Chapter.4
Moving Charges and Magnetism
Class – XII
Subject – Physics

4.1. **A circular coil of wire consisting of 100 turns, each of radius 8.0 cm carries a current of 0.40 A. What is the magnitude of the magnetic field B at the centre of the coil?**

Sol.

Given:
N = 100
R = 8cm
I = 0.4 A

By the formula

$$B = \frac{\mu_o I N}{2R}$$

Substitution yields
B = $3.1\text{x}10^{-4}$ T

4.2. **A long straight wire carries a current of 35 A. What is the magnitudeof the field B at a point 20 cm from the wire?**

Sol.

Given:
I = 35 A
x = 20 cm

Let us consider an Amperian loop of radius equal to x, i.e. 20 cm
Therefore by formula

$$B = \frac{\mu_o I}{2\pi R}$$

Solving for B
B = 3.5×10^{-5} T

4.3. A long straight wire in the horizontal plane carries a current of 50 Ain north to south direction. Give the magnitude and direction of B at a point 2.5 m east of the wire.

Sol.

Given:
I = 50 A
R = 2.5 m

Using the above formula
B = 4×10^{-6} T
Direction is vertical up.

4.4. A horizontal overhead power line carries a current of 90 A in east towest direction. What is the magnitude and direction of the magnetic field due to the current 1.5 m below the line?

Sol.

Given:
I = 90 A
R = 1.5 m

Considering Amperian loop and using the above formula
B = $(2 \times 10^{-7}).(90) / 1.5$

Or $B = 1.2 \times 10^{-5}$ T
Direction is towards south.

4.5. What is the magnitude of magnetic force per unit length on a wirecarrying a current of 8 A and making an angle of 30° with the direction of a uniform magnetic field of 0.15 T?

Sol.

Given:
I = 8 A
angle = 30°
B = 0.15 T
l = 1m

The force is given by

$F = I.l.B.\sin\Theta$

Or $F = 8 \times 1 \times 0.15 \times 0.5$

Or $F = 0.6$ N / m

4.6. A 3.0 cm wire carrying a current of 10 A is placed inside a solenoidperpendicular to its axis. The magnetic field inside the solenoid is given to be 0.27 T. What is the magnetic force on the wire?

Sol.

Given:
l = 3 cm
I = 10 A
B = 0.27 T
$\Theta = 90°$

Then the force

F = I.l.B.sin Ө

Substituting the values give

F = 0.081 N

4.7. Two long and parallel straight wires A and B carrying currents of8.0 A and 5.0 A in the same direction are separated by a distance of 4.0 cm. Estimate the force on a 10 cm section of wire A.

Sol.

Given:

Ia = 8 A

Ib = 5 A

d = 4 cm

L = 10 cm

Force of wire A

$$F = \frac{\mu_o.Ia.Ib.L}{2\pi d}$$

Or

$F = 2x10^{-5}$ N

4.8. A closely wound solenoid 80 cm long has 5 layers of windings of 400turns each. The diameter of the solenoid is 1.8 cm. If the current carried is 8.0 A, estimate the magnitude of B inside the solenoid near its centre.

Sol.

Given:

L = 80 cm

N = 2000

r = 0.9
I = 8 A

Enclosed current Ie = 8 x 2000 = 16000 A
Since, BL = μ_oIe
Putting the values
B = μ_o.16000 / 0.8 = 0.025 T

4.9. A square coil of side 10 cm consists of 20 turns and carries a currentof 12 A. The coil is suspended vertically and the normal to the plane of the coil makes an angle of 30º with the direction of a uniform horizontal magnetic field of magnitude 0.80 T. What is the magnitude of torque experienced by the coil?

Sol.

Given:
L = 10 cm
N = 20
I = 12 A
ϴ = 30º
B = 0.8 T

We know
Torque = mB.sinϴ
Or T = NIABsinϴ
Or T = 20 x 12 x 0.1 x 0.1 x 0.8 x 0.5
Or T = 0.96 Nm

4.10. Two moving coil meters, M1 and M2 have the following particulars:
R1 = 10 Ω, N1 = 30,
A1 = 3.6 × 10–3 m2, B1 = 0.25 T
R2 = 14 Ω, N2 = 42,
A2 = 1.8 × 10–3 m2, B2 = 0.50 T

(The spring constants are identical for the two meters).
Determine the ratio of

a) **current sensitivity and**
b) **Voltage sensitivity of M2 and M1.**

Sol.

Given:

Details of M1
R1 = 10 ohms
N1 = 30
A1 = 3.6x10-3 m2
B1 = 0.25 T

Details of M2
R2 = 14 ohms
N2 = 42
A2 = 1.8x10-3 m2
B2 = 0.5 T

a) Current sensitivity of M
= N1.A1.B1 / k
Current sensitivity of M2
= N2.A2.B2 / k
Ratio of current sensitivity
= N2A2B2 / N1A1B1 (since k is identical)
= 0.0378 / 0.027
= 1.4

Thus ratio of current sensitivity of M2 and M1 is 1.4

b) Voltage sensitivity of M1
= N1.A1.B1 / k.R1
Voltage sensitivity of M2
= N2.A2.B2 / k.R2
Ratio of voltage sensitivity
= N2A2B2R1 / N1A1B1R2

= 0.378 / 0.378
= 1

Thus ratio of voltage sensitivity of M2 and M1 is 1.

4.11. In a chamber, a uniform magnetic field of 6.5 G (1 G = 10–4 T) is maintained. An electron is shot into the field with a speed of 4.8 × 106 m s–1 normal to the field. Explain why the path of the electron is a circle. Determine the radius of the circular orbit. (e = 1.6 × 10–19 C, me = 9.1×10–31 kg)

Sol.

Since the electron has velocity perpendicular to magnetic field B, the centripetal force (q.V x B) comes in action and a circular motion is described by electron perpendicular to the magnetic field.

Its radius is given by
$r = mv / qB$
Here
$m = 9.1 \times 10^{-31}$ kg
$v = 4.8 \times 10^{6}$ m / s
$q = 1.6 \times 10^{-19}$ C
$B = 6.5 \times 10^{-4}$ T

Substituting the values we get
r = 0.042 m

4.12. In Exercise 4.11 obtain the frequency of revolution of the electron in its circular orbit. Does the answer depend on the speed of the electron? Explain.

Sol.

Frequency of revolution, w = v / r
Or $2\pi f = 4.8x106 / 0.042$
Or f = 18 MHz
Frequency is independent of velocity.

4.13.

a) **A circular coil of 30 turns and radius 8.0 cm carrying a current of 6.0 A is suspended vertically in a uniform horizontal magnetic field of magnitude 1.0 T. The field lines make an angle of 60°with the normal of the coil. Calculate the magnitude of the counter torque that must be applied to prevent the coil from turning.**

b) **Would your answer change, if the circular coil in (a) were replaced by a planar coil of some irregular shape that encloses the same area? (All other particulars are also unaltered.)**

Sol.

Given:
N = 30
r = 8 cm
I = 6 A
B = 1T
Θ = 60°

a) We know
Torque = NIABsinΘ
Substituting the values
Torque = 3.13 Nm

b) No, the torque does not depend on configuration of loop.