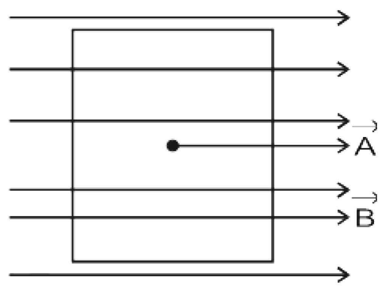
SHORT QUESTIONS

14.1 A plane conducting loop is located in a uniform magnetic field that is directed along the x-axis. For what orientation of the loop is the flux a maximum? For what orientation is the flux a minimum?

Ans. (i) When a conducting loop is held perpendicular to the magnetic field (vector area is parallel to the magnetic field) then $\theta = 0°$.



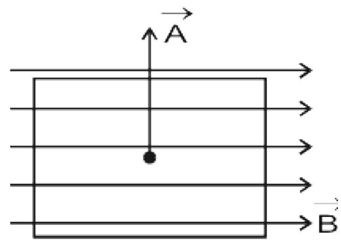
So, $\phi = \vec{B}.\vec{A}$

$= BA\cos\theta = BA\cos 0°$

$= BA$

Hence flux will be maximum when plane of conducting loop is held perpendicular to the field.

(ii) When the conducting loop is held parallel to the magnetic field (vector area is perpendicular to the field) then $\theta = 90°$.



So, $\phi = \vec{B}.\vec{A}$

$= BA\cos\theta$

$= BA\cos 90°$

$\phi = 0$

Hence flux will be minimum when plane of the conducting loop is held parallel to the field.

14.2 A current in a conductor produces a magnetic field, which can be calculated using Ampere's law. Since current is defined as the rate of flow of charge, what can you conclude about the magnetic field due to stationary charges? What about moving charges?

Ans. A stationary charge cannot produce any magnetic field but it produces only the electric field. Where as a moving charge can produce a magnetic field around the path of its motion similar to the magnetic field produced around the current carrying conductor.

14.3 Describe the change in the magnetic field inside a solenoid carrying a steady current I, if (a) the length of the solenoid is doubled but the number of turns remains the same and (b) the number of turns is doubled, but the length remains the same.

Ans. We know that the expression for the magnetic field produced by a solenoid is given by

$$B = \mu_0 nI$$

But $n = \frac{N}{L}$

$$B = \mu\frac{NI}{L} \qquad \text{...... (i)}$$

(a) Let B′ be the magnetic field when the length of the solenoid is doubled i.e., $L' = 2L$ and the number of turns, remains same.

Then $B' = \dfrac{\mu_0 NI}{2L}$

$B' = \dfrac{1}{2} \times \dfrac{\mu_0 NI}{L}$

i.e., $B' = \dfrac{\mu_0 NI}{L}$

$B' = \dfrac{1}{2} \times B$

Then $B' = \dfrac{B}{2}$

Hence the magnetic field becomes half if the length of solenoid becomes double but the number of turns remain, same.

(b) Let B' be the magnetic field when the number of turns is doubled i.e., $N' = 2N$ and the length remains same.

Then $B' = \dfrac{\mu_0 (2N)I}{L}$

$B' = 2\dfrac{\mu_0 NI}{L}$

Since $\dfrac{\mu_0 NI}{L} = B$

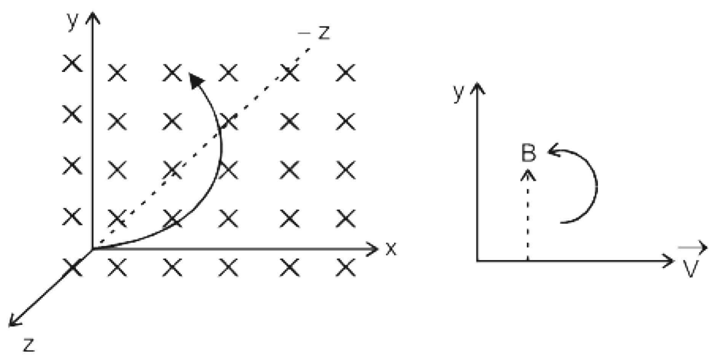
$B' = 2B$

Hence the magnetic field becomes double if the number of turns of the solenoid becomes doubled but length remains same.

14.4 At a given instant, a proton moves in the positive x-direction in a region where there is magnetic field in the negative z-direction. What is the direction of the magnetic force? Will the proton continue to move in the positive x-direction? Explain.

Ans. According to right hand rule, the direction of magnetic force is along y-axis. Because $\vec{F} = e(\vec{V} \times \vec{B})$

No, the proton will not continue to move in the positive x-direction but it will deflect towards y-axis and circulate in xy-plane.



14.5 Two charged particles are projected into a region where there is a magnetic field perpendicular to their velocities. If the charges are deflected in opposite directions, what can you say about them?

Ans. When the charge particles are projected across the magnetic field, experiences a force. This magnetic force on the charge particle tends to deflects the particles into a curved path. If the charge particles are deflected opposite to each other, then the particles are oppositely charged. That is, if one particle positively charged then other must be negatively charged.

14.6 Suppose that a charge q is moving in a uniform magnetic field with a velocity V. Why is there no work done by the magnetic force that acts on the charge?

Ans. The magnetic force on the charged particle moving in a magnetic field is given by

$$\vec{F}_m = q(\vec{V} \times \vec{B})$$

Due to the magnetic force, the charge particle will moves in a circular path. In circular path, the force $\vec{F}_m$ is perpendicular to the velocity $\vec{V}$. Hence magnetic force has done no work, i.e.,

$$W = \vec{F} . \vec{d}$$

$$W = Fd \cos \theta$$

But $\theta = 90°$ (The angle b/w $\vec{F}$ and $\vec{V}$ is 90°)

So, $W = Fd \text{ Cos}90°$

$$W = 0$$

So there is no work done by the magnetic force. This means that magnetic force is only a deflecting force.

14.7 If a charged particle moves in a straight line through some region of space, can you say that the magnetic field in the region is zero?

Ans. ***Case I:*** Yes the charge particle moves in a straight line if there is no external magnetic field.

Case II: No because the charge particle may be moving parallel or antiparallel to the externally applied magnetic field.

i.e., $\theta = 0°$ or $\theta = 180°$

As $F = qvB \sin \theta$

Since $\sin 0° = 0$

and $\sin 180° = 0$

Therefore $F = 0$

As there is no magnetic field acting on the charge particle so it will move in a straight line.

14.8 Why does the picture on a TV screen become distorted when a magnet is brought near the screen?

Ans. The picture on TV screen is due to the motion of charged particle (electron). As a magnet is brought close to the TV screen, the path of electron is disturbed due to the magnetic force acting on them they deflect and not hitting on the target. Hence the picture on TV screen is distorted.

14.9 Is it possible to orient a current loop in a uniform magnetic field such that the loop will not tend to rotate? Explain.

Ans. A current carrying loop when placed in a magnetic field experiences a torque.

i.e., $\tau = BINA \cos \alpha$

Where α is the angle between magnetic field $\vec{B}$ and plane of the loop.

When the plane of the loop is at right angle to the magnetic field i.e., $\alpha = 90°$.

$$\tau = BINA \cos 90°$$

$$\tau = 0$$

Hence the value of torque is zero so the loop will not tend to rotate.

14.10 How can a current loop be used to determine the presence of a magnetic field in a given region of space?

Ans. When a current carrying loop is placed in a uniform magnetic field, at different orientations a torque is produced in a loop. If the loop is deflected in that region then we can say that magnetic field is present due to torque otherwise not.

14.11 How can you use a magnetic field to separate isotopes of chemical element?

Ans. The isotopes of an element are projected perpendicular to the uniform magnetic field. Then they follow different circular path due to difference in their masses in **mass spectrograph apparatus**. So according to formula for e/m of

$$\frac{e}{m} = \frac{V}{rB}$$

$$r = \frac{mV}{eB}$$

where $\frac{V}{eB}$ is constant so

$$r \propto m$$

So isotopes of different masses will have different radii and thus they can be separated by a magnetic field.

14.12 What should be the orientation of a current carrying coil in a magnetic field so that torque acting upon the coils is (a) maximum (b) minimum?

Ans. The torque acting on rectangular coil of area A, magnetic field B, and current I, when placed in a magnetic field is given by

$$\tau = BINA \cos \alpha$$

where α is the angle between plane of coil and magnetic field.

(a) When the plane of the coil is parallel to the magnetic field, i.e., $\alpha = 0°$

$$\tau = BINA \cos 0$$

$$\tau = BINA$$

So the torque will be maximum.

(b) When the plane of the coil is perpendicular to the magnetic field i.e., $\alpha = 90°$. So,

$$\tau = BINA \cos 90°$$

$$\tau = 0$$

So the torque acting upon the coil is minimum.

14.13 A loop of wire is suspended between the poles of a magnet with its plane parallel to the pole faces. What happens if a direct current is put through the coil? What happens if an alternating current is used instead?

Ans. As plane of the coil is parallel to the pole faces i.e., plane of the coil is perpendicular to the magnetic field i.e., $\alpha = 90°$.

So, $\tau = BINA \cos 90°$

$\tau = 0$

Hence for both A.C and D.C, the coil will not tend to rotate.

14.14 Why the resistance of an ammeter should be very low?

Ans. In order to measure the current ammeter is always connected in series therefore the its resistance should be very low so that it does not disturb the circuit.

14.15 Why the voltmeter should have a very high resistance?

Ans. In order to measure the potential differences voltmeter is always connected in parallel to the circuit. Therefore, its resistance should be very large so that it does not draw any current through the circuit.