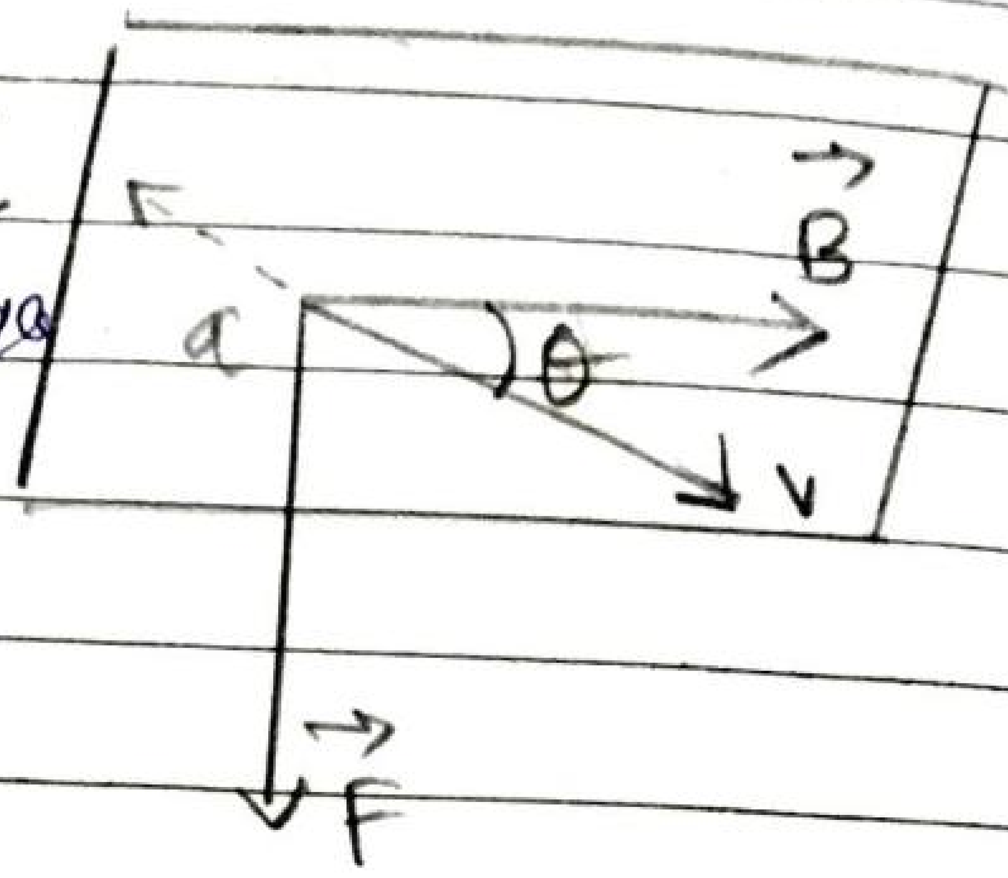
Where θ is the angle between $\vec{V}$ and $\vec{B}$

Special Cases -

1) If the charge is at rest i.e $v=0$ I then $F_m=0$ So, a stationary charge in a magnetic field does not experience any force.



II) If $\theta = 0°$ or $180°$ i.e if the charge moves parallel or anti parallel to the direction of the magnetic field, then $F_m = 0$.

Home Assignment-

1. State Ampere's circuit law. Show through an example, how this law enables an easy evalution of the magnitude magnetic field inside a very long Solenoid having n turns per unit length carrying a current I.

Ampere's circuital law states that the line integral of magnetic field $\vec{B}$ around any closed path in vacuum is μ_0 times the total current through the closed path.

Let n be the no. of turns per unit length.
Total no. of turns = nh.
Enclosed current is $I_e - I(nh)$

From Ampere's circuital law

$$Bl = \mu_0 I_e \qquad Bh = \mu_0 I(nh)$$

$$B = \mu_0 n I.$$

2. Answer the following.

a) Using Ampere's circuital law, obtain the expression for the magnetic field due to a long solenoid on its axis.

b) In what respect, is a toroid different from a solenoid? Draw and compare the pattern of the magnetic field lines in the two cases.

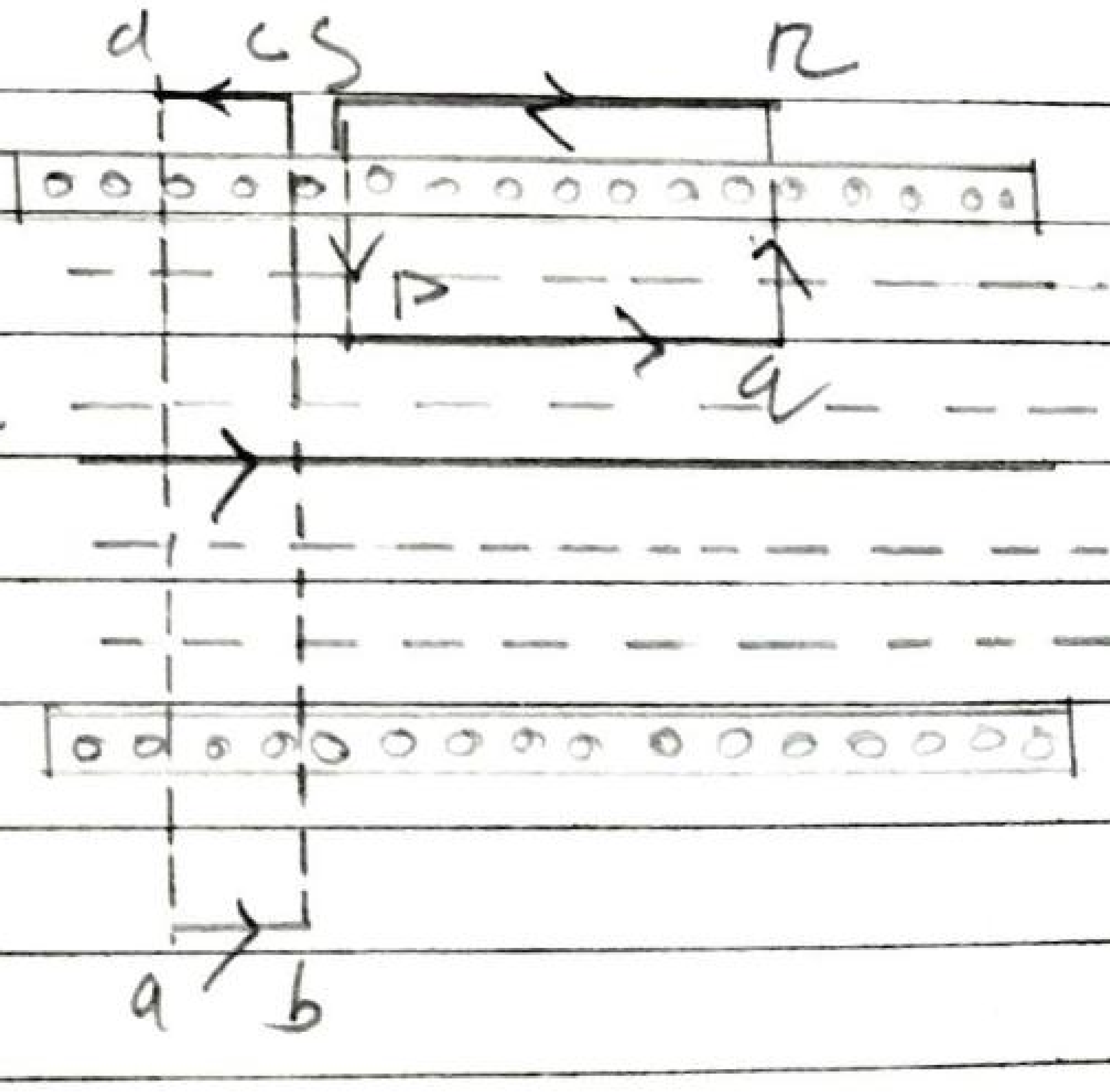
c) How is the magnetic field inside a given solenoid made strong?

Ans (a) $\oint \vec{B}\cdot\vec{dl} = \mu \times 0$.

$$\oint_{pqrs} \vec{B}\cdot\vec{dl} = \int_{pq}\vec{B}\cdot\vec{dl} + \int_{qr}\vec{B}\cdot\vec{dl} + \int_{rs}\vec{B}\cdot\vec{dl} + \int_{sp}\vec{B}\cdot\vec{dl}$$

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

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



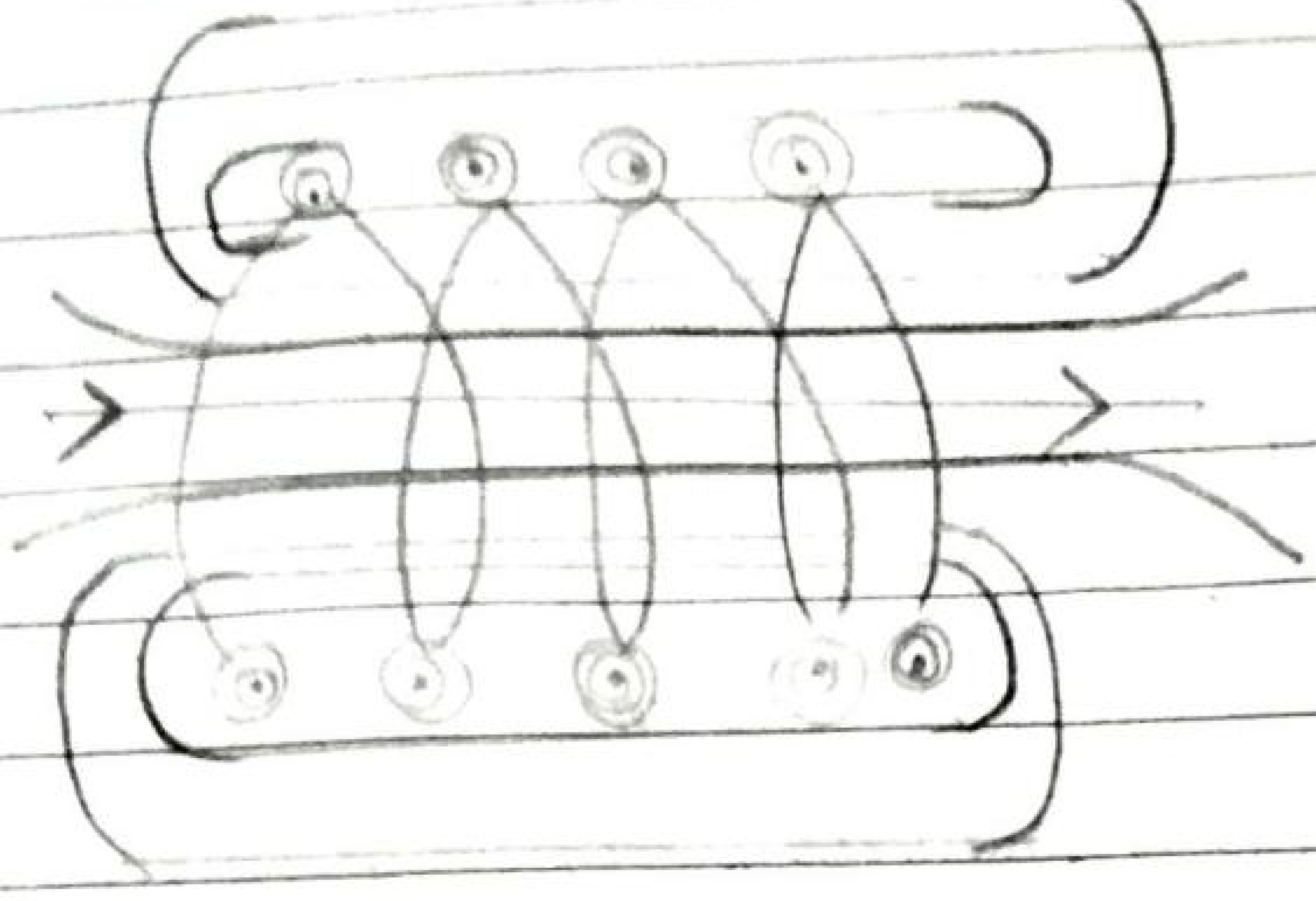
$$\oint_{pqrs}\vec{B}\cdot\vec{dl} = \int_{pq}\vec{B}\cdot\vec{dl} = BL$$

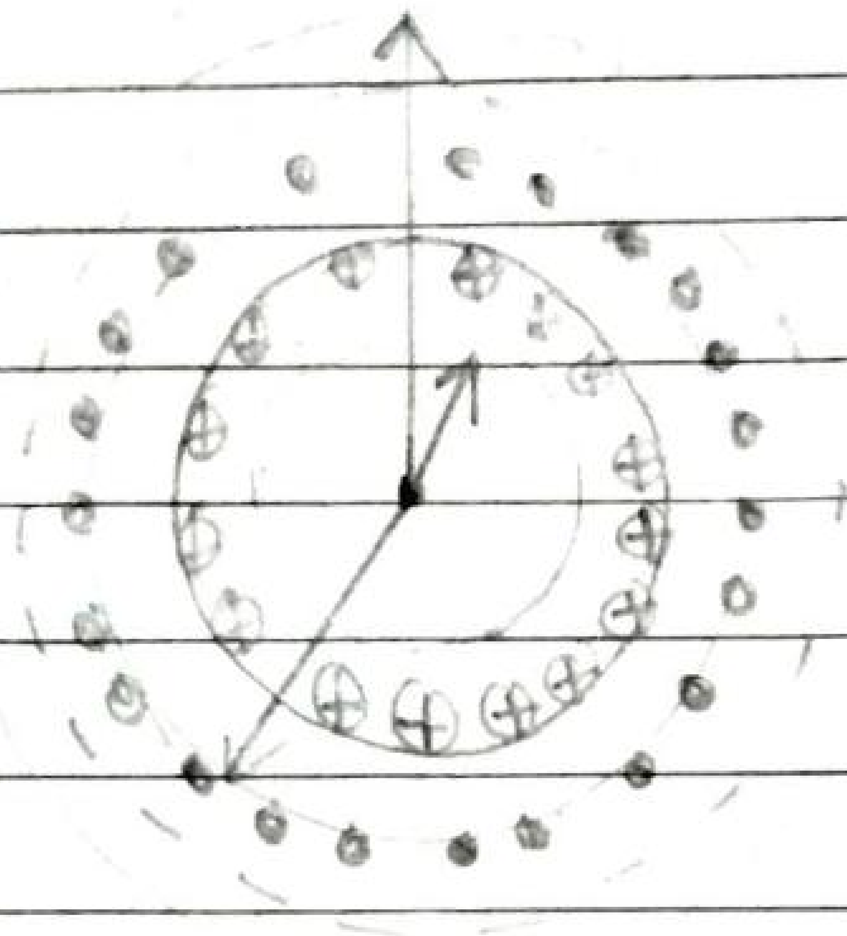
$$\oint \vec{B}\cdot\vec{dl} = \mu_0 I.$$

$$BL = \mu_0 (nl I)$$

$$B = \mu_0 n I.$$

(b) Magnetic lines do not exist outside the body of a toroid. Toroid is closed and Solenoid is open on both side. Magnetic field is uniform inside a toroid whereas, for a solenoid it is different at two ends and centre.





(c) The magnetic field is made strong by

i) passing large current and

ii) using Laminated coil of soft iron.

3. A Solenoid coil of 300 turns/m is carrying a current of 5A. The length of solenoid is 0.5 m and has a radius of 1cm. Find the ~~magnitude~~ magnetic field inside the solenoid.

Ans $n = 300 \quad i = 5A \quad L = 0.5m$

$r = 10^{-2} m.$

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

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

4. A 0.5m long Solenoid has 500 turns and has a flux density of 2.52×10^{-3} T at the center. Find the current in the solenoid Given $\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}.

Ans

$B = 2.52 \times 10^{-3}$ T. $\mu_0 = 4\pi \times 10^{-7}$.

$l = 0.5$ m $N = 500$.

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

$B = \mu_0 n i$

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

$= 2.0$ A.

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