl$

By Ampere's law $\oint \vec{B}\cdot\vec{dl} = \mu_0 \times$ net current enclosed by path

$\therefore Bl = \mu_0 (nIl) \quad \therefore B = \mu_0 nI$

b) In a toroid magnetic field lines donot ~~intersect~~ exist outside the body. Toroid is closed whereas solenoid is open on both sides. Magnetic field is uniform inside a toroid whereas for a solenoid, it is different at the two ends and centres



c) The magnetic field lines of toroid are circular having common centre. Inside a given solenoid the magnetic field may be made strong by

i) Passing large current
ii) using laminated coil of soft iron.

3) $n = 300$ turns/m

$I = 5A$

$l = 0.5m$

$r = 10^{-2} m$

$B = \mu_0 nI = (4\pi \times 10^{-7}) \times 300 \times 5$

$= 1.9 \times 10^{-3}$ T

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Q4) $B = 2.52 \times 10^{-3}\,T$

$\mu_0 = 4\pi \times 10^{-7}\,Hm^{-1}$

$l = 0.5\,m.$

$N = 500.$

The number of turns per unit length of solenoid

$n = \frac{N}{l} = \frac{500}{0.5} = 1000\,m^{-1}$

If 'i' is the current through the solenoid then

$B = \mu_0 n i$

or $i = \frac{B}{\mu_0 n} = \frac{2.52 \times 10^{-3}}{4\pi \times 10^{-7} \times 1000} = 2.0\,A$