Theoretical Questions

1. Ampere's Circuital Law

Ampere's circuital law states that:

1. The line integral of the magnetic field around any closed loop is proportional to the total current passing through the loop.
2. The line integral of the electric field around any closed loop is proportional to the total current passing through the loop.
3. The surface integral of the magnetic field over any closed surface is zero.
4. The surface integral of the electric field over any closed surface is proportional to the total charge enclosed.

Correct Answer: 1

2. Applications of Ampere's Circuital Law

Ampere's circuital law is used to calculate the magnetic field due to:

1. A point charge.
2. A current-carrying straight wire.
3. A dipole.
4. A charged capacitor.

Correct Answer: 2

3. Magnetic Field Due to an Infinitely Long Wire

The magnetic field at a distance r from an infinitely long straight wire carrying current I is given by:

1. $B = \frac{\mu_0 I}{2\pi r}$
2. $B = \frac{\mu_0 I}{4\pi r}$
3. $B = \frac{\mu_0 I}{2r}$
4. $B = \frac{\mu_0 I}{4r}$

Correct Answer: 1

4. Magnetic Field Due to a Finite Wire

The magnetic field at a point perpendicular to the center of a finite wire of length L carrying current I is:

1. Directly proportional to L.
2. Inversely proportional to L.
3. Independent of L.
4. Directly proportional to L^2.

Correct Answer: 2

5. Magnetic Field Due to a Semi-Infinite Wire

The magnetic field at a point near the end of a semi-infinite wire carrying current I is:

1. Half the value of the magnetic field due to an infinitely long wire.
2. Twice the value of the magnetic field due to an infinitely long wire.
3. Equal to the magnetic field due to an infinitely long wire.
4. Zero.

Correct Answer: 1

Numerical Questions

6. Magnetic Field Due to an Infinitely Long Wire

An infinitely long straight wire carries a current of 5 A. What is the magnetic field at a distance of 10 cm from the wire? (Take $\mu_0 = 4\pi \times 10^{-7}\,\text{Tm/A}$)

1. $1 \times 10^{-5}\,\text{T}$
2. $2 \times 10^{-5}\,\text{T}$
3. $3 \times 10^{-5}\,\text{T}$
4. $4 \times 10^{-5}\,\text{T}$

Correct Answer: 2
Solution:

$$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 0.1} = 2 \times 10^{-5}\,\text{T}$$

7. Magnetic Field Due to a Finite Wire

A finite wire of length 2 m carries a current of 3 A. What is the magnetic field at a point 1 m away from the center of the wire and perpendicular to it? (Take $\mu_0 = 4\pi \times 10^{-7}\,\mathrm{Tm/A}$)

1. $1 \times 10^{-7}\,\mathrm{T}$
2. $2 \times 10^{-7}\,\mathrm{T}$
3. $3 \times 10^{-7}\,\mathrm{T}$
4. $4 \times 10^{-7}\,\mathrm{T}$

Correct Answer: 3
Solution:
For a finite wire,

$$B = \frac{\mu_0 I}{4\pi r}\left(\sin\theta_1 + \sin\theta_2\right)$$

. Here, $\theta_1 = \theta_2 = 45^\circ$, so

$$B = \frac{4\pi \times 10^{-7} \times 3}{4\pi \times 1}\left(\sin 45^\circ + \sin 45^\circ\right) = 3 \times 10^{-7}\,\mathrm{T}$$

.

8. Magnetic Field Due to a Semi-Infinite Wire

A semi-infinite wire carries a current of 4 A. What is the magnetic field at a point 5 cm away from the end of the wire? (Take $\mu_0 = 4\pi \times 10^{-7}\,\mathrm{Tm/A}$)

1. $1 \times 10^{-6}\,\mathrm{T}$
2. $2 \times 10^{-6}\,\mathrm{T}$
3. $3 \times 10^{-6}\,\mathrm{T}$
4. $4 \times 10^{-6}\,\mathrm{T}$

Correct Answer: 2
Solution:
For a semi-infinite wire,

$$B = \frac{\mu_0 I}{4\pi r} = \frac{4\pi \times 10^{-7} \times 4}{4\pi \times 0.05} = 2 \times 10^{-6}\,\mathrm{T}$$

.

9. Application of Ampere's Circuital Law

A long solenoid has 1000 turns per meter and carries a current of 2 A. What is the magnetic field inside the solenoid? (Take $\mu_0 = 4\pi \times 10^{-7}\,\text{Tm/A}$)

1. $2\pi \times 10^{-4}\,\text{T}$
2. $4\pi \times 10^{-4}\,\text{T}$
3. $6\pi \times 10^{-4}\,\text{T}$
4. $8\pi \times 10^{-4}\,\text{T}$

Correct Answer: 4
Solution:

$$B = \mu_0 n I = 4\pi \times 10^{-7} \times 1000 \times 2 = 8\pi \times 10^{-4}\,\text{T}$$

.

10. Magnetic Field Due to a Circular Loop

A circular loop of radius 0.1 m carries a current of 1 A. What is the magnetic field at the center of the loop? (Take $\mu_0 = 4\pi \times 10^{-7}\,\text{Tm/A}$)

1. $2\pi \times 10^{-6}\,\text{T}$
2. $4\pi \times 10^{-6}\,\text{T}$
3. $6\pi \times 10^{-6}\,\text{T}$
4. $8\pi \times 10^{-6}\,\text{T}$

Correct Answer: 1
Solution:

$$B = \frac{\mu_0 I}{2R} = \frac{4\pi \times 10^{-7} \times 1}{2 \times 0.1} = 2\pi \times 10^{-6}\,\text{T}$$

.