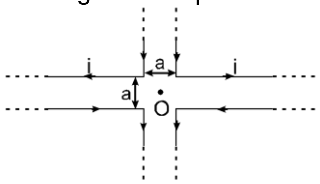
Self Practice Paper (SPP)

1. Four infinitely long 'L' shaped wires, each carrying a current i have been arranged as shown in the figure. Obtain the magnetic field strength at the point 'O' equidistant from all the four corners.

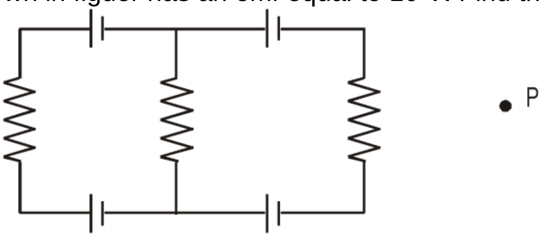


(1) 0 (2) $\frac{\mu_0 i}{2\pi a}$ (3) $\frac{2\mu_0 i}{\pi a}$ (4) $\frac{\mu_0 i}{\pi a}$

2. Find the magnetic field B at the centre of a square loop of side 'a', carrying a current i.

(1) $\frac{2\sqrt{2}\mu_0 i}{\pi a}$ (2) $\frac{\sqrt{2}\mu_0 i}{\pi a}$ (3) $\frac{2\mu_0 i}{\pi a}$ (4) $\frac{\mu_0 i}{2\pi a}$

3. Each of the batteries shown in figuer has an emf equal to 10 V. Find the magnetic field B at the point p.



(1) 0 T (2) 2 T (3) 3 T (4) 5 T

4. A charged particle is accelerated through a potential difference of 24 kV and acquires a speed of 2×10^6 m/s. It is then injected perpendicularly into a magnetic field of strength 0.2 T. Find the radius of the circle described by it.

(1) 12 cm (2) 10 cm (3) 6 cm (4) 4 cm

5. In the formula $X = 3\, YZ^2$, the quantities X and Z have the dimensions of capacitance and magnetic induction respectively. The dimensions of Y in the MKS system are............. **[JEE - 88]**

(1) $M^{-3} L^{-2} T^4 Q^4$ (2) $M^{-3} L^{-2} T^2 Q^4$ (3) $M^{-2} L^{-2} T^4 Q^4$ (4) (1) $M^{-3} L^{-4} T^4 Q^4$

6. A particle having a charge of 2.0×10^{-8} C and a mass of 2.0×10^{-10} g is projected with a speed of 2.0×10^3 m/s in a region having a uniform magnetic field (B = 0.1 T). Find the radius of the circle formed by the particle and also the frequency.

(1) 20 cm, $\frac{5}{\pi}\times10^3 s^{-1}$ (2) 10 cm, $\frac{5}{\pi}\times10^3 s^{-1}$ (3) 20 cm, $\frac{2}{\pi}\times10^3 s^{-1}$ (4) 20 cm, $\frac{4}{\pi}\times10^3 s^{-1}$

7. A proton describes a circle of radius 1 cm in a magnetic field of strength 0.10 T. What would be the radius of the circle described by an deuterium moving with the same speed in the same magnetic field?

(1) 2 cm (2) 4 cm (3) 6 cm (4) 8 cm

8. A proton is projected with a velocity of 3×10^6 m/s perpendicular to a uniform magnetic field of 0.6T. Find the acceleration of the proton mass of proton = $\frac{5}{3}\times10^{-27}$ kg

(1) $\frac{864}{5}\times10^{11}$ m/s^2 (2) $\frac{864}{5}\times10^{10}$ m/s^2

(3) $\frac{864}{5}\times10^{14}$ m/s^2 (4) $\frac{864}{5}\times10^{12}$ m/s^2

9. A particle having a charge of 5.0 μC and a mass of 5.0 × 10^{-12} kg is projected with a speed of 1.0 km/s in a magnetic field of magnitude 5.0 mT. The angle between the magnetic field vector and the velocity vector is $\sin^{-1}$ (0.90). Show that the path of the particle will be a helix. Find the diameter of the helix and its pitch.
(1) 47 cm, 67 cm (2) 36 cm, 56 cm (3) 56 cm, 67 cm (4) 57 cm, 58 cm

10. A proton projected in a magnetic field of 0.04 T travels along a helical path of radius 5.0 cm and pitch 20 cm. Find the components of the velocity of the proton along and perpendicular to the magnetic field. Take the mass of the proton = 1.6 × 10^{-27} kg.
(1) $\frac{4}{\pi} \times 10^5$ m/s, 2×10^5 m/s (2) $\frac{2}{\pi} \times 10^5$ m/s, 2×10^5 m/s
(3) $\frac{4}{\pi} \times 10^5$ m/s, 4×10^5 m/s (2) $\frac{2}{\pi} \times 10^5$ m/s, 4×10^5 m/s

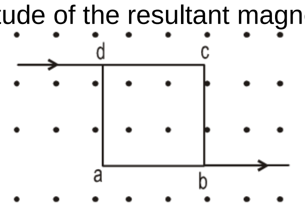
11. A particle moves in a circle of radius 1.0 cm under the action of a magnetic field of 0.40 T. An electric field of 200 V/m makes the path straight. Find the charge/mass ratio of the particle.
(1) $\frac{5}{4} \times 10^5$ C/kg (2) $\frac{5}{3} \times 10^5$ C/kg (3) $\frac{5}{8} \times 10^5$ C/kg (4) $\frac{8}{5} \times 10^5$ C/kg

12. A proton goes undeflected in a crossed electric and magnetic field (the fields are perpendicular to each other) at a speed of 10^5 m/s. The velocity is perpendicular to both the fields. When the electric field is switched off, the proton moves along a circle of radius 2 cm. Find the magnitudes of the electric and the magnetic fields. Take the mass of the proton = 1.6 × 10^{-27} kg.
(1) 2×10^3 N/C. 5×10^{-2} T (2) 5×10^3 N/C. 5×10^{-1} T
(3) 5×10^3 N/C. 5×10^{-2} T (4) 5×10^3 N/C. 5×10^{-3} T

13. A particle having mass m and charge q is released from the origin in a region in which electric field and magnetic field are given by $\vec{B} = +B_0\hat{j}$ and $\vec{E} = +E_0\hat{i}$. Find the speed of the particle as a function of its X-coordinate.
(1) $\sqrt{\frac{2qE_0x}{m}}$ (2) $\sqrt{\frac{qE_0x}{2m}}$ (3) $\sqrt{\frac{qE_0x}{4m}}$ (4) $\sqrt{\frac{qE_0x}{m}}$

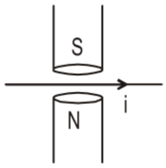
14. Consider a 10 cm long portion of a straight wire carrying a current of 10 A placed in a magnetic field of 0.1 T making an angle of 37º with the wire. What magnetic force does the wire experience?
(1) 6×10^{-1} N (2) 6×10^{-2} N (3) 6×10^{-3} N (4) 6×10^{-4} N

15. A current of 2 A enters at the corner d of a square frame abcd of side 10 cm and leaves at the opposite corner b. A magnetic field B = 0.1 T exists in the space in direction perpendicular to the plane of the frame as shown in figure. Find the magnitude of the resultant magnetic force on the four sides of the frame.



(1) 1×10^{-2} N (2) 2×10^{-2} N (3) $\sqrt{2} \times 10^{-2}$ N (4) $2\sqrt{2} \times 10^{-2}$ N

16. A magnetic field of strength 1.0 T is produced by a strong electromagnet in a cylindrical region of diameter 4.0 cm as shown in figure. A wire, carrying a current of 2.0 A, is placed perpendicular to and intersecting the axis of the cylindrical region. Find the magnitude of the force acting on the wire.



(1) 4×10^{-2} N (2) 16×10^{-2} N (3) 32×10^{-2} N (4) 8×10^{-2} N

17. A wire of length l carries a current i along the y-axis. A magnetic field exists which is given as $\vec{B} = B_0(\hat{i} + \hat{j} + \hat{k})T$. Find the magnitude of the magnetic force acting on the wire.

(1) $\sqrt{2}B_0 i\ell$ (2) $2\sqrt{2}B_0 i\ell$ (3) $3\sqrt{2}B_0 i\ell$ (4) $4\sqrt{2}B_0 i\ell$

18. A straight, long wire carries a current of 20 A. Another wire carrying equal current is placed parallel to it. If the force acting on unit length of the second wire is 2.0×10^{-4} N, what is the separation between them?

(1) 20 cm (2) 40 cm (3) 60 cm (4) 80 cm

19. A circular coil of 100 turns has an effective radius 0.05 m and carries a current of 0.1 amp. How much work is required to turn it in an external magnetic field of 1.5 wb/m^2 through 180^0 about an axis perpendicular to the magnetic field. The plane of the coil is initially perpendicular to the magnetic field.

[REE - 86]

(1) $\pm 50\pi \times 10^{-3}$ J (2) $\pm 75\pi \times 10^{-3}$ J (3) $\pm 45\pi \times 10^{-3}$ J (4) $\pm 35\pi \times 10^{-3}$ J

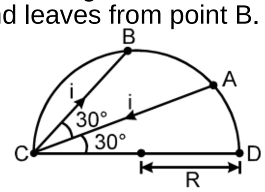
20. A rectangular coil of 100 turns has length 4 cm and width 5 cm. It is placed with its plane parallel to a uniform magnetic field and a current of 2A is sent through the coil. Find the magnitude of the magnetic field B, if the torque acting on the coil is 0.2 N-m.

(1) $\frac{1}{2}$T (2) $\frac{1}{4}$T (3) $\frac{1}{8}$T (4) $\frac{1}{3}$T

21. A point charge is moving in a circle with constant speed. Consider the magnetic field produced by the charge at a fixed point P (not centre of the circle) on the axis of the circle.

(1) it is constant in magnitude only
(2) it is constant in direction only
(3) it is constant in direction and magnitude both
(4) it is not constant in magnitude and direction both.

22. A current carrying wire is placed in the grooves of an insulating semi circular disc of radius 'R', as shown. The current enters at point A and leaves from point B. Determine the magnetic field at point



(1) $\frac{\mu_0 I}{8\pi R\sqrt{3}}$ (2) $\frac{\mu_0 I}{4\pi R\sqrt{3}}$ (3) $\frac{\sqrt{3}\,\mu_0 I}{4\pi R}$ (4) none of these

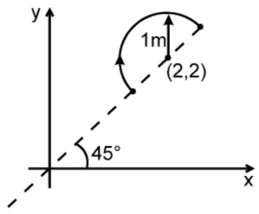
23. Axis of a solid cylinder of infinite length and radius R lies along y-axis it carries a uniformly distributed current 'i' along +y direction. Magnetic field at a point $\left(\frac{R}{2}, y, \frac{R}{2}\right)$ is :-

(1) $\frac{\mu_0 i}{4\pi R}(\hat{i} - \hat{k})$ (2) $\frac{\mu_0 i}{2\pi R}(\hat{j} - \hat{k})$ (3) $\frac{\mu_0 i}{4\pi R}\hat{j}$ (4) $\frac{\mu_0 i}{4\pi R}(\hat{i} + \hat{k})$

24. A long, straight wire carries a current along the Z-axis. One can not find two points in the X-Y plane such that

(1) the magnetic fields are equal in magnitude and same in direction
(2) the directions of the magnetic fields are the same
(3) the magnitudes of the magnetic fields are equal
(4) the field at one point is opposite to that at the other point.

25. A uniform magnetic field $\vec{B} = \left(3\hat{i} + 4\hat{j} + \hat{k}\right)$ exists in region of space. A semicircular wire of radius 1 m carrying current 1 A having its centre at (2, 2, 0) is placed in x-y plane as shown in fig. The force on semicircular wire will be

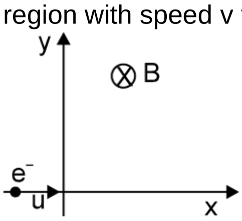


(1) $\sqrt{2}(\hat{i}+\hat{j}+\hat{k})$ (2) $\sqrt{2}(\hat{i}-\hat{j}+\hat{k})$ (3) $\sqrt{2}(\hat{i}+\hat{j}-\hat{k})$ (4) $\sqrt{2}(-\hat{i}+\hat{j}+\hat{k})$

26. A proton of mass 1.67×10^{-27} kg and charge 1.6×10^{-19} C is projected with a speed of 2×10^6 m/s at an angle of 60° to the x-axis. If a uniform magnetic field of 0.104 T is applied along the y-axis, the path of the proton is : **[JEE - 95]**

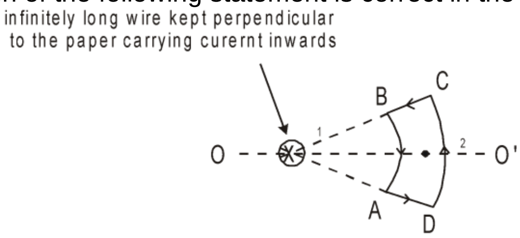
(1) A circle of radius 0.2 m and time period $\pi \times 10^{-7}$ s
(2) A circle of radius 0.1 m and time period $2\pi \times 10^{-7}$ s
(3) A helix of radius 0.1 m and time period $2\pi \times 10^{-7}$ s
(4) A helix of radius 0.2 m and time period $4\pi \times 10^{-7}$ s

27. An electron traveling with a speed u along the positive x-axis enters into a region of magnetic field where $B = -B_0\,\hat{k}$ (x > 0). It comes out of the region with speed v then **[JEE 2004 (Screening) 3/84]**



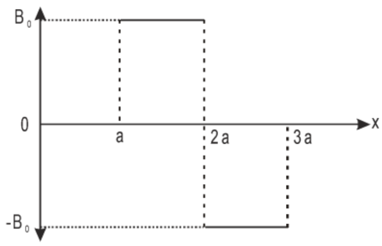
(1) v = u at y > 0 (2) v = u at y < 0 (3) v > u at y > 0 (4) v > u at y < 0

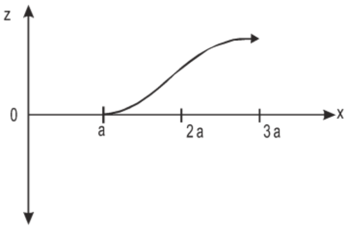
28. Which of the following statement is correct in the given figure. **[JEE 2006 ; +5,-1/35]**

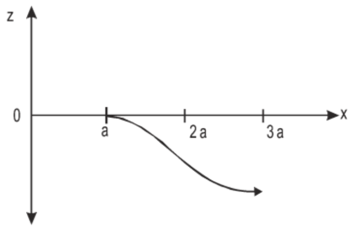


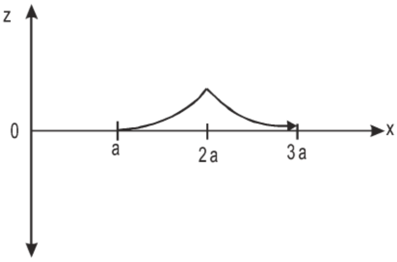
(1) net force on the loop is non-zero (2) net torque on the loop is zero
(3) loop will rotate clockwise about axis OO' when seen from O
(4) loop will rotate anticlockwise about OO' when seen from O

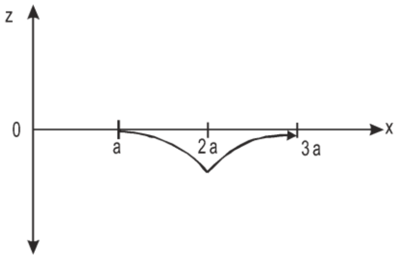
29. A magnetic field $\vec{B} = B_0\hat{j}$ exists in the region a < x < 2a and $\vec{B} = -B_0\hat{j}$, in the region 2a < x < 3a, where B_0 is a positive constant. A positive point charge moving with a velocity $\vec{V} = v_0\hat{i}$, where v_0 is a positive constant, enters the magnetic field at x = a. The trajectory of the charge in this region can be like. **[JEE - 2007' +3, -1/162]**



(1)


(2)


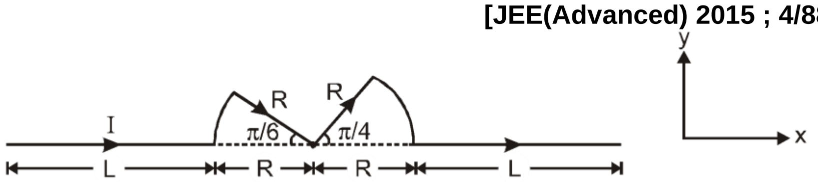
(3)


(4)


30. A particle of mass M and positive charge Q, moving with a constant velocity $\vec{u}_1 = 4\hat{i}\ ms^{-1}$, enters a region of uniform static magnetic field normal to the x-y plane. The region of the magnetic field extends from x = 0 to x = L for all values of y. After passing through this region, the particle emerges on the other side after 10 milliseconds with a velocity $\vec{u}_2 = 2\left(\sqrt{3}\,\hat{i} + \hat{j}\right)$ ms^{-1}. The correct statement(s) is (are) : **[JEE-2013]**

(1) The direction of the magnetic field is –x direction.
(2) The direction of the magnetic field is +z direction
(3) The magnitude of the magnetic field $\frac{50\pi M}{3Q}$ units.
(4) The magnitude of the magnetic field is $\frac{100\pi M}{3Q}$ units.

31. A conductor (shown in the figure) carrying contant current I is kept in the x-y plane in a uniform magnetic field $\vec{B}$. IF F is the magnitude of the total magnetic force acting on the conductor, then the incorrect statement is: **[JEE(Advanced) 2015 ; 4/88, –2]**



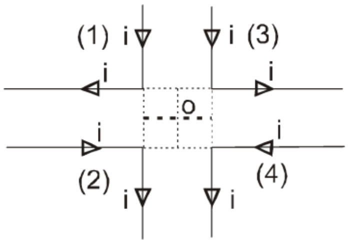
(1) If $\vec{B}$ is along $\hat{z}$, F ∝ (L + R)
(2) If $\vec{B}$ is along $\hat{x}$, F = 0
(3) If $\vec{B}$ is along $\hat{y}$, F ∝ (L + R)
(4) If $\vec{B}$ is along $\hat{z}$, F = 0

SPP Answers

1.	(1)	**2.**	(1)	**3.**	(1)	**4.**	(1)	**5.**	(1)	**6.**	(1)	**7.**	(1)
8.	(4)	**9.**	(2)	**10.**	(1)	**11.**	(1)	**12.**	(3)	**13.**	(1)	**14.**	(2)
15.	(4)	**16.**	(4)	**17.**	(1)	**18.**	(2)	**19.**	(2)	**20.**	(1)	**21.**	(1)
22.	(2)	**23.**	(1)	**24.**	(1)	**25.**	(2)	**26.**	(3)	**27.**	(2)	**28.**	(3)
29.	(1)	**30.**	(3)	**31.**	(4)								

SPP Solutions

1.



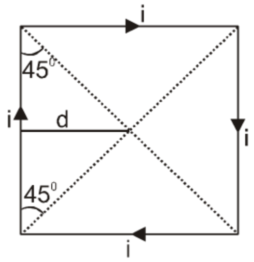
$B_{\text{due to(1)}} = B_{\text{due to (2)}} = B_{\text{due to(3)}} = B_{\text{due to (4)}}$

$B_{\text{due to(1)}}$ & $B_{\text{due to (2)}}$ are in same direction out of paper

$B_{\text{due to(3)}}$ & $B_{\text{due to (4)}}$ are into the paper

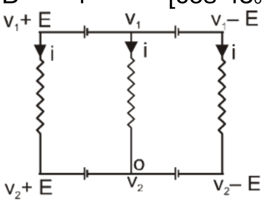
So $B_{Net} = 0$ Ans.

2.



$B = 4\,\frac{\mu_0 i}{4\pi d}\,[\cos 45^0 + \cos 45^0] = 4\,\frac{\mu_0 i}{4\pi \frac{a}{2}}\,[2 \times \frac{1}{\sqrt{2}}] = 2\sqrt{2}\,\frac{\mu_0 i}{\pi a}$ into the plane of paper .

3.



Junction rule at o gives

$i + i + i = 0$

i . e . $i = 0$

So No current flows in any section. Hence B = 0 At pt. P

4. $qV = \frac{1}{2} mv^2$

$qvB = \frac{mv^2}{r}$

$\frac{q}{m} = \frac{v^2}{2V}$

$$r = \frac{mv}{qB} = \frac{v}{B} \times \frac{2V}{v^2} = \frac{2V}{Bv} = 12cm \quad \text{Ans.}$$

5. $x = 3yz_2$

$$[y] = \frac{[x]}{[z]^2} = \frac{Q^2M^{-1}L^{-2}T^2}{[MQ^{-1}T^{-1}]^2} = M_{-3}L_{-2}T_4Q_4 \quad \textbf{Ans.}$$

6. $r = \frac{mv}{qB} = \frac{2\times10^{-10}\times10^{-3}2\times10^{3}}{2\times10^{-8}\times0.1} = 0.2m$

$$f = \frac{1}{T} = \frac{V}{2\pi r} = \frac{5}{\pi} \times 10_3 \text{ /s.} \quad \text{Ans.}$$

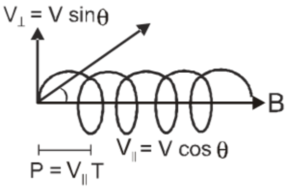
7. A proton describes a circle of radius 1 cm in a magnetic field of strength 0.10 T. What would be the $r = \frac{mv}{qB}$

$\left(\frac{m}{q}\right)_D = 2\left(\frac{m}{q}\right)_P$

$r_D = 2r_P = 2cm$ Ans.

8. $f = qVB$

$$a = \frac{f}{m} = \frac{qVB}{m} = \frac{864}{5} \times 10_{12} \text{ m/s}_2$$



9.

$$r = \frac{mV_\perp}{qB} = \frac{5\times10^{-12}\times1\times10^{3}\times0.9}{5\times10^{-6}\times5\times10^{-3}} = 18cm \quad \textbf{Ans.}$$

Diameter = 36cm

$$T = \frac{2\pi r}{V_\perp} = \frac{2\pi m}{qB}$$

$$P = V\cos\theta \times \frac{2\pi r}{V\sin\theta} = 2\pi \cot\theta\, r = 56cm. \quad \textbf{Ans.}$$

10. $r = \frac{mV_\perp}{qB}$

$$V_\perp = \frac{qBr}{m} = \frac{1.6\times10^{-19}\times0.04\times0.05}{1.67\times10^{-27}} \approx 2\times10_5 \text{ m/s} \quad \text{Ans.}$$

$$P = V_{||}\frac{2\pi r}{V_\perp}$$

$$V_{||} = \frac{P\times V_\perp}{2\pi r} = \frac{4}{\pi}\times 10_5 \text{ m/s} \quad \text{Ans.}$$

11. $r = \frac{mV}{qb}$

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

As, $qE = qVB$

$E = VB$

$$\frac{q}{m} = \frac{E}{rB^2}$$

$$= \frac{5}{4} \times 10^5 \text{ C/kg Ans.}$$

12. $V = \frac{E}{B}$

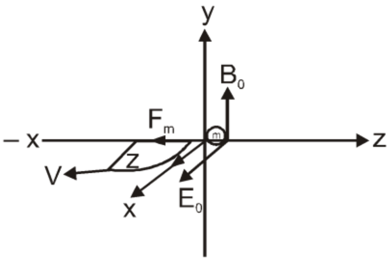
$$r = \frac{mV}{qB}$$

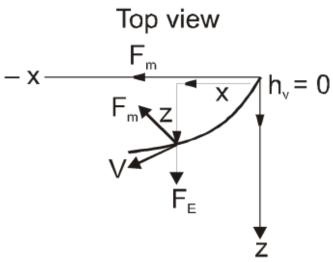
$$B = \frac{mV}{rq}$$

$$= \frac{1.6\times10^{-27}\times2\times10^{5}}{4\times10^{-2}\times1.6\times10^{-19}}$$

$$= 5 \times 10^{-2} \text{ T}$$ Ans.

$E = VB = 5 \times 10^3$ N/C



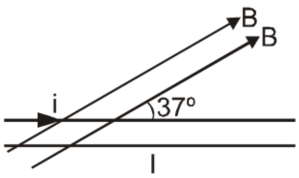


13.

$W_E = \Delta k$

$$qE_0x = \frac{1}{2} mV^2 - 0$$

$$V = \sqrt{\frac{2qE_0x}{m}}$$ Ans.



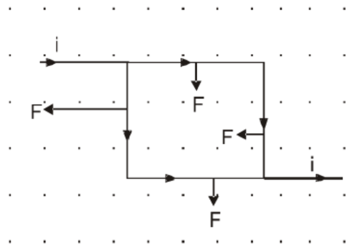
14.

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

$F = BiL \sin\theta$

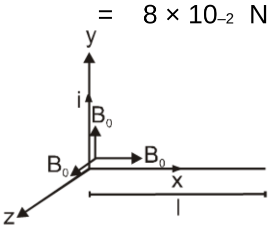
$$= 0.1 \times 10 \times 0.1 \times \frac{3}{5}$$

$$= 6 \times 10^{-2} \text{ N}$$

15. 

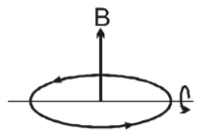
$$F = B\frac{i}{2}l$$
$$= 0.1 \times 1 \times 0.1$$
$$= 1 \times 10^{-2}\ N \qquad \text{Ans.}$$

16. $F = BiL \qquad L = 2r$
$$= Bi\,(2r)$$
$$= 1 \times 2 \times 4 \times 10^{-2}$$
$$= 8 \times 10^{-2}\ N$$

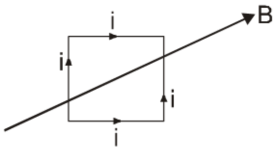
17. 

$$\vec{F} = i[\vec{l} \times \vec{B}]$$
$$= B_0 il\,[\hat{j} \times (\hat{i} + \hat{j} + \hat{k})]$$
$$= B_0 il\,[-\hat{k} + \hat{i}]$$
$$F = \sqrt{2}\,B_0 il \qquad \textbf{Ans.}$$

18. $\dfrac{\mu_0 i_1 i_2}{2\pi d} = \dfrac{F}{l} \Rightarrow \quad = 2\times10^{-7} \times \dfrac{20\times20}{d} = 2 \times 10^{-4}$
$$= 2 \times 10^{-4}$$
$$d = 40\ \text{cm.}$$

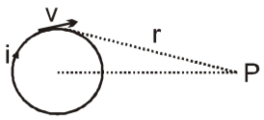
19. 

$U_i = -MB$
$U_f = +MB$
or $U_i = +MB$
$U_f = -MB$
$W = \Delta U = 2MB = 2 \times Ni\,\pi r^2 B$
$W = \pm 75\pi \times 10^{-3}\ J$

20. 

$\tau = MB$
$0.2 = iNL\,bB$
$$B = \frac{0.2}{100\times2\times5\times4\times10^{-4}} = 0.5\ T$$

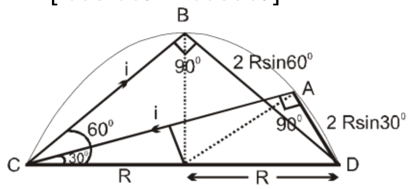
21. $\vec{B} = \frac{\mu_0}{4\pi}\frac{q(\vec{v}\times\vec{r})}{r^3}$



Magnitude fixed but direction keeps on changing

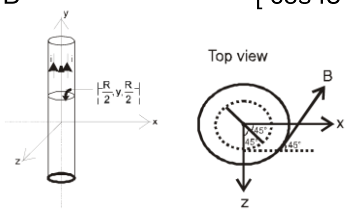
22. $B_{\text{due to AC}} = \frac{\mu_0 i}{4\pi\, 2R\sin 30^0}$ [cos 30₀ + cos90₀] = $\frac{\mu_0 i\sqrt{3}}{8\pi R}$

$B_{\text{due to BC}} =$ [cos 60₀ + cos90₀]



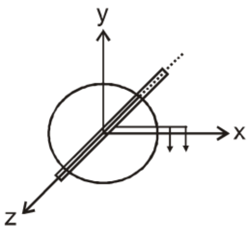
$= \frac{\mu_0 i}{8\pi R\sqrt{3}}$ $\quad B_{\text{Net}} = B_{\text{due to AC}} - B_{\text{due to BC}} = \frac{\mu_0 i}{4\pi R\sqrt{3}}$ (B)

23. $B = \dfrac{\frac{\mu_0 i}{\pi R^2}\times\pi\left(\frac{R}{\sqrt{2}}\right)^2}{2\pi\ \sqrt{2}\frac{R}{2}}$ $[\cos 45°\,\hat{i} - \cos 45°\,\hat{k}]$



$= \frac{\mu_0 i^2}{4\pi R}(\hat{i} - \hat{k})$ Ans. (A)

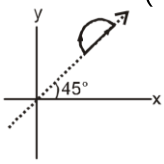
24.



Take any two points along x - axis, direction of B is same .
Take any two points on a circle, magnitude of B is same .
Take two diametrically opposite points field are in opposite directions .

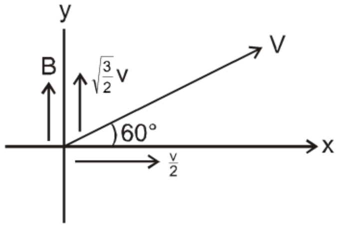
25. $\vec{B} = 3\hat{i} + 4\hat{j} + \hat{k}$

$\vec{l} = \frac{2}{\sqrt{2}}(\hat{i} + \hat{j})$



$\vec{F} = I(\hat{i} \times \vec{B}) = \sqrt{2}\,[\hat{i}\,(+\hat{j}) \times (3\hat{i} + 4\hat{j} + \hat{k})] = \sqrt{2}\,(\hat{i} - \hat{j} + \hat{k})$ Ans. (B)

26. Helix $\dfrac{m\left(\frac{v}{2}\right)^2}{r} = q\left(\dfrac{v}{2}\right)B$



$r = \dfrac{mv}{2qB} = \dfrac{1.67 \times 10^{-27} \times 2 \times 10^{6}}{2 \times 1.6 \times 10^{-19} \times 0.104} = 0.1$ m

$T = \dfrac{2\pi r}{\frac{v}{2}} = \dfrac{2\pi \times 10^{-1}}{10^{6}} = 2\pi \times 10^{-7}$

27. Magnetic force does not change the speed of charged particle. Hence, v = u. Further magnetic field on the electron in the given condition is along negative y–axis in the starting. Or it describes a circular path in clockwise direction. Hence, when it exists from the field, y < 0.
Therefore, the correct option is (4).

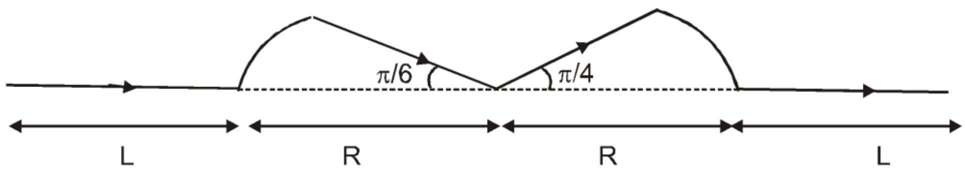
28. Magnetic force on wire BC would be perpendicular to the plane of the loop along the outward direction and on wire DA the magnetic force would be along the inward normal, so net force on the wire loop is zero and torque on the loop would be along the clockwise sence as seen from O.

29. Magnetic field in the region a < x < 2a will turn the particle towards positive Z-axis while the magnetic field in the region 2a < x < 3a will exert force in opposite direction. The turning is smooth because the magnetic force is NOT impulsive.

30. Component of final velocity of particle is in positive y direction.
Centre of circle is present on positive y axis. so magnetic field is present in negative z-direction
Angle of deviation is 30° because

$\tan\theta = \dfrac{v_y}{v_x} = \dfrac{1}{\sqrt{3}}$

$\theta = \dfrac{\pi}{6} \Rightarrow \omega t = \theta \Rightarrow \theta = \dfrac{QB}{M}t \Rightarrow B = \dfrac{M\theta}{Qt} \Rightarrow B = \left(\dfrac{50M\pi}{3Q}\right)$



31.
$\vec{F} = i\left(\vec{\ell} \times \vec{B}\right) = i\{2(L + R)\,\hat{i} \times \vec{B}\}$

If $\vec{B}$ is along $\hat{z}$

$\vec{F} = [i\,2(L + R)B]\left(-\hat{j}\right)$

If $\vec{B}$ is along $\hat{x}$

$\vec{F} = 0$

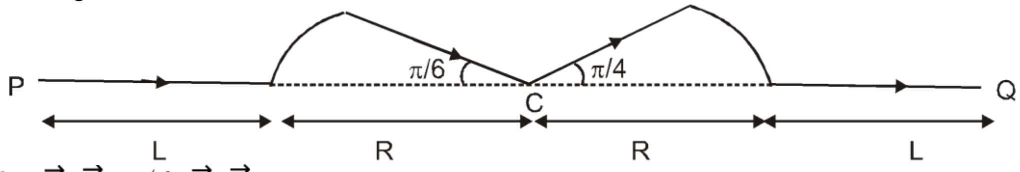
If $\vec{B}$ is along $\hat{y}$

$\vec{F} = i\left\{2(L+R)B)\hat{k}\right\}$

Alternate solution

$d\vec{F} = i\left(d\vec{\ell} \times \vec{B}\right)$

In unfirom magnetic field



$\int d\vec{F} = \int i\left(d\vec{\ell} \times \vec{B}\right) = i\left(\int d\vec{\ell} \times \vec{B}\right)$

$\Rightarrow \quad \vec{F} = i\left(\vec{PQ} \times \vec{B}\right)$

(1) F = [i 2(L + R)B] = 2iB (L + R)
(2) F = 0
(3) F = [i 2(L + R)B] = 2iB (L + R)
(4) F = [i 2(L + R)B] = 2iB (L + R)