8th July

Application of Ampere's law to find the magnetic field of solenoid and toroid

Class-XII
Subject: Physics
Ch-4
Chapter Name: Moving charges and magnetism

Ans1

According to Ampere's circuital law, the line integral of magnetic field induction along a closed curve is equal to the total current passing through the surface enclosed in the closed curve times the permeability of the medium.

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{enclosed}$$

Applying ampere's law for the given toroid,

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

But, $N = 2\pi r n$

$B = \mu_0 nI$

2) Answer the following questions :-

(a) Ampere's circuital law states that line integral of magnetic field around any closed loop is equal to μ_0 times the current flowing through the cross-section area enclosed by that loop.

Mathematically, $\oint B \cdot dl = \mu I$.

Let the steady current flowing in the solenoid having number of turns per unit length n be I. Magnitude of magnetic field inside

the solenoid is B while at outside is zero.

Now $\oint_{loop} B \cdot dl = \int B_{ab} \cdot L + \int B_{bc} \cdot L' + \int B_{cd} \cdot L + \int B_{da} \cdot L'$

The value of first term $\int B_{ab} \cdot L = BL$

The second and fourth term are zero because angle between magnetic field and the length loop is 90°

The third term is also zero as the value of magnetic field outside the solenoid is zero.

Total current flowing through the loop

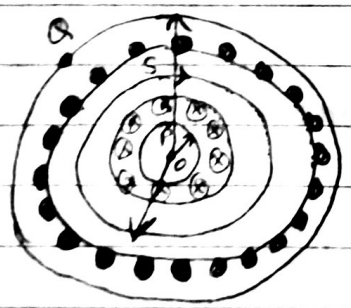
$$I_{total} = (nL)I$$

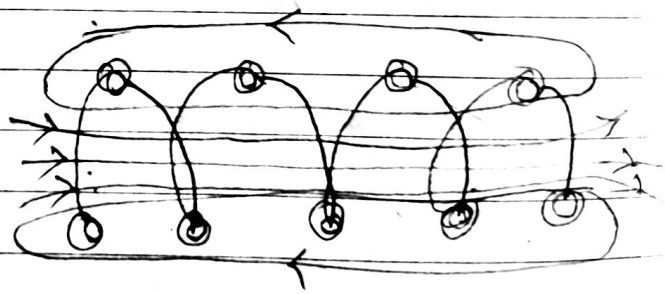
From Ampere's circuital law, we get $BL = \mu_0 (nLI)$

$$\Rightarrow B = \mu_0 n I$$

Ans b

A toroid is a solenoid bent into the form of a closed ring. The magnetic field lines of solenoid are straight lines parallel to the axis inside the solenoid.





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 and (ii) using laminated coil of soft iron.

Q3

Ans 3

given that :-

$n = 300$

$i = 5A$

$l = 0.5\,m$

$r = 0.1\,m$

$\frac{l}{r} = \frac{0.5}{0.1 \times 10^{-2}} = 100 \Rightarrow l >> r$

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

$= 6000 \times \pi \times 10^{-7} = 6\pi \times 10^{-4}$

$= 1.88 \times 10^{-3}\,T$

Ans 4

$B = \frac{\mu_0 N I}{l}$

$2.25 \times 10^{-3} = \frac{4\pi \times 10^{-7} \times 500 \times I}{0.5}$

$I = \frac{0.5 \times 2.25 \times 10^{-3}}{4\pi \times 10^{-7} \times 500}$

$\therefore I = 1.79 \approx 1.8\,A$