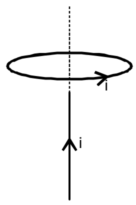
OBJECTIVE - I

1. A vertical wire carries a current in upward direction. An electron beam sent horizontally towards the wire will be deflected
(A) towards right (B) towards left (C*) upwards (D) downwards

Sol. **C**

2. A current-carrying, straight wire is kept along the axis of a circular loop carrying a current. The straight wire
(A) will exert an inward force on the circular loop
(B) will exert an outward force on the circular loop
(C*) will not exert any force on the circular loop
(D) will exert a force on the circular loop parallel to itself.

Sol. **C**



The straight wire will not exert any force on the circular loop.

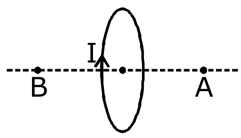
$F = i\,(\vec{L} \times \vec{B})$

3. A proton beam is going from north to south and an electron beam is going from south to north. Neglection the earth's magnetic field, the electron beam will be deflected
(A*) towards the proton beam (B) away from the proton beam
(C) upwards (D) downwards

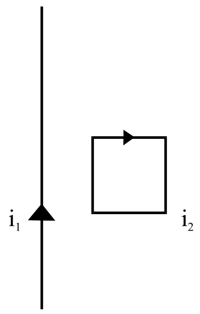
Sol. **A**
Proton contain the +ve charge & electron contain the -ve charge. So the electron beam will be deflected towards the proton beam.

4. A circular loop is kept in that vertical plane which contains the north-south direction. It carries a current that is towards north at the topmost point. Let A be a point on axis of the circle to the east of it and B a point on this axis to the west of it. The magnetic field due to the loop
(A) is towards east at A and towards west at B
(B) is towards west at A and towards east at B
(C) is towards east at both A and B
(D*) is towards west at both A and B

Sol. **D**
Current goes in the clockwise direction.
Þ Curled the fingers along the direction of current
then the streached thumb will points towards the magnetic field.



5. Consider the situation shown in fig. The straight wire is fixed but the loop can move under magnetic force. The loop will -

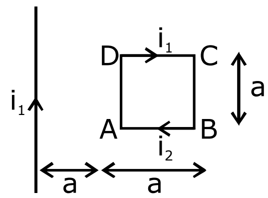


(A) remain stationery (B*) move towards the wire
(C) move away from the wire (D) rotate about the wire

Sol. **B**

F Þ force per unit length
L Þ Lenght of the segment of loop
B Þ Magnetic field.
Force on the side AB & DC is equal & opposite in direction to i_1.
Force on AD Þ

$F_{AD} = \frac{M_0 i_1 i_2 a}{2\pi d}$ towards the wire (west direction)



Force on BC

$F_{BC} = \frac{\mu_0 i_1 i_2 a}{2\pi(d+a)}$ towards the East direction

Net force on the loop due to wire

$F_{net} = F_{AD} + F_{BC} + F_{AB} + F_{DC}$

$$= \frac{\mu_0 i_1 i_2 a}{2\pi d} \frac{-\mu_0 i_1 i_2 a}{2\pi(d+a)} + F_{AB} - F_{AB}$$

$$F_{net} = \frac{\mu_0 i_1 i_2 a^2}{2\pi d(d+a)}$$

$$= \frac{\mu_0 i_1 i_2 a}{2\pi}\left(\frac{1}{d} - \frac{1}{(d+a)}\right)$$

$F_{net} = \frac{\mu_0 i_1 i_2 a}{2\pi d(d+a)}$ towards the wire

So the Loop will move towards the wire.

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

$F = qvB\sin\theta$

angle between v & B is zero
So F = 0

6. A charge particle is moved along a magnetic field line. The magnetic force on the particle is
(A) along its velocity (B) magnetic field only (C) both of them (D*) none of them

7. A moving charge produces
(A) electric field only (B) magnetic filed only (C*) both of them (D) none of these

Sol. **C**
A moving charge produces electric field as well as Magnetic field.

8. A particle is projected in a plane perpendicular to a uniform magnetic field. The area bounded by a the path described by the particle is proportional to
(A) the velocity (B) the momentum (C*) the kinetic energy (D) none of these

Sol. **C**

$$r = \frac{mv}{qB} \quad , \quad \text{area} = pr^2 = \pi\left(\frac{mv}{qB}\right)^2 = \frac{\pi m^2}{q^2B^2}v^2$$

Þ area $\propto v^2$ & K.E. $\propto v^2$

9. Two particles X and Y having equla charge, after being acceleration through the same potential difference circular paths of radii R_1 and R_2 respectively. The ratio of the mass of X to that of Y is -
,
(A) $(R_1/R_2)^{1/2}$ (B) R_1/R_2 (C*) $(R_1/R_2)^2$ (D) R_1R_2

Sol. **C**

$$r = \frac{mv}{qB} \Rightarrow v = \frac{qrB}{m}$$

$$v_x = \frac{qR_1B}{m_1} \Rightarrow \text{velocity of 'x' particle}$$

$$v_y = \frac{qR_2B}{m_2} \Rightarrow \text{velocity of 'y' particle}$$

They accelerated through same potential difference mean their K.E. is same.

$$\frac{1}{2}m_1v_x^2 = \frac{1}{2}m_2v_y^2$$

$$\frac{1}{2}m_1\frac{q^2R_1^2B^2}{m_1^2} = \frac{1}{2}m_2\frac{q^2R_2^2B^2}{m_2^2}$$

$$\frac{R_1^2}{m_1} = \frac{R_2^2}{m_2}$$

$$\text{ratio of } \frac{\text{mass of x}}{\text{mass of y}} = \frac{m_1}{m_2} = \left(\frac{R_1}{R_2}\right)^2$$

10. Two parallel wires carry currents of 20 A and 40 A in opposite directions. Another wire carrying a current antiparallel to 20 A is placed midway between the two wires. The magnetic force on it will be
(A) towards 20 A (B*) towares 40 A (C) zero (D) perpendicular to the plane of the current

Sol. **B**
Þ Magnetic field direction due to (20A & 40A) wire is downward direction according to midway wire.

$$F = I\left(\vec{L} \times \vec{B}\right)$$

Magnetic force on midway wire due to Both (20A & 40A) wire is towards 40 A wire.

11. Two parallel, long wires carry currents i_1 and i_2 with $i_1 > i_2$. When the current are in the same direction, the magnetic field at a point midway between the wire is 10mT. If the direction of i_2 is reversed, the field becomes 30mT. The ratio $\frac{i_1}{i_2}$ is -

(A) 4 (B) 3 (C*) 2 (D) 1

Sol. **C**

Magnetic field on the mid way wire due to i_1& i_2 is Þ $\frac{\mu_0 i_1}{2\pi d} - \frac{\mu_0 i_2}{2\pi d} = 10\mu T$ ....(i)

Magnetic field on the mid way wire due to i_1& i_2 is Þ $\frac{\mu_0 i_1}{2\pi d} + \frac{\mu_0 i_2}{2\pi d} = 30\mu T$ ....(ii)

From equation (i) & (ii) we get :-

$\frac{2\mu_0 i_1}{2\pi d} = 40\mu$ & $\frac{2\mu_0 i_2}{2\pi d} = 20\mu$

$i_1 = \frac{(40\mu)\pi d}{\mu_0}$ & $i_2 = \frac{(20\mu)\pi d}{\mu_0}$

ratio of $\frac{i_1}{i_2} = 2$

12. Consider a long, straight wire of cross-section area A carrying a current i.Let there be n free electrons per unit volume. An observer places himself on a trolley moving in the direction opposite to the current with a speed u = (i/nAe) and separated from the wore bu a distance r. The magnetic field seen by the observer is very nearly

(A*) $\frac{\mu_0 i}{2\pi r}$ (B) zero (C) $\frac{\mu_0 i}{\pi r}$ (D) $\frac{2\mu_0 i}{\pi r}$

Sol. **A**

Magnetic field due to long wire carrying a current $i = \frac{\mu_0 i}{2\pi r}$

OBJECTIVE - II

1. The magnetic field at the origin due to a current element i $d\vec{\ell}$ placed at a position $\vec{r}$ is -

(A) $\frac{\mu_0 i}{4\pi}\frac{d\vec{l}\,x\vec{r}}{r^3}$ (B) $-\frac{\mu_0 i}{4\pi}\frac{d\vec{l}\,x\vec{r}}{r^3}$ (C*) $-\frac{\mu_0 i}{4\pi}\frac{\vec{r}\,x d\vec{l}}{r^3}$ (D*) $-\frac{\mu_0 i}{4\pi}\frac{d\vec{l}\,x\vec{r}}{r^3}$

Sol. **CD**

$\vec{B} = \frac{\mu_0 i}{4\pi}\left(\frac{d\vec{l}\times\vec{r}}{r^3}\right)$ Þ When id$\vec{l}$ placed at a position $\vec{r}$ then magnetic field.

$\because \vec{A}\times\vec{B} = -\vec{B}\times\vec{A}$ (By property of the cross product)

$\therefore \vec{B} = -\frac{\mu_0 i}{u\pi}\frac{d\vec{l}\times\vec{r}}{r^3}$

2. Consider three quantities x = E/B, y = Ö1/m$_o$e$_o$ and z = l / CR. Here, l is the length of a wire, C is a capacitance and R is a resistance. All other symbols have standard meanings

(A*) x, y have the same dimensions. (B*) y, z have the same dimensions
(C*) z, x have the same dimensions (D) None of the three pairs have the same dimensions

Sol. **ABC**

Force$_1$ = qE
Force$_2$ = qvB
Dimension of Force$_1$ = Dimension of Force$_2$

[qE] = [qvB]

$x = \left[\frac{E}{B}\right] v - (i)\{v \Rightarrow \text{velocity}\}$

Þ $y = \sqrt{\frac{1}{\mu_0 \in_0}} = c - (iii)\{c \Rightarrow \text{velocity light}\}$

Þ RC Þ gives the lime constant of the RC circuit

Þ $z = \frac{l}{RC} = \frac{l}{t} = \text{velocity}$ ....(iv)

3. A long, straight wire carries a current along the Z-axis. One can find two points in the X-Y plane such that

(A) the magnetic fields are equal
(B*) the directions of the magnetic fields are the same
(C*) the magnitudes of the magnetic fields are equal
(D*) the field at one point is opposite to that at the other point
,

Sol. **BCD**

4. A long, straight wire of radius R carries a current distrobuted uniformly over its cross-section. The magnitude of the magnetic field is

(A) maximum at the axis of the wire (B*) minimum at the axis of the wire
(C*) maximum at the surface of the wire (D) minimum at the surface of the wire.

Sol. **AC**

The magnitude of the Magnetic field is maximum at the surface of the wire.

$B_A = \frac{\mu_0 i}{2\pi d}$

The magnitude of the Magnetic field is nimumum at axis of the wire.

$B_0 = 0$

5. A hollow tube is carrying an electric current along its length distributed uniformly over its surface. The magnetic field

(A) increases linearly from the axis to the surface
(B*) is constant inside the tube
(C*) is zero at the axis
(D) is zero just outside the tube

Sol. **BC**

Þ The magnetic field is constant inside the current carrying hollow tube. (due to Ampere's Law)

Þ The magnetic field is zero at the axis of current carrying hollow tube.

6. In a coaxial, straight cable, the central conductor and the outer conductor carry equal currents in opposite directions. The magnetic field is zero.

(A*) outside the cable
(B) inside the inner conductor
(C) inside the outer conductor
(D) in between the two conductors.

Sol. **A**

The magnetic field is zero outside the cable due to Ampere's Law.

$\int B \cdot \overline{dl} = \mu_0 i_{inside}$

Magnetic field at distance 'r' is Þ

$\int B \cdot 2\pi r = \mu_0 (i - i) = 0$

$B = 0$

7. A steady electric current is flowing through a cylindrical conductor.

(A) the electric field at the axis of the conductor is zero
(B*) the magnetic field at the axis of the conductor is zero
(C*) the electric field in the vicinity of the conductor is zero
(D) the magnetic field in the vidinity of the conductor is zero

Sol. **BC**

Þ The magnetic field at tha axis of the cylindrical conductor is zero.
Þ The electric field in the vinicinity of the conductor is zero by the Gauss Law.