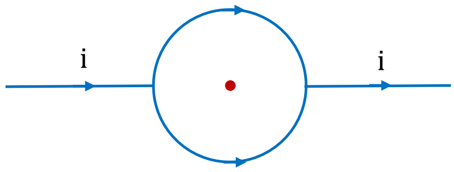
# EXERCISE - O

## SINGLE CORRECT TYPE QUESTIONS

### *Biot-Savart Law and Ampere's Law*

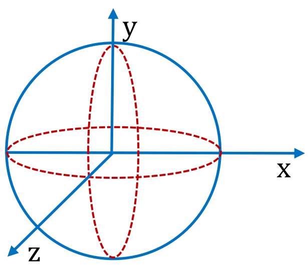
**1.** A conducting circular loop of radius $a$ is connected to two long, straight wires. The straight wires carry a current $i$ as shown in figure. Find the magnetic field $B$ at the centre of the loop.




(A) zero (B) $\frac{\mu_0 I}{2a}$ (C) $\frac{\mu_0 I}{a}$ (D) $\frac{\mu_0 I}{a}+\frac{\mu_0 I}{2\pi a}$

**PMG084**

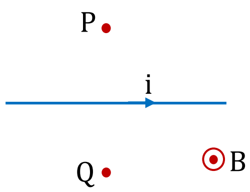
**2.** Three rings, each having equal radius $R$, are placed mutually perpendicular to each other and each having its centre at the origin of co-ordinate system. If current $I$ is flowing through each ring then the magnitude of the magnetic field at the common centre is




(A) $\sqrt{3}\frac{\mu_0 I}{2R}$ (B) zero (C) $\left(\sqrt{2}-1\right)\frac{\mu_0 I}{2R}$ (D) $\left(\sqrt{3}-\sqrt{2}\right)\frac{\mu_0 I}{2R}$

**PMG086**

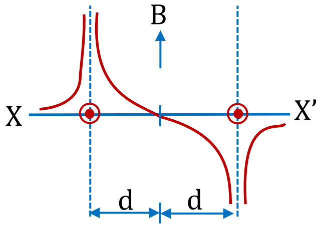
**3.** A long, straight wire carrying a current of 1.0 $A$ is placed horizontally in a uniform magnetic field $B = 1.0 \times 10^{-5}$ $T$ pointing vertically upward (figure). The magnitude of the resultant magnetic field at the points $P$ and $Q$, both situated at a distance of 2.0 $cm$ from the wire in the same horizontal plane are respectively

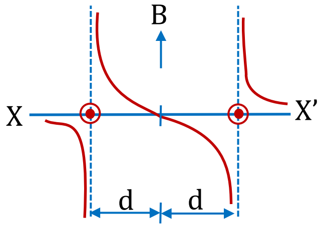


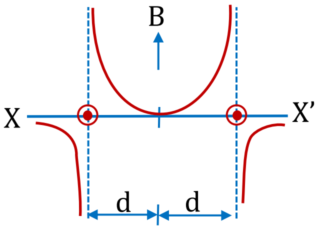

(A) zero, 20 $\mu T$ (B) 20 $\mu T$, zero (C) zero, zero (D) 20 $\mu T$, 20 $\mu T$

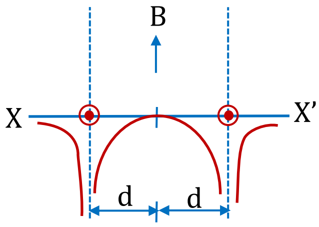
**PMG087**

**4.** Two long parallel wires are at a distance $2d$ apart. They carry steady equal currents flowing out of the plane of the paper, as shown. The variation of the magnetic field $B$ along the $XX'$ is given by

(A) 

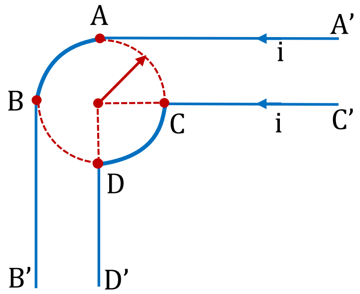

(B) 


(C) 


(D) 


**PMG088**

**5.** All straight wires are very long. Both $AB$ and $CD$ arc area of the same circle, both subtending right angles at the centre $O$. Then the magnetic field at $O$ is




(A) $\frac{\mu_0 i}{4\pi R}$ (B) $\frac{\mu_0 i}{4\pi R}\sqrt{2}$ (C) $\frac{\mu_0 i}{2\pi R}$ (D) $\frac{\mu_0 i}{2\pi R}(\pi+1)$

**PMG089**

**6.** Two parallel wires carry equal currents of 10 $A$ along the same direction and are separated by a distance of 2.0 $cm$. Find the magnetic field at a point which is 2.0 $cm$ away from each of these wires.

(A) $3.4 \times 10^{-4}$ $T$ in a direction parallel to the plane of the wires and perpendicular to the wires

(B) $1.7 \times 10^{-4}$ $T$ in a direction parallel to the plane of the wires and parallel to the wires

(C) $1.7 \times 10^{-4}$ $T$ in a direction parallel to the plane of the wires and perpendicular to the wires

(D) $3.4 \times 10^{-4}$ $T$ in a direction parallel to the plane of the wires and parallel to the wires

**PMG090**

**7.** Two mutually perpendicular long conducting wire carrying currents $I_1$ and $I_2$ lie in one plane. Locus of the point at which the magnetic induction is zero, is a

(A) circle with centre as the point of intersection of the wire.

(B) parabola with vertex as the point of intersection of the wire

(C) straight line passing through the point of intersection of the wire

(D) rectangular hyperbola

**PMG091**

**8.** A long straight wire along the $z$-axis carries a current $I$ in the negative $z$ direction. The magnetic vector field $\vec{B}$ at a point having coordinates $(x, y)$ in the $z = 0$ plane is :-

(A) $\frac{\mu_0 I}{2\pi}\frac{(y\hat{i}-x\hat{j})}{(x^2+y^2)}$ (B) $\frac{\mu_0 I}{2\pi}\frac{(x\hat{i}+y\hat{j})}{(x^2+y^2)}$ (C) $\frac{\mu_0 I}{2\pi}\frac{(x\hat{j}-y\hat{i})}{(x^2+y^2)}$ (D) $\frac{\mu_0 I}{2\pi}\frac{(x\hat{i}-y\hat{j})}{(x^2+y^2)}$

**PMG093**

**9.** A straight wire extends from (0, 0, –5$m$) to (0, 0, +5$m$) and carries a current of 2$A$ in +$z$ direction. Magnetic field at (3, 4, 0) is

(A) $\frac{2\sqrt{2}}{25}\times10^{-7}(-4\hat{i}+3\hat{j})\,T$ (B) $\frac{2\sqrt{2}}{25}\times10^{-7}(3\hat{i}+4\hat{j})\,T$

(C) $\frac{2\sqrt{2}}{25}\times10^{-7}(4\hat{i}-3\hat{j})\,T$ (D) None

**PMG094**

**10.** Considering magnetic field along the axis of a circular loop of radius 1 meter, at what distance from the centre of the loop the magnetic field is $\frac{1}{2\sqrt{2}}$ times of its value at the centre ?

(A) 1 $m$ (B) 3 $m$ (C) 5 $m$ (D) 9 $m$

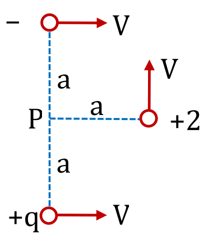
**PMG097**

**11.** An electron makes $3 \times 10^5$ revolutions per second in a circle of radius 0.5 angstrom. Find the magnetic field $B$ at the centre of the circle.

(A) $6 \times 10^{-10}$ $T$ (B) $12 \times 10^{-10}$ $T$ (C) $18 \times 10^{-10}$ $T$ (D) $24 \times 10^{-10}$ $T$

**PMG098**

**12.** A charge +2$q$ moves vertically upwards with speed $v$, a second charge – $q$ moves horizontally to the right with the same speed $v$, and a third charge + $q$ moves horizontally to the right with the same speed $v$. The point $P$ is located at a perpendicular distance $a$ away from each charge as shown in the figure. The magnetic field at point $P$ is




(A) Into the page with magnitude $\frac{\mu_0}{4\pi}\frac{2qv}{a^2}$

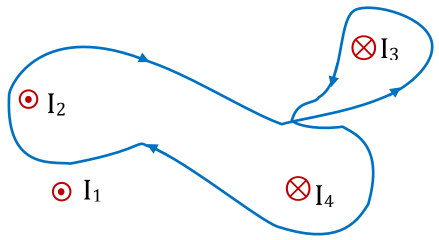
(B) Into the page with magnitude $\frac{\mu_0}{4\pi}\frac{4qv}{a^2}$

(C) Out of the page with magnitude $\frac{\mu_0}{4\pi}\frac{2qv}{a^2}$

(D) Out the page with magnitude $\frac{\mu_0}{4\pi}\frac{4qv}{a^2}$

**PMG100**

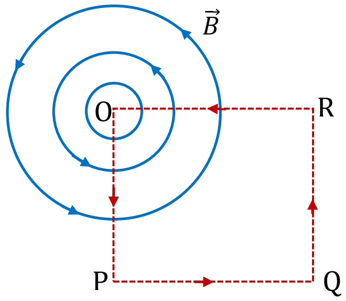
**13.** Four wires carrying current $I_1$ = 2$A$, $I_2$ = 4$A$, $I_3$ = 6$A$ and $I_4$ = 8$A$ respectively cut the page perpendicularly as shown in figure. The value of $\int \vec{B}.d\vec{\ell}$ for the loop shown would be :-




(A) +2 $\mu_0$-$wb/m$ (B) –2 $\mu_0$-$wb/m$ (C) + 10 $\mu_0$-$wb/m$ (D) – 10 $\mu_0$-$wb/m$

**PMG101**

**14.** A current carrying wire (current = $i$) perpendicular to the plane of the paper produces a magnetic field, as shown in the figure. A square of side $a$ is drawn with one of its vertices on the centre of the wire. The integral $\int \vec{B}.d\vec{r}$ along $OPQRO$ has the value




(A) $+\mu_0 i$ (B) $\frac{\mu_0 i}{8}$ (C) $\frac{\mu_0 i}{4}$ (D) $\frac{\mu_0 i}{2}$

**PMG103**

**15.** A long straight wire of radius $a$ carries a steady current $i$. The current is uniformly distributed across its cross-section. The ratio of the magnetic field at $\frac{a}{2}$ and $2a$ is-

(A) $\frac{1}{4}$ (B) 4 (C) 1 (D) 2

**PMG104**

**16.** **Statement-1 :** Ampere law is useful to find magnetic field due to finite length of a straight current carrying wire.

**Statement-2 :** The magnetic field due to finite length of a straight current carrying wire is symmetric about the wire.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

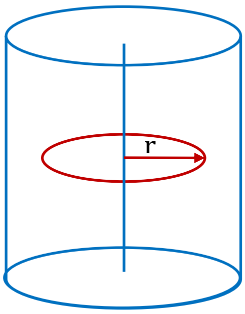
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

**PMG105**

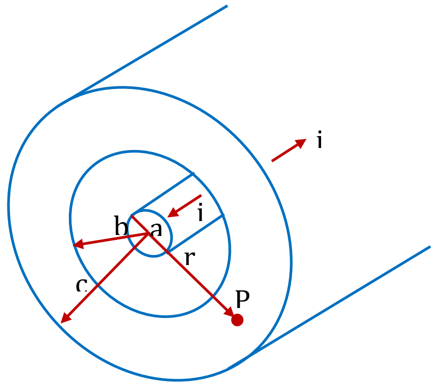
**17.** The magnetic field inside a solid conducting long wire at distance $r$ from its axis is given as $B = B_0r^3$ where $B_0$ is constant. Which of the following relations correctly represents current enclosed in the loop of radius $r$ shown in the figure ?




(A) $\frac{2\pi B_0 r^3}{5\mu_0}$ (B) $\frac{\pi B_0 r^4}{2\mu_0}$ (C) $\frac{2\pi B_0 r^2}{\mu_0}$ (D) $\frac{2\pi B_0 r^4}{\mu_0}$

**PMG106**

**18.** A coaxial cable having radius "$a$" of inner wire and inner and outer radii "$b$" and "$c$" respectively of the outer shell carries equal and opposite currents of magnitude $i$ on the inner and outer conductors as shown. What is the magnitude of the magnetic induction at point $P$ of the cable at a distance $r$ ($b < r < c$) from the axis?

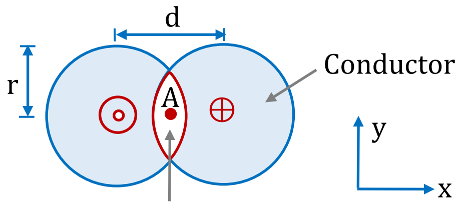



(A) Zero (B) $\frac{\mu_0 i r}{2\pi a^2}$

(C) $\frac{\mu_0 i}{2\pi r}$ (D) $\frac{\mu_0 i}{2\pi r}\frac{c^2-r^2}{c^2-b^2}$

**PMG111**

**19.** Two long conductors are arranged as shown above to form overlapping cylinders, each of radius $r$, whose centers are separated by a distance $d$. Current of density $J$ flows into the plane of the page along the shaded part of one conductor and an equal current flows out of the plane of the page along the shaded portion of the other, as shown. What are the magnitude and direction of the magnetic field at point $A$?




(A) $(\mu_0/2\pi)\pi dJ$, in the $+y$-direction (B) $(\mu_0/2\pi)d^2/r$, in the $+y$-direction

(C) $(\mu_0/2\pi)4d^2J/r$, in the $-y$-direction (D) $(\mu_0/2\pi)Jr^2/d$, in the $-y$-direction

**PMG113**

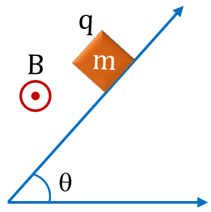
**20.** A tightly-wound, long solenoid carries a current of 2.00 $A$. An electron is found to execute a uniform circular motion inside the solenoid with a frequency of $1.00 \times 10^8$ $rev/s$. Find the number of turns per metre in the solenoid.

(A) 500 Turns/$m$ (B) 1020 Turns/$m$ (C) 1232 Turns/$m$ (D) 1420 Turns/$m$

**PMG116**

## *Magnetic Force on a Charged Particle*

**21.** A block of mass $m$ and charge $q$ is released on a long smooth inclined plane magnetic field $B$ is constant, uniform, horizontal and parallel to surface as shown. Find the time from start when block loses contact with the surface.




(A) $\frac{m\cos\theta}{qB}$ (B) $\frac{m\ \mathrm{cosec}\ \theta}{qB}$

(C) $\frac{m\cot\theta}{qB}$ (D) none

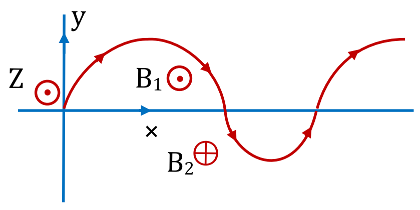
**PMG115**

**22.** A charged particle enters a non-uniform uni-directional field such that initial velocity is parallel to magnetic field, then the radius of curvature of its path is (in standard notation):

(A) $mV/qB$ (B) 0 (C) $\infty$ (D) $qB/mV$

**PMG117**

**23.** At $t$ = 0 a charge $q$ is at the origin and moving in the $y$-direction with velocity $\vec{v} = v\hat{j}$. The charge moves in a magnetic field that is for $y > 0$ out of page and given by $B_1\hat{z}$ and for $y < 0$ into the page and given $-B_2\hat{z}$. The charge's subsequent trajectory is shown in the sketch. From this information, we can deduce that




(A) $q > 0$ and $|B_1| < |B_2|$ (B) $q < 0$ and $|B_1| < |B_2|$

(C) $q > 0$ and $|B_1| > |B_2|$ (D) $q < 0$ and $|B_1| > |B_2|$

**PMG119**

**24.** An electron moving with a velocity $\vec{V}_1 = 2\hat{i}m/s$ at a point in a magnetic field experiences a force $\vec{F}_1 = -2\hat{j}N$. If the electron is moving with a velocity $\vec{V}_2 = 2\hat{j}m/s$ at the same point, it experiences a force $\vec{F}_2 = +2\hat{j}N$. The force the electron would experience if it were moving with a velocity $\vec{V}_3 = 2\hat{k}m/s$ at the same point is

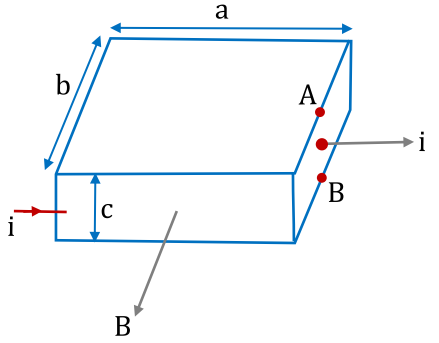
(A) zero (B) $2\hat{k}N$

(C) $-2\hat{k}N$ (D) information is insufficient

**PMG120**

**25.** A current flows through a rectangular conductor in the presence of uniform magnetic field $B$ pointing out of the page as shown. Then the potential difference $V_B - V_A$ is equal to

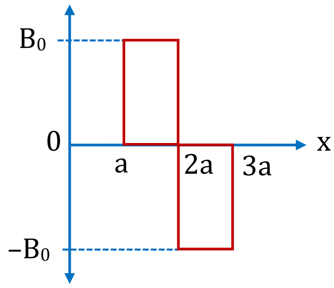
(Assume charge carriers in the conductor to be positively charged moving with speed $v$)

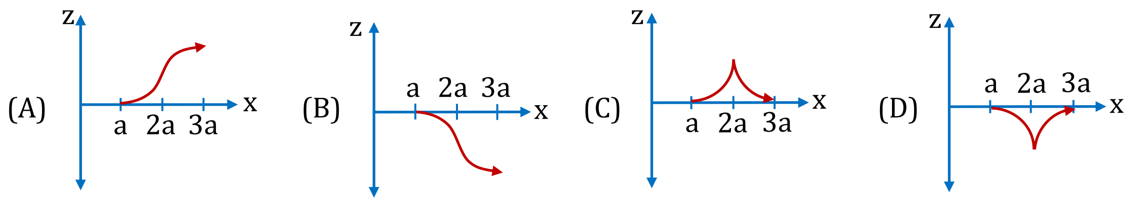



(A) $Bvc$ (B) $-Bvc$ (C) $Bvb$ (D) $-Bvb$

**PMG123**

**26.** 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 = $v_0$, 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,




**PMG125**

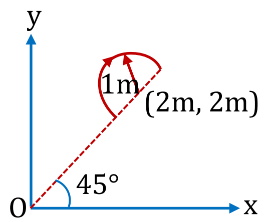
**27.** A particle of specific charge (charge/mass) α starts moving from the origin under the action of an electric field $\vec{E} = \vec{E}_0\hat{\imath}$ and magnetic field $\vec{B} = B_0\hat{k}$. Its velocity at $(x_0, y_0, 0)$is $(4\hat{\imath} - 3\hat{\jmath})$. The value of $x_0$ is:

(A) $\frac{13}{2}\frac{\alpha E_0}{B_0}$ (B) $\frac{16\alpha B_0}{E_0}$ (C) $\frac{25}{2\alpha E_0}$ (D) $\frac{5\alpha}{2B_0}$

**PMG126**

## *Magnetic Force on a Current Carrying Wire*

**28.** A uniform magnetic field $\vec{B} = (3\hat{\imath} + 4\hat{\jmath} + \hat{k})$ Tesla exist in a region of space. A semicircular wire of radius 1 $m$ carrying a current of 1$A$ having its centre at (2, 2, 0) $m$ is placed on the $X$-$Y$ plane as shown. The force on the semi-circular wire will be

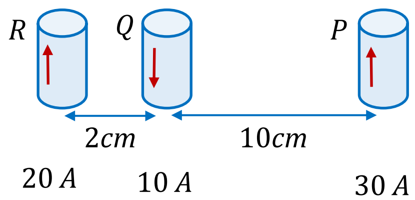



(A) $(\hat{\imath} - \hat{\jmath} + \hat{k})N$ (B) $\sqrt{2}(\hat{\imath} - \hat{\jmath} + \hat{k})N$

(C) $\frac{1}{\sqrt{2}}(\hat{\imath} + \hat{\jmath} - \hat{k})N$ (D) $\sqrt{2}(\hat{\imath} + \hat{\jmath} - \hat{k})N$

**PMG130**

**29.** Three long, straight and parallel wires carrying currents are arranged as shown in figure. The force experienced by 10 $cm$ length of wire $Q$ is

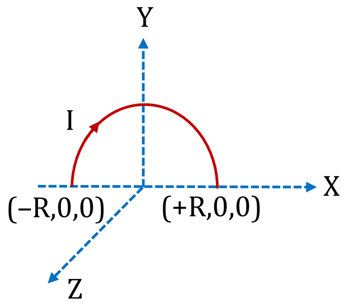



(A) $1.4 \times 10^{-4}N$ towards the right (B) $1.4 \times 10^{-4}N$ towards the left

(C) $2.6 \times 10^{-4}N$ to the right (D) $2.6 \times 10^{-4}N$ to the left

**PMG131**

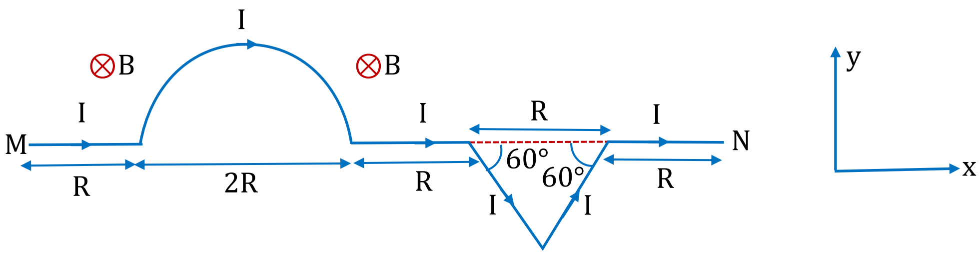
**30.** A semi circular current carrying wire having radius $R$ is placed in $x$-$y$ plane with its centre at origin '$O$'. There is non-uniform magnetic field $\vec{B} = \frac{B_0 x}{2R}\hat{k}$ (here $B_o$ is $+ve$ constant) is existing in the region. The magnetic force acting on semi circular wire will be along :-




(A) – $x$-axis (B) + $y$-axis (C) – $y$-axis (D) + $x$-axis

**PMG132**

**31.** A conducting wire $MN$ carrying a current $I$ is bent into the shape as shown and placed in $xy$ plane. A uniform magnetic field $\vec{B} = -B\hat{k}$ is existing in the region. The net magnetic force experienced by the conducting wire $MN$ is :-




(A) 2 $BIR$ (B) 3 $BIR$ (C) 4 $BIR$ (D) 6 $BIR$

**PMG135**

**32.** A very long wire carrying current $I$ is fixed along $x$-axis. Another parallel finite wire carrying a current in the opposite direction is kept at a distance d above the wire in $xy$ plane. The second wire is free to move parallel to itself. The options available for its small displacements are in

(i) $+ve$ $x$ direction (ii) $+ve$ $y$ direction (iii) $+ve$ $z$ direction

Taking gravity in negative $y$ direction, the nature of equilibrium of second wire is

(A) stable for movement in $x$ direction, unstable for movement in $y$ direction, neutral for movement in $z$ direction.

(B) stable for movement in $y$ direction, unstable for movement in $z$ direction, neutral for movement in $x$ direction.

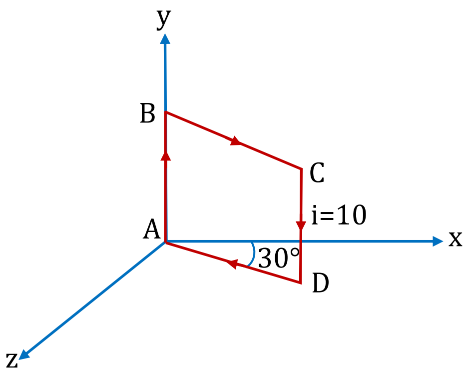
(C) stable for movement in $z$ direction, unstable for movement in $y$ direction, neutral for movement in $x$ direction.

(D) stable for movement in $y$ direction, unstable for movement in $x$ direction, neutral for movement in $z$ direction.

**PMG136**

### *Torque on a Current Carrying Loop*

**33.** Figure shows a square current carrying loop *ABCD* of side 10 *cm* and current *i* = 10*A*. The magnetic moment $\vec{M}$ of the loop is

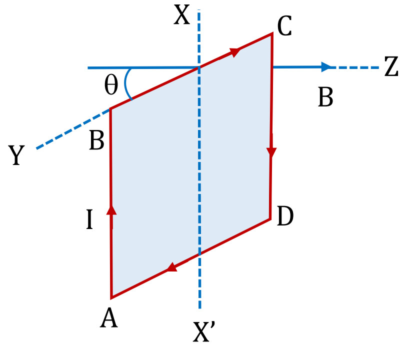



(A) $(0.05)\ (\hat{\imath} - \sqrt{3}\hat{k})A - m^2$ (B) $(0.05)\ (\hat{\jmath} + \hat{k})A - m^2$

(C) $(0.05)\ (\hat{\jmath} + \hat{k})A - m^2$ (D) $(\hat{\imath} + \hat{k})A - m^2$

**PMG138**

**34.** The square loop *ABCD*, carrying a current *I*, is placed in a uniform magnetic field *B*, as shown. The loop can rotate about the axis *XX'*. The plane of the loop makes an angle θ (θ < 90°) with the direction of *B*. Through what angle will the loop rotate by itself before the torque on it becomes zero–




(A) θ (B) 90° – θ (C) 90° + θ (D) 180° – θ

**PMG139**

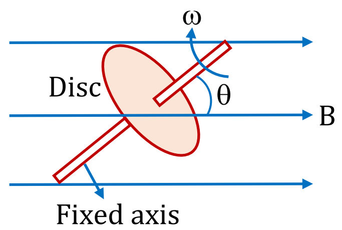
**35.** A disc of radius *r* and carrying positive charge *q* is rotating with an angular speed ω in a uniform magnetic field *B* about a fixed axis as shown in figure, such that angle made by axis of disc with magnetic field is θ. Torque applied by axis on the disc is

(A) $\dfrac{q\omega r^2 B\sin\theta}{2}$, clockwise

(B) $\dfrac{q\omega r^2 B\sin\theta}{4}$, anticlockwise

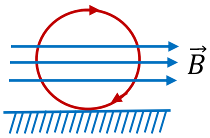
(C) $\dfrac{q\omega r^2 B\sin\theta}{2}$, anticlockwise

(D) $\dfrac{q\omega r^2 B\sin\theta}{4}$, clockwise




**PMG140**

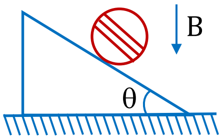
**36.** A conducting ring of mass 2 $kg$ and radius 0.5 $m$ is placed on a smooth horizontal plane. The ring carries a current $i = 4A$. A horizontal magnetic field $B = 10T$ is switched on at time $t = 0$ as shown in figure. The initial angular acceleration of the ring will be :-




(A) 40 $\pi$ rad/$s^2$ (B) 20 $\pi$ rad/$s^2$ (C) 5 $\pi$ rad/$s^2$ (D) 15 $\pi$ rad/$s^2$

**PMG141**

**37.** In the figure shown a coil of single turn is wound on a sphere of radius $R$ and mass $m$. The plane of the coil is parallel to the plane and lies in the equatorial plane of the sphere. Current in the coil is $i$. The value of $B$ if the sphere is in equilibrium is :-




(A) $\frac{mg\cos\theta}{\pi iR}$ (B) $\frac{mg}{\pi iR}$ (C) $\frac{mg\tan\theta}{\pi iR}$ (D) $\frac{mg\sin\theta}{\pi iR}$

**PMG142**

**38.** A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10 divisions per milli ampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 $V$, the resistance in Ohm needed to be connected in series with the coil will be-

(A) $10^3$ (B) $10^5$ (C) 99995 (D) 9995

**PMG145**

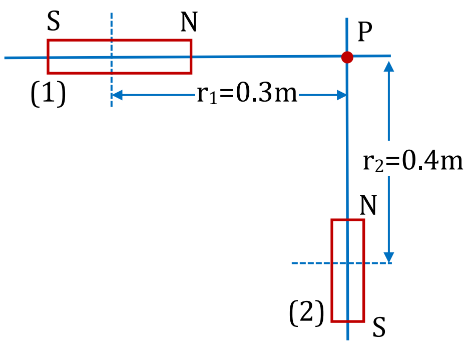
## *Magnetic Material and Earth Magnetism*

**39.** A steel wire of length $L$ has a magnetic moment $M$. It is then bent into a semi-circular arc; the new magnetic moment will be :

(A) $M$ (B) $2M/\pi$ (C) $M/L$ (D) $M \times L$

**PMG151**

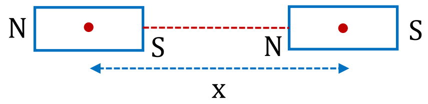
**40.** Two short magnets of magnetic moment 2 $Am^2$ and 5 $Am^2$ respectively are placed along two lines drawn at right angle to each other on the sheet of paper as shown in the figure. What is the magnetic field at the point of intersection of their axis:




(A) $2.15 \times 10^{-5}\ T$ (B) $215 \times 10^{-5}\ T$ (C) $2.15 \times 10^{-4}\ T$ (D) $21.5 \times 10^{-5}\ T$

**PMG152**

**41.** The mid points of two small magnetic dipoles of length $d$ in end-on positions, are separated by a distance $x$, ($x >> d$). The force between them is proportional to $x^{-n}$ where $n$ is :-




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

**PMG154**

**42.** Horizontal magnetic field of earth at Mumbai is $1.5 \times 10^{-4}$ $T$ in North direction. A small bar magnet of magnetic moment 10 $Am^2$ is kept on a horizontal table such that its North pole points due North. What is the magnetic field at 10 $cm$ from centre of magnet at a point on its axis due North of it :-

(A) $3.5 \times 10^{-4}$ $T$ (B) $5 \times 10^{-5}$ $T$ (C) $2.15 \times 10^{-3}$ $T$ (D) $1.15 \times 10^{-3}$ $T$

**PMG155**

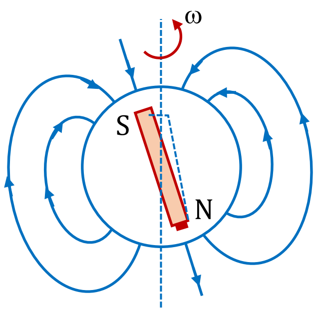
**43.** Our earth behaves as it has a powerful magnet within it. The value of magnetic field on the surface of earth is a few tenth of gauss ($1G = 10^{-4}T$). There are three elements of Earth's magnetism:

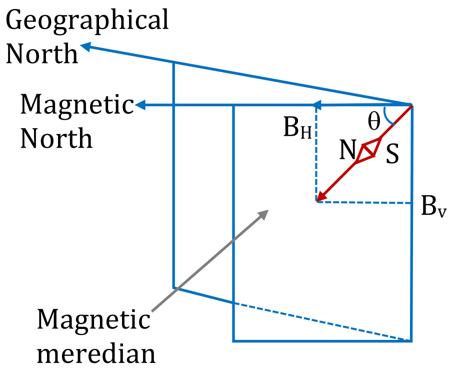
(i) Angle of declination

(ii) Angle of dip

(iii) Horizontal component of Earth's magnetic field.

In the magnetic meridian of a certain place, the horizontal component of Earth's magnetic field is 0.6 $G$ and the dip angle is 53°. The value of net magnetic field at this place is




(A) 0.8 $G$ (B) 0.6 $G$ (C) 1.0 $G$ (D) 2.0 $G$

**PMG156**

**44.** A bar magnet of magnetic moment 2$A$-$m^2$ free to rotate about a vertical axis passing through its centre. The magnet is released from rest from east-west position. Then the kinetic energy of the magnet as it takes North-South position is (horizontal component of the earth's field is 25μ$T$ and angle of declination is zero :-

(A) 25 μ$J$ (B) 50 μ$J$ (C) 100 μ$J$ (D) 125 μ$J$

**PMG157**

**45.** A magnet is suspended in the magnetic meridian with an untwisted wire. The upper end of wire is rotated through 180° to deflect the magnet by 30° from magnetic meridian. When the magnet is replaced by another magnet, the upper end of wire is rotated through 270° to deflect the magnet 30° from magnetic meridian. The ratio of magnetic moments of magnets is :-

(A) 1 : 5 (B) 1 : 8 (C) 5 : 8 (D) 8 : 5

**PMG159**

**46.** A compass needle kept on a horizontal table points in direction 30° west of north. A line is marked showing this direction and compass is now kept in vertical plane containing this line. The needle points in direction 30° below horizontal. If the plane of compass is still vertical but contains true north south direction at what angle to horizontal will needle point:-

(A) $\tan^{-1}\left(\frac{3}{2}\right)$ (B) $\tan^{-1}\left(\frac{2}{3}\right)$ (C) $\tan^{-1}(2)$ (D) $\tan^{-1}\left(\frac{1}{2}\right)$

**PMG160**

**47.** The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is $2s$. The magnet is cut along its length into three equal parts and three parts are then placed on each other with their like poles together. The time period of this combination will be-

(A) $2s$ (B) $2/3\ s$ (C) $2\sqrt{3}\ s$ (D) $2/\sqrt{3}\ s$

**PMG161**

**48.** A specimen of iron of permeability $8 \times 10^{-3}$ weber/amp × metre is placed in a magnetic field of intensity 160 amp/metre. Then magnetic field in this iron is :

(A) $20 \times 10^{3}\ Wb/m^2$ (B) $1.28\ Wb/m^2$ (C) $5 \times 10^{-5}\ Wb/m^2$ (D) $0.8\ Wb/m^2$

**PMG162**

**49.** Curie temperature is the temperature above which :

(A) a paramagnetic material becomes diamagnetic
(B) a ferromagnetic material becomes diamagnetic
(C) a paramagnetic material becomes ferromagnetic
(D) a ferromagnetic material becomes paramagnetic

**PMG163**

**50.** If a solution of ferromagnetic material is poured into a $U$-tube and one arm of this is placed between the poles of a strong magnet with the meniscus in line with the field, then the level of the solution will:

(A) Rise (B) Fall
(C) Rise till the liquid comes out (D) Remain unchanged

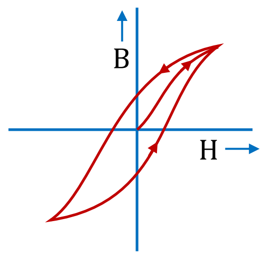
**PMG164**

**51.** A sample of paramagnetic salt contains $2.0 \times 10^{24}$ atomic dipoles each of dipole moment $1.5\times10^{-23} J\ T^{-1}$. The sample is placed under a homogeneous magnetic field of $0.84T$, and cooled to a temperature of $4.2K$. The degree of magnetic saturation achieved is equal to 15%. What is the total dipole moment (approximate) of the sample for a magnetic field of 0.98 $T$ and a temperature of $2.8K$? (Assume Curie's law).

(A) $7.9\ JT^{-1}$ (B) $52.5\ J\ T^{-1}$ (C) $30\ J\ T^{-1}$ (D) $4.6 J\ T^{-1}$

**PMG165**

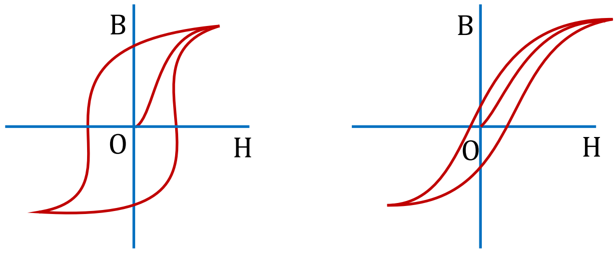
**52.** The $B$-$H$ curve for a certain specimen is schematically shown by the given diagram. Which one of the following is the correct magnetic nature of the specimen?




(A) Diamagnetic and not ferromagnetic or paramagnetic
(B) Ferromagnetic and not diamagnetic or paramagnetic
(C) Paramagnetic and not diamagnetic or ferromagnetic
(D) Applicable to all the three types of magnetism mentioned above

**PMG166**

**53.** Two types of steel are characterized by the hysteresis loops shown in figure (a) and (b). The loops are obtained in the processes of magnetization and demagnetization of the steels. Which of the two types is best suited for using as the core of a transformer and which, for using as a permanent magnet ?




**(a)** **(b)**

(A) Both are best suited for transformer

(B) Both are best suited for permanent magnet

(C) *A* is best suited for permanent magnet and *B* is best suited for core of transformer

(D) *A* is best suited for core of transformer and *B* is best suited for permanent magnet

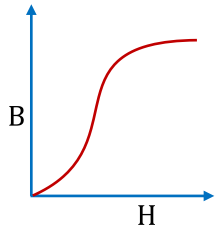
**PMG167**

**54.** A material satisfied the relation $\mu_0(H + M) = 0$, where $H$ and $M$ are magnetic intensity and magnetisation respectively, then material is :-

(A) nonmagnetic (B) paramagnetic (C) ferromagnetic (D) diamagnetic

**PMG168**

**55.** The figure represents *B-H* curve for commercial iron. As *H* is increased, permeability :-




(A) increases and becomes constant

(B) increases, reaches a maximum and then decreases

(C) decreases continuously till it becomes very small

(D) decreases, reaches a minimum and then increases

**PMG169**

**56.** **Statement-1 :** The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.

**and**

**Statement-2 :** Soft iron has a high magnetic permeability and cannot be easily magnetized or demagnetized.

(A) Statement-1 is True, Statement-2 is True ; statement-2 is a correct explanation for statement-1

(B) Statement-1 is True, Statement-2 is True ; statement-2 is NOT a correct explanation for statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

**PMG170**

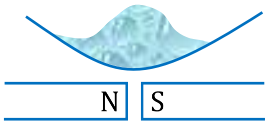
**57.** The materials suitable for making electromagnets should have-

(A) high retentivity and high coercivity (B) low retentivity and low coercivity

(C) high retentivity and low coercivity (D) low retentivity and high coercivity

**PMG171**

**58.** The liquid in the watch glass in the following figure is:




(A) Ferromagnetic (B) Paramagnetic (C) Diamagnetic (D) Nonmagnetic

**PMG172**

**59.** The magnetic susceptibility of a paramagnetic material at $-73°C$ is 0.0075 then its value at $-173°C$ will be :-

(A) 0.0045 (B) 0.0030 (C) 0.015 (D) 0.0075

**PMG173**

**60.** The relation between μ and $H$ for a specimen of iron is as follows:

$$\mu=\left[\frac{0.4}{H}+12\times10^{-4}\right]\text{Henry/meter}$$

The value of $H$ which produces flux density of 1 Tesla will be-

(A) 250 $A/m$ (B) 500 $A/m$ (C) 750 $A/m$ (D) 103 $A/m$

**PMG174**

**61.** Which statement is true:

(A) atomic magnetic dipole moment of diamagnet is zero

(B) atomic magnetic dipole moment of para-magnet is zero

(C) atomic magnetic dipole moment of ferro-magnet is zero

(D) ferromagnet is demagnetised rapidly after moving in magnetising field.

**PMG175**

**62.** Ferromagnetic substance contain:

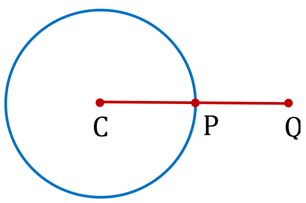
(A) empty subshell (B) partially empty subshell

(C) full fill subshell (D) none of these

**PMG176**

## MULTIPLE CORRECT TYPE QUESTIONS

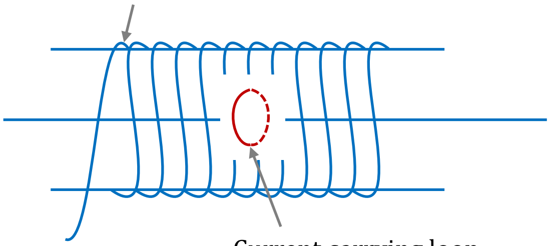
**63.** An electron is at $P$ at $t$ = 0. It is circulating in anti clockwise direction with a constant angular speed ω along the shown circular path. Magnetic field at $Q(CQ = 2R)$, where $R$ is radius of the circle) will be recorded as zero at times.




(A) $\frac{\pi}{3\omega}$ (B) $\frac{3\pi}{3\omega}$ (C) $\frac{5\pi}{3\omega}$ (D) $\frac{7\pi}{3\omega}$

**PMG099**

**64.** A single circular loop of wire with radius 0.02 $m$ carries a current of 8.0 $A$. It is placed at the centre of a long solenoid that has length 0.65$m$, radius 0.080 $m$ and 1300 turns. (Axis of circular loop coincide with axis of solenoid). Let '$i$' be the current in solenoid.




(A) If $i$ = 100 $mA$, the magnetic field at the center of coil can be zero.

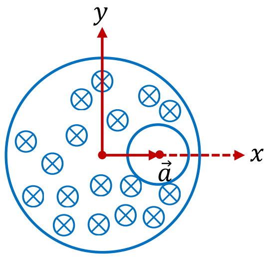
(B) If $i$ = 44 $mA$, the magnetic field at the center of coil can be zero.

(C) If $i$ = 100 $mA$, the magnetic field at the center of coil can be $8\pi \times 10^{-5}$ $T$.

(D) If $i$ = 100 $mA$, the magnetic field at the center of coil can be $16\pi \times 10^{-5}$ $T$.

**PMG108**

**65.** Figure shows cross-section view of an infinite cylindrical wire with a cylindrical cavity, current density is uniform $\vec{J} = -j_0\hat{k}$ as shown in figure.




(A) Field inside cavity is uniform.
(B) Field inside cavity is along $\vec{a}$.
(C) Field inside cavity is perpendicular to $\vec{a}$.
(D) If an electron is projected with velocity $v_0\,\vec{j}$ it will move undeviated before colliding with cavity wall.

**PMG112**

**66.** A long cylindrical conductor whose axis is coincide with the $z$ axis has an internal magnetic field given by

$$B = \frac{\mu_0 J_0 r}{6a}(3a - 2r)$$

where $a$ is the conductor's radius.

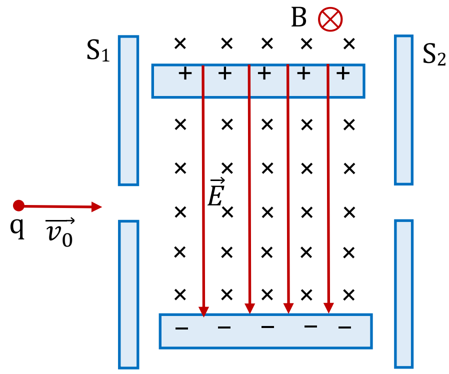
(A) The total current flowing in the conductor is $\frac{J_0 \pi a^2}{3}$.

(B) The magnetic field outside the conductor is $\frac{\mu_0 J_0 \pi a^2}{6r}$.

(C) The current density is maximum at the axis of the conductor.
(D) The current density is minimum at the axis of the conductor.

**PMG055**

**67.** A positive charge enters a region of perpendicular electric and magnetic fields as shown in the figure, travelling with speed $V_0$ directed horizontally to the right. Initially the charge moves through the region shown with no deflection and emerges through the hole in screen $S_2$. If we now want the charge to hit below the hole in the screen $S_2$ we should not :-




(A) Decrease its speed below $V_0$ or increase the magnitude of $E$.

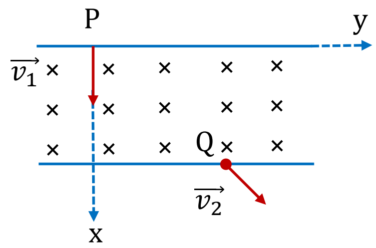
(B) Decrease its speed below $V_0$ or decrease the magnitude of $E$.

(C) Increase its speed above $V_0$ or increase the magnitude of $E$.

(D) Increase its speed above $V_0$ or decrease the magnitude of $E$.

**PMG127**

**68.** A charged particle moving in $x$-$y$ plane enters a region of uniform magnetic field of intensity $\vec{B} = -B_0\hat{k}$ at $P(0, 0)$ with velocity $\vec{v}_1 = v\hat{\imath}$ and leaves the magnetic field at $Q(a, b)$ with velocity $\vec{v}_2 = v'\hat{\imath} + \sqrt{3}v'\hat{\jmath}$. Choose the correct statement(s):




(A) The particle can't be positron

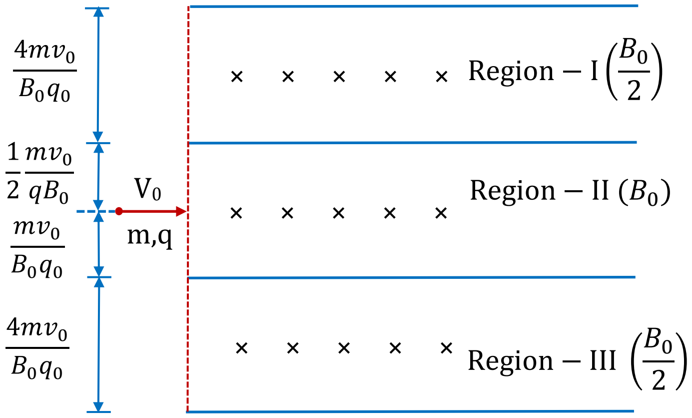
(B) Deviation suffered by the particle as it moves from $P$ to $Q$ equals 60°

(C) $\sqrt{3}a = b$

(D) $\vec{v}_1 = \vec{v}_2$

**PMG056**

**69.** In given figure at $t = 0$, a charged particle of mass $m$ and charge $q$ enters in the region-II.




(A) If $q > 0$, particle will enter into region-I after leaving region-II.

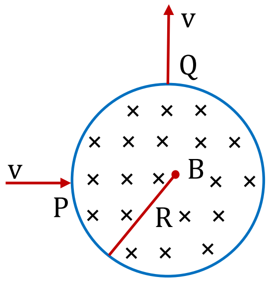
(B) If $q < 0$ the particle will leave region-II at $t = \frac{\pi m}{2|q|B_0}$

(C) If $q > 0$ particle will re-enter in region-II at $t = \frac{\pi m}{3B_0q}$

(D) Particle will not leave region-II.

**PMG057**

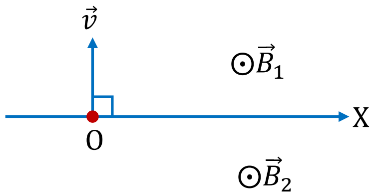
**70.** A particle of charge '$q$' and mass '$m$' enters normally (at point $P$) in a region of magnetic field with speed $v$. It comes out normally from $Q$ after time $T$ as shown in figure. The magnetic field $B$ is present only in the region of radius $R$ and is uniform. Initial and final velocities are along radial direction and they are perpendicular to each other. For this to happen, which of the following expression(s) is/are correct :-




(A) $B = \frac{mv}{qR}$ (B) $T = \frac{\pi R}{2v}$ (C) $T = \frac{\pi m}{2qB}$ (D) None of these

**PMG058**

**71.** An interface $OX$ separates two region of space having homogenous magnetic fields $B_1$ and $B_2$ ($B_1 \neq B_2$) outside the plane of paper. A positive charged particle flies at a speed of $v_0$ perpendicular to the interface (figure). Which of the following is correct :




(A) If $B_1 > B_2$, the net deflection of charged particle will be towards right as it moves on and on.

(B) If $B_1 < B_2$, the net deflection of charged particle will be towards right as it moves on and on.

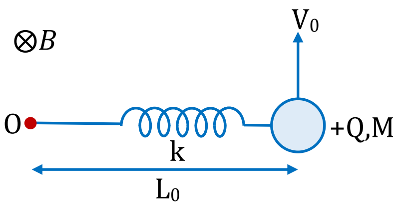
(C) The speed of charge particle will keep on increasing as it moves in the field.

(D) The speed of charge particle will remain constant while in the field.

**PMG177**

**72.** In zero gravity region, a point charge $+Q$ of mass $M$ is connected to a spring of natural length $L_0$ and spring constant $k$. A uniform magnetic field B is directed inside the plane of paper. The point charge is given an initial velocity $v_0$ perpendicular to the length of spring as shown. It is given that $B = \frac{Mv_0}{QL_0}$.

Then which of the following quantities remain(s) conserved during the motion of particle?

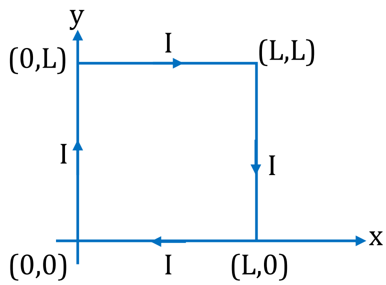



(A) Kinetic energy (B) Potential energy

(C) Total energy of system (D) Angular momentum of particle about $O$

**PMG178**

**73.** Figure shows a square loop carrying current $I$ is present in the magnetic field which is given by $\vec{B}=\frac{B_0 z}{L}\hat{j}+\frac{B_0 y}{L}\hat{k}$ where $B_0$ is positive constant. Which of the following statement(s) is/are **CORRECT**?




(A) force on side (0, 0) to (0, $L$) is $\left(\frac{B_0 IL}{2}\right)\hat{i}$.

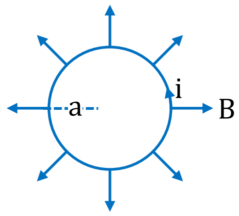
(B) force on side (0, $L$) to ($L$, $L$) is $-B_0 I L\hat{j}$.

(C) Net magnetic force on loop is zero.

(D) force on side ($L$, 0) to (0, 0) is zero.

**PMG179**

**74.** A circular loop of radius a, carrying a current $i$, is placed in a two-dimensional magnetic field. The centre of the loop coincides with the centre of the field (fig). The strength of the magnetic field at the periphery of the loop is $B$. Find the magnetic force on the wire.




(A) $4\pi a^2 iB\hat{k}$

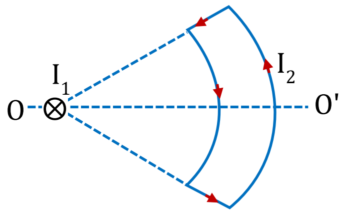
(B) $2\pi aiB\hat{k}$

(C) $\pi aiB\hat{k}$

(D) $6\pi aiB\hat{k}$

**PMG180**

**75.** Which of the following statement is correct in the given figure?




(A) net force on the loop is zero

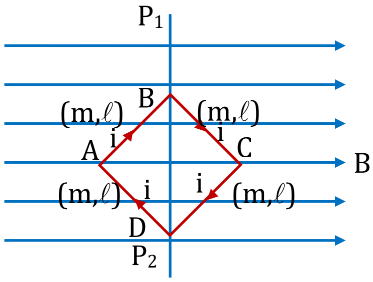
(B) net torque on the loop is zero

(C) loop will rotate clockwise about axis $OO'$ when seen from $O$.

(D) loop will rotate anticlockwise about $OO'$ when seen from $O$.

**PMG181**

**76.** Rod $AB$, $BC$, $CD$ & $DA$ form a square loop having current i, mass and length of each rod is $m$ and $\ell$ respectively, is situated in a uniform magnetic field $B$ as shown in the figure and it can rotate about axis $P_1P_2$. At $t$ = 0, if square loop is released from rest from the given position as shown in the diagram, then




(A) Angular acceleration of the square loop at $t$ = 0, is $\frac{3}{2}\frac{Bi}{m}$

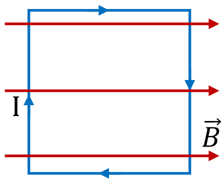
(B) Angular velocity when square loop rotated by 30°, is $\sqrt{\frac{3iB}{2m}}$

(C) Torque on the loop when it rotated by 60°, is $\frac{iB\ell^2}{2}$

(D) Angular acceleration of the square loop, when it is rotated from starting to 90°, decreases continuously

**PMG182**

**77.** Figure shows a square frame with a current in a uniform magnetic field of magnitude $B$ in direction shown. The sides are $a \times a$. The net magnetic field at the center of the frame is $\sqrt{3}B$ in magnitude.




(A) The torque on the frame is $\frac{\pi a^3 B^2}{2\mu_0}$.

(B) The potential energy of interaction of frame with the magnetic field is zero.

(C) The total magnetic field at center of the loop will be $\left(\sqrt{3}+1\right)B$ if the magnetic dipole moment of the frame is aligned parallel to the magnetic field.

(D) The total magnetic field at center of the loop will be $\left(\sqrt{2}-1\right)B$ if the magnetic dipole moment of the frame is aligned anti parallel to the magnetic field.

**PMG183**

## COMPREHENSION TYPE QUESTIONS

### PARAGRAPH FOR QUESTION NO. 78 AND 79

Electric field and magnetic field in region of space are given by and $\vec{E} = E_0\hat{j}$ and $\vec{B} = B_0\hat{j}$. A particle of specific charge α (charge per unit mass) is released from origin with velocity $\vec{V} = V_0\hat{i}$.

**78.** $y$ coordinate of particle when it crosses $y$-axis for $n^{th}$ time is :-

(A) $\frac{2n^2\pi^2E_0}{B_0^2\alpha}$ (B) $\frac{n^2\pi E_0}{B_0^2\alpha}$ (C) $\frac{2\pi^2E_0}{n^2B_0\alpha}$ (D) 0

**PMG059**

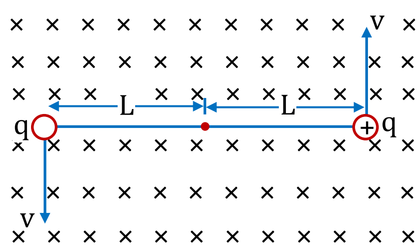
**79.** Angle between particle's velocity and $y$-axis at that moment is :-

(A) $\tan^{-1}\left(\frac{V_0B_0}{2\pi E_0}\right)$ (B) $\tan^{-1}\left(\frac{V_0B_0}{2\pi nE_0}\right)$ (C) $\tan^{-1}\left(\frac{V_0B_0}{E_0}\right)$ (D) $\tan^{-1}\left(\frac{B_0}{E_0}\right)$

**PMG060**

### PARAGRAPH FOR QUESTION NO. 80 AND 81

Two charge particles each of mass '$m$', carrying charge $+q$ and connected with each other by a massless inextensible string of length $2L$ are describing circular path in the plane of paper, each with speed $v = \frac{qB_0L}{m}$ (where $B_0$ is constant) about their centre of mass in the region in which an uniform magnetic field $\vec{B}$ exists into the plane of paper as shown in figure. Neglect any effect of electrical and gravitational forces.




**80.** The magnitude of the magnetic field such that no tension is developed in the string will be

(A) $\frac{B_0}{2}$ (B) $B_0$ (C) $2B_0$ (D) 0

**PMG061**

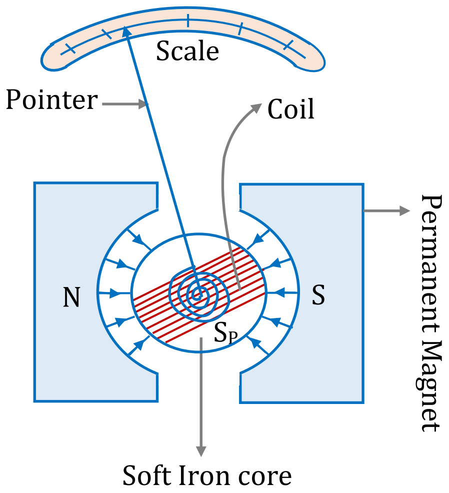
**81.** If the actual magnitude of magnetic field is half to that of calculated in part (i) then tension in the string will be

(A) $\frac{3}{4}\frac{q^2B_0^2L}{m}$ (B) zero (C) $\frac{q^2B_0^2L}{2m}$ (D) $\frac{2q^2B_0^2L}{m}$

**PMG062**

**PARAGRAPH FOR QUESTIONS NO. 82 TO 84**

Analog voltmeters and ammeters work by measuring the torque exerted by a magnetic field on a current carrying coil. The reading is displayed by means of the deflection of a pointer over a scale. The adjacent figure shows the essentials of a galvanometer, on which both analog ammeters and analog voltmeters are based. Assume that the coil is 2.1 *cm* high, 1.2 *cm* wide, has 250 turns and is mounted so that it can rotate about an axis (into the page) in a uniform radial magnetic field with $B = 0.23\ T$. For any orientation of the coil, the net magnetic field through the coil is perpendicular to the normal vector of the coil (and thus parallel to the plane of coil). A spring $S_P$ provides a counter torque that balances the magnetic torque, so that a given steady current $I$ in the coil results in a steady angular deflection $\phi$. The greater the current is, greater the deflection is, and thus greater the torque required of the spring is. A current of 100 $\mu A$ produces an angular deflection of 28°.




**82.** What must be the torsional constant $K$ of the spring?

(A) $2.6 \times 10^{-8}$ $Nm$/degree
(B) $5.2 \times 10^{-8}$ $Nm$/degree
(C) $2.6 \times 10^{-4}$ $Nm$/degree
(D) $5.2 \times 10^{-4}$ $Nm$/degree

**PMG146**

**83.** If we reduce the value of this $K$ to half of its value, then the deflection would be

(A) 28°
(B) 56°
(C) 14°
(D) none of these

**PMG147**

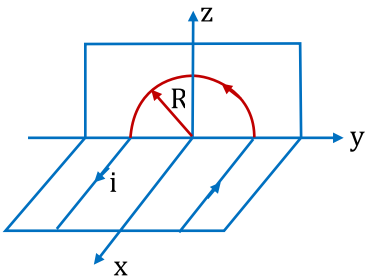
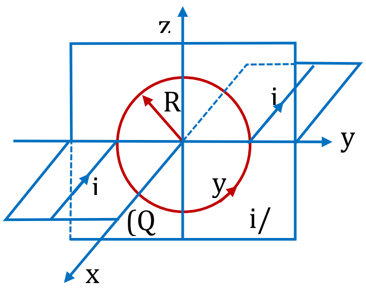
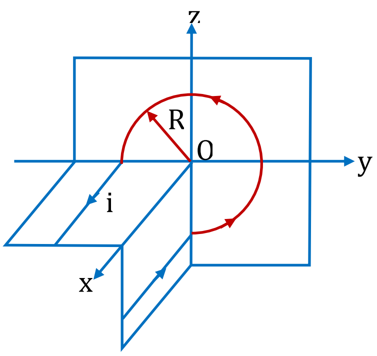
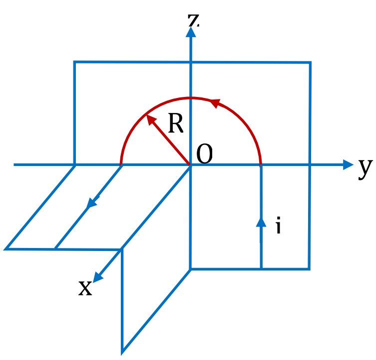
**84.** If the value of magnetic field is put equal to 0.69 $T$ and $K = 15.6 \times 10^{-8}$ $Nm$/degree. Then, the deflection would be

(A) < 28°
(B) = 28°
(C) 14°
(D) none of these

**PMG148**

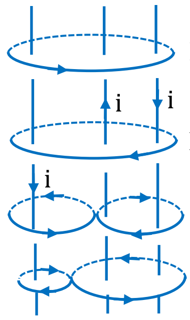
## MATRIX MATCH TYPE QUESTION

**85.** Column I shows four current configurations. Match each entry of column I with those axes in column II along which the magnetic field at origin has positive component.

| **Column-I** | **Column-II** [+ve component of magnetic field at origin] |
|---|---|
| (A)   | (P) $x$ |
| (B)   | (Q) $y$ |
| (C)   | (R) $z$ |
| (D)   | (S) None |

PMG096

**86.** Three wires are carrying same constant current *i* in different directions. Four loops enclosing the wires in different manners are shown. The direction of $d\vec{\ell}$ is shown in figure.




| **Column-I** | | **Column-II** | |
|---|---|---|---|
| (A) | Along closed loop–1 | (P) | $\oint \vec{B}.d\vec{\ell} = \mu_0 i$ |
| (B) | Along closed loop–2 | (Q) | $\oint \vec{B}.d\vec{\ell} = -\mu_0 i$ |
| (C) | Along closed loop–3 | (R) | $\oint \vec{B}.d\vec{\ell} = 0$ |
| (D) | Along closed loop–4 | (S) | Net work done by the magnetic force to move a unit charge along the loop is zero |

**PMG102**

**87.** A charge particle with some initial velocity is projected in a region where uniform electric and/or magnetic fields are present. In Column-I information about the existence of electric and/or magnetic field and direction of initial velocity of charge particle are given, while in column-II the possible paths of charged particle is mentioned. Match the entries of Column I with the entries of Column-II.

| **Column-I** | | **Column-II** | |
|---|---|---|---|
| (A) | $\vec{E}=0, \vec{B}\neq 0$ and initial velocity is At an unknown angle with $\vec{B}$ | (P) | Straight line |
| (B) | $\vec{E}\neq 0, \vec{B}=0$ and initial velocity is At an unknown angle with $\vec{E}$ | (Q) | Parabola |
| (C) | $\vec{E}\neq 0, \vec{B}\neq 0, \vec{E}\,||\,\vec{B}$ and initial velocity Is perpendicular to $\vec{E}$ | (R) | Circular |
| (D) | $\vec{E}\neq 0, \vec{B}\neq 0, \vec{E}$ is perpendicular to $\vec{B}$ And initial velocity is perpendicular Both $\vec{E}$ and $\vec{B}$ | (S) | Helical path nonuniform pitch |
| | | (T) | Helical path with uniform pitch |

**PMG204**

**88.** **Column-I (Magnetic moment of)** **Column-II**

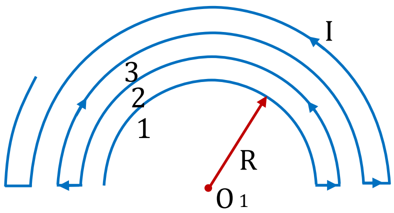
| Column-I (Magnetic moment of) | | Column-II | |
|---|---|---|---|
| (A) | A uniformly charged ring rotating uniformly about its axis | (P) | $\frac{q\omega r^2}{5}$ |
| (B) | A charged particle rotating uniformly about a point | (Q) | $\frac{q\omega r^2}{4}$ |
| (C) | A uniformly charged disk rotating uniformly about its axis | (R) | $\frac{q\omega r^2}{3}$ |
| (D) | A uniformly charged spherical shell rotating uniformly about one of its diameter | (S) | $\frac{q\omega r^2}{2}$ |
| (E) | A uniformly charged sphere rotating | (T) | $q\omega r^2$ |

**PMG149**

# EXERCISE - S

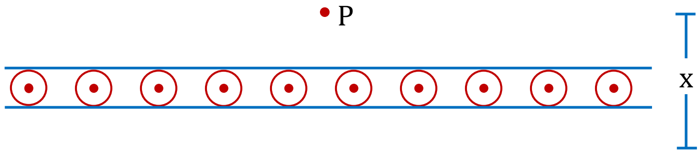
## *Biot-Savart Law and Ampere's Law*

**1.** Infinite semi-circular wires are placed out from a single wire in a continuous fashion as shown in the figure. The radii of the semicircles increases as $R_n = \alpha^{n-1}R_n$ where $R_n$ is the radius of the $n^{th}$ semicircle and $\alpha$ is constant greater than 1. The semicircles are concentric. The net magnetic field at the centre is given by $\frac{\mu_0}{4}\times\frac{I}{R_1}\left(\frac{\alpha}{\beta+\alpha}\right)$ where $\beta$ is the numerical constant. Find the value of $\beta$.




**PMG095**

**2.** Figure shows a cross section of a large metal sheet carrying an electric current along its surface. The current in a strip of width *dl* is *Kdl* where *K* is a constant. Find the magnetic field at a point *P* at a distance *x* from the metal sheet.




**PMG109**

**3.** Consider the situation described in the previous question. A particle of mass m having a charge *q* is placed at a distance *d* from the metal sheet and is projected towards it. Find the maximum velocity of projection for which the particle does not hit the sheet.

**PMG110**

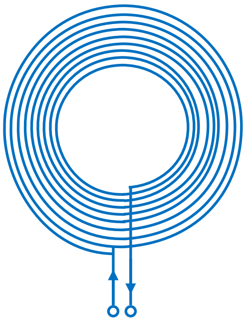
**4.** An equilateral triangular loop of wire of side $\ell$ carries a current *i*. The magnetic field produced at the circumcenter of the loop is $\frac{\mu_0}{4\pi}\frac{\alpha i}{\ell}$, then the value of $\alpha$ is

**PMG063**

**5.** The current density inside a long solid cylindrical wire of radius *a* is in the direction of the central axis and varies linearly with radial distance *r* from the axis according to $J = J_0\frac{r}{a}$. If the magnetic field inside wire is given by $\frac{\mu_0 J_0 r^x}{ya}$ then find value of $x + y$.

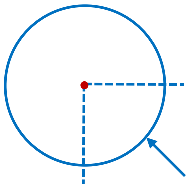
**PMG064**

**6.** A thin insulated wire forms a plane spiral of $N = 100$ tight turns carrying a current $I = 8\ mA$. The radii of inside and outside turns are equal to $a = 50\ mm$ and $b = 100\ mm$. Find the magnetic induction at the centre of the spiral.



**PMG184**

**7.** A long thin walled pipe of radius $R$ carries a current $I$ along its length. The current density is uniform over the circumference of the pipe. The magnetic field at the center of the pipe due to quarter portion of the pipe shown is



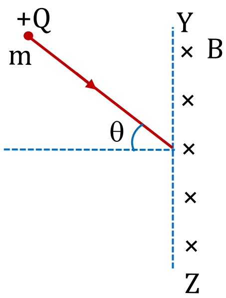
**PMG185**

**8.** A current $I$ flow in an infinity long wire with cross section in the form of a semicircular ring of radius $R$. The magnitude of the magnetic induction along its axis is :-

**PMG186**

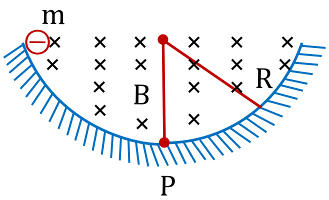
## *Magnetic Force on a Charged Particle*

**9.** A particle with charge $+Q$ and mass $m$ enters a magnetic field of magnitude $B$, existing only to the right of the boundary $YZ$. The direction of the motion of the particle is perpendicular to the direction of $B$. Let $T = 2\pi \dfrac{m}{QB}$. The time spent by the particle in the field is $T_1$. In another case if $-Q$ is taken then time spend spent is $T_2$. Find the ratio of $\dfrac{T_1}{T_2}$.




**PMG118**

**10.** A charge particle of mass '$m$' and charge $-q$ is released from rest from the given position. In the presence and absence of uniform horizontal magnetic field normal reaction acting on the charge at point $P$ are $N_1$ and $N_2$ respectively. Neglect friction. The value of $N_1 - N_2$ is given by $\frac{5Bq\sqrt{2gR}}{k}$. Find $k$.




Hemispherical surface

**PMG122**

**11.** There exists a uniform magnetic and electric field of magnitude 1 $T$ and 1 $V/m$ respectively along positive $y$-axis. A charged particle of mass 1 $kg$ and charge 1 $C$ moving with velocity 1 $m$/sec along positive $x$-axis is at origin at $t$ = 0. If the coordinates of particle at time $\pi$ seconds is given as $(X, Y, Z)$ in meter, then find the value of $(XY + YZ + ZX) \times \frac{5}{\pi^2}$.

**PMG067**

## *Magnetic Force on a Current Carrying Wire*

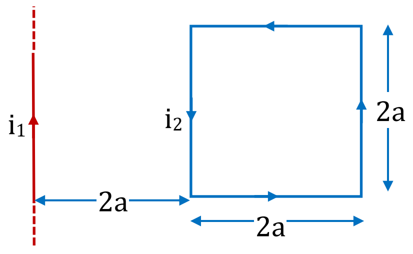
**12.** A straight horizontal conducting rod of length 0.45 $m$ and mass 60 $g$ is suspended by two vertical wires at its ends. A current of 5.0 $A$ is set up in the rod through the wires.

(a) What magnetic field should be set up normal to the conductor in order that the tension in the wires is zero ?

(b) What will be the total tension in the wires if the direction of current is reversed keeping the magnetic field same as before ? [Ignore the mass of the wires] $g$ = 9.8 $ms^{-2}$.

**PMG133**

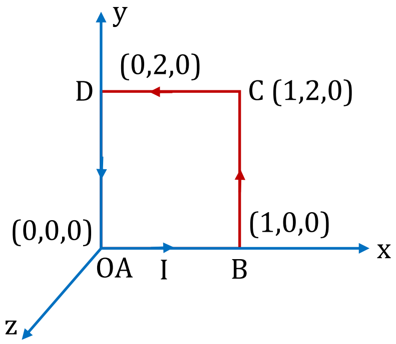
**13.** An infinitely long straight wire carries a current $i_1$ =1 amp. A rectangular current loop placed in the same plane of shown dimensions carries a current $i_2$ = 1 amp anticlockwise. Magnitude of net force on the loop is found to be $\beta\frac{\mu_0}{4\pi}$. Find value of $\beta$.




**PMG134**

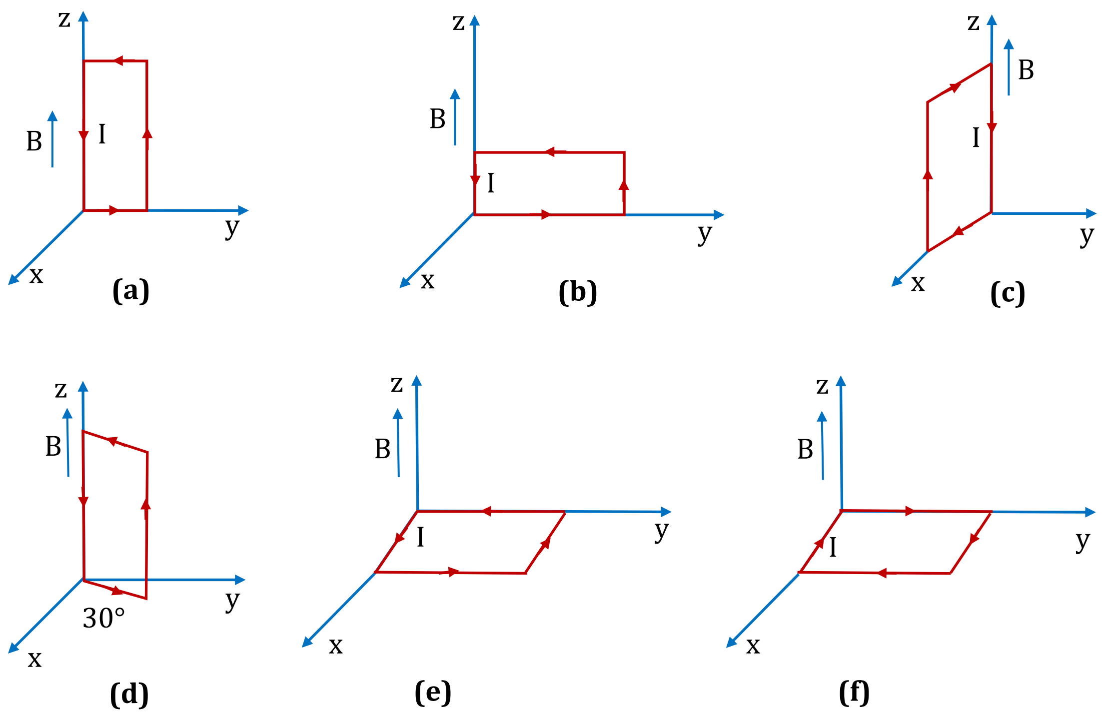
### *Torque on a Current Carrying Loop*

**14.** A rectangular filamentary current loop in the $z = 0$ plane has corners at (0, 0, 0) (1, 0, 0) (1, 2, 0) and (0, 2, 0). The loop carries a current of 5 $A$ in the anticlockwise direction. Find (a) the total force and (b) torque on the loop produced by the magnetic field $B = 2\vec{i} + 2\hat{j} - 4\hat{k}\ Wb/m^2$.



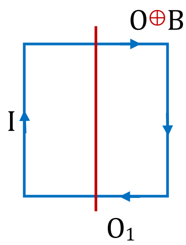

**PMG137**

**15.** A uniform magnetic field of 3000 $G$ is established along the positive $z$-direction. A rectangular loop of sides 10 $cm$ and 5 $cm$ carries a current of 12$A$. What is the torque on the loop in the different cases shown in figure. What is the force on each case? Which case corresponds to stable equilibrium?




**PMG143**

**16.** A square current carrying loop made of thin wire and having a mass $m = 10g$ can rotate without friction with respect to the vertical axis $OO_1$, passing through the centre of the loop at right angles to two opposite sides of the loop. The loop is placed in a homogeneous magnetic field with an induction $B = 10^{-1}\ T$ directed at right angles to the plane of the drawing. A current $I = 2A$ is flowing in the loop. Find the period of small oscillations that the loop performs about its position of stable equilibrium.




**PMG144**

**17.** A non–conducting thin disc of radius $R$ charged uniformly over one side with surface density $\sigma$ rotates about its axis with an angular velocity $\omega$. Find:

(a) the magnetic induction at the centre of the disc;

(b) the magnetic moment of the disc.

**PMG205**

## *Magnetic Material and Earth Magnetism*

**18**. A non-conducting sphere of radius $R$ = 50 *mm*, charged uniformly with surface density $\sigma = 10.0\,\mu C / \text{m}^2$ rotates with an angular velocity $\omega = 70\,\text{rad}/s$ about the axis passing through its centre. Find magnetic induction at the centre of the sphere.

**PMG188**

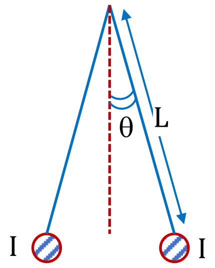
# EXERCISE - JEE (Main) PYQ

**1.** The coercivity of a small magnet where the ferromagnet gets demagnetized is $3 \times 10^3\ A\ m^{-1}$. The current required to be passed in a solenoid of length 10 cm and number of turns 100, so that the magnet gets demagnetized when inside the solenoid, is : **[JEE (Main) 2014]**

(1) 3 $A$ (2) 6 $A$ (3) 30 $mA$ (4) 60 $mA$

**PMG031**

**2.** Two long current carrying thin wires, both with current I, are held by the insulating threads of length $L$ and are in equilibrium as shown in the figure, with threads making an angle 'θ' with the vertical. If wires have mass λ per unit length then the value of $I$ is :- ($g$ = gravitational acceleration) **[JEE (Main) 2015]**




(1) $2\sqrt{\dfrac{\pi g L}{\mu_0}\tan\theta}$ (2) $\sqrt{\dfrac{\pi\lambda g L}{\mu_0}\tan\theta}$ (3) $\sin\theta\sqrt{\dfrac{\pi\lambda g L}{\mu_0\cos\theta}}$ (4) $2\sin\theta\sqrt{\dfrac{\pi\lambda g L}{\mu_0\cos\theta}}$

**PMG032**

**3.** Two coaxial solenoids of different radii carry current $I$ in the same direction. Let $\vec{F_1}$ be the magnetic force on the inner solenoid due to the outer one and $\vec{F_2}$ be the magnetic force on the outer solenoid due to the inner one. Then : **[JEE (Main) 2015]**

(1) $\vec{F_1}$ is radially inwards and $\vec{F_2} = 0$

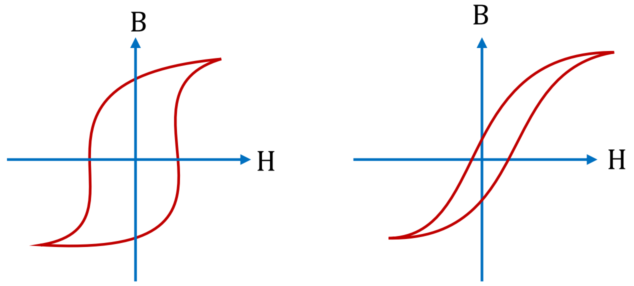
(2) $\vec{F_1}$ is radially outwards and $\vec{F_2} = 0$

(3) $\vec{F_1} = \vec{F_2} = 0$

(4) $\vec{F_1}$ is radially inwards and $\vec{F_2}$ is radially outwards.

**PMG033**

**4.** Hysteresis loops for two magnetic materials $A$ and $B$ are given below :




(A) (B)

These materials are used to make magnets for electric generators, transformer core and electromagnet core. Then it is proper to use : **[JEE (Main) 2016]**

(1) $B$ for electromagnets and transformers.

(2) $A$ for electric generators and transformers.

(3) $A$ for electromagnets and $B$ for electric transformers.

(4) $A$ for transformers and $B$ for electric generators.

**PMG034**

**5.** Two identical wires $A$ and B, each of length '$l$', carry the same current $I$. Wire $A$ is bent into a circle of radius $R$ and wire $B$ is bent to form a square of side '$a$'. If $B_A$ and $B_B$ are the values of magnetic field at the centres of the circle and square respectively, then the ratio $\frac{B_A}{B_B}$ is : **[JEE (Main) 2016]**

(1) $\frac{\pi^2}{8\sqrt{2}}$ (2) $\frac{\pi^2}{8}$ (3) $\frac{\pi^2}{16\sqrt{2}}$ (4) $\frac{\pi^2}{16}$

**PMG035**

**6.** A magnetic needle of magnetic moment $6.7 \times 10^{-2}\ Am^2$ and moment of inertia $7.5 \times 10^{-6}\ kg\ m^2$ is performing simple harmonic oscillations in a magnetic field of 0.01 $T$. Time taken for 10 complete oscillations is : **[JEE (Main) 2017]**

(1) 6.98 $s$ (2) 8.76 $s$ (3) 6.65 $s$ (4) 8.89 $s$

**PMG036**

**7.** The dipole moment of a circular loop carrying a current $I$, is $m$ and the magnetic field at the centre of the loop is $B_1$. When the dipole moment is doubled by keeping the current constant, the magnetic field at the centre of the loop is $B_2$. The ratio $\frac{B_1}{B_2}$ is : **[JEE (Main) 2018]**

(1) $\sqrt{3}$ (2) $\sqrt{2}$ (3) $\frac{1}{\sqrt{2}}$ (4) 2

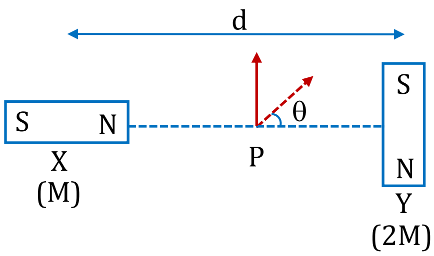
**PMG037**

**8.** A paramagnetic material has $10^{28}$ atoms/$m^3$. Its magnetic susceptibility at temperature 350 $K$ is $2.8 \times 10^{-4}$. Its susceptibility at 300 $K$ is : **[JEE (Main) 2019]**

(1) $3.672 \times 10^{-4}$ (2) $3.726 \times 10^{-4}$ (3) $3.267 \times 10^{-4}$ (4) $2.672 \times 10^{-4}$

**PMG038**

**9.** Two magnetic dipoles $X$ and $Y$ are placed at a separation $d$, with their axes perpendicular to each other. The dipole moment of $Y$ is twice that of $X$. A particle of charge $q$ is passing, through their midpoint $P$, at angle $\theta = 45°$ with the horizontal line, as shown in figure. What would be the magnitude of force on the particle at that instant ?
($d$ is much larger than the dimensions of the dipole) **[JEE (Main) 2019]**




(1) $\sqrt{2}\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d/2)^3}\times qv$ (2) $\left(\frac{\mu_0}{4\pi}\right)\frac{2M}{(d/2)^3}\times qv$

(3) $\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d/2)^3}\times qv$ (4) 0

**PMG039**

**10.** A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45°, and 40 times per minute where the dip is 30°. If $B_1$ and $B_2$ are respectively the total magnetic field due to the earth at the two places, then the ratio $B_1/B_2$ is best given by : **[JEE (Main) 2019]**

(1) 2.2 (2) 1.8 (3) 0.7 (4) 3.6

**PMG040**

**11.** An insulating thin rod of length $\ell$ has a $x$ linear charge density $p(x) = \rho_0 \frac{x}{\ell}$ on it. The rod is rotated about an axis passing through the origin ($x = 0$) and perpendicular to the rod. If the rod makes $n$ rotations per second, then the time averaged magnetic moment of the rod is : **[JEE (Main) 2019]**

(1) $\frac{\pi}{4}n\rho\ell^3$ (2) $n\rho\ell^3$ (3) $\pi n\rho\ell^3$ (4) $\frac{\pi}{3}n\rho\ell^3$

**PMG041**

**12.** A galvanometer having a resistance of 20 Ω and 30 divisions on both sides has figure of merit 0.005 ampere/division. The resistance that should be connected in series such that it can be used as a voltmeter upto 15 volt, is :- **[JEE (Main) 2019]**

(1) 80 Ω (2) 120 Ω (3) 125 Ω (4) 100 Ω

**PMG042**

**13.** A particle of mass $m$ and charge $q$ is in an electric and magnetic field given by

$\vec{E} = 2\hat{\imath} + 3\hat{\jmath}\ ;\ \vec{B} = 4\hat{\jmath} + 6\hat{k}$

The charged particle is shifted from the origin to the point $P(x = 1\ ;\ y = 1)$ along a straight path. The magnitude of the total work done is :- **[JEE (Main) 2019]**

(1) $(0.35)q$ (2) $(0.15)q$ (3) $(2.5)q$ (4) $5q$

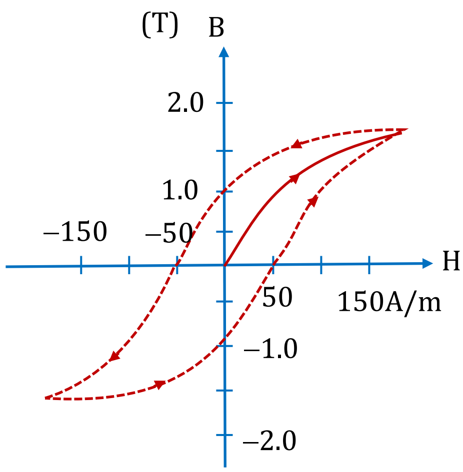
**PMG043**

**14.** A rectangular coil (Dimension 5 $cm$ × 2.5 $cm$) with 100 turns, carrying a current of 3 $A$ in the clock-wise direction is kept centered at the origin and in the $X$-$Z$ plane. A magnetic field of 1 $T$ is applied along $X$-axis. If the coil is tilted through 45° about $Z$-axis, then the torque on the coil is : **[JEE (Main) 2019]**

(1) 0.55 $Nm$ (2) 0.27 $Nm$ (3) 0.38 $Nm$ (4) 0.42 $Nm$

**PMG044**

**15.** The figure gives experimentally measured $B$ vs. $H$ variation in a ferromagnetic material. The retentivity, co-ercivity and saturation, respectively, of the material are: **[JEE (Main) 2020]**




(1) 150 $A/m$, 1.0 $T$ and 1.5 $T$

(2) 1.0 $T$, 50 $A/m$ and 1.5 $T$

(3) 1.5 $T$, 50 $A/m$ and 1.0 $T$

(4) 1.5 $T$, 50 $A/m$ and 1.0 $T$

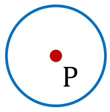
**PMG045**

**16.** A paramagnetic sample shows a net magnetisation of 6 $A/m$ when it is placed in an external magnetic field of 0.4 $T$ at a temperature of 4 $K$. When the sample is placed in an external magnetic field of 0.3 $T$ at a temperature of 24 $K$, then the magnetisation will be : **[JEE (Main) 2020]**

(1) 4 $A/m$ (2) 0.75 $A/m$ (3) 2.25 $A/m$ (4) 1 $A/m$

**PMG046**

**17.** A perfectly dimagnetic sphere has a small spherical cavity at its centre, which is filled with a paramagnetic substance. The whole system is placed in a uniform magnetic field $\vec{B}$. Then the field inside the paramagnetic substance is: **[JEE (Main) 2020]**




(1) Zero (2) $\vec{B}$

(3) much large than $|\vec{B}|$ but opposite to $\vec{B}$ (4) much large than $|\vec{B}|$ and parallel to $\vec{B}$

**PMG047**

**18.** A particle of mass $m$ and charge $q$ has an initial velocity $\vec{v} = v_0\hat{j}$ . If an electric field $\vec{E} = E_0\hat{i}$ and magnetic field $\vec{B} = B_0\hat{i}$ act on the particle, its speed will double after a time: **[JEE (Main) 2020]**

(1) $\frac{2m\upsilon_0}{qE_0}$ (2) $\frac{3m\upsilon_0}{qE_0}$ (3) $\frac{\sqrt{3}m\upsilon_0}{qE_0}$ (4) $\frac{\sqrt{2}m\upsilon_0}{qE_0}$

**PMG048**

**19.** A coil in the shape of an equilateral triangle of side 10 $cm$ lies in a vertical plane between the pole pieces of permanent magnet producing a horizontal magnetic field 20 $mT$. The torque acting on the coil when a current of 0.2 $A$ is passed through it and its plane becomes parallel to the magnetic field will be $\sqrt{x}\times10^{-5}$ $Nm$. The value of $x$ is.......... **[JEE (Main) 2021]**

**PMG049**

**20.** The magnetic field at the centre of a circular coil of radius $r$, due to current $I$ flowing through it, is $B$. The magnetic field at a point along the axis at a distance $\frac{r}{2}$ from the centre is: **[JEE (Main) 2022]**

(1) $B/2$ (2) $2B$ (3) $\left(\frac{2}{\sqrt{5}}\right)^3 B$ (4) $\left(\frac{2}{\sqrt{3}}\right)^3 B$

**PMG050**

**21.** The current required to be passed through a solenoid of 15 $cm$ length and 60 turns in order to demagnetise a bar magnet of magnetic intensity $2.4 \times 10^3 Am^{-1}$ is _________ $A$.

**[JEE (Main) 2023]**

**PMG189**

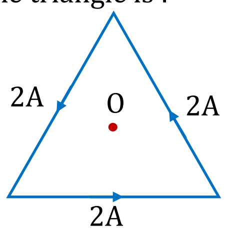
**22.** A square loop of area $25 cm^2$ has a resistance of $10\Omega$. The loop is placed in uniform magnetic field of magnitude 40.0 $T$. The plane of loop is perpendicular to the magnetic field. The work done in pulling the loop out of the magnetic field slowly and uniformly in 1.0 sec, will be

**[JEE (Main) 2023]**

(1) $2.5 \times 10^{-3} J$ (2) $1.0 \times 10^{-3} J$ (3) $1.0 \times 10^{-4} J$ (4) $5 \times 10^{-3} J$

**PMG190**

**23.** As shown in the figure, a current of $2A$ flowing in an equilateral triangle of side $4\sqrt{3}cm$. The magnetic field at the centroid $O$ of the triangle is :




(Neglect the effect of earth's magnetic field.) **[JEE (Main) 2023]**

(1) $4\sqrt{3} \times 10^{-4}T$ (2) $4\sqrt{3} \times 10^{-5}T$ (3) $\sqrt{3} \times 10^{-4}T$ (4) $3\sqrt{3} \times 10^{-5}T$

**PMG191**

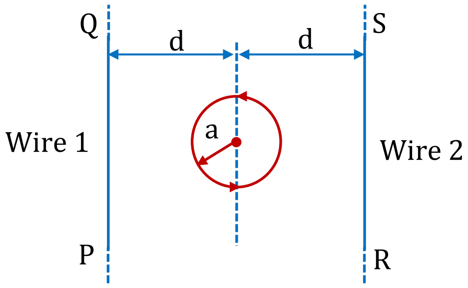
# EXERCISE - JEE (Advanced) PYQ

**1.** Two parallel wires in the plane of the paper are distance $X_0$ apart. A point charge is moving with speed $u$ between the wires in the same plane at a distance $X_1$ from one of the wires. When the wires carry current of magnitude $I$ in the same direction, the radius of curvature of the path of the point charge is $R_1$. In contrast, if the currents $I$ in the two wires have directions opposite to each other, the radius of curvature of the path is $R_2$. If $\frac{X_0}{X_1} = 3$, and value of $\frac{R_1}{R_2}$ is:- **[JEE (Advanced) 2014]**

**PMG069**

**PARAGRAPH FOR QUESTION NO. 2 AND 3**

The figure shows a circular loop of radius a with two long parallel wires (numbered 1 and 2) all in the plane of the paper. The distance of each wire from the centre of the loop is $d$. The loop and the wires are carrying the same current $I$. The current in the loop is in the counter clockwise direction if seen from above. **[JEE (Advanced) 2014]**




**2.** When $d \approx a$ but wires are not touching the loop, it is found that the net magnetic field on the axis of the loop is zero at a height $h$ above the loop. In that case

(A) current in wire 1 and wire 2 is the direction $PQ$ and $RS$, respectively and $h \approx a$

(B) current in wire 1 and wire 2 is the direction $PQ$ and $SR$, respectively and $h \approx a$

(C) current in wire 1 and wire 2 is the direction $PQ$ and $SR$, respectively and $h \approx 1.2\ a$

(D) current in wire 1 and wire 2 is the direction $PQ$ and $RS$, respectively and $h \approx 1.2\ a$

**PMG070**

**3.** Consider $d >> a$, and the loop is rotated about its diameter parallel to the wires by 30° from the position shown in the figure. If the currents in the wires are in the opposite directions, the torque on the loop at its new position will be (assume that the net field due to the wires is constant over the loop) **[JEE (Advanced) 2015]**

(A) $\frac{\mu_0 I^2 a^2}{d}$ (B) $\frac{\mu_0 I^2 a^2}{2d}$ (C) $\frac{\sqrt{3}\mu_0 I^2 a^2}{d}$ (D) $\frac{\sqrt{3}\mu_0 I^2 a^2}{2d}$

**PMG071**

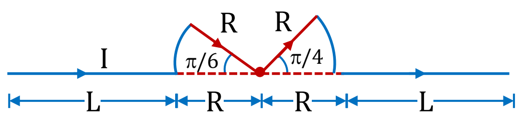
**4.** A conductor (shown in the figure) carrying constant current $I$ is kept in the $x$-$y$ plane in a uniform magnetic field $\vec{B}$. If $F$ is the magnitude of the total magnetic force acting on the conductor, then the correct statement(s) is (are) **[JEE (Advanced) 2015]**

(A) If $\vec{B}$ is along $\hat{z}$, $F \propto (L + R)$

(B) If $\vec{B}$ is along $\hat{x}$, $F = 0$

(C) If $\vec{B}$ is along $\hat{y}$, $F \propto (L + R)$

(D) If $\vec{B}$ is along $\hat{z}$, $F = 0$




**PMG072**

**Answer Q.5, Q.6 and Q.7 by appropriately matching the information given in the three columns of the following table.**

A charged particle (electron or proton) is introduced at the origin ($x = 0, y = 0, z = 0$) with a given initial velocity $\vec{v}$. A uniform electric field $\vec{E}$ and a uniform magnetic field $\vec{B}$ exist everywhere. The velocity $\vec{v}$, electric field $\vec{E}$ and magnetic field $\vec{B}$ are given in column 1, 2 and 3, respectively. The quantities $E_0$, $B_0$ are positive in magnitude. **[JEE (Advanced) 2017]**

| Column-1 | Column-2 | Column-3 |
|---|---|---|
| (I) Electron with $\vec{v}=2\frac{E_0}{B_0}\hat{x}$ | (i) $\vec{E}=E_0\hat{z}$ | (P) $\vec{B}=-B_0\hat{x}$ |
| (II) Electron with $\vec{v}=\frac{E_0}{B_0}\hat{y}$ | (ii) $\vec{E}=-E_0\hat{y}$ | (Q) $\vec{B}=B_0\hat{x}$ |
| (III) Proton with $\vec{v}=0$ | (iii) $\vec{E}=-E_0\hat{x}$ | (R) $\vec{B}=B_0\hat{y}$ |
| (IV) Proton with $\vec{v}=2\frac{E_0}{B_0}\hat{x}$ | (iv) $\vec{E}=E_0\hat{x}$ | (S) $\vec{B}=B_0\hat{z}$ |

**5.** In which case will the particle move in a straight line with constant velocity ?

(A) (II) (iii) (S) (B) (IV) (i) (S) (C) (III) (ii) (R) (D) (III) (iii) (P)

**PMG073**

**6.** In which case will the particle describe a helical path with axis along the positive $z$-direction ?

(A) (II) (ii) (R) (B) (IV) (ii) (R) (C) (IV) (i) (S) (D) (III) (iii) (P)

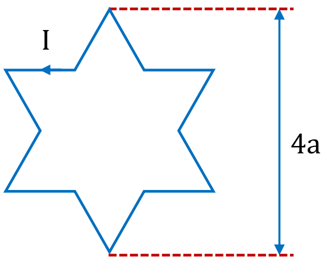
**PMG074**

**7.** In which case would the particle move in a straight line along the negative direction of $y$-axis (i.e., move along $-\hat{y}$) ?

(A) (IV) (ii) (S) (B) (III) (ii) (P) (C) (II) (iii) (Q) (D) (III) (ii) (R)

**PMG075**

**8.** A symmetric star shaped conducting wire loop is carrying a steady state current $I$ as shown in the figure. The distance between the diametrically opposite vertices of the star is $4a$. The magnitude of the magnetic field at the center of the loop is : **[JEE (Advanced) 2017]**

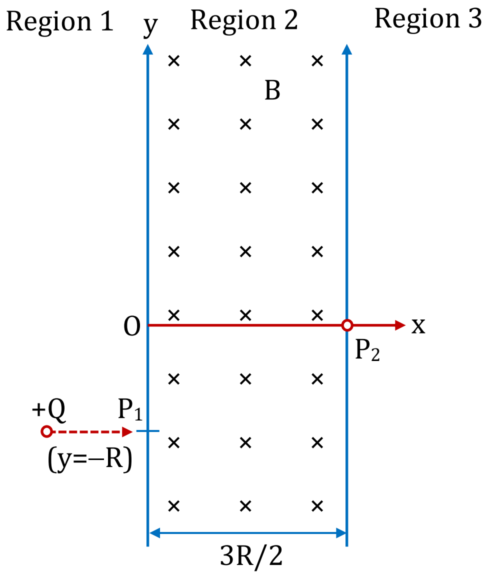



(A) $\frac{\mu_0 I}{4\pi a}3\left[\sqrt{3}-1\right]$ (B) $\frac{\mu_0 I}{4\pi a}6\left[\sqrt{3}-1\right]$

(C) $\frac{\mu_0 I}{4\pi a}6\left[\sqrt{3}+1\right]$ (D) $\frac{\mu_0 I}{4\pi a}3\left[2-\sqrt{3}\right]$

**PMG076**

**9.** A uniform magnetic field $B$ exists in the region between $x = 0$ and $x = \frac{3R}{2}$ (region 2 in the figure) pointing normally into the plane of the paper. A particle with charge $+Q$ and momentum $p$ directed along $x$-axis enters region 2 from region 1 at point $P_1(y = -R)$. Which of the following options(s) is/are correct ? **[JEE (Advanced) 2017]**




(A) For $B = \frac{8}{13}\frac{p}{QR}$, the particle will enter region 3 through the point $P_2$ on $x$-axis.

(B) For $B > \frac{2}{3}\frac{p}{QR}$, the particle will re-enter region 1.

(C) For a fixed $B$, particle of same charge $Q$ and same velocity $v$, the distance between the point $P_1$ and the point of re-entry into region 1 is inversely proportional to the mass of the particle.

(D) When the particle re-enters region 1 through the longest possible path in region 2, the magnitude of the change in its linear momentum between point $P_1$ and the farthest point from $y$-axis is $\frac{p}{\sqrt{2}}$.

**PMG077**

**10.** Two infinitely long straight wires lie in the $xy$-plane along the lines $x = \pm R$. The wire located at $x = +R$ carries a constant current $I_1$ and the wire located at $x = -R$ carries a constant current $I_2$. A circular loop of radius $R$ is suspended with its centre at $(0, 0, \sqrt{3}R)$ and in a plane parallel to the $xy$-plane. This loop carries a constant current $I$ in the clockwise direction as seen from above the loop. The current in the wire is taken to be positive if it is in the $+\hat{j}$ direction. Which of the following statements regarding the magnetic field $\vec{B}$ is (are) true ? **[JEE (Advanced) 2018]**

(A) If $I_1 = I_2$, then $\vec{B}$ cannot be equal to zero at the origin (0, 0, 0)

(B) If $I_1 > 0$ and $I_2 < 0$, then $\vec{B}$ can be equal to zero at the origin (0, 0, 0)

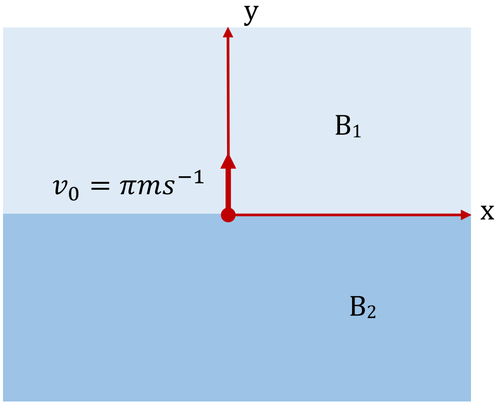
(C) If $I_1 < 0$ and $I_2 > 0$, then $\vec{B}$ can be equal to zero at the origin (0, 0, 0)

(D) If $I_1 = I_2$, then the $z$-component of the magnetic field at the centre of the loop is $\left(-\frac{\mu_0 I}{2R}\right)$

**PMG078**

**11.** In the $x$-$y$-plane, the region $y > 0$ has a uniform magnetic field $B_1\hat{k}$ and the region $y < 0$ has a another uniform magnetic field $B_1\hat{k}$. A positively charged particle is projected from the origin along the positive $y$-axis with speed $v_0 = \pi ms^{-1}$ at $t = 0$, as shown in the figure. Neglect gravity in this problem. Let $t = T$ be the time when the particle crosses the $x$-axis from below for the first time. If $B_2 = 4B_1$, the average speed of the particle, in $ms^{-1}$, along the $x$-axis in the time interval $T$ is ______.

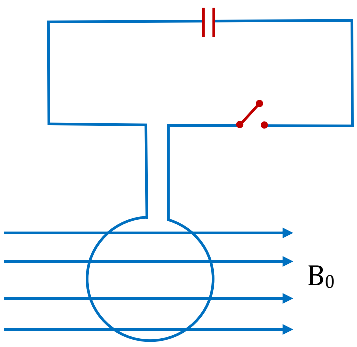
**[JEE (Advanced) 2018]**




**PMG079**

**12.** A circular coil of radius $R$ and $N$ turns has negligible resistance. As shown in the schematic figure, its two ends are connected to two wires and it is hanging by those wires with its plane being vertical. The wires are connected to a capacitor with charge $Q$ through a switch. The coil is in a horizontal uniform magnetic field $B_o$ parallel to the plane of the coil. When the switch is closed, the capacitor gets discharged through the coil in a very short time. By the time the capacitor is discharged fully, magnitude of the angular momentum gained by the coil will be (assume that the discharge time is so short that the coil has hardly rotated during this time)-

**[JEE (Advanced) 2020]**




(A) $\frac{\pi}{2}NQB_oR^2$ (B) $\pi NQB_oR^2$ (C) $2\pi NQB_oR^2$ (D) $4\pi NQB_oR^2$

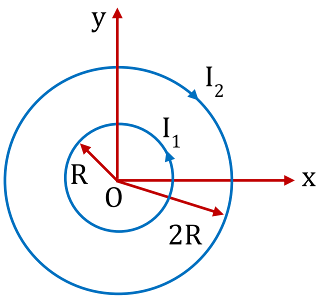
**PMG080**

**13.** An $\alpha$-particle (mass 4 *amu*) and a singly charged sulfur ion (mass 32 *amu*) are initially at rest. They are accelerated through a potential $V$ and then allowed to pass into a region of uniform magnetic field which is normal to the velocities of the particles. Within this region, the $\alpha$-particle and the sulfur ion move in circular orbits of radii $r_\alpha$ and $r_s$, respectively. The ratio $(r_s/r_\alpha)$ is___.

**[JEE (Advanced) 2021]**

**PMG081**

**14.** Two concentric circular loops, one of radius $R$ and the other of radius $2R$, lie in the $xy$-plane with the origin as their common center, as shown in the figure. The smaller loop carries current $I_1$ in the anti-clockwise direction and the larger loop carries current $I_2$ in the clockwise direction, with $I_2 > 2I_1$. $\vec{B}$ $(x, y)$ denotes the magnetic field at a point $(x, y)$ in the $xy$-plane. Which of the following statement(s) is(are) correct? **[JEE (Advanced) 2021]**




(A) $\vec{B}$ $(x, y)$ is perpendicular to the $xy$-plane at any point in the plane.

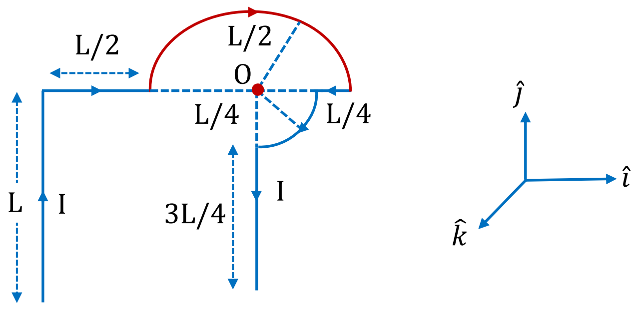
(B) $|\vec{B}(x, y)|$ depends on $x$ and $y$ only through the radial distance $r = \sqrt{x^2 + y^2}$.

(C) $|\vec{B}(x, y)|$ is non-zero at all points for $r < R$.

(D) $\vec{B}$ $(x, y)$ points normally outward from the $xy$-plane for all the points between the two loops.

**PMG082**

**15.** Which one of the following options represents the magnetic field $\vec{B}$ at $O$ due to the current flowing in the given wire segments lying on the $xy$ plane? **[JEE (Advanced) 2022]**




(A) $\vec{B} = \frac{-\mu_0 I}{L}\left(\frac{3}{2} + \frac{1}{4\sqrt{2}\pi}\right)\hat{k}$

(B) $\vec{B} = -\frac{\mu_0 I}{L}\left(\frac{3}{2} + \frac{1}{2\sqrt{2}\pi}\right)\hat{k}$

(C) $\vec{B} = \frac{-\mu_0 I}{L}\left(1 + \frac{1}{4\sqrt{2}\pi}\right)\hat{k}$

(D) $\vec{B} = \frac{-\mu_0 I}{L}\left(1 + \frac{1}{4\pi}\right)\hat{k}$

**PMG083**

# JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

## SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

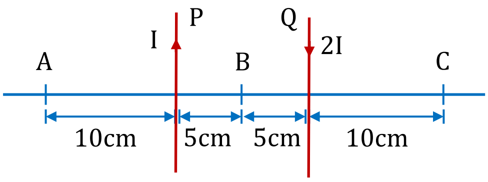
*Full Marks* : +4, if only the bubble corresponding to the correct option is darkened.
*Zero Marks* : 0, if none of the bubbles is darkened.
*Negative Marks* : –1 in all other cases.

**1.** A particle with charge $q$ and mass m starts its motion from origin with a velocity $\vec{v} = a\hat{i}$. A uniform magnetic field $\vec{B} = \frac{b}{4}\hat{i} + \frac{\sqrt{3}b}{4}\hat{j}$ exists everywhere in space. The component of velocity vector in $y$-direction when the value of $z$-coordinate becomes maximum is

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

**PMG001**

**2.** Two infinitely long wires $P$ and $Q$ separated by a distance of 10 $cm$ in air, carry current $I$ and $2I$ in opposite directions as shown in figure. The resultant magnetic field due to current in these wires will be zero at :-




(1) Point $A$ (2) Point $B$
(3) Point $C$ (4) None of the points $A$, $B$, $C$

**PMG002**

**3.** A length of wire carries a steady current. It is first bent to form a circular coil of one turn. The same length is now bent more sharply to give a double loop of a smaller radius. The magnetic field cause at the centre by the same current is

(1) a quarter of its first value (2) two times its first value
(3) four times its first value (4) half its first value

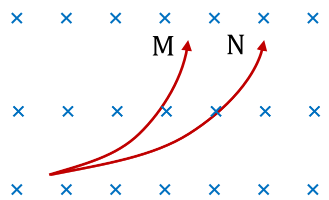
**PMG003**

**4.** A long slender solenoid has tightly spaced turns wound in a single layer over its surface. The winding wire has a thickness = 0.1 $mm$. If a current of 1$A$ flows through the winding wire, what is the approximate value of magnetic field at the mid plane of the solenoid winding, on its axis ?

(1) $2\pi\sqrt{2}\times10^{-3}T$ (2) $\pi\sqrt{2}\times10^{-3}T$ (3) $2\pi \times 10^{-3}$ $T$ (4) $4\pi \times 10^{-3}$ $T$

**PMG004**

**5.** Two charged particle $M$ and $N$ are projected with same velocity in a uniform magnetic field then $M$ and $N$ respectively :-




(1) an electron and a proton

(2) a deutron and a proton

(3) a deutron and an electron

(4) a proton and $\alpha$ particle

**PMG005**

**6.** Match the following (symbols have usual meaning)

| | List-I | | List-II |
|---|---|---|---|
| (P) | $\dfrac{\oint \vec{B}.d\vec{\ell}}{\mu_0}$ | (1) | Zero |
| (Q) | $\oint \vec{B}.d\vec{s}$ | (2) | Magnetic field of current loop at center of loop. |
| (R) | $\dfrac{\mu_0}{4\pi}\dfrac{i\,d\vec{\ell}\times\vec{r}}{\lvert\vec{r}\rvert^3}$ | (3) | Current enclosed |
| (S) | $\dfrac{\mu_0 i}{2R}$ | (4) | Magnetic field of small current element. |

**Codes :**

| | **P** | **Q** | **R** | **S** |
|---|---|---|---|---|
| (1) | 2 | 4 | 1 | 3 |
| (2) | 3 | 1 | 4 | 2 |
| (3) | 1 | 4 | 2 | 3 |
| (4) | 4 | 3 | 2 | 1 |

**PMG006**

**7.** A charged particle of mass 1 $\mu g$ and charge $1\mu C$ having speed $2m/s$ moves in a magnetic field $1\hat{K}$ Tesla. At a certain instant its velocity is $\vec{v} = \hat{i} + \hat{j} + m\hat{k}$. The value of '$m$' is :

(1) $\sqrt{2}$  (2) 0  (3) 1  (4) Cannot be determined.

**PMG007**

**8.** A charged particle of mass $m$ and charge $q$ is accelerated through a potential difference of $V$ volt. It enters a region of uniform magnetic field $B$ which is directed perpendicular to the direction of motion of the particle. The particle will move on a circular path of radius :-

(1) $\sqrt{\dfrac{Vm}{qB^2}}$  (2) $\dfrac{2Vm}{qB^2}$  (3) $\sqrt{\dfrac{2Vm}{q}}\left(\dfrac{1}{B}\right)$  (4) $\sqrt{\dfrac{Vm}{2q}}\left(\dfrac{1}{B}\right)$

**PMG008**

**9.** A particle of specific charge $\sigma$ $(q / m)$ moving with a certain velocity $v$ enters a uniform magnetic field of strength $B$ directed along the negative $Z$-axis extending from $x = r_1$ to $x = r_2$. The minimum value of $v$ required in order that the particle can just enter the region $x > r_2$ is :

(1) $\sigma r_2 B$  (2) $\sigma r_1 B$  (3) $\sigma(r_2 - r_1)B$  (4) $\sigma\sqrt{r_2^2 - r_1^2}\,B$

**PMG009**

**10.** A particle is projected with a velocity (10 $m/s$) along $y$-axis from point (2, 3). Magnetic field of $(3\hat{i}+4\hat{j})$ Tesla exist uniformly in the space. Its speed when particle passes through $y$-axis for the third time is : (neglect gravity)

(1) $\sqrt{20}\ m/s$ (2) $\sqrt{60}\ m/s$ (3) $\sqrt{30}\ m/s$ (4) $10\ m/s$

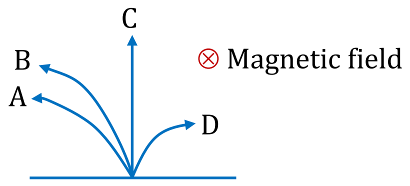
**PMG010**

**11.** A particle of mass $m$ and charge $q$ is thrown from origin at $t = 0$ with velocity $2\hat{i}+3\hat{j}+4\hat{k}$ units in a region with uniform magnetic field $\vec{B} = 2\hat{i}$ units. After time $t = \dfrac{\pi m}{qB}$, an electric field $\vec{E}$ is switched on such that particle moves on a straight line with constant speed. $\vec{E}$ may be :-

(1) $5\hat{k}-10\hat{j}$ units (2) $-6\hat{k}-9\hat{j}$ units (3) $-6\hat{k}+8\hat{j}$ units (4) $6\hat{k}+8\hat{j}$ units

**PMG011**

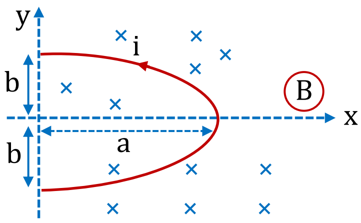
**12.** A neutron, a proton, an electron and an α-particle enter a region of uniform magnetic field with the same velocities. The magnetic field is perpendicular and directed into the plane of the paper. The tracks of the particles are labelled in the figure. The electron follows the track .....




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

**PMG012**

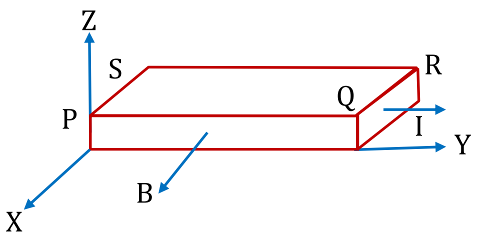
**13.** In the figure, there is a conducting wire having current $i$ and which has a shape of half ellipse $\left[\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}=1\right]$ is kept in a uniform magnetic field $B$ as shown. If the mass of wire is $m$, the acceleration of wire will be:




(1) $\dfrac{ibB}{m}$ (2) $\dfrac{iaB}{m}$ (3) $\dfrac{2iaB}{m}$ (4) $\dfrac{2ibB}{m}$

**PMG013**

**14.** A conducting slab of copper $PQRS$ is kept on the $xy$ plane in a uniform magnetic field along $x$-axis as indicated in the figure. A steady current $I$ flows through the cross section of the slab along the $y$-axis. The direction of the electric field inside the slab, arising due to the applied magnetic field is along the :-




(1) negative $Y$ direction

(2) positive $Y$ direction

(3) negative $Z$ direction

(4) positive $Z$ direction

**PMG014**

**15.** A conducting coil is bent in the form of equilateral triangle of side 5 *cm*. Current flowing through it is 0.2 *A*. The magnetic moment of the triangle is :-

(1) $\sqrt{3} \times 10^{-2}\ A\text{–}m^2$ (2) $2.2 \times 10^{-4}\ A\text{–}m^2$ (3) $2.2 \times 10^{-2}\ A\text{–}m^2$ (4) $\sqrt{3} \times 10^{-4}\ A\text{–}m^2$

**PMG015**

**16.** A charge $q$ is uniformly distributed on a hollow sphere of radius $R$. It is rotated with an angular speed ($\omega$) about an axis passing through the centre of mass of the hollow sphere. The magnetic moment of the hollow sphere is :-

(1) $\frac{q}{5}R^2\omega$ (2) $\frac{q}{4}R^2\omega$ (3) $\frac{q}{3}R^2\omega$ (4) $qR^2\omega$

**PMG016**

**17.** A current $I$ flows along the length of an infinitely long, straight, thin walled pipe. Then-

(1) the magnetic field is zero only on the axis of the pipe

(2) the magnetic field is different at different points inside the pipe

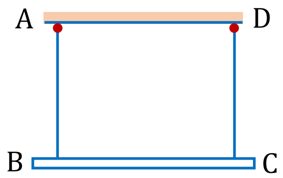
(3) the magnetic field at any point inside the pipe is zero

(4) the magnetic field at all points inside the pipe is the same, but not zero

**PMG017**

**18.** A conducting rod of length $L$ is hanging from ceiling with help of two light metallic threads as shown. There is some potential difference between $A$ and $D$ so that some current flows in the rod. When displaced perpendicular to plane of diagram slightly, the system oscillates with time period $T$. Now magnetic field $B$ perpendicular to plane of diagram is switched on. The time period of oscillation now becomes $\frac{T}{\sqrt{2}}$. The magnitude of current flowing through rod is.

(The magnetic field cuts through the rod only and not the threads)




(1) $\frac{mg}{BL}$ (2) $\frac{mg}{2BL}$ (3) $\frac{2mg}{BL}$ (4) $\frac{\sqrt{2}mg}{BL}$

**PMG018**

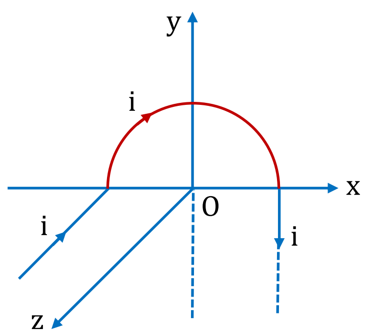
**19.** Find the magnetic field induction at '$O$' due to the given current carrying wire in diagram :

(1) $B = \frac{\mu_0 i}{4\pi r}(-\hat{j}) - \left(\frac{\mu_0 i}{4R} + \frac{\mu_0 i}{4\pi R}\right)\hat{k}$

(2) $B = \frac{\mu_0 i}{4\pi R}(\hat{j}) + \left(\frac{\mu_0 i}{4R}\right)$

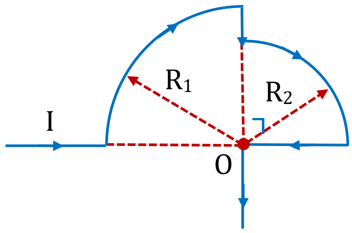
(3) $B = \frac{\mu_0 i}{4\pi r}(\hat{i}) - \left(\frac{\mu_0 i}{4R} + \frac{\mu_0 i}{4\pi R}\right)\hat{k}$

(4) $B = \frac{\mu_0 i}{4\pi r}(\hat{i}) - \left(\frac{\mu_0 i}{4R} + \frac{\mu_0 i}{4\pi R}\right)\hat{j}$




**PMG019**

**20.** In the loop shown, the magnetic induction at the point '$O$' is




(1) $\frac{\mu_0 I}{8}\left(\frac{R_1 - R_2}{R_1 R_2}\right)$ (2) $\frac{\mu_0 I}{8}\left(\frac{R_1 + R_2}{R_1 R_2}\right)$ (3) $\frac{\mu_0 I}{8}\left(\frac{R_1 R_2}{R_1 + R_2}\right)$ (4) 0

**PMG020**

## SECTION–B

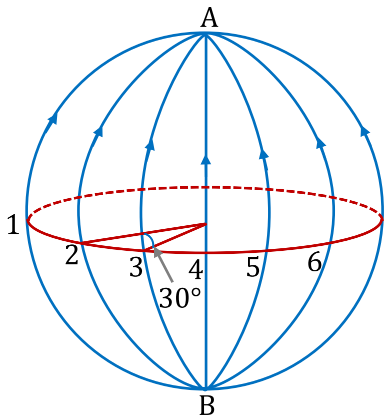
- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

| | | | |
|---|---|---|---|
| Full Marks | : | +4, | if only correct answer is given. |
| Zero Marks | : | 0, | if no answer is given. |
| Negative Marks | : | –1 | for incorrect answer. |

**1.** An infinite hollow cylinder of radius $R$ having uniform surface charge density σ is rotated with constant angular velocity ω about its axis. Magnetic field at the centre of cylinder is $B = \mu_0 \sigma R^x \omega$. Find $x$.

**PMG021**

**2.** Figure shows 12 current carrying wires wound around the sphere of radius $R$. Each wire carries the same current '$I$' and is separated by an angle of 30°. None of the wires are touching each other and current in all the wires is moving up as shown in figure. A constant magnetic field $B$ exists horizontally thorough out the region of space. The net force on the wires is given by $F = (\alpha\beta)BiR$. Here αβ is a two digit number. Write α + β in OMR sheet.




**PMG022**

**3.** Two concentric circular coils $X$ and $Y$ of radii 16 cm and 10 cm, respectively, lie in the same vertical plane containing the north to south direction. Coil $X$ has 20 turns and carries a current of 16$A$ ; coil $Y$ has 25 turns and carries a current of 18 $A$. The sense of the current in $X$ is anticlockwise, and clockwise in $Y$, for an observer looking at the coils facing west. The magnitude of net magnetic field is $\frac{\pi}{\alpha}$ milli tesla. The value of $\alpha$ is ________.

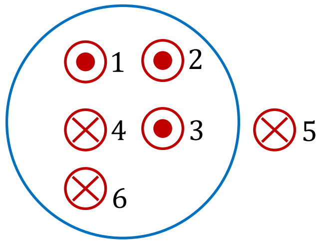
**PMG023**

**4.** A circular loop of radius $r$ carries a current $i$. A long, straight wire carrying a current 4$i$ should be placed in the plane of the circle so that the magnetic field at the centre becomes zero. The distance of wire from centre of circle is $\frac{xr}{\pi}$. The value of $x$ is ________.

**PMG024**

**5.** Six wires of current $I_1 = 1A$, $I_2 = 2A$, $I_3 = 3A$, $I_4 = 1A$, $I_5 = 5A$ and $I_6 = 4A$ cut the page perpendicularly at the points 1, 2, 3, 4, 5 and 6 respectively as shown in the figure. The value of the integral $\oint \vec{B}.d\vec{\ell}$ around the closed path in SI units is $\frac{\alpha\mu_0}{2}$.

The value of $\alpha$ is __________.




**PMG025**

**6.** A charged particle (charge $q$, mass m) has velocity $v_0$ at origin in +$x$ direction. In space there is a uniform magnetic field b in – $z$ direction. The $y$ coordinate of particle when it crosses $y$ axis is $\frac{\lambda m v_0}{2qB}$. What is the value of $\lambda$.

**PMG026**

**7.** A beam of protons with a velocity $4 \times 10^5$ $m/s$ enters a uniform magnetic field of 0.3 $T$ at an angle of 60° to the magnetic field. Find the pitch (in $mm$) of the helix (which is the distance travelled by a proton in the beam parallel to the magnetic field during one period of rotation). Round off to nearest integer.

**PMG027**

**8.** Two moving coil meters. $M_1$ and $M_2$ have the following particulars :

| | | | |
|---|---|---|---|
| $R_1 = 10\ \Omega$, | $N_1 = 30$, | $A_1 = 3.6 \times 10^{-3}\ m^2$, | $B_1 = 0.25\ T$ |
| $R_2 = 14\ \Omega$, | $N_2 = 42$ | $A_2 = 1.8 \times 10^{-3}\ m^2$, | $B_2 = 0.50\ T$ |

(The spring constants are identical for the two meters). The ratio of current sensitivity of $M_2$ and $M_1$ is $\alpha$. The value of 10$\alpha$ is _______.

**PMG028**

**9.** A magnetic needle suspended in a vertical plane at 37° from the magnetic meridian makes an angle of 45° with the horizontal. If the true angle of dip is $\delta$ then the value of 5 tan $\delta$ is

**PMG029**

**10.** A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 $m$, 100 turns, and carrying a current of 5.2 $A$. The coercivity of the bar magnet ($A/m$) is :

**PMG030**

# JEE (Advanced) Practice Paper

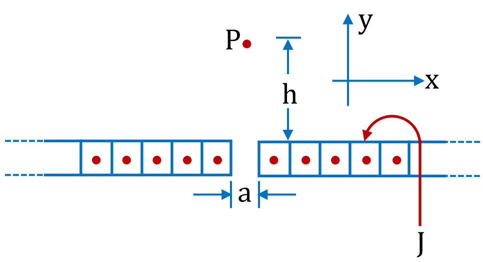
This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

## SECTION–I

- This section contains **FOUR** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

*Full Marks* : +3 if only the bubble corresponding to the correct option is darkened.
*Zero Marks* : 0 if none of the bubbles is darkened.
*Negative Marks* : –1 in all other cases.

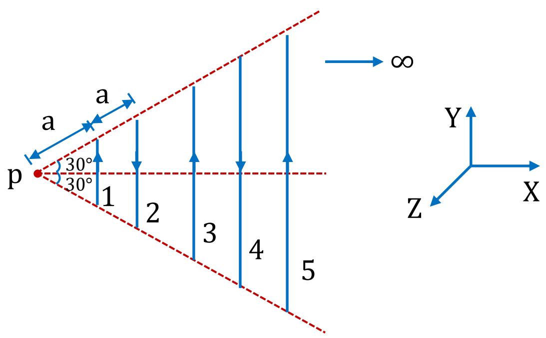
**1.** A small segment of length *a* is cut along *z*-axis from a infinite sheet having a surface current density *J* (current per unit width). The magnetic field at *P* is :-




(A) $2\mu_0 J\left(1-\frac{h}{a\pi}\right)\hat{i}$  (B) $\frac{\mu_0 Jh}{2a\pi}\hat{i}$  (C) $\frac{\mu_0 J}{2}\left(\frac{a}{h\pi}-1\right)\hat{i}$  (D) $-\frac{\mu_0 j}{2}\left(\frac{h}{a\pi}-1\right)\hat{i}$

**PMG051**

**2.** Infinite number of straight wires each carrying current *I* are equally placed as shown in the figure. Adjacent wires have current in opposite direction. Net magnetic field at point *P* is-

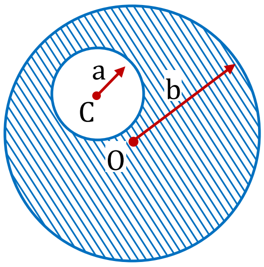



(A) $\frac{\mu_0 I}{4\pi}\frac{\ell n2}{\sqrt{3}a}\hat{k}$  (B) $\frac{\mu_0 I}{4\pi}\frac{\ell n4}{\sqrt{3}a}\hat{k}$

(C) $\frac{\mu_0 I}{4\pi}\frac{\ell n4}{\sqrt{3}a}(-\hat{k})$  (D) zero

**PMG052**

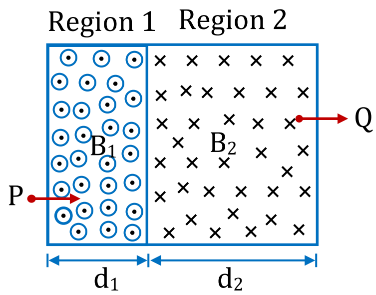
**3.** A long straight metal rod has a very long hole of radius '$a$' drilled parallel to the rod axis as shown in the figure. If the rod carries a current '$i$', the value of magnetic induction on the axis of the hole will be, where $OC = c$




(A) $\frac{\mu_0 ic}{\pi(b^2-a^2)}$ (B) $\frac{\mu_0 ic}{2\pi(b^2-a^2)}$ (C) $\frac{\mu_0 i(b^2-a^2)}{2\pi c}$ (D) $\frac{\mu_0 ic}{2\pi a^2 b^2}$

**PMG053**

**4.** Consider the figure shown. A charged particle enters magnetic field at $P$ and emerges out of magnetic field at $Q$ moving parallel to its direction of motion at $P$. If $r_1$ and $r_2$ are the radii of circular path of the particle in region 1 and region 2 respectively :-




(A) $\frac{r_1}{r_2}=\frac{d_1}{d_2}$ (B) $\frac{r_1}{r_2}=\frac{d_1+d_2}{d_2}$ (C) $\frac{r_1}{r_2}=\frac{B_2+B_1}{B_1}$ (D) $\frac{r_1}{r_2}=\frac{B_1}{B_2}$

**PMG054**

## SECTION-II

- This section contains **FOUR** questions.
- Each question has **FOUR** options for correct answer($s$). **ONE OR MORE THAN ONE** of these four option($s$) is (are) correct option($s$).
- For each question, choose the correct option($s$) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

*Full Marks* : +4 if only (all) the correct option($s$) is (are) chosen.
*Partial Marks* : +3 if all the four options are correct but ONLY three options are chosen.
*Partial Marks* : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.
*Partial Marks* : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.
*Zero Marks* : 0 if none of the options is chosen (i.e. the question is unanswered).
*Negative Marks* : –2 in all other cases.

**For Example :** If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(*s*) (second option in this case), with or without selection of any correct option(*s*) will result in –2 marks.

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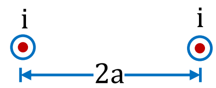
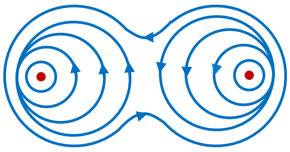
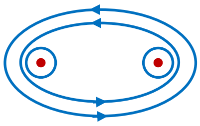
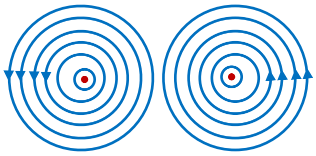
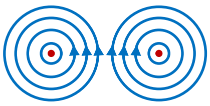
**5.** Which of the following field patterns is correct for two long straight equal parallel current carrying wires ?




(A) 

(B) 

(C) 

(D) 

**PMG193**

**6.** A particle of mass $m$ and charge $q$ moving with velocity $v$ enters a region of uniform magnetic field of induction $\vec{B}$. Then

(A) its path in the region of the field is always circular

(B) its path in the region of the field is circular if $\vec{v}.\vec{B}=0$

(C) its path in the region of the field is a straight line if $\vec{v}\times\vec{B}=0$

(D) distance travelled by the particle in time $T$ does not depend on the angle between $\vec{v}$ and $\vec{B}$

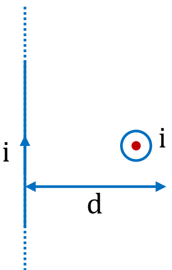
**PMG194**

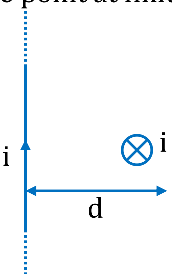
**7.** A ring of radius $R$ has uniformly distributed charge. It spins about its axis with an angular velocity ω. $P$ is a point on its axis at a distance $x$ from its centre. The velocity of light in vacuum is $c$. The ratio of the magnetic field to the electric field at $P$ is proportional to–

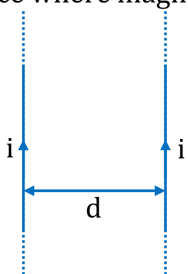
(A) ω (B) $R^2$ (C) $\frac{1}{x}$ (D) $\frac{1}{x^2}$

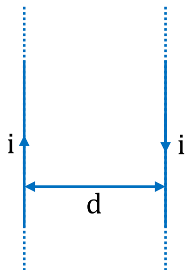
**PMG195**

**8.** Figure shows two perpendicular wires carrying the same current. In which of the following cases, there will not exist even one point at finite distance where magnetic field is zero.

(A) 


(B) 


(C) 


(D) 


**PMG196**

## SECTION-III

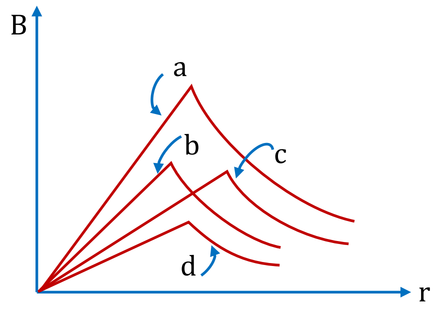
- This section contains **TWO** paragraphs.
- Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

*Full Marks* : +3 if only the bubble corresponding to the correct answer is darkened.

*Zero Marks* : 0 in all other cases.

### PARAGRAPH FOR QUESTION NOS. 9 AND 10

Curves in the graph shown give relation between radial distance and the magnitude '$B$' of the magnetic field inside and outside four long wires $a$, $b$, $c$ and $d$ carrying currents that are uniformly distributed across the cross sections of the wires. The wires are far from one another.




**9.** Which wire has the greatest radius?

(A) $a$ (B) $b$ (C) $c$ (D) $d$

**PMG197**

**10.** The current density in wire $a$ is

(A) greater than in wire $c$

(B) less than in wire $c$

(C) equal to that in wire $c$

(D) not comparable to that in wire $c$ due to lack of information

**PMG198**

### PARAGRAPH FOR QUESTION NO. 11 AND 12

One of the most fierce battles in the history of humanity was the battle between Arjuna and Karna at Kurukshetra. One night, Karna conceived of a plan to defeat and kill Arjuna in the war. He prepared an arrow with a charge of +1 $C$ deposited on its tip. From his study of circuits at school days, he estimated that if this arrow hits the crown of Arjuna, this charge will be conducted to the ground in almost 0.001 sec. The arrow has a mass of 100 gm. Arjuna would be shocked to death. Not only that, the heat that would be produced would burn his body to ashes.

But Karna was not aware that Arjuna was being protected personally by Supreme Lord Sri Krishna. Lord Krishna knew of this plan and he devised a simple plan to counter it. As Karna would fire his arrow, the Lord would build a uniform magnetic field directed vertically so that the arrow would be deviated and would not touch Arjuna. In fact, the magnetic field could be such that the arrow would come back and hit Karna.

**11.** Assume that as the charge flows through Arjuna's body, the current is constant. What is the total heat that would be dissipated in his body? The resistance of his body is 100Ω.

(A) 10,000 $J$ (B) 100,000 $J$ (C) 100 $J$ (D) $10^8 J$

**PMG199**

**12.** Assume that Arjuna is standing 10 $m$ east from Karna. The arrow is fired with a horizontal velocity of 50 $m/s$. What is the magnetic field so that the arrow deviates by 90° by the time it travels a distance of 10$m$ in the east direction? Neglect gravity for this question only.

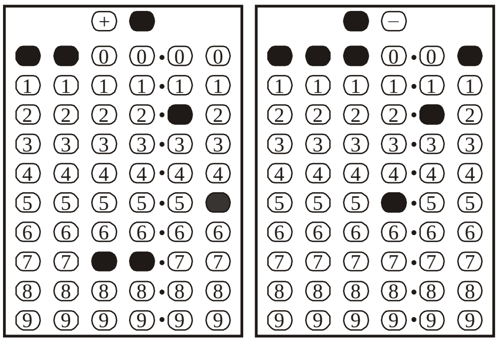
(A) 0.5 $T$ (B) 5 $T$ (C) 1 $T$ (D) 0.1 $T$

**PMG200**

## SECTION-IV

- This section contains **SIX** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

**For Example :** If answer is –77.25, 5.2 then fill the bubbles as follows:



- Answer to each question will be evaluated according to the following marking scheme:

*Full Marks* : +3 if ONLY the correct numerical value is entered as answer.

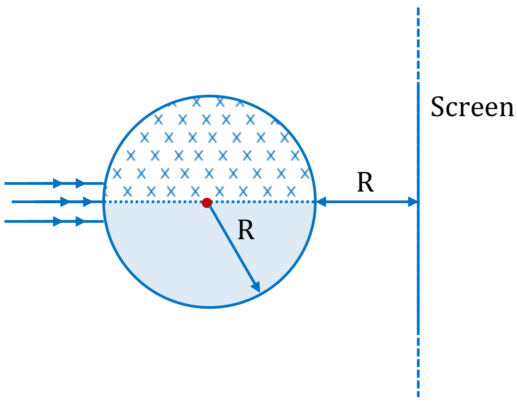
*Zero Marks* : 0 in all other cases.

**13.** In a coordinate system an electric field $E$ and a magnetic field $B$ exist in $X$-direction and particle of charge $q$ and mass m is projected with a velocity $v$ from origin along $Y$-direction. A target is located at point ($x_0$, 0, 0). Find the magnitude of magnetic induction $B$ (in Tesla) so that the particle will hit the target when it is crossing the $X$-axis third time.

[consider that $\pi^2$ = 10, $E$ =1, $x_0$ =1, $m$=2, $q$=10 all quantities in SI Unit]

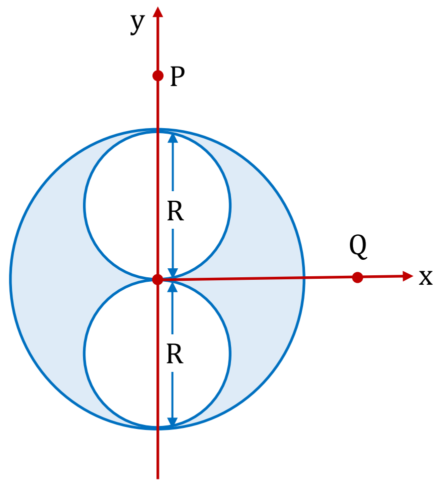
**PMG201**

**14.** Figure shows circular region of radius $R = \sqrt{3}\,m$ in which upper half has uniform magnetic field $\vec{B} = 0.2(-\hat{k})T$ and lower half has uniform magnetic field $\vec{B} = 0.2\hat{k}T$. A very thin parallel beam of point charges each having mass $m$ = 2 gm, speed $v$ = 0.3 m/sec and charge $q$ = +1 $mC$ are projected along the diameter as shown in figure. A screen is placed perpendicular to initial velocity of charges as shown. If the distance between the points on screen where charges will strikes after being deflected by the magnetic field is 4$X$ meters, then calculate $X$.



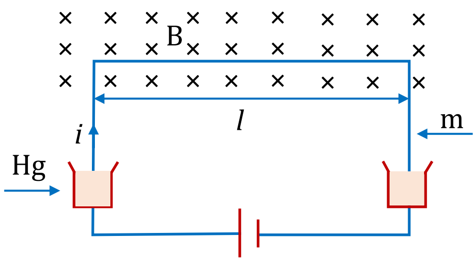

**PMG202**

**15.** A long, cylindrical conductor of radius $R$ has two cylindrical cavities of diameter $R$ running parallel to its axis as shown in figure. The conductor carries a uniform current density $J$. The field strength $B$ at position $Q$ ($x = 2R$) along the $y$-axis is $\frac{\alpha}{68}\mu_0 JR$ then find $\alpha$.




**PMG065**

**16.** A U-shaped wire of mass m and length $l$ is immersed with its two ends in mercury (see figure). The wire is in a homogeneous field of magnetic induction $B$. If a charge, that is, a current pulse $q = \int i\,dt$, is sent through the wire, the wire will jump up.



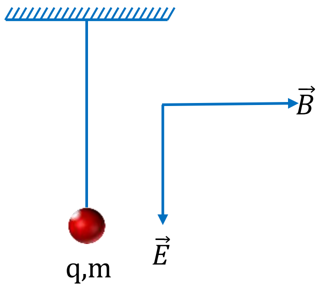

Calculate, the height h that the wire reaches, the size of the charge or current pulse, assuming that the time of the current pulse is very small in comparison with the time of flight. Make use of the fact that impulse of force equals $\int F\,dt$ ,which equals $mv$. Evaluate $q$ for $B = 0.1\ Wb/m^2$, $m = 10gm$, $\ell = 20cm$ and $h = 3$ meters. [$g = 10\ m/s^2$]

If your answer is $q = \sqrt{\alpha}$ coulomb, what is the value of $\alpha$.

**PMG066**

**17.** In the region having mutually perpendicular electric and magnetic fields, a dielectric ball is attached to a thread of length $l$ (see figure). Mass of the ball is $m$, charge $q$, the electric field $E$, magnetic field $B$. Find the period of small oscillations of the pendulum in a plane perpendicular to the magnetic field.

(Take $l = 1m$, $q = -1\mu C$, $E = 7.5\ V/m$, $m = 1mg$, $B = 0.5\ T$)




**PMG203**

**18.** A rod of length $\ell$ and total charge '$q$' which is uniformly distributed is rotating with angular velocity $\omega$ about an axis passing through the centre of rod and perpendicular to rod. Find the magnitude of magnetic dipole moment (in Amp. $m^2$) of rod. (Take : $q = 4C$, $\omega = 6$ rad/$s$ and $\ell = 2m$.)

**PMG068**

# ANSWER KEY

## EXERCISE - O

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | A | A | B | B | C | C | C | A | A | A |
| Que. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Ans. | A | D | B | C | C | D | D | D | A | D |
| Que. | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Ans. | C | C | A | A | A | A | C | B | A | A |
| Que. | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| Ans. | D | B | A | C | D | A | B | D | B | A |
| Que. | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| Ans. | B | C | C | B | C | B | D | B | D | A |
| Que. | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| Ans. | A | B | C | D | B | C | B | B | C | B |
| Que. | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| Ans. | A | B | ACD | AD | ACD | AC | BCD | AB | AB | ABC |
| Que. | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| Ans. | BD | ABCD | ABD | B | AC | ABCD | ABD | A | B | B |
| Que. | 81 | 82 | 83 | 84 | 85 | | | | | |
| Ans. | C | B | B | B | (A-P,R), (B-S), (C-P,Q,R), (D-P,R) | | | | | |
| Que. | 86 | | | | 87 | | | | | |
| Ans. | (A-Q,S), (B-P,S), (C-Q,S), (D-P,S) | | | | (A-P,R,T), (B-P,Q), (C-S), (D-P) | | | | | |
| Que. | 88 | | | | | | | | | |
| Ans. | (A-S), (B-S), (C-Q), (D-R), (E-P) | | | | | | | | | |

## EXERCISE - S

**1.** 1

**2.** $B=\frac{1}{2}\mu_0 K$

**3.** $V=\frac{\mu_0 qkd}{2m}$

**4.** 18

**5.** 5

**6.** $7\ \mu T$

**7.** $\frac{\mu_0 I\sqrt{2}}{4\pi^2 R}$

**8.** $\frac{\mu_0 I}{\pi^2 R}$

**9.** $\frac{\pi+2\theta}{\pi-2\theta}$

**10.** 5

**11.** 5

**12.** (a) A horizontal magnetic field of magnitude 0.26 $T$ normal to the conductor in such a direction that Fleming's left-hand rule gives a magnetic force upward.
(b) 1.176 $N$.

**13.** 1

**14.** (a) zero (b) $|\vec{\tau}| = 20\sqrt{2}Nm, \vec{\tau} = 20\hat{\imath} - 20\hat{\jmath}$

**15.** Use $\tau = I(A \times B)$ and $F = I(l \times B)$

**16.** $T_0 = 2\pi\sqrt{\frac{m}{6IB}} = 0.57s$

**17.** (a) $\frac{\mu_0\sigma\omega R}{2}$ (b) $\frac{\sigma\omega\pi R^4}{4}$

**18.** $29pT$

## EXERCISE - JEE (Main) PYQ

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | 1 | 4 | 3 | 1 | 1 | 3 | 2 | 3 | 4 | 3 |
| Que. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Ans. | 1 | 1 | 4 | 2 | 2 | 2 | 1 | 3 | 3 | 3 |
| Que. | 21 | 22 | 23 | | | | | | | |
| Ans. | 6 | 2 | 4 | | | | | | | |

## EXERCISE - JEE (Advanced) PYQ

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | 3 | C | B | ABC | A | C | D | B | AB | ABD |
| Que. | 11 | 12 | 13 | 14 | 15 | | | | | |
| Ans. | 2 (1.99, 2.01) | B | 4 | AB | C | | | | | |

## JEE (Main) Practice Paper

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Section-A | Q. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | A. | 2 | 1 | 3 | 4 | 4 | 2 | 1 | 3 | 3 | 4 |
| | Q. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| | A. | 3 | 4 | 4 | 4 | 2 | 3 | 3 | 1 | 1 | 2 |
| Section-B | Q. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | A. | 1 | 6 | 2 | 4 | 2 | 4 | 44 | 14 | 4 | 2600 |

## JEE (Advanced) Practice Paper

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Section-I | Q. | 1 | 2 | 3 | 4 | | |
| | A. | C | B | B | A | | |
| Section-II | Q. | 5 | 6 | 7 | 8 | | |
| | A. | A | BCD | ABC | ABD | | |
| Section-III | Q. | 9 | 10 | 11 | 12 | | |
| | A. | C | A | B | A | | |
| Section-IV | Q. | 13 | 14 | 15 | 16 | 17 | 18 |
| | A. | 6 | 3 | 9 | 15 | 4 | 4 |

# Important Notes