PRACTICE EXERCISES

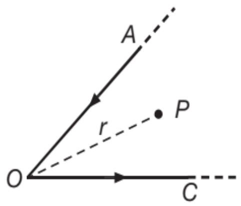
SINGLE CORRECT CHOICE TYPE QUESTIONS

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. Two observers moving with different velocities see that a point charge produces same magnetic field at the same point A. Their relative velocity must be parallel to $\vec{r}$, where $\vec{r}$ is the position vector of point A with respect to point charge. This statement is

(A) true
(B) false
(C) nothing can be said
(D) true only if the charge is moving perpendicular to the $\vec{r}$

2. Two semi-infinite wires AO and OC coinciding at O carry equal currents I as shown in Figure.



Angle AOC is α. The magnitude of magnetic field at a point P on the bisector of these two wires at a distance r from point O is

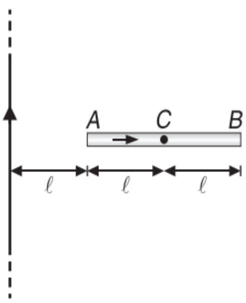
(A) $\dfrac{\mu_0 I}{2\pi r}\cot\left(\dfrac{\alpha}{2}\right)$

(B) $\dfrac{\mu_0 I}{4\pi r}\cot\left(\dfrac{\alpha}{2}\right)$

(C) $\dfrac{\mu_0 I}{2\pi r}\text{cosec}\left(\dfrac{\alpha}{2}\right)+\cot\left(\dfrac{\alpha}{2}\right)$

(D) $\dfrac{\mu_0 I}{4\pi r}\sin\left(\dfrac{\alpha}{2}\right)$

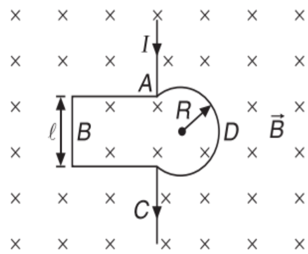
3. A current carrying rod AB is placed perpendicular to an infinitely long current carrying wire as shown in Figure.



The point at which the conductor should be hinged so that it will not rotate $(AC = CB)$

(A) A
(B) somewhere between B and C
(C) C
(D) somewhere between A and C

4. Figure shows a conducting loop $ABCDA$ placed in a uniform magnetic field (strength B) perpendicular to its plane. The part ABC is the $\left(\dfrac{3}{4}\right)$ the portion of the square of side length l. The part ADC is a circular arc of radius R. The point A and C are connected to a battery which supplies a current I to the circuit. The magnetic force on the loop due to the field B is



(A) ZERO
(B) BIl
(C) $2BIR$
(D) $\dfrac{BIlR}{I+R}$

5. A conducting gas is in the form of a long cylinder. Current flows through the gas along the length of the cylinder. The cylinder is distributed uniformly across the cross-section of the gas. Disregard thermal and electrostatic forces among the gas molecules. Due to the magnetic fields set up inside the gas and the forces which they exert on the moving ions, the gas will tend to

(A) expand
(B) contract
(C) expand and contract alternately
(D) None of the above

6. Two very long straight parallel wires carry steady currents I and $2I$ in opposite directions. The distance between the wires is d. At a certain instant of time a point charge q is at a point equidistant from the two wires in the plane of the wires. Its instantaneous velocity $\vec{v}$ is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is

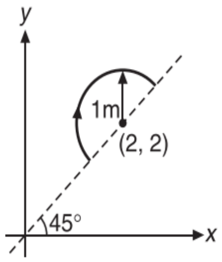
(A) $\frac{\mu_0 Iqv}{\pi d}$ (B) $\frac{\mu_0 Iqv}{2\pi d}$

(C) $\frac{3\mu_0 Iqv}{2\pi d}$ (D) ZERO

7. An infinitely long wire has linear charge density λ. It moves along its axis with a non-relativistic speed v. A point P lies at a distance r from the wire. The ratio of the electric field to the magnetic field at this point is

(A) proportional to r
(B) inversely proportional to r
(C) proportional to λ
(D) independent of r

8. A uniform magnetic field $\vec{B} = (3\hat{i} + 4\hat{j} + \hat{k})$ exists in region of space. A semi-circular wire of radius 1 m carrying current 1 A having its centre at (2, 2, 0) is placed in x-y plane as shown in Figure.

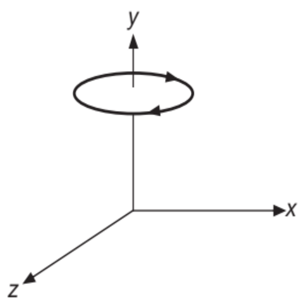


The force on semi-circular wire will be

(A) $\sqrt{2}(\hat{i} + \hat{j} + \hat{k})$ (B) $\sqrt{2}(\hat{i} - \hat{j} + \hat{k})$

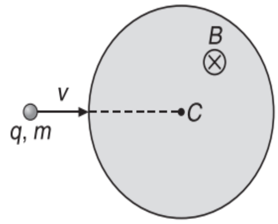
(C) $\sqrt{2}(\hat{i} + \hat{j} - \hat{k})$ (D) $\sqrt{2}(-\hat{i} + \hat{j} + \hat{k})$

9. A circular coil carrying a current I (in the direction shown), having mass m is kept above the ground (x-z plane) at some height. For the magnetic force to balance the weight of the coil, a uniform magnetic field $\vec{B}$ must be applied along the



(A) positive x-direction
(B) negative x-direction
(C) positive z-direction
(D) None of the above

10. A charged particle of mass 2 g and charge $-5\ \mu C$ enters a circular region of radius 10 cm, in which there is a uniform magnetic field of strength 4 T and directed perpendicular to the plane of circular region as shown in Figure.



If the particle's velocity vector rotates through an angle of 90° in passing through this region, then its speed is

(A) $0.25\ \text{mms}^{-1}$ (B) $4\ \text{mms}^{-1}$

(C) $1\ \text{cms}^{-1}$ (D) $1\ \text{mms}^{-1}$

11. A charged particle enters a uniform magnetic field with velocity that makes an angle of 45° with the magnetic field. The pitch of the helical path followed by the particle is p. The radius of the helix is

(A) $\sqrt{2}p$ (B) $\frac{p}{\sqrt{2}\pi}$

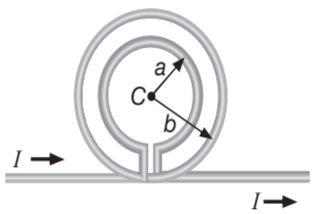
(C) $\frac{\sqrt{2}p}{\pi}$ (D) $\frac{p}{2\pi}$

12. A wire lying along y-axis from $y = 0$ to $y = 1$ m carries a current of 2 mA in the negative y-direction. The wire lies in a non-uniform magnetic field given by $\vec{B} = (0.3\ \text{Tm}^{-1})y\hat{i} + (0.4\ \text{Tm}^{-1})y\hat{j}$. The magnetic force on the entire wire, in newton, is

(A) $(-3\times10^{-4})\hat{j}$ (B) $(6\times10^{-3})\hat{k}$

(C) $(-3\times10^{-4})\hat{k}$ (D) $(3\times10^{-4})\hat{k}$

13. An otherwise infinite, straight wire has two concentric loops of radii a and b carrying equal currents in opposite directions as shown. The magnetic field at the common centre is zero for

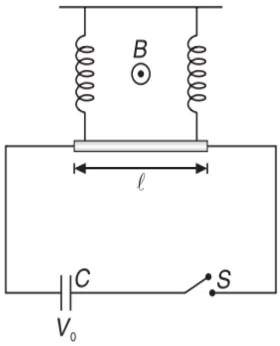


No cross-contacts Exist

(A) $\frac{a}{b} = \frac{\pi+1}{\pi}$ (B) $\frac{a}{b} = \frac{\pi}{\pi+1}$

(C) $\frac{a}{b} = \frac{\pi-1}{\pi+1}$ (D) $\frac{a}{b} = \frac{\pi+1}{\pi-1}$

14. A straight conducting bar of mass m and length l is suspended horizontally with two non-conducting springs of stiffness k as shown in Figure.



The capacitor is initially charged to the potential difference V_0. At time $t=0$ the switch S is closed and the capacitor discharges. The bar start oscillating in vertical plane. The amplitude of these oscillations (assuming the time of discharge of capacitor is much smaller than the period T of the mechanical oscillation of the bar) is

(A) $\frac{BlCV_0}{\sqrt{2km}}$ (B) $\frac{BlCV_0}{\sqrt{km}}$

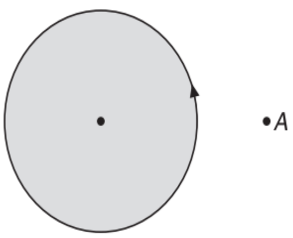
(C) $\frac{BlCV_0}{\sqrt{8km}}$ (D) $\frac{BlCV_0}{4\sqrt{km}}$

15. A uniform magnetic field of intensity 1 T is applied in a circular region of radius 0.1 m, directed into the plane of paper. A charged particle of mass 5×10^{-5} kg and charge $q=5\times10^{-4}$ C enters the field with velocity $\frac{1}{\sqrt{3}}\text{ ms}^{-1}$ making an angle of ϕ with a radial line of circular region in such a way that it passes through centre of applied field the angle ϕ is

(A) 30° (B) 45°

(C) 60° (D) 90°

16. The negatively and uniformly charged nonconducting disc as shown is rotated clockwise as shown in Figure.



The direction of the magnetic field at point A in the plane of the disc is

(A) into the page (B) out of the page

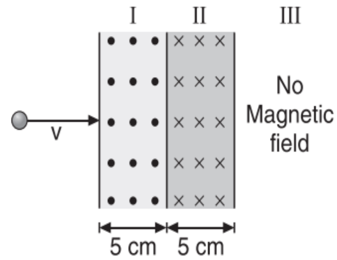
(C) up to the page (D) down the page

17. A particle of mass m and charge q starts moving from the origin under the action of an electric field $\vec{E}=E\hat{i}$ and magnetic field $\vec{B}=B\hat{i}$ with a velocity $\vec{v}=v_0\hat{j}$. The speed of the particle becomes $2v_0$ after a time t. Then t equals

(A) $2\left(\frac{mv_0}{qE}\right)$ (B) $2\left(\frac{m}{qB}\right)$

(C) $\sqrt{3}\left(\frac{m}{qB}\right)$ (D) $\sqrt{3}\left(\frac{mv_0}{qE}\right)$

18. Two uniform magnetic fields exist in two regions each consists of width 5 cm as shown in Figure. In the first region I, the magnetic induction is 0.001 T outwards and in region II the magnetic induction is 0.002 T inwards. The minimum speed of an electron entering region I as shown in Figure so that it can come out from region II to enter region III is (Take mass of electron to be 9×10^{-31} kg)



(A) $\frac{8}{9}\times10^{7}\text{ ms}^{-1}$ (B) $\frac{4}{9}\times10^{7}\text{ ms}^{-1}$

(C) $\frac{16}{9}\times10^{7}\text{ ms}^{-1}$ (D) $\frac{4}{7}\times10^{7}\text{ ms}^{-1}$

19. If W_E is the work done by an electric force in displacing a charged particle and W_M is the work done by a magnetic force associated with a steady magnetic field to displace the charged particle, then

(A) $W_E=W_M=0$ (B) $W_E=0;\ W_M\neq0$

(C) $W_E\neq0;\ W_M=0$ (D) $W_E\neq0;\ W_M\neq0$

20. A straight section PQ of a circuit lies along the x-axis from $x=-\left(\frac{a}{2}\right)$ to $x=+\left(\frac{a}{2}\right)$ and carries a steady current I. The magnetic field due to the section PQ at a point $x=+a$ will be

(A) proportional to a (B) proportional to a^2

(C) proportional to $\left(\frac{1}{a}\right)$ (D) equal to zero

21. A charge q moves with a velocity 2 ms^{-1} along x-axis in a uniform magnetic field $\vec{B}=(\hat{i}+2\hat{j}+3\hat{k})T$. The charge will experience a force that lies

(A) along $-y$ axis (B) along $-z$ axis

(C) along $+z$ axis (D) in yz plane

22. A wire of mass 100 g is carrying a current of 2 A towards increasing x in the form of $y=x^2$ where $-2\text{ m}\le x\le +2\text{ m}$. This wire is placed in a magnetic field $\vec{B}=-0.02\hat{k}$ tesla. The acceleration of the wire (in ms^{-2}) is

(A) $-1.6\hat{j}$ (B) $-3.2\hat{j}$

(C) $1.6\hat{j}$ (D) ZERO

23. A particle is moving with velocity $\vec{v}=\hat{i}+3\hat{j}$ and at a point it produces an electric field given by $\vec{E}=2\hat{k}$. The magnetic field produced by the particle at the same point is

(A) $\dfrac{6\hat{i}-2\hat{j}}{c^2}$

(B) $\dfrac{6\hat{i}+2\hat{j}}{c^2}$

(C) zero

(D) true only if the charge is moving perpendicular to the $\vec{r}$

24. A proton experiences a force $\vec{F}_1=e(-\hat{j}+\hat{k})$ N in a magnetic field $\vec{B}$ when it has a velocity $\vec{v}_1=1\hat{i}\ ms^{-1}$. The force becomes $\vec{F}=e(\hat{i}-\hat{k})$ N when the velocity is changed to $\vec{v}_2=1\hat{j}\ ms^{-1}$. The magnetic induction vector at that point is

(A) $(\hat{i}-\hat{j}-\hat{k})T$ (B) $(-\hat{i}-\hat{j}+\hat{k})T$

(C) $(\hat{i}+\hat{j}-\hat{k})T$ (D) $(\hat{i}+\hat{j}+\hat{k})T$

25. 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 1.00×10^8 revs^{-1}. The number of turns per metre in the solenoid will be

(A) 142 turns/m (B) 1420 turns/m

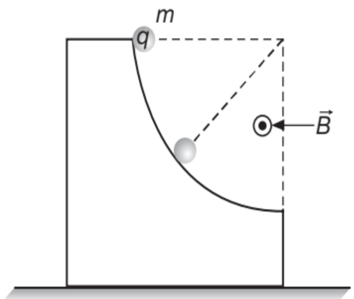
(C) 152 turns/m (D) 1520 turns/m

26. The dimensional formula of magnetic flux is

(A) $MLT^{-3}A^2$ (B) $ML^{-2}T^2A$

(C) $ML^2T^{-2}A^{-1}$ (D) $ML^{-2}TA^{-1}$

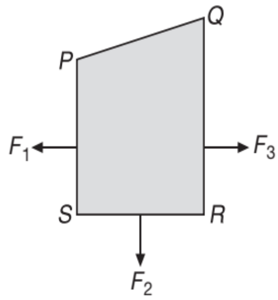
27. In the figure a charged sphere of mass m and charge q starts sliding from rest on a vertical fixed circular track of radius R from the position shown. There exists a uniform and constant horizontal magnetic field of induction B. The maximum force exerted by the track on the sphere is



(A) $mg+qB\sqrt{2gR}$ (B) $3mg-qB\sqrt{2gR}$

(C) $3mg+qB\sqrt{2gR}$ (D) $mg-qB\sqrt{2gR}$

28. A closed loop $PQRS$ carrying a current is placed in a uniform magnetic field. If the magnetic forces on segments PS, SR and RQ are F_1, F_2 and F_3 respectively and are in the plane of the paper and along the directions shown, the force on the segment QP is



(A) $\sqrt{(F_3-F_1)^2-F_2^2}$ (B) $F_3-F_1+F_2$

(C) $F_3-F_1-F_2$ (D) $\sqrt{(F_3-F_1)^2+F_2^2}$

29. In a region of space that extents from $x=0$ to $x=L$, a uniform magnetic field of magnitude B directed along the negative z-axis. A charged particle is projected with velocity v_0 at $x=0$ along positive x-axis. The particle emerges at $x=L$ after suffering a deviation of 60°. The velocity with which the same particle is projected at $x=0$ along positive x-axis so that when it emerges at $x=L$, the deviation suffered by it is 30° is

(A) $2v_0$ (B) $\dfrac{v_0}{2}$

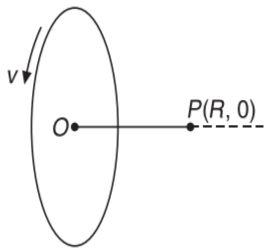
(C) $\dfrac{v_0}{\sqrt{3}}$ (D) $v_0\sqrt{3}$

30. A charged particle moving along positive x-direction with a velocity v enters a region where there is a uniform magnetic field $\vec{B}=-B\hat{k}$ from $x=0$ to $x=d$. The particle gets deflected at an angle θ from its initial path. The specific charge of the particle is

(A) $\frac{Bd}{v\cos\theta}$ (B) $\frac{v\tan\theta}{Bd}$

(C) $\frac{B\sin\theta}{vd}$ (D) $\frac{v\sin\theta}{Bd}$

31. A uniformly charged ring of radius R is rotated about its axis with constant linear speed v of each of its particles. The ratio of electric field to magnetic field at a point P on the axis of the ring distant $x = R$ from centre of ring is (c is speed of light)



(A) $\frac{c^2}{v}$ (B) $\frac{v^2}{c}$

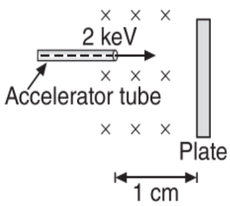
(C) $\frac{v}{c}$ (D) $\frac{c}{v}$

32. A particle of specific charge α is released from origin with a velocity $\vec{v} = v_0\hat{i}$ in a uniform magnetic field $\vec{B} = -B_0\hat{k}$. If the particle passes through the point $(0, y, 0)$, then y equals

(A) $-\frac{v_0}{B_0\alpha}$ (B) $-\frac{2v_0}{B_0\alpha}$

(C) $\frac{v_0}{B_0\alpha}$ (D) $\frac{2v_0}{B_0\alpha}$

33. A charge particle having mass of 1.6×10^{-26} kg comes out of accelerator tube with kinetic energy 2 keV. The smallest magnitude of magnetic field that should be applied in vertically downwards direction to just prevent the charge particle from colliding the plate (assuming charge on particle to be equal to charge of proton) is



(A) 2 T (B) 4 T

(C) 0.02 T (D) 0.04 T

34. A particle of mass m and charge q is projected towards negative x-axis with speed v from a point $(d, 0, 0)$ in a region of space where a uniform magnetic field $\vec{B} = B_0\hat{j}$ exists. The maximum value of v for which the particle does not hit the y-z plane is v_0. Then v_0 equals

(A) $\frac{qB}{2md}$ (B) $\frac{qBd}{2m}$

(C) $\frac{qBd}{m}$ (D) $\frac{2qB}{md}$

35. A charged particle enters a uniform magnetic field with a velocity vector at an angle of 45° with the magnetic field. The pitch of helical path followed by the particle is p. The radius of the helix will be

(A) $\frac{p}{\sqrt{2}\pi}$ (B) $\sqrt{2}p$

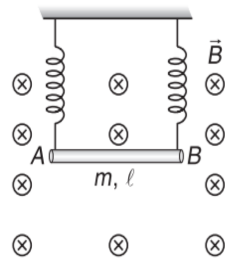
(C) $\frac{p}{2\pi}$ (D) $\frac{\sqrt{2}p}{\pi}$

36. The ratio of the magnetic field at the centre of a current carrying coil of radius a to the field at a distance $3a$ on its axis is

(A) $20\sqrt{10}$ (B) $2\sqrt{10}$

(C) $10\sqrt{10}$ (D) $\sqrt{10}$

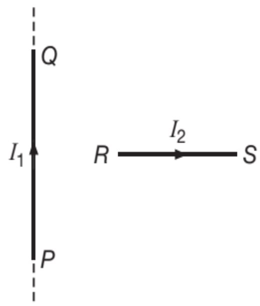
37. In the arrangement shown, if the extension in both the springs each of spring constant k increases from x to x_0 on flowing current I in the rod (of mass m, length l) from B to A, then the value of magnetic field will be



(A) $\frac{mg}{Il}$ (B) $\frac{mgx}{Il}$

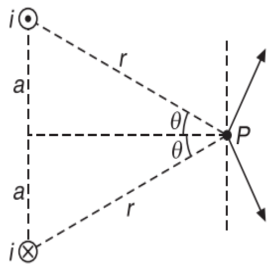
(C) $\frac{mgI}{lx_0}$ (D) $\frac{mg}{Il}\left(\frac{x_0 - x}{x}\right)$

38. A current carrying wire RS is placed near an another long current carrying wire PQ. If free to move, wire RS will have



(A) translational motion only
(B) rotational motion only
(C) translational as well as rotational motion
(D) neither translational nor rotational motion

39. Two parallel wires situated at a distance $2a$ are carrying equal current i in opposite direction as shown in Figure.

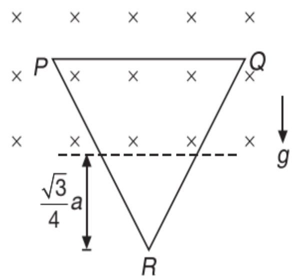


The value of magnetic field at a point P situated at equal distances from both the wires will be

(A) $\frac{\mu_0 ia}{\pi r}$ (B) $\frac{\mu_0 ia^2}{\pi r}$

(C) $\frac{\mu_0 ia^2}{\pi r^2}$ (D) $\frac{\mu_0 ia}{\pi r^2}$

40. An equilateral triangle frame PQR of mass M and side a is kept under the influence of magnetic force due to inward perpendicular magnetic field B and gravitational field as shown in Figure.



The magnitude and direction of current in the frame so that the frame remains at rest, is

(A) $I = \frac{2Mg}{aB}$, counter-clockwise

(B) $I = \frac{2Mg}{aB}$, clockwise

(C) $I = \frac{Mg}{aB}$, counter-clockwise

(D) $I = \frac{Mg}{aB}$, clockwise

41. Three infinitely long wires arranged along positive x, y and z directions have equal currents I flowing through them. The magnetic field at a point $P(0, 0, -a)$ is

(A) $\frac{\mu_0 I}{2\pi a}(\hat{i}+\hat{j})$ (B) $\frac{\mu_0 I}{2\pi a}(\hat{i}-\hat{j})$

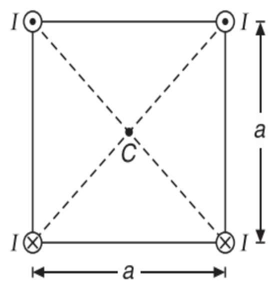
(C) $\frac{\mu_0 I}{2\pi a}(-\hat{i}+\hat{j})$ (D) $\frac{\mu_0 I}{2\pi a}(\hat{i}+\hat{j}+\hat{k})$

42. Current i_0 is being carried by an infinite wire passing through origin along the direction $\hat{i}+\hat{j}+\hat{k}$. The magnetic field due to the wire at point $(1\text{ m}, 1\text{ m}, 1\text{ m})$ is

(A) $\frac{\mu_0 i}{2\pi}$ T (B) $\frac{\mu_0 i}{\sqrt{2}\pi}$ T

(C) $\frac{\mu_0 i}{\sqrt{3}\pi}$ T (D) ZERO

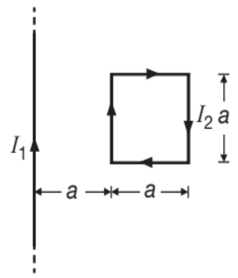
43. Four long and parallel wires each carrying current I are kept at the corners of a square having side a. Magnetic field produced at centre C is



(A) $\frac{2\mu_0 I}{\pi a}$ (B) $\sqrt{2}\frac{\mu_0 I}{\pi a}$

(C) $\frac{\mu_0 I}{2\pi a}$ (D) $\frac{4\mu_0 I}{\pi a}$

44. A current carrying square loop is placed near an infinitely long current carrying wire as shown in Figure.



The torque acting on the loop is τ. Then τ equals

(A) ZERO (B) $\frac{\mu_0 I_1 I_2 a}{2\pi}$

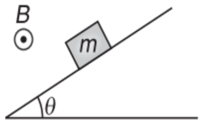
(C) $\frac{\mu_0}{2\pi}\left(\frac{I_1 I_2 a}{2}\right)$ (D) $\frac{\mu_0 I_1 I_2 a}{2\pi}\log_e(2)$

45. Four very long straight wires carry equal electric currents in the $+z$-direction. They intersect the x-y plane at $(x, y) = (-a, 0)$, $(0, a)$ $(a, 0)$ and $(0, -a)$. The magnetic force exerted on the wire at position $(-a, 0)$ is along

(A) $+y$-axis (B) $-y$-axis

(C) $+x$-axis (D) $-x$-axis

46. A block of mass m and charge q is released from rest on a long smooth inclined plane in the presence of a magnetic field B which is constant, uniform, horizontal and parallel to the surface as shown in Figure. The time from start when block loses contact with the surface is



(A) $\dfrac{m\cos\theta}{qB}$ (B) $\dfrac{m\operatorname{cosec}\theta}{qB}$

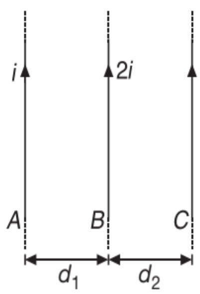
(C) $\dfrac{m\cot\theta}{qB}$ (D) $\dfrac{m\sin\theta}{qB}$

47. For the semi-infinite wire shown, a point P is taken at a distance r from its finite end as shown. Assume that the current in the wire is I, the field at P is

(A) $\dfrac{\mu_0 I}{4\pi r}$ (B) $\dfrac{\mu_0 I}{4\pi r}\sin\alpha$

(C) $\dfrac{\mu_0 I}{4\pi r}\cot\left(\dfrac{\alpha}{2}\right)$ (D) $\dfrac{\mu_0 I}{4\pi r}\tan\left(\dfrac{\alpha}{2}\right)$

48. In the figure shown all the wires are long and parallel, if net force per unit length on wire B is zero, then $\dfrac{d_1}{d_2}$ will be

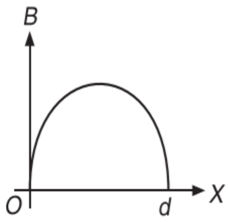


(A) $\dfrac{1}{3}$ (B) $\dfrac{2}{3}$

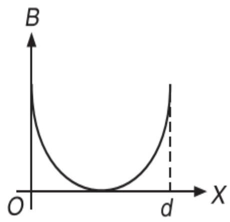
(C) $\dfrac{1}{6}$ (D) $\dfrac{1}{4}$

49. Two parallel current carrying wires carrying equal currents I in the same direction are fixed at a separation d. P is a point on a line joining the wires, at a distance x from any one of them. The magnetic field at P is B. The plot of B vs x is best represented by

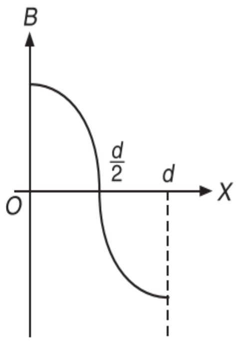
(A)



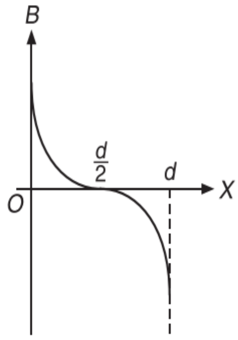
(B)



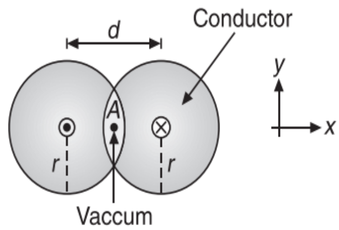
(C)



(D)



50. Two long conductors are arranged as shown in Figure to form overlapping cylinders, each of radius r, having their centres separated by a distance d. A 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 in Figure.



The magnitude and direction of the magnetic field at point A is given by

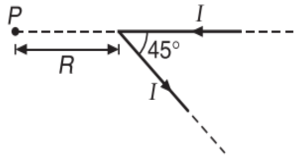
(A) $\left(\dfrac{\mu_0}{2\pi}\right)\pi dJ$, along the $+y$- direction

(B) $\left(\dfrac{\mu_0}{2\pi}\right)\dfrac{d^2}{r}$, along the $+y$- direction

(C) $\left(\dfrac{\mu_0}{2\pi}\right)\dfrac{4d^2 J}{r}$, along the $-y$- direction

(D) $\left(\dfrac{\mu_0}{2\pi}\right)\dfrac{Jr^2}{d}$, along the $-y$- direction

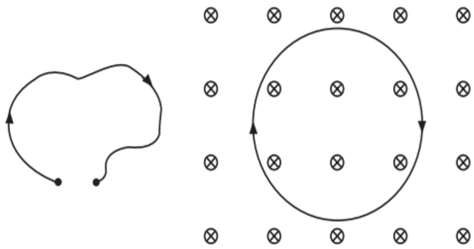
51. A long straight wire carrying current I, is bent at its midpoint to form an angle of $45°$ as shown in Figure. Magnetic induction at point P, distance R from point of bending is equal to



(A) $\frac{(\sqrt{2}-1)\mu_0 I}{4\pi R}$ (B) $\frac{(\sqrt{2}+1)\mu_0 I}{4\pi R}$

(C) $\frac{(\sqrt{2}+1)\mu_0 I}{4\sqrt{2}\pi R}$ (D) $\frac{(\sqrt{2}-1)\mu_0 I}{2\sqrt{2}\pi R}$

52. A thin flexible wire of length L is connected to two adjacent fixed points carries a current I in the clockwise direction, as shown in Figure.

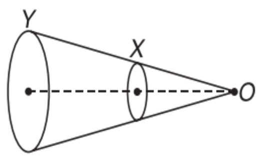


When system is put in a uniform magnetic field of strength B going into the plane of paper, the wire takes the shape of a circle. The tension in the wire is

(A) IBL (B) $\frac{IBL}{\pi}$

(C) $\frac{IBL}{2\pi}$ (D) $\frac{IBL}{4\pi}$

53. Two circular coils X and Y have equal number of turn and carry equal currents in the same sense and subtend same solid angle at point O. If the smaller coil X is midway between O and Y, then if we represent the magnetic induction due to bigger coil Y at O as B_Y and that due to smaller coil X at O as B_X, then



(A) $\frac{B_Y}{B_X}=1$ (B) $\frac{B_Y}{B_X}=2$

(C) $\frac{B_Y}{B_X}=\frac{1}{2}$ (D) $\frac{B_Y}{B_X}=\frac{1}{4}$

54. A particle of charge q and mass m is released from origin with velocity $\vec{v}=v_0\hat{i}$ in a magnetic field given by

$$\vec{B}=\begin{cases}-B_0\hat{k} & \text{for } x\le \frac{\sqrt{3}}{2}\frac{mv_0}{qB_0}\\ 0 & \text{for } x>\frac{\sqrt{3}}{2}\frac{mv_0}{qB_0}\end{cases}$$

The x-co-ordinates of the particle at time $t\left(>\frac{m\pi}{3qB_0}\right)$ is

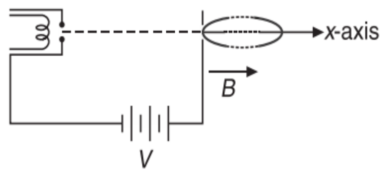
(A) $\frac{\sqrt{3}}{2}\frac{mv_0}{qB_0}+\frac{\sqrt{3}}{2}v_0\left(t-\frac{m\pi}{qB_0}\right)$

(B) $\frac{\sqrt{3}}{2}\frac{mv_0}{qB_0}+v_0\left(t-\frac{m\pi}{3qB_0}\right)$

(C) $\frac{\sqrt{3}}{2}\frac{mv_0}{qB_0}+\frac{v_0 t}{2}$

(D) $\frac{\sqrt{3}}{2}\frac{mv_0}{qB_0}+\frac{v_0}{2}\left(t-\frac{m\pi}{3qB_0}\right)$

55. Electrons emitted with negligible speed from an electron gun are accelerated through a potential difference V along the x-axis. These electrons emerge from a narrow hole into a uniform magnetic field of strength B directed along x-axis. Some electrons emerging at slightly divergent angles as shown in Figure.

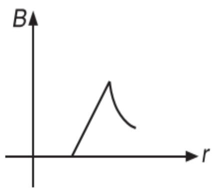


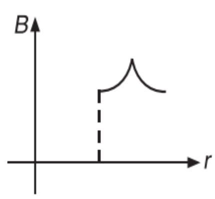
These paraxial electrons are refocused on the x-axis at a distance

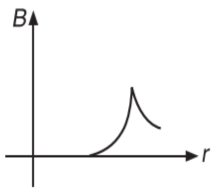
(A) $\sqrt{\frac{8\pi^2 mV}{eB^2}}$ (B) $\sqrt{\frac{2\pi^2 mV}{eB}}$

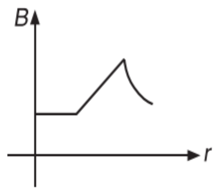
(C) $\sqrt{\frac{4\pi^2 mV}{eB^2}}$ (D) $\sqrt{\frac{2\pi^2 mV}{eB^2}}$

56. A current I is uniformly distributed over the cross section of a long hollow cylindrical wire of inner radius a and outer radius b. The variation of the magnetic field B with distance r from the axis of the cylinder is given by

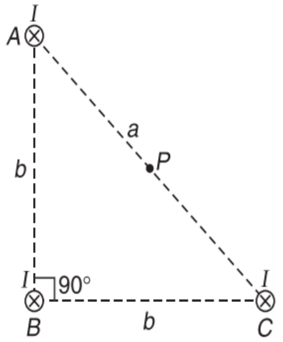
(A)


(B)


(C)


(D)


57. Three infinitely long straight wires A, B and C are arranged as shown in Figure.

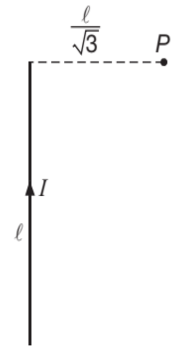


If the wires A, B and C each carry a current I into the plane of the paper then magnetic induction at mid-point (P) of AC is

(A) $\frac{\mu_0 I}{\pi a}$ (B) $\frac{3\mu_0 I}{\pi a}$

(C) $\frac{\sqrt{2}\mu_0 I}{\pi a}$ (D) ZERO

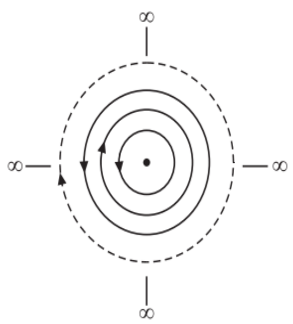
58. The magnitude of magnetic field produced by the current carrying straight wire of length l carrying a current I, at point P is B. Then B equals



(A) $\frac{\mu_0 I}{4\pi l}$ (B) $\frac{\sqrt{2}\mu_0 I}{\pi l}$

(C) $\frac{\mu_0 I}{2\sqrt{2}\pi l}$ (D) $\frac{3\mu_0 I}{8\pi l}$

59. In figure, infinite conducting rings each having current I in the direction shown are placed concentrically in the same plane as shown in Figure.

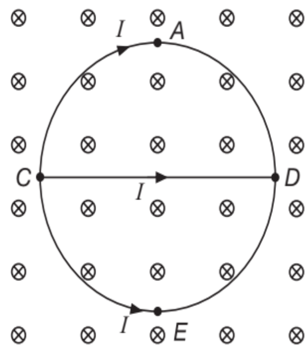


The radii of rings are r, $2r$, 2^2r, 2^3r,..., ∞. The magnetic field at the centre of rings will be

(A) ZERO (B) $\frac{\mu_0 I}{r}$

(C) $\frac{\mu_0 I}{2r}$ (D) $\frac{\mu_0 I}{3r}$

60. Consider a wireframe shown in figure. Equal currents I flow through all the three branches of the wire frame. The frame is a combination of two semicircles ACD and CDE of radius a. It is placed in uniform magnetic field B acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is



(A) $6BIa$ (B) $3BIa$

(C) BIa (D) ZERO

61. An electron is projected with velocity v_0 in a uniform electric field E perpendicular to the field. Again, it is projected with velocity v_0 perpendicular to a uniform magnetic field B. If r_1 is initial radius of curvature just after entering in the electric field and r_2 is the final radius of curvature just after entering in magnetic field, then the ratio $\frac{r_1}{r_2}$ is equal to

(A) $\frac{Bv_0^2}{E}$ (B) $\frac{B}{E}$

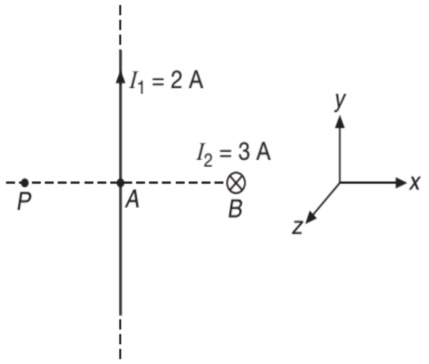
(C) $\frac{Ev_0}{B}$ (D) $\frac{Bv_0}{E}$

62. A charged particle enters a magnetic field at right angles to the magnetic field. The field exists in space for a length equal to 1.5 times the radius of the circular path of the particle. The particle will be deviated from its path by

(A) $\frac{\pi^c}{2}$ (B) $\sin^{-1}\left(\frac{2}{3}\right)$

(C) $\frac{\pi^c}{6}$ (D) π^c

63. Two infinitely long straight wires are arranged perpendicular to each other and are in mutually perpendicular planes as shown in Figure.



If $I_1 = 2$ A along the y-axis and $I_2 = 3$ A along negative z-axis and $AP = AB = 1$ cm. The magnetic induction $\vec{B}$ at point P is

(A) $(3\times10^{-5}\text{ T})\hat{j}+(-4\times10^{-5}\text{ T})\hat{k}$

(B) $(3\times10^{-5}\text{ T})\hat{j}+(4\times10^{-5}\text{ T})\hat{k}$

(C) $(4\times10^{-5}\text{ T})\hat{j}+(3\times10^{-5}\text{ T})\hat{k}$

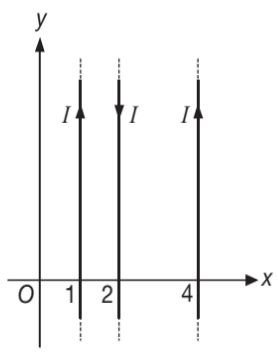
(D) $(-3\times10^{-5}\text{ T})\hat{j}+(4\times10^{-5}\text{ T})\hat{k}$

64. A small circular coil of radius r and number of turns n is placed at the centre of another big circular coil of radius R and number of turns N. Initially the two coils are coplanar and the same current I flows through both the coils. Then the amount of work done in rotating the small coil about any of its diameter by an angle π will be

(A) $\dfrac{2\mu_0\pi nNr^2I^2}{R}$ (B) $\dfrac{\mu_0\pi nNr^2I^2}{2R}$

(C) $\dfrac{\mu_0\pi nNr^2I^2}{R}$ (D) ZERO

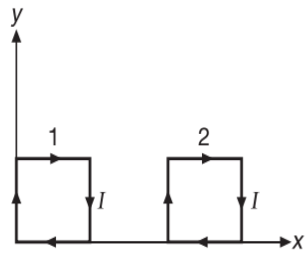
65. A considerably large number of very long wires are placed parallel to the y-axis at locations with x values given by 1 m, 2 m, 4 m, 8 m and so on. Each wire carries a current of 1 A and every consecutive wire having current in opposite direction. The magnetic field at origin (in tesla) is



(A) $-1.33\times10^{-7}\hat{k}$ (B) $-2.67\times10^{-7}\hat{k}$

(C) $1.33\times10^{-7}\hat{k}$ (D) $2.67\times10^{-7}\hat{k}$

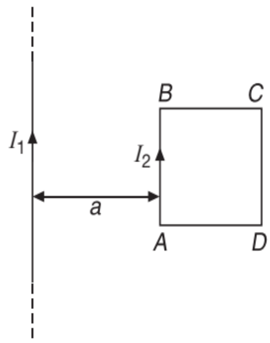
66. Magnetic field in a region is given by $\vec{B} = B_0x\hat{k}$. Two loops each of side a is placed in this magnetic region in the xy-plane with one of its sides on x-axis. If F_1 is the force on loop 1 and F_2 be the force on loop 2, then



(A) $F_1 = F_2 = 0$ (B) $F_1 > F_2$

(C) $F_2 > F_1$ (D) $F_1 = F_2 \neq 0$

67. A square loop of side a is placed at a distance a away from a long wire carrying a current I_1. If the loop carries a current I_2 as shown in Figure, then the nature of the force and its magnitude is



(A) $\dfrac{\mu_0I_1I_2}{2\pi a}$, attractive (B) $\dfrac{\mu_0I_1I_2}{4\pi}$, attractive

(C) $\dfrac{\mu_0I_1I_2}{4\pi}$, repulsive (D) $\dfrac{\mu_0I_1I_2}{4\pi a}$, repulsive

68. An electron is moving along positive x-axis. A uniform electric field exists towards negative y-axis. The direction of magnetic field of suitable magnitude so that net force on electron is zero is along

(A) positive z-axis (B) positive y-axis

(C) negative z-axis (D) negative y-axis

69. A metallic wire is folded to form a square loop of side a. It carries a current I and is kept perpendicular to the region of uniform magnetic field B. If the shape of the loop is changed from square to an equilateral triangle without changing the length of the wire and current, the amount of work done in doing so is

(A) $BIa^2\left(1-\dfrac{4\sqrt{3}}{9}\right)$ (B) $BIa^2\left(1-\dfrac{\sqrt{3}}{9}\right)$

(C) $\dfrac{2}{3}BIa^2$ (D) ZERO

70. If E and B denote electric and magnetic fields respectively, which of the following is dimensionless?

(A) $\sqrt{\mu_0\varepsilon_0}\left(\frac{B}{E}\right)$ (B) $(\mu_0\varepsilon_0)\left(\frac{E}{B}\right)$

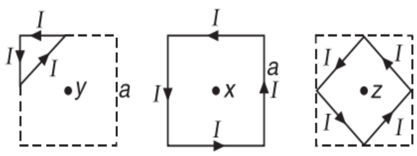
(C) $\frac{1}{\mu_0\varepsilon_0}\left(\frac{B}{E}\right)^2$ (D) $\left(\frac{\mu_0}{\varepsilon_0}\right)\left(\frac{E}{B}\right)$

71. A long straight wire carrying a current of 30 A is placed in an external uniform magnetic field of induction 4×10^{-4} T. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction in tesla at a point 2.0 cm away from the wire is

(A) 10^{-4} (B) 3×10^{-4}

(C) 5×10^{-4} (D) 6×10^{-4}

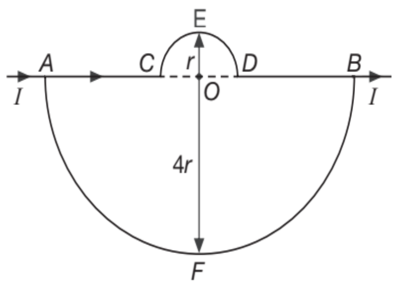
72. The magnetic flux density in vacuum at the centre of any square coil (of one turn) of side a and carrying a current I is $\frac{KI}{a}$ where K is independent of a. The magnitude of induction at x, y, z are B_1, B_2 and B_3 respectively. Then



(A) $B_3>B_1>B_2$ (B) $B_2>B_3>B_1$

(C) $B_2>B_1>B_3$ (D) $B_1>B_2>B_3$

73. In the shown in Figure AC and BD are straight lines and CED and AFB are semi-circular with radii r and $4r$, respectively.



The entire setup is lying in the same plane. If I is current entering at A what fraction of I will flow in the $ACEDB$ such that resultant magnetic field at O is zero

(A) 1 (B) $\frac{3}{5}$

(C) $\frac{4}{5}$ (D) $\frac{1}{5}$

74. A uniform magnetic field exists in region which forms an equilateral triangle of side a. The magnetic field is perpendicular to the plane of the triangle. A charge q enters into this magnetic field perpendicularly with speed v along perpendicular bisector to one side and comes out along perpendicular bisector to the other side. The magnetic field in the triangle is

(A) $\frac{mv}{qa}$ (B) $\frac{2mv}{qa}$

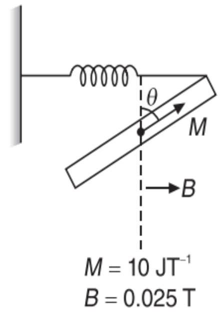
(C) $\frac{mv}{2qa}$ (D) $\frac{mv}{4qa}$

75. A wire of length l is bent in the form of a circular coil of some turns. A current I flows through the coil. The coil is placed in a uniform magnetic field B. The maximum torque on the coil can be τ_0. Then τ_0 equals

(A) $\frac{BIl^2}{2\pi}$ (B) $\frac{2BIl^2}{\pi}$

(C) $\frac{BIl^2}{4\pi}$ (D) $\frac{BIl^2}{\pi}$

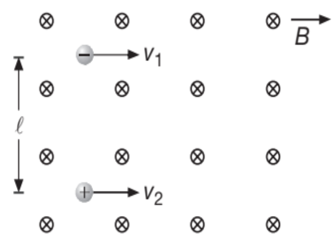
76. A spring is connected to the end of a magnetic dipole having magnetic moment of 10 JT^{-1} which is pivoted about its mid-point and is placed in a uniform external field of 0.025 T as shown in Figure. The torque exerted on the dipole by the spring can be represented by $\tau=C\theta$, where $C=1\text{ Nmrad}^{-1}$ and θ is a small angle in radian. Under equilibrium, the angle θ is



(A) 0.24 radian (B) 4.12 radian

(C) 0.36 radian (D) 0.18 radian

77. Two identical particles having the same mass m and charges $+q$ and $-q$ separated by a distance l enter in a uniform magnetic field B directed perpendicular to paper inwards with speeds v_1 and v_2 as shown in Figure.

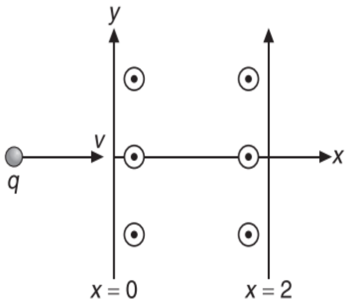


The particles will not collide when (Ignore electrostatic force between the particles)

(A) $v_1 = v_2$ (B) $l > \frac{m}{qB}(v_1 + v_2)$

(C) $l < \frac{m}{qB}(v_1 + v_2)$ (D) $l > \frac{2m}{qB}(v_1 + v_2)$

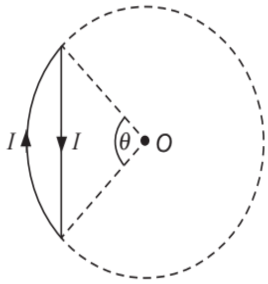
78. A charge $q = +2\ \mu C$ enters a uniform magnetic field $B = 2\sqrt{3} \times 10^{-3} \hat{k}$ tesla while travelling along positive x-axis. The magnetic field exists in the region $x = 0$ and $x = 2$ m. The particle emerges from magnetic field region such that its deviation from initial direction is 60°. Magnitude of linear momentum of particle is



(A) 2.4×10^{-9} kgms^{-1} (B) 1.6×10^{-8} kgms^{-1}

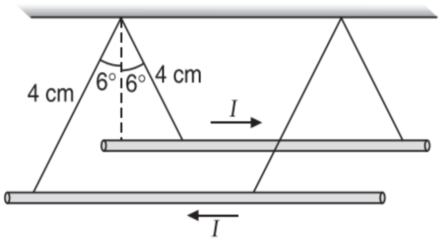
(C) 1.2×10^{-6} kgms^{-1} (D) 3.2×10^{-9} kgms^{-1}

79. For the current carrying loop shown, the net magnetic field at the centre of the circle O due to it, for $\theta < 180°$ is B. Then B is



(A) perpendicular to paper inwards
(B) perpendicular to paper outwards
(C) perpendicular to paper inwards if $\theta \le 90°$ and perpendicular to paper outwards if $90° \le \theta < 180°$
(D) ZERO

80. Two long parallel wires are hung by 4 cm long cords from a common axis. The wires have mass 0.0125 kgm^{-1} and carry equal currents in opposite direction. The current in each wire if the cords hang at 6° with the vertical (as shown in Figure) is (Take $g = 10\ \text{ms}^{-2}$)



(A) 11.2 A (B) 22.3 A

(C) 717 A (D) 71.7 A

81. Consider a coaxial cable which consists of an inner wire of radius a surrounded by an outer shell of inner and outer radii b and c, respectively. The inner wire carries a current I and outer shell carries an equal and opposite current. The magnetic field at a distance x from the axis where $b < x < c$ is

(A) $\frac{\mu_0 I}{2\pi x}\left(\frac{c^2 - b^2}{c^2 - a^2}\right)$ (B) $\frac{\mu_0 I}{2\pi x}\left(\frac{c^2 - x^2}{c^2 - a^2}\right)$

(C) $\frac{\mu_0 I}{2\pi x}\left(\frac{c^2 - x^2}{c^2 - b^2}\right)$ (D) ZERO

82. A charged particle of specific charge α is released from origin at time $t = 0$ with velocity $\vec{v} = v_0(\hat{i} + \hat{j})$ in a uniform magnetic field $\vec{B} = B_0\hat{i}$. At time $t = \frac{\pi}{B_0\alpha}$ the particle is at the point. $P(x, y, z)$. Then we have the coordinates of the point P as

(A) $\left(\frac{-v_0}{2B_0\alpha}, 0, 0\right)$

(B) $\left(0, \frac{2v_0}{B_0\alpha}, \frac{v_0\pi}{2B_0\alpha}\right)$

(C) $\left(\frac{v_0\pi}{B_0\alpha}, 0, \frac{-2v_0}{B_0\alpha}\right)$

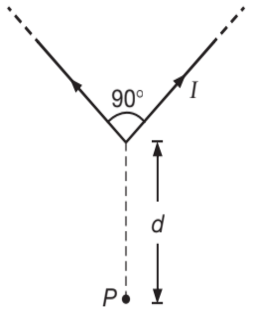
(D) $\left(\frac{v_0}{2B_0\alpha}, \frac{\sqrt{2}v_0}{\alpha B_0}, \frac{-v_0}{B_0\alpha}\right)$

83. A straight wire of length L can slide on two parallel plastic rails kept in horizontal plane with a separation d. The coefficient of friction between the wire and the rails is μ. If the wire carries current i what minimum magnetic field should exist in the space in order to slide the wire on the rails?

(A) $\frac{\mu mg}{iL\sqrt{1+\mu^2}}$ (B) $\frac{\mu m^2 g}{iL}$

(C) $\frac{\mu mg^2}{iL}$ (D) $\frac{\mu mg}{L}$

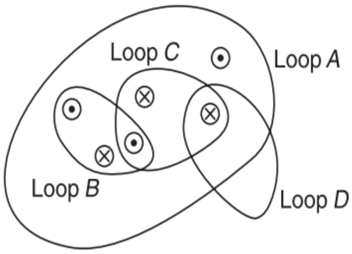
84. In the current carrying arrangement shown, the magnetic field at the point P is



(A) $\frac{\mu_0 I}{\sqrt{2}\pi d}\left(1+\frac{1}{\sqrt{2}}\right)$, ⊗ (B) $\frac{\mu_0 I}{\sqrt{2}\pi d}\left(1-\frac{1}{\sqrt{2}}\right)$, ⊗

(C) $\frac{\sqrt{2}\mu_0 I}{\pi d}$, ⊗ (D) $\frac{\mu_0 I}{\sqrt{2}\pi d}$, ⊗

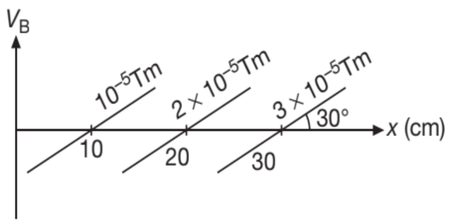
85. Consider six wires coming into or out of the page as shown in figure, all with the same current. Rank the line integral of the magnetic field from most positive to most negative taken counter clockwise around each loop shown in Figure.



(A) $B>C>D>A$ (B) $B>C=D>A$

(C) $B>A>C=D$ (D) $C>B=D>A$

86. Figure shows some of the equipotential surfaces drawn for the magnetic scalar potential. The magnetic field at a point in the region can then be given by



(A) 2×10^{-5} T (B) 10^{-5} T

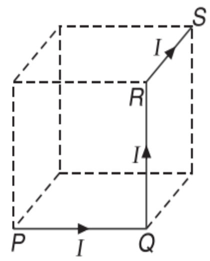
(C) 10^{-4} T (D) 2×10^{-4} T

87. For a current carrying circular coil, the ratio of the magnetic field at the centre of a current carrying circular coil to its magnetic moment is x. On doubling the radius and the current, the x values

(A) decreases by $\frac{x}{8}$ (B) increases by $\frac{x}{8}$

(C) decreases by $\frac{7x}{8}$ (D) increases by $\frac{7x}{8}$

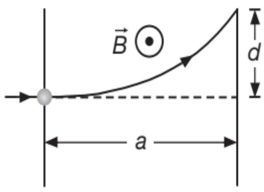
88. A wire $PQRS$ carrying a current I run along three edges of a cube of side l as shown. There exists a uniform magnetic field of magnitude B along one of the sides of the cube. The magnitude of the force acting on the wire is



(A) ZERO (B) BIl

(C) $\sqrt{2}BIl$ (D) $2BIl$

89. A charged particle q enters a region of uniform $\vec{B}$ (out of the page) and is deflected a distance d after travelling a horizontal distance a. The magnitude of the momentum of the particle is



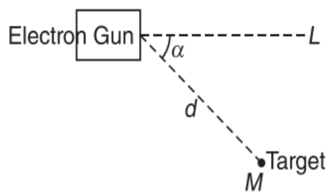
(A) $\frac{1}{2}qB\left[\frac{a^2}{d}+d\right]$

(B) $\frac{1}{2}qBa$

(C) ZERO

(D) not possible to be determined as it keeps changing

90. An electron gun T emits an electron of mass m that is accelerated by a potential difference V in a vacuum in the direction of the line L as shown in Figure. A target M is placed at a distance d as shown in Figure.

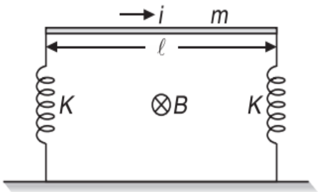


The magnetic field perpendicular to the plane determined by line L and the point M so that the electron hits the target M is

(A) $2\sqrt{\frac{2Vm}{e}\frac{\sin\alpha}{d}}$ (B) $\sqrt{\frac{2Vm}{e}\frac{\sin\alpha}{2d}}$

(C) $\sqrt{\frac{2Vm}{e}\frac{\sin\alpha}{d}}$ (D) $8\sqrt{\frac{2Vm}{e}\frac{\sin\alpha}{d}}$

91. A horizontal metallic rod of mass m and length l is supported by two vertical identical springs of spring constant k each and natural length l_0. A current i is flowing in the rod in the direction shown. If the rod is in equilibrium, then the length of each spring in this state is



(A) $l_0+\frac{ilB-mg}{k}$ (B) $l_0+\frac{ilB-mg}{2k}$

(C) $l_0+\frac{mg-ilB}{2k}$ (D) $l_0+\frac{mg-ilB}{k}$

92. A coaxial cable consists of a thin inner conductor fixed along the axis of a hollow outer conductor. The two conductors carry equal currents in the same directions. Let B_1 and B_2 be the magnetic fields in the regions between the conductors, and outside the conductor, respectively

(A) $B_1=B_2=0$ (B) $B_1\neq 0$, $B_2\neq 0$

(C) $B_1=0$, $B_2\neq 0$ (D) $B_1\neq 0$, $B_2=0$

93. The magnetic field B due to a current carrying circular loop of radius 12 cm at its centre is 0.5×10^{-4} T. The magnetic field due to this loop at a point on the axis at a distance of 5 cm from the centre

(A) 3.9×10^{-5} T (B) 5.2×10^{-5} T

(C) 2.1×10^{-5} T (D) 9×10^{-5} T

94. The pressure experienced by the lateral surface of a long straight solenoid having n turns per unit length carrying a current I through it is P. Then

(A) $P=\mu_0 n^2 I^2$ (B) $P=\frac{\mu_0 n^2 I^2}{2}$

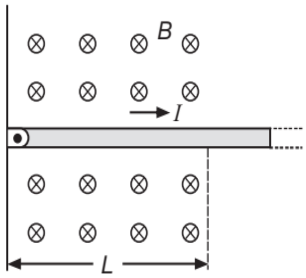
(C) $P=\frac{\mu_0 n^2 I^2}{3}$ (D) $P=\frac{\mu_0 n^2 I^2}{4}$

95. A proton, a deuteron and an α particle with the same kinetic energy enter in a region of uniform magnetic field, moving at right angles to B. What is the ratio of the radii of their circular paths?

(A) $1:\sqrt{2}:1$ (B) $1:\sqrt{2}:\sqrt{2}$

(C) $\sqrt{2}:1:1$ (D) $\sqrt{2}:\sqrt{2}:1$

96. A straight conductor of mass m and carrying a current I is hinged at one end and placed in a plane perpendicular to the magnetic field of intensity $\vec{B}$ as shown in Figure.

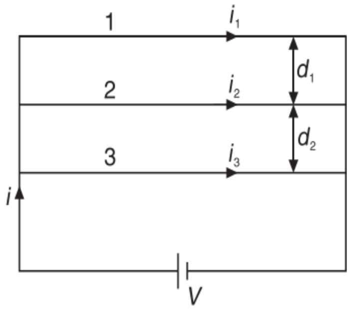


At any moment if the conductor is let free, then the angular acceleration of the conductor will be (neglect gravity)

(A) $\frac{IB}{2m}$ (B) $\frac{2IB}{3m}$

(C) $\frac{3IB}{2m}$ (D) $\frac{IB}{3m}$

97. Three long wires of resistances in the ratio $3:4:5$ are connected in parallel to each other as shown in Figure.



If net force on middle wire is zero, then $\frac{d_1}{d_2}$ will be

(A) $9:25$ (B) $5:3$

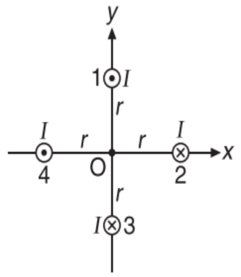
(C) $\sqrt{5}:\sqrt{3}$ (D) $3:5$

98. O^{++}, C^{+}, He^{++} and H^{+} ions are projected on the photographic plate with same velocity in a mass spectrograph. Which one will strike farthest?

(A) O^{++} (B) C^{+}

(C) He^{++} (D) H^{+}

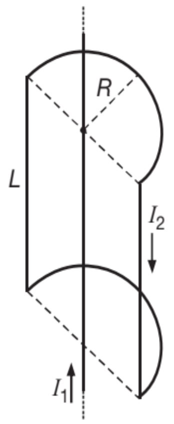
99. The magnitude of magnetic field at origin due to four infinite wires, if each wire produces a magnetic field B at origin is



(A) $4B$ (B) $\sqrt{2}B$

(C) $2\sqrt{2}B$ (D) ZERO

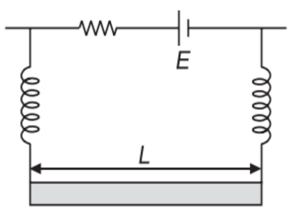
100. An infinitely long straight wire carrying a current I_1 is partially surrounded by a loop of length L, radius R and carrying a current I_2 as shown, with its axis coinciding with the wire. The force exerted on the loop is



(A) $\frac{\mu_0 \pi I_1 I_2}{R}$ (B) $\frac{\mu_0 I_1 I_2 L}{R}$

(C) $\frac{\mu_0 I_1 I_2 L}{\pi R}$ (D) $\frac{\mu_0 I_1 I_2 R}{\pi L}$

101. A straight rod of mass m and length L is suspended from the identical springs as shown in Figure.

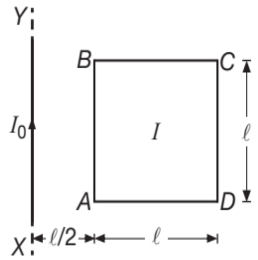


The spring stretched a distance x_0 due to the weight of the wire. The circuit has total resistance R. When the magnetic field perpendicular to the plane of paper is switched on, springs are observed to extend further by the same distance. The magnetic field strength is

(A) $\frac{2mgR}{EL}$ (B) $\frac{mgR}{EL}$

(C) $\frac{mgR}{2EL}$ (D) $\frac{mgR}{E}$

102. A square loop $ABCD$, carrying a current I, is placed near and coplanar with a long straight conductor XY carrying a current I_0. The net force on the loop is



(A) $\frac{\mu_0 I I_0}{2\pi}$ (B) $\frac{\mu_0 I I I_0}{2\pi}$

(C) $\frac{2\mu_0 I I I_0}{3\pi}$ (D) $\frac{2\mu_0 I I_0}{3\pi}$

103. A wire along x-axis carries a current 3.5 A. The force, in newton, on a 1 cm section of the wire exerted by a magnetic field of $\vec{B} = \left(0.74\hat{j} - 0.3\hat{k}\right)$ T is

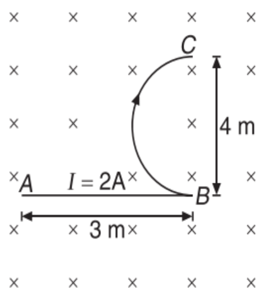
(A) $\left(2.59\hat{k} + 1.26\hat{j}\right) \times 10^{-2}$

(B) $\left(1.26\hat{k} - 2.59\hat{j}\right) \times 10^{-2}$

(C) $\left(-2.59\hat{k} - 1.26\hat{j}\right) \times 10^{-2}$

(D) $\left(-1.26\hat{k} + 2.59\hat{j}\right) \times 10^{-2}$

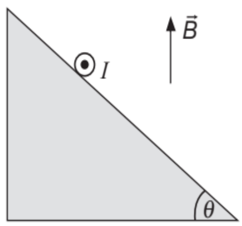
104. In the figure, the force on the wire ABC in the given uniform magnetic field will be $(B = 2\text{ tesla})$



(A) $4(3 + 2\pi)$ N (B) 20 N

(C) 30 N (D) 40 N

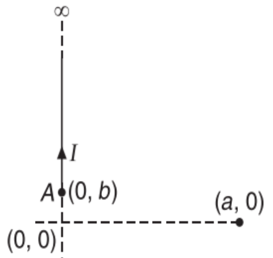
105. A conducting rod of length l and mass m is moving down a smooth inclined plane of inclination θ with constant velocity v. A current I is flowing in the conductor in a direction perpendicular to paper inwards and a vertically upward magnetic field $\vec{B}$ exists in space. Then



(A) $|\vec{B}| = \frac{mg}{Il}\sin\theta$ (B) $|\vec{B}| = \frac{mg}{Il}\tan\theta$

(C) $|\vec{B}| = \frac{mg\cos\theta}{Il}$ (D) $|\vec{B}| = \frac{mg}{Il\sin\theta}$

106. An infinitely long wire carrying current I is along y-axis such that its one end is at point $A(0, b)$ while the wire extends up to $+\infty$. The magnitude of magnetic field strength at point $(a, 0)$ is



(A) $\frac{\mu_0 I}{4\pi a}\left(1+\frac{b}{\sqrt{a^2+b^2}}\right)$ (B) $\frac{\mu_0 I}{4\pi a}\left(1-\frac{b}{\sqrt{a^2+b^2}}\right)$

(C) $\frac{\mu_0 I}{4\pi a}\left(\frac{b}{\sqrt{a^2+b^2}}\right)$ (D) None of these

107. The magnetic field at the centre of an equilateral triangular loop of side $2L$ carrying a current I is

(A) $\frac{3\sqrt{3}\mu_0 I}{4\pi L}$ (B) $\frac{2\sqrt{3}\mu_0 I}{\pi L}$

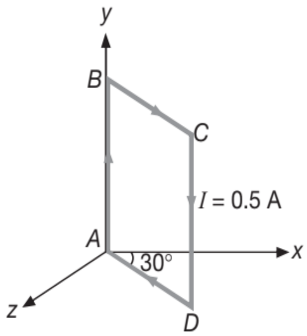
(C) $\frac{3\mu_0 I}{4\pi L}$ (D) $\frac{9\mu_0 I}{4\pi L}$

108. An electron enters into a homogeneous magnetic field perpendicular to the force lines. The velocity of the electron is $v = 4\times10^7\ \text{ms}^{-1}$. The induction of the field is 10^{-3} T. The tangential acceleration of electron in the magnetic field is

(A) $7\times10^{15}\ \text{ms}^{-2}$ (B) $7\times10^{13}\ \text{ms}^{-2}$

(C) $7\times10^{14}\ \text{ms}^{-2}$ (D) ZERO

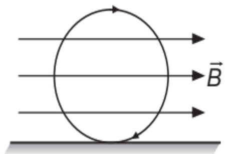
109. Figure shows a square current carrying loop $ABCD$ of side 2 m and current $I = 0.5$ A. The magnetic moment $\vec{M}$ of the loop is



(A) $(\hat{j}-\hat{k})\ \text{Am}^2$ (B) $(\sqrt{3}\hat{i}+\hat{k})\ \text{Am}^2$

(C) $(\hat{i}-\sqrt{3}\hat{k})\ \text{Am}^2$ (D) $(\hat{i}+\hat{k})\ \text{Am}^2$

110. A conducting ring of mass 2 kg and radius 0.5 m is placed on a smooth horizontal plane. The ring carries a current $I = 4$ A. A horizontal magnetic field $B = 10$ T is switched on at time $t = 0$ as shown in Figure.



The initial angular acceleration of the ring is

(A) 5π rads^{-2} (B) 15π rads^{-2}

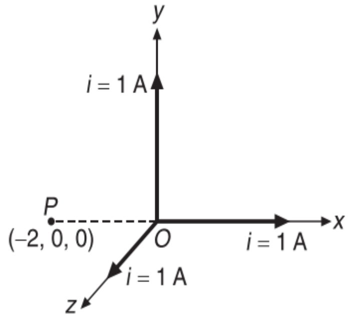
(C) 20π rads^{-2} (D) 40π rads^{-2}

111. A long coaxial cable consists of two hollow concentric cylinders of radii a and b. The central conductor of the cable carries a steady current I and outer conductor provides the return path of the same current. Calculate the energy stored in the magnetic field l of such a cable

(A) $\frac{\mu_0 I^2 l}{4\pi}\log_e\left(\frac{b}{a}\right)$ (B) $\frac{\mu_0 I^2 l}{4\pi}\log_e\left(\frac{a}{b}\right)$

(C) $\frac{\mu_0 I^2 l}{4\pi}\log_e\left(\frac{2b}{a}\right)$ (D) $\frac{\mu_0 I^2 l}{4\pi}\log_e\left(\frac{a}{2b}\right)$

112. Three infinitely long wires each carrying a current 1 A are placed such that one end of each wire is at origin and one of these wires are along x-axis, y-axis and z-axis. Magnetic induction at point $P(-2, 0, 0)$ m is



(A) $\frac{\mu_0}{4\pi}(\hat{j}+\hat{k})$ (B) $\frac{\mu_0}{4\pi}(\hat{j}-\hat{k})$

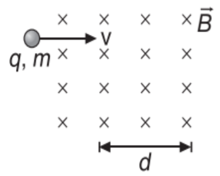
(C) $\frac{\mu_0}{8\pi}(-\hat{j}+\hat{k})$ (D) $\frac{\mu_0}{8\pi}(\hat{j}+\hat{k})$

113. A particle of mass m and charge q starts moving from the origin under the action of an electric field $\vec{E} = E_0\hat{i}$ and magnetic field $\vec{B} = B_0\hat{k}$. Its velocity at $(x_0, 0, 0)$ is $(4\hat{i}+3\hat{j})$. Then

(A) $x_0 = \frac{13qE_0}{2mB_0}$ (B) $x_0 = \frac{16qB_0}{mE_0}$

(C) $x_0 = \frac{25m}{2qE_0}$ (D) $x_0 = \frac{5q}{2B_0 m}$

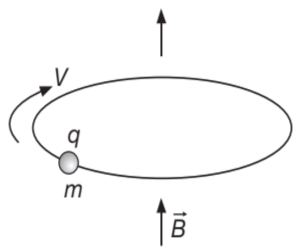
114. A charged particle of mass m and charge q is projected into a uniform magnetic field of induction B with speed v which is perpendicular to B. The width of the magnetic field is d. The impulse imparted to the particle by the field when $qBd \ll mv$ is



(A) qBv (B) $\frac{mv}{qB}$

(C) qBd (D) $\frac{2mv^2}{qB}$

115. A circular wire loop of radius r can withstand a radial force T before breaking. A particle of mass m and charge $q(q>0)$ is sliding over the wire. A magnetic field B is applied normal to the plane of the wire. The maximum speed $V_{\max}$ the particle can have before the loop breaks is



(A) ZERO

(B) $\sqrt{\frac{rT}{m}}$

(C) $\frac{r}{2}\left[qB + \sqrt{q^2B^2 + \frac{4T}{mr}}\right]$

(D) $\frac{r}{2}\left[\frac{qB}{m} + \sqrt{\frac{q^2B^2}{m^2} + \frac{4T}{mr}}\right]$

116. A cyclotron is accelerating proton, where the applied magnetic field is 2 T and the potential gap is 100 keV. To acquire a kinetic energy of 20 MeV, the number of turns, the proton has to move between the dees is

(A) 200 (B) 300

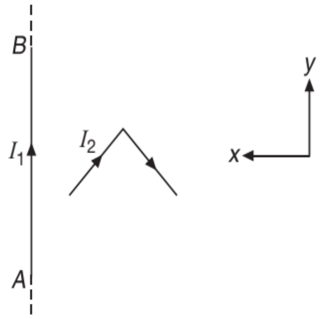
(C) 150 (D) 100

117. The field normal to the plane of coil of N turns, radius r carrying a current I at a point lying a small distance h $(\ll r)$ from the centre of coil is B_a and the field at the centre of coil is B_c.

(A) $\frac{B_c - B_a}{B_c} = \frac{2h^2}{3r^2}$ (B) $\frac{B_c - B_a}{B_c} = \frac{3r^2}{2h^2}$

(C) $\frac{B_c - B_a}{B_c} = \frac{3h}{2r}$ (D) $\frac{B_c - B_a}{B_c} = \frac{3h^2}{2r^2}$

118. In the figure shown a current I_1 is established in the long straight wire AB. Another wire CD carrying current I_2 is placed in the plane of the paper. The line joining the ends of this wire is perpendicular to the wire AB. The resultant force on the wire CD is



(A) ZERO

(B) towards negative x-axis

(C) towards positive y-axis

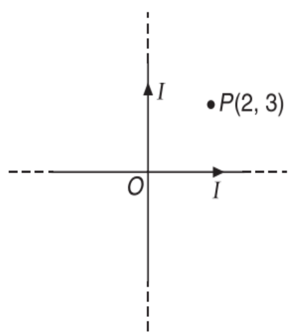
(D) in the xy plane

119. The dimensional formula of $\frac{B^2R^2C^2}{2\mu_0}$ (where B is magnetic field, and μ_0 is permeability of free space, R is resistance and C is capacitance) is same as that of

(A) qvB (B) $\frac{qB}{v}$

(C) $\frac{qB}{v^2}$ (D) qv^2B

120. Two mutually perpendicular insulated very conducting wires carrying equal currents I, intersect at origin. Then the resultant magnetic induction at point $P(2, 3)$ m will be



(A) $\frac{\mu_0 I}{5a}$ (B) $\frac{5\mu_0 I}{2\pi}$

(C) $\frac{\mu_0 I}{12\pi}$ (D) 0

121. A wire of length 1 m carrying a current of 1 A, placed in x-z plane. The coefficient of friction between the wire and the surface is 0.2 and mass of the wire is 2 kg. The magnetic field of strength 2 T exists along positive y- direction. Then choose the correct statement.

(A) Acceleration of wire is 0.5 ms^{-2}

(B) Acceleration of wire is 1 ms^{-2}

(C) Acceleration of wire is 2 ms^{-2}

(D) Wire will not move at all

122. A circular coil carrying a certain current produces a magnetic field B_0 at its centre. The coil is now rewound so as to have 3 turns and the same current is passed through it. The new magnetic field at the centre is

(A) $\frac{B_0}{9}$ (B) $9B_0$

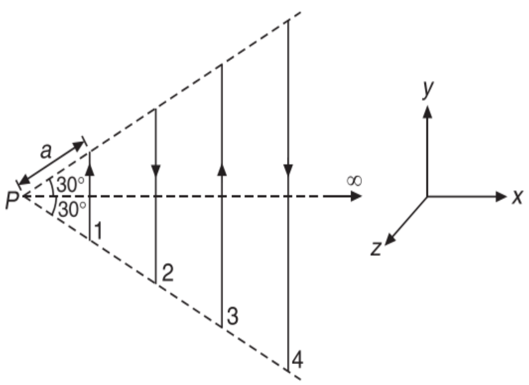
(C) $\frac{B_0}{3}$ (D) $3B_0$

123. A rigid circular loop of radius r and mass m lies in the x-y plane on a flat table and has a current I flowing in it. At this particular place, the earth's magnetic field is $\vec{B} = B_x\hat{i} + B_z\hat{k}$. The value of I so that one edge of the loop lifts from the table is

(A) $I = \frac{mg}{\pi r B_z}$ (B) $I = \frac{mg}{\pi r B_x}$

(C) $I = \frac{mg}{\pi r\sqrt{B_x^2 + B_z^2}}$ (D) $I = \frac{mg}{\pi r\sqrt{B_x B_z}}$

124. Infinite number of straight wires each carrying current I are equally spaced as shown in Figure.

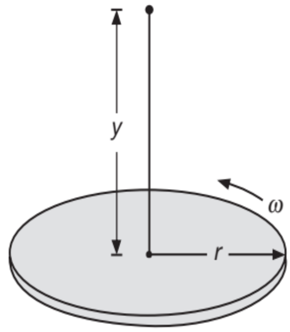


Adjacent wires have current in opposite direction. Net magnetic induction at point P is

(A) $\frac{\mu_0 I}{4\pi}\frac{\ln 2}{\sqrt{3}a}\hat{k}$ (B) $\frac{\mu_0 I}{4\pi}\frac{\ln 4}{\sqrt{3}a}\hat{k}$

(C) $\frac{\mu_0 I}{4\pi}\frac{\ln 4}{\sqrt{3}a}(-\hat{k})$ (D) ZERO

125. The magnetic field at distance y from the centre of the axis of a disc of radius r and uniform surface charge density σ, if the disc spins with angular velocity ω is



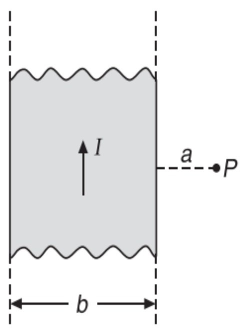
(A) $\frac{\mu_0\sigma\omega}{3}\left(\frac{r^2 - 2y^2}{\sqrt{r^2 - y^2}} + 2y\right)$

(B) $\frac{\mu_0\sigma\omega}{2}\left(\frac{r^2 + y^2}{\sqrt{r^2 + y^2}}\right)$

(C) $\frac{\mu_0\sigma\omega}{2}\left(\frac{r^2 + 2y^2}{\sqrt{r^2 + y^2}} - 2y\right)$

(D) $\frac{2\mu_0\sigma\omega}{3}\left(\frac{r^2 + 2y^2}{\sqrt{r^2 + y^2}} - 2y\right)$

126. A very long thin strip of metal of width b carries a current I along its length as shown in Figure.



The magnitude of magnetic field in the plane of the strip at a distance a from the edge nearest to the point is

(A) $\frac{\mu_0}{4\pi}\frac{2I}{b}\log_e\left(1 - \frac{b}{a}\right)$ (B) $\frac{\mu_0}{4\pi}\frac{2I}{b}\log_e\left(1 + \frac{b}{a}\right)$

(C) $\frac{\mu_0}{2\pi}\frac{2I}{b}\log_e\left(1 - \frac{b}{a}\right)$ (D) $\frac{\mu_0 I}{\pi b}\left(1 + \frac{b}{a}\right)$

127. A non-conducting disc of radius R, having charge q distributed uniformly over its surface is rotating about an axis passing through its centre and perpendicular to its plane with an angular velocity ω. The magnetic moment of the disc is M. Then M equals

(A) $q\omega R^2$ (B) $\frac{1}{2}q\omega R^2$

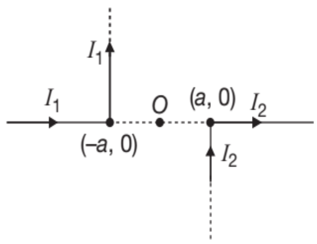
(C) $\frac{1}{8}q\omega R^2$ (D) $\frac{1}{4}q\omega R^2$

128. A particle of mass m and charge q is launched from origin at $t=0$ with velocity $\left(2\hat{i}+3\hat{j}+4\hat{k}\right)$ ms^{-1} in a region with uniform magnetic field $\vec{B}=2\hat{i}$ tesla. After time $t=\frac{\pi m}{qB}$, an electric field $\vec{E}$ is switched on such that particle moves on a straight line with constant speed. $\vec{E}$ may be

(A) $5\hat{k}-10\hat{j}$ units (B) $-6\hat{k}-9\hat{j}$ units

(C) $-6\hat{k}+8\hat{j}$ units (D) $6\hat{k}+8\hat{j}$ units

129. Currents I_1 and I_2 flow in the wires shown in Figure.

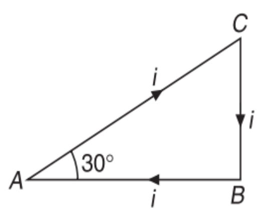


The field is zero at distance x to the right of O. Then,

(A) $x=\left(\frac{I_1}{I_2}\right)a$ (B) $x=\left(\frac{I_2}{I_1}\right)a$

(C) $x=\left(\frac{I_1-I_2}{I_1+I_2}\right)a$ (D) $x=\left(\frac{I_1+I_2}{I_1-I_2}\right)a$

130. A wire bent in the form of a right-angled triangle ABC as shown in Figure carries a current 1 A. It is placed in the region of a uniform magnetic induction field $B=0.2$ T as shown in Figure.

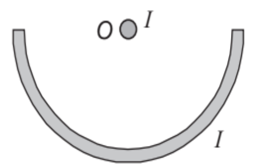


If $AC=1$ m. The net force on the wire is

(A) 1.73 N (B) 3.46 N

(C) 2.732 N (D) 0

131. A direct current I flows in a long straight conductor whose cross-section has the form of a thin half-ring of radius R. The same current flows in the opposite direction along a thin conductor located on the axis of the first conductor. The magnetic interaction force between the given conductors reduced to a unit of their length is



(A) $\frac{\mu_0 I^2}{2\pi R}$ (B) $\frac{\mu_0 I^2}{\pi R^2}$

(C) $\frac{\mu_0 I^2}{\pi^2 R}$ (D) $\frac{\mu_0 I}{\pi^2 R}$

132. A point charge is moving in clockwise direction in a circle with constant speed. Consider the magnetic field produced by the charge at a point P on the axis of the circle. Then this magnetic field is

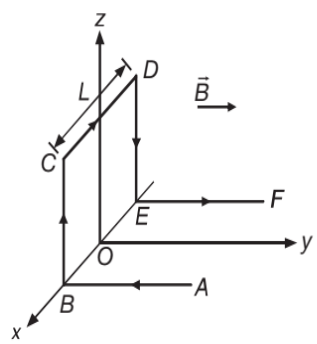
(A) constant in magnitude only.

(B) constant in direction only.

(C) constant both in direction and magnitude.

(D) not constant both in magnitude and direction.

133. A conductor $ABCDEF$, with each side of length L, is bent as shown. It is carrying a current I in a uniform magnetic induction B, parallel to the positive y direction. The force experienced by the wire is



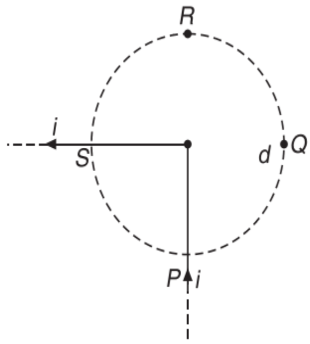
(A) BIL in the positive y-direction

(B) BIL in the positive z-direction.

(C) $3BIL$ in the positive y-direction

(D) ZERO

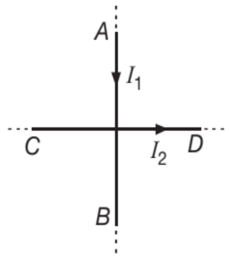
134. A long wire is bent at the middle to form a right angle as shown in Figure. The magnitude of the magnetic field at the points Q and R is



(A) $\frac{\mu_0 i}{4\pi d}, \frac{\mu_0 i}{4\pi d}$ (B) $\frac{\mu_0 i}{2\pi d}, \frac{\mu_0 i}{4\pi d}$

(C) $\frac{\mu_0 i}{\pi d}, \frac{\mu_0 i}{2\pi d}$ (D) $\frac{\mu_0 i}{d}, \frac{\mu_0 i}{d}$

135. Two long wires AB and CD carry currents I_1 and I_2 in the directions shown in Figure.



If $\vec{F}$ be the net force on the wire and $\vec{\tau}$ be net torque on it, then

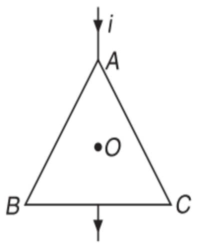
(A) $\vec{F}=\vec{0}$, $\vec{\tau}=\vec{0}$

(B) $\vec{F}=\vec{0}$, $\vec{\tau}\neq\vec{0}$ (CCW)

(C) $\vec{F}=\vec{0}$, $\tau\neq\vec{0}$ (CW)

(D) $\vec{F}\neq\vec{0}$, $\vec{\tau}=\vec{0}$

136. The wire ABC shown in Figure forms an equilateral triangle.

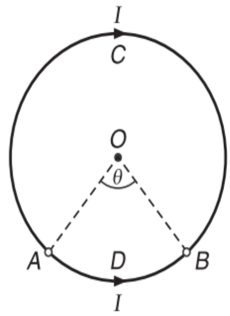


The magnetic field B at the centre O of the triangle assuming the wire to be uniforms, will be

(A) ∞ (B) 0

(C) $\frac{\mu_0 i}{AB}$ (D) $\frac{\mu_0 i}{BC}$

137. In two segments of a circular loop of radius a, equal currents I flow in the directions shown in Figure.



Magnetic field at the centre of the loop is

(A) $\frac{\mu_0 I}{2a}$ (B) $\frac{\mu_0 I}{2\pi a}(2\pi-\theta)$

(C) $\frac{\mu_0 I}{2\pi a}(\pi-\theta)$ (D) ZERO

138. In a cyclotron, if a deuteron can gain an energy of 40 MeV, then a proton can gain an energy of

(A) 40 MeV (B) 80 MeV

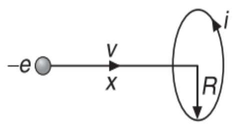
(C) 20 MeV (D) 60 MeV

139. A coaxial cable consists of a thin inner conductor fixed along the axis of a hollow outer conductor. The two conductors carry equal currents in opposite directions. Let B_1 and B_2 be the magnetic fields in the regions between the conductors, and outside the conductor, respectively

(A) $B_1 = B_2 = 0$ (B) $B_1 \neq 0$, $B_2 \neq 0$

(C) $B_1 = 0$, $B_2 \neq 0$ (D) $B_1 \neq 0$, $B_2 = 0$

140. An electron moving with a velocity v along the axis approaches a circular current carrying loop as shown in Figure.

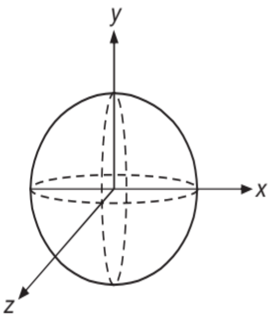


The magnitude of magnetic force on electron at this instant is

(A) $\frac{\mu_0 e v i R^2 x}{2(x^2+R^2)^{\frac{3}{2}}}$ (B) $\frac{\mu_0 e v i R^2 x}{\pi(x^2+R^2)^{\frac{3}{2}}}$

(C) $\frac{\mu_0 e v i R^2 x}{4\pi(x^2+R^2)^{\frac{3}{2}}}$ (D) 0

141. Three rings, each having equal radius R and carrying a current I are placed mutually perpendicular to each other such that each has its centre at the origin of co-ordinate system. The magnitude of the magnetic field at the common centre is



(A) ZERO (B) $\sqrt{3}\left(\frac{\mu_0 I}{2R}\right)$

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

142. A current carrying flat coil has a magnetic moment M. It is initially in equilibrium, with its plane perpendicular to a magnetic field of magnitude B. If the coil is now rotated through an angle θ, then the work done is

(A) $MB\sin\theta$ (B) $MB\cos\theta$

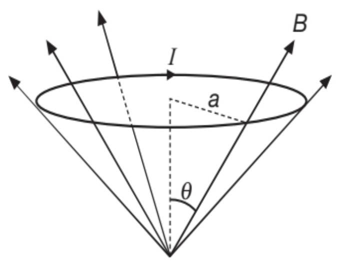
(C) $MB\theta$ (D) $MB(1-\cos\theta)$

143. A neutral atom of atomic mass number 100 is lying at the origin in gravity free space. It emits an α-particle A in x-direction and the product ion formed is P. A uniform magnetic field exists in the $-z$-direction. Neglecting the electromagnetic interaction between A and P, the angle of rotation of A (in radian) after which A and P meet for the first time is

(A) $\frac{12\pi}{25}$ (B) $\frac{24\pi}{25}$

(C) $\frac{36\pi}{25}$ (D) $\frac{48\pi}{25}$

144. A circular current loop of radius a is placed in a radial field B as shown. The net force acting on the loop is



(A) ZERO (B) $2\pi BIa$

(C) $2\pi aIB\sin\theta$ (D) πaIB

145. A wire of length l carries a current I along the x-axis. A magnetic field exists which is given as $\vec{B} = B_0\left(\hat{i}+\hat{j}+\hat{k}\right)$ T. The magnitude of the magnetic force acting on the wire will be

(A) $B_0 Il$ (B) $3B_0 Il$

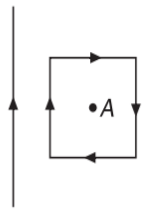
(C) $\sqrt{3}B_0 Il$ (D) $\sqrt{2}B_0 Il$

146. A metallic wire carrying a current I, kept perpendicular to a uniform magnetic field, is folded to form a square loop of side a. Now the shape of the loop is changed from square to a circle without changing the length of the wire and current. The amount of work done in doing so is

(A) $BIa^2\left(\frac{4}{\pi-1}\right)$ (B) $BIa^2(\pi+2)$

(C) $BIa^2\left(1-\frac{4}{\pi}\right)$ (D) $BIa^2(\pi-2)$

147. A wire is parallel to a square coil. The coil and wire carries currents in the directions shown. Then, at any point A within the coil the magnetic field will be



(A) less than the magnetic field produced due to coil only

(B) more than the magnetic field produced due to coil only

(C) equal to the field by coil alone

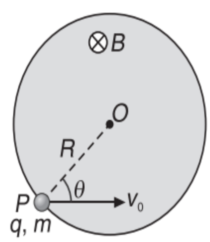
(D) zero

148. A copper wire of diameter 3.2 mm carries a current I. The maximum magnetic field due to this wire is 5×10^{-3} T. The value of I is

(A) 40 A (B) 10 A

(C) 20 A (D) 80 A

149. A particle of charge q and mass m is projected with a velocity v_0 towards a circular region of radius R having uniform magnetic field B perpendicular and into the plane of paper from point P as shown in Figure.



If O is the centre of the circular region and the line OP makes angle θ with the direction of v_0, then the value of v_0 so that particle passes through O is

(A) $\dfrac{qBR}{m\sin\theta}$ (B) $\dfrac{qBR}{2m\sin\theta}$

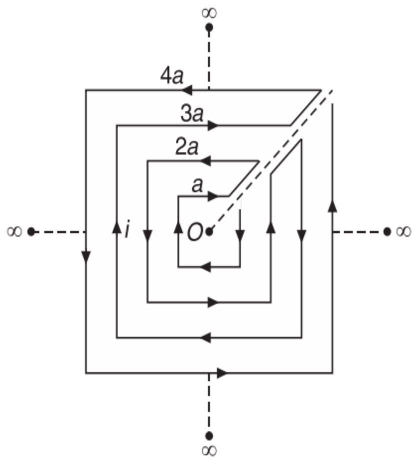
(C) $\dfrac{2qBR}{m\sin\theta}$ (D) $\dfrac{3qBR}{2m\sin\theta}$

150. The magnetic field at the centre of a circular current carrying loop of area A is B. The magnetic moment of the loop is M. Then

(A) $M = \dfrac{BA}{\mu_0}\sqrt{A}$ (B) $M = \dfrac{BA^2}{\mu_0 \pi}$

(C) $M = \dfrac{2BA}{\mu_0}\sqrt{\dfrac{A}{\pi}}$ (D) $M = \dfrac{BA\sqrt{A}}{\mu_0 \pi}$

151. Determine the magnetic field at the centre of the current carrying wire arrangement shown in figure.

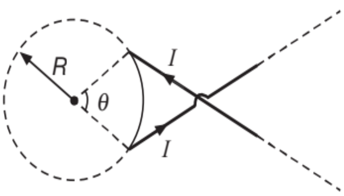


The arrangement extends to infinity. (The wires joining the successive squares are along the line passing through the centre).

(A) $\dfrac{\mu_0 i}{\sqrt{2}\pi a}$ (B) $\dfrac{2\sqrt{2}\mu_0 i}{\pi a}\ln(2)$

(C) $\dfrac{2\sqrt{2}\mu_0 i}{\pi a}$ (D) $\dfrac{2\sqrt{2}\mu_0 i}{\pi a}\ln(3)$

152. A current carrying wire has the configuration shown in Figure.



Two semi-infinite straight sections, each tangent to the same circle, are connected by a circular arc, of angle θ along the circumference of the circle, with all sections lying in the same plane. What must be θ in order for B (magnetic field) to be zero at the centre of the circle?

(A) $\theta = 4$ rad (B) $\theta = 3$ rad

(C) $\theta = 2$ rad (D) $\theta = 1$ rad

153. A length L of wire carrying current I is bent into a circle of one turn. The field at the centre of the coil is B_1. A similar wire of length L carrying current I is bent into a square of one turn. The field at its centre is B_2. Then

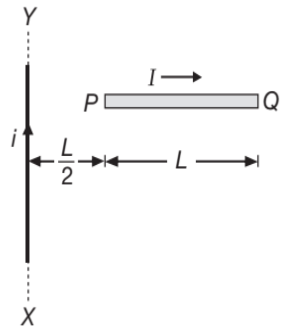
(A) $B_1 > B_2$

(B) $B_1 < B_2$

(C) $B_1 = B_2$

(D) nothing can be predicted

154. A conductor PQ of length L, carries a current I. PQ is placed perpendicular to a long straight conductor XY carrying a current i as shown. The force acting on PQ is F.



(A) $F = \dfrac{\mu_0 I i}{2\pi}\ln 2$; upwards

(B) $F = \dfrac{\mu_0 I i}{2\pi}\ln 2$; downwards

(C) $F = \dfrac{\mu_0 I i}{2\pi}\ln 3$; upwards

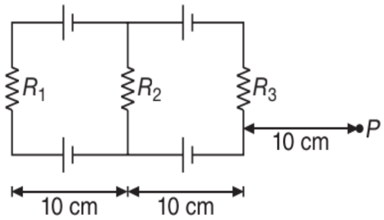
(D) $F = \dfrac{\mu_0 I i}{2\pi}\ln 3$; downwards

155. On a smooth horizontal surface, a conducting rod of mass m and length l is placed. A uniform magnetic field B is acting perpendicular to the rod. A charge q is suddenly passed through the rod and it acquires a velocity v on the surface, then

(A) $q = \dfrac{mv}{2Bl}$ (B) $q = \dfrac{mv}{Bl}$

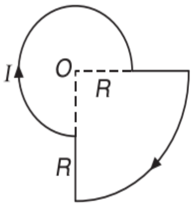
(C) $q = \dfrac{2mv}{Bl}$ (D) $q = \dfrac{Blv}{2m}$

156. In the Figure shown, each battery has emf of 5 V. Then the magnetic field at P is



(A) ZERO
(B) $\frac{10\mu_0}{R_1(4\pi)(0.2)}$
(C) $\frac{20\mu_0}{(R_1+R_2)(4\pi)(0.2)}$
(D) None of these

157. A current I flowing through the loop as shown in the adjoining figure. The magnetic field at centre O is

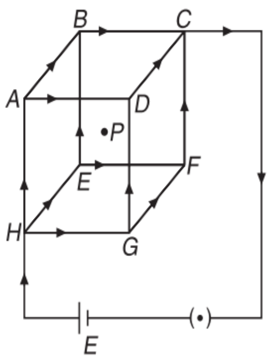


(A) $\frac{7\mu_0 I}{16R}\otimes$
(B) $\frac{7\mu_0 I}{16R}\odot$
(C) $\frac{5\mu_0 I}{16R}\otimes$
(D) $\frac{5\mu_0 I}{16R}\odot$

158. The magnetic field near a large metal sheet that carries an electric current of current per unit length λ, along its surface is

(A) $\frac{\mu_0\lambda}{2\pi}$
(B) $\frac{\mu_0\lambda}{2}$
(C) $\mu_0\lambda$
(D) $\frac{\mu_0}{2\lambda\pi}$

159. A steady current is set up in a network composed of wires of equal resistance and length d as shown in Figure. The magnetic field at the centre P is

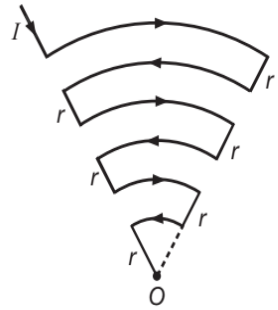


(A) $\frac{\mu_0}{4\pi}\frac{2I}{d}$
(B) $\frac{\mu_0}{4\pi}\frac{3I}{\sqrt{2}d}$
(C) ZERO
(D) $\frac{\mu_0}{4\pi}\frac{I\theta}{d}$

160. A particle of charge Q and of negligible initial speed is accelerated through a potential difference of U. The particle reaches a region of uniform magnetic field of induction B, where it undergoes circular motion. If potential difference is doubled and B is also doubled then magnetic moment of the circular current due to circular motion of charge Q will become.

(A) double
(B) half
(C) four times
(D) remain same

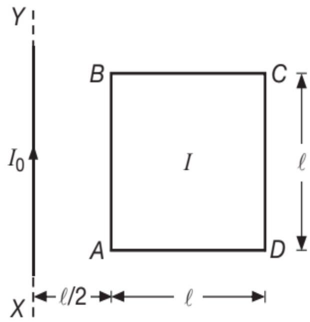
161. Shown in Figure is a conductor carrying a current I.



The magnetic field intensity at the point O (common centre of all the three arcs) is

(A) $\frac{37\mu_0 I\theta}{120\pi r}$
(B) $\frac{37\mu_0 I\theta}{240\pi r}$
(C) $\frac{11\mu_0 I\theta}{240\pi r}$
(D) ZERO

162. A square loop $ABCD$, carrying a current I, is placed near and coplanar with a long straight conductor XY carrying a current I_0



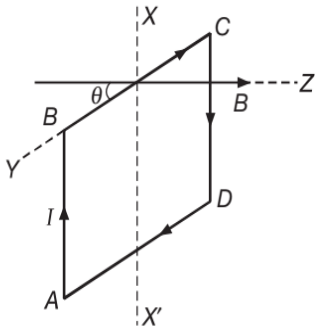
(A) There is no net force on the loop.
(B) The loop will always be attracted by the conductor.
(C) The loop will be attracted by the conductor only if the current in the loop flows anticlockwise.
(D) The loop will be attracted by the conductor only if the current in the loop flows clockwise.

163. Two long parallel wires separated by a distance r have equal currents I flowing in each. Either wire experiences a magnetic force F Nm^{-1}. If the distance r is increased to $3r$ and current in each wire is reduced to $\frac{I}{3}$, the force per unit length between them will now be

(A) $3F$ (B) $9F$

(C) $\frac{F}{9}$ (D) $\frac{F}{27}$

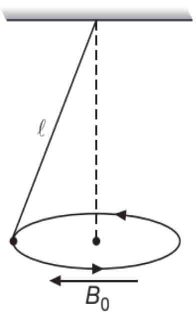
164. The square loop $ABCD$, carrying a current I, is placed in a uniform magnetic field B, as shown. The loop can rotate about the axis XX', as shown. The plane of the loop makes an angle $\theta(\theta < 90°)$ with the direction of B. The angle through which the loop will rotate all by itself before the torque on it becomes zero is



(A) $(\pi-\theta)$ (B) $\left(\frac{\pi}{2}+\theta\right)$

(C) $\left(\frac{\pi}{2}-\theta\right)$ (D) θ

165. A uniform current carrying ring of mass m and radius R is connected by a massless string of length l as shown in Figure.



A uniform magnetic field B_0 exists in the region to keep the ring in horizontal position, then the current in the ring is

(A) $\frac{mg}{\pi RB_0}$ (B) $\frac{mg}{RB_0}$

(C) $\frac{mg}{3\pi RB_0}$ (D) $\frac{mg}{\pi R^2 B_0}$

166. A coaxial cable consists of a thin inner conductor fixed along the axis of a hollow outer conductor. The two conductors carry equal currents in the same directions. Let B_1 be the magnetic field at a point between the two conductors, at a distance x from the axis. Let B_2 be the magnetic field at a point outside the outer conductor, at a distance $2x$ from the axis

(A) $B_1 = 2B_2$ (B) $B_2 = 2B_1$

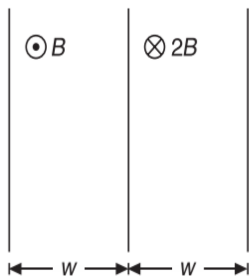
(C) $B_2 = B_1$ (D) $B_2 = 4B_1$

167. A current I flows through a lengthy thin walled tube of radius R having a longitudinal slit of width w. The magnetic field inside the tube at the axis under the condition $w \ll R$ is

(A) ZERO (B) $B = \frac{\mu_0 wI}{2\pi R^2}$

(C) $B = \frac{\mu_0 wI}{4\pi^2 R^2}$ (D) $B = \frac{\mu_0 wI}{4\pi R^2}$

168. The magnetic field shown in the figure consist of the two magnetic fields as shown.



If v is the velocity just required for a charge particle of mass m and charge q to pass through the magnetic field and the particle is projected with this velocity v, then, the time spend by the charged particle in the magnetic field is

(A) $\frac{\pi m}{2qB}$ (B) $\frac{\pi m}{qB}$

(C) $\frac{\pi m}{4qB}$ (D) $\frac{3\pi m}{2qB}$

169. The magnetic moment of an electron in nth orbit of hydrogen atom is M. If m be the mass of electron, then M equals

(A) $\frac{neh}{2\pi m}$ (B) $\frac{neh}{4\pi m}$

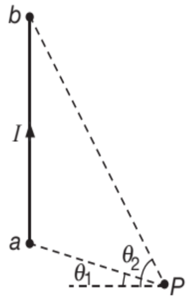
(C) $\frac{neh}{\pi m}$ (D) $\frac{2neh}{\pi m}$

170. Two coaxial long solenoids of equal lengths have current i_1, i_2, number of turns per unit length n_1, n_2 and radius r_1, $r_2 (> r_1)$ respectively. If $n_1 i_1 = n_2 i_2$ and the two solenoids carry currents in opposite sense, the magnetic energy stored per unit length e is

(A) $\frac{\mu_0 \pi}{2} n_1^2 i_1^2 \left(r_2^2 - r_1^2\right)$ (B) $\mu_0 n_1^2 i_1^2 \pi \left(r_2^2 - r_1^2\right)$

(C) $\frac{\mu_0}{2} n_1^2 i_1^2 \pi r_1^2$ (D) $\frac{\mu_0 \pi}{2} n_2^2 i_2^2 r_2^2$

171. P is a point at perpendicular distance d from a straight wire ab carrying a current I. The magnetic field at P due to ab has magnitude



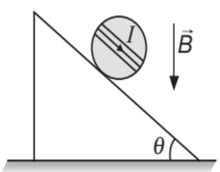
(A) $\frac{\mu_0 I}{4\pi d}(\cos\theta_1 + \cos\theta_2)$

(B) $\frac{\mu_0 I}{4\pi d}(\cos\theta_1 - \cos\theta_2)$

(C) $\frac{\mu_0 I}{4\pi d}(\sin\theta_1 + \sin\theta_2)$

(D) $\frac{\mu_0 I}{4\pi d}(\sin\theta_2 - \sin\theta_1)$

172. In the Figure shown, a coil of single turn, carrying a current I is wound on a sphere of radius R and mass m. The plane of the coil is parallel to the incline and lies in the equatorial plane of the sphere. The sphere is in equilibrium, then $|\vec{B}|$ equals



(A) $\frac{mg\tan\theta}{\pi IR}$ (B) $\frac{mg\sin\theta}{\pi IR}$

(C) $\frac{mg\cos\theta}{\pi IR}$ (D) $\frac{mg}{\pi IR}$

173. A rectangular loop of metallic wire is of length a and breadth b and carries a current i. The magnetic field at the centre of the loop is

(A) $\frac{\mu_0 i}{4\pi}\left(\frac{8\sqrt{a^2+b^2}}{ab}\right)$ (B) $\frac{\mu_0 i}{4\pi}\left(\frac{4\sqrt{a^2+b^2}}{ab}\right)$

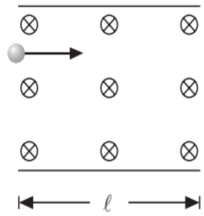
(C) $\frac{\mu_0 i}{4\pi}\left(\frac{2\sqrt{a^2+b^2}}{ab}\right)$ (D) $\frac{\mu_0 i}{4\pi}\left(\frac{\sqrt{a^2+b^2}}{ab}\right)$

174. An α particle is moving along a circle of radius R with a constant angular velocity ω. A point A lies in the same plane at a distance $2R$ from the centre. The magnetic field produced by α particle is measured at the point A. If the minimum time interval between two successive times at which A records zero magnetic field is t, then the angular speed ω in terms of t is

(A) $\frac{2\pi}{t}$ (B) $\frac{2\pi}{3t}$

(C) $\frac{\pi}{3t}$ (D) $\frac{\pi}{t}$

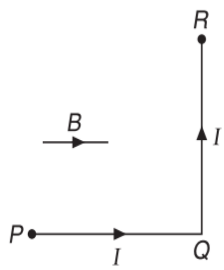
175. An electron moves straight inside a charged parallel plate capacitor of uniform surface charge density σ. The space between the plates is filled with constant magnetic field of induction $\vec{B}$. The time of straight-line motion of the electron in the capacitor is



(A) $\frac{e\sigma}{\varepsilon_0 lB}$ (B) $\frac{\varepsilon_0 lB}{\sigma}$

(C) $\frac{e\sigma}{\varepsilon_0 B}$ (D) $\frac{\varepsilon_0 B}{e\sigma}$

176. A wire PQR is bent as shown in Figure and is placed in a region of uniform magnetic field B.



The length of $PQ = QR = l$. A current I ampere flows through the wire as shown. The magnitude of force on PQ and QR will be

(A) $BIl, 0$ (B) $2BIl, 0$

(C) $0, BIl$ (D) $0, 0$

177. Two parallel wires carrying equal currents in opposite directions are placed at $x = \pm a$ parallel to y-axis with $z = 0$. If B_0 be the field at the origin and B be the field at point $P(2a, 0, 0)$, then B equals

(A) $\frac{B_0}{2}, \otimes$ (B) $\frac{B_0}{2}, \odot$

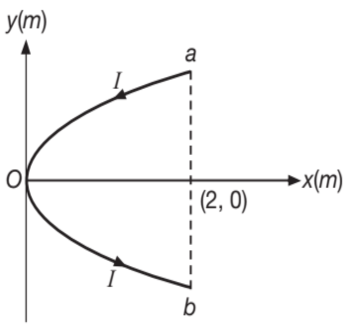
(C) $\frac{B_0}{3}, \otimes$ (D) $\frac{B_0}{3}, \odot$

178. A hypothetical magnetic field existing in a region is given by $\vec{B} = B_0\hat{r}$, where $\hat{r}$ denotes the unit vector along the radial direction. A circular loop of radius a carrying a current i, is placed with its plane parallel to the x-y plane and centre at $(0, 0, d)$. The magnitude of magnetic force acting on the loop is

(A) $\frac{2\pi a^2 i B_0}{d}$ (B) $\frac{2\pi a^2 i B_0}{\sqrt{a^2 + d^2}}$

(C) $\frac{\pi a^2 i B_0}{d}$ (D) $\frac{\pi a^2 i B_0}{\sqrt{a^2 + d^2}}$

179. A conducting wire, carrying a current $I = 2$ A is bent in the form of a parabola having an equation given by $y^2 = 2x$ as shown in Figure.



This wire is placed in a uniform magnetic field $\vec{B} = -4\hat{k}$ tesla. The magnetic force on the wire, in newton, is

(A) $-16\hat{i}$ (B) $32\hat{i}$

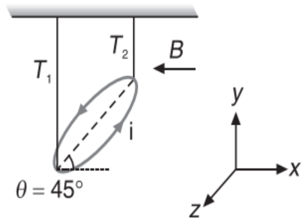
(C) $-32\hat{i}$ (D) $16\hat{i}$

180. A particle of charge $q = 4\ \mu$C and mass $m = 10$ mg starts moving from the origin under the action of an electric field $\vec{E} = 4\hat{i}$ and magnetic field $\vec{B} = (0.2T)\hat{k}$. Its velocity at $(x, 3, 0)$ is $(4\hat{i} + 3\hat{j})$. The value of x is

(A) $\frac{115}{16}$ m (B) $\frac{125}{16}$ m

(C) $\frac{135}{16}$ m (D) $\frac{145}{16}$ m

181. A current carrying circular coil of single turn of mass m is suspended in xz plane with the help of two ideal strings as shown in Figure.



A constant magnetic field $\vec{B}$ is set up in the horizontal direction in the region. The ratio of tension $\frac{T_1}{T_2}$ in the string will be [Take $\pi BIR = \frac{mg}{4}$ and $\theta = 45°$ in Figure shown]

(A) $2:1$ (B) $5:3$

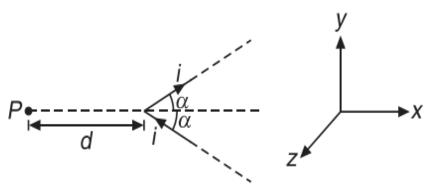
(C) $4:1$ (D) $1:2$

182. Two long concentric cylindrical conductors of radii a and b $(b < a)$ are maintained at a potential difference V and carry equal and opposite currents I. An electron with a particular velocity v_0 parallel to the axis will travel undeviated in the evacuated region between the conductors. Then v_0 equals

(A) $\frac{4\pi V}{\mu_0 I \ln\left(\frac{b}{a}\right)}$ (B) $\frac{2\pi V}{\mu_0 I \ln\left(\frac{a}{b}\right)}$

(C) $\frac{2\pi V}{\mu_0 I \ln\left(\frac{b}{a}\right)}$ (D) $\frac{8\pi V}{\mu_0 I \ln\left(\frac{a}{b}\right)}$

183. V shaped wire is in x-y plane. The direction of the field B at P is along



(A) $+x$ axis (B) $+z$ axis

(C) $-x$ axis (D) $+y$ axis

MULTIPLE CORRECT CHOICE TYPE QUESTIONS

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

1. A co-axial cable consists of a thin inner current carrying conductor fixed along the axis of a hollow current carrying conductor. Let B_1 and B_2 be the magnetic fields in the region between the conductors and outside the conductor, respectively

(A) $B_1 \neq 0$, $B_2 \neq 0$ for conductors carrying equal currents in opposite directions

(B) $B_1 \neq 0$, $B_2 = 0$ for conductors carrying equal currents in opposite directions

(C) $B_1 \neq 0$, $B_2 \neq 0$ for conductors carrying equal currents in the same direction

(D) $B_1 = B_2$ for conductors carrying equal currents in same directions at distances x and $2x$ from the axis respectively

2. Two thick wires and two thin wires, all of same material and same length form a square in the three different ways P, Q and R as shown in Figure. The current flowing through the arrangement is i. Let B_P, B_Q and B_R represent the magnetic field at the centre of squares in the three cases, then

(A) $B_P = 0$ (B) $B_Q = 0$

(C) $B_R = 0$ (D) $B_P \neq 0$

3. A particle having specific charge α moves with a velocity $\vec{v} = v_0\hat{i}$ in a magnetic field $\vec{B} = \frac{B_0}{\sqrt{2}}(\hat{j}+\hat{k})$. It is observed that the

(A) path of the particle is a helix

(B) path of the particle is a circle

(C) distance moved by particle in time $t = \frac{\pi}{\alpha B_0}$ is $\frac{\pi v_0}{\alpha B_0}$

(D) velocity of particle after time $t = \frac{\pi}{3\alpha B_0}$ is $\left(\frac{v_0}{\sqrt{2}}\hat{i} + \frac{v_0}{\sqrt{2}}\hat{j}\right)$

4. Two identical charged particles enter a uniform magnetic field with same speed but at angles 30° and 60° with field. The ratio of their time periods, radii and pitches of the helical paths are a, b and c respectively. Then

(A) $abc < 1$ (B) $c = 3ab$

(C) $abc = 1$ (D) $a = bc$

5. A thin wire carrying current i is bent to form a closed loop of one turn. The loop is placed in y-z plane with centre at origin. If R is the radius of the loop, B_x be the magnetic field at a point $(x, 0)$ on the x-axis, then

(A) $B_x = \frac{\mu_0 i R^2}{2(R^2+x^2)^{3/2}}$ (B) $\int_0^{\infty} B_x dx = \frac{\mu_0 i}{2}$

(C) $\int_{-\infty}^{\infty} B_x dx = \mu_0 i$ (D) $\int_{-\infty}^{\infty} B_x dx = 0$

6. Which of the following statement(s) is/are correct?

(A) Units of magnetic field B can be written as $NA^{-1}m^{-1}$

(B) Units of magnetic permeability μ_0 can be written as NA^{-2}

(C) Units of magnetic flux ϕ_B can be written as $NA^{-1}m^{-2}$

(D) Units of $\sqrt{\frac{L}{C}}$ can be VA^{-1}

7. Two circular coils A and B with their centres lying on the same axis have same number of turns and carry equal currents in the same sense. They are separated by a distance, have different diameters but subtend same angle at a point P lying on their common axis. The coil B lies exactly midway between coil A and the point P. The magnetic field at point P due to coils A and B is B_1 and B_2 respectively

(A) $B_1 > B_2$ (B) $B_1 < B_2$

(C) $\frac{B_1}{B_2} = 2$ (D) $\frac{B_1}{B_2} = \frac{1}{2}$

8. If the acceleration and velocity of a charged particle moving in a constant magnetic region is given by $\vec{a} = a_1\hat{i} + a_2\hat{k}$, $\vec{v} = b_1\hat{i} + b_2\hat{k}$, where a_1, a_2, b_1 and b_2 are constants, then select the correct statement(s).

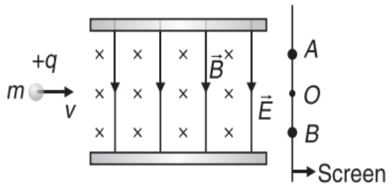
(A) Magnetic field may be along y-axis

(B) $a_1 b_1 + a_2 b_2 = 0$

(C) Magnetic field is along x-axis

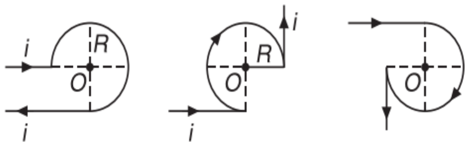
(D) Kinetic energy of particle is always constant

9. A region of space has electric field $\vec{E}$ and magnetic field $\vec{B}$ as shown. A particle of charge $+q$, mass m enters this region with velocity $\vec{v}$ perpendicular to $\vec{E}$ and $\vec{B}$ both.



(A) The charged particle will hit the screen at A, experiencing a net force $q(vB-E)$.
(B) The charged particle will hit the screen at B, experiencing a net force $q(E-vB)$.
(C) The charged particle will hit the plate at O, under the state of equilibrium.
(D) The velocity v is the ratio of the magnitude of electric field to that of magnitude of magnetic field.

10. Three long straight current carrying conductors are shown in Figure. The straight parts are long and the circular part in each case in three fourth of a complete circle. Let B_a, B_b and B_c represents the strength of field at the centre O in the three cases, then



(A) $B_a=\frac{\mu_0 i}{4R}\left(\frac{3}{2}+\frac{1}{\pi}\right)$ (B) $B_b=\frac{\mu_0 i}{2R}\left(\frac{3}{4}-\frac{1}{\pi}\right)$

(C) $B_a=\frac{\mu_0 i}{4R}\left(\frac{3}{2}-\frac{1}{\pi}\right)$ (D) $B_c=\frac{3\mu_0 i}{8R}$

11. A charged particle is fired at an angle θ to a uniform magnetic field directed along the x-axis. During its motion along a helical path, the particle will
(A) never move parallel to the x-axis
(B) move parallel to the x-axis once during every rotation for all values of θ
(C) move parallel to the x-axis at least once during every rotation if $\theta=45°$
(D) never move perpendicular to the x-direction

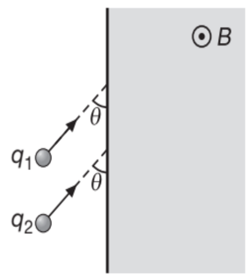
12. A charged particle of charge q, mass m is projected in a plane perpendicular to uniform magnetic field. The areal velocity (area swept per unit time), kinetic energy, momentum, field strength are denoted by $\frac{dA}{dt}$, K, p and $|\vec{B}|$ respectively. Then

(A) $\frac{dA}{dt}\propto K$ (B) $\frac{dA}{dt}\propto\frac{1}{|\vec{B}|}$

(C) $\frac{dA}{dt}\propto p^2$ (D) $\frac{dA}{dt}\propto q$

13. A proton, moving with velocity $\vec{v}$, enters a region having simultaneous, uniform electric and magnetic fields $\vec{E}$ and $\vec{B}$ respectively such that $\vec{v}$, $\vec{E}$ and $\vec{B}$ are mutually perpendicular the proton is deflected along positive x-axis when either of the fields or both are switched on simultaneously. Which of the following supports the argument given above?
(A) $\vec{B}$ may be along negative y-axis
(B) $\vec{B}$ may be along positive z-axis
(C) $\vec{E}$ is along positive x-axis
(D) $\vec{v}$ may be along positive y-axis

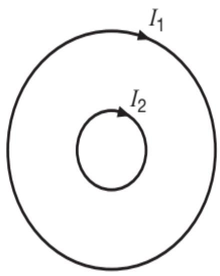
14. Two charges q_1 and q_2 having same magnitude and equal mass are moving parallel to each other and they enter into a region of uniform magnetic field as shown. If the time spent by them in the magnetic field are t_1 and t_2 respectively, then select the correct statement(s).



(A) For $q_1=-q_2$, $t_1=t_2$
(B) For $q_1=q_2$, $t_1=t_2$
(C) For $q_1>0$, $q_2<0$, $t_1<t_2$
(D) For $q_1<0$, $q_2>0$, $t_1<t_2$

15. Current flows through a straight cylindrical conductor of radius r. The current is distributed uniformly over its cross-section. The magnetic field at a distance x from the axis of the conductor has magnitude B
(A) $B=0$ at the axis
(B) $B\propto x$ for $0\le x\le r$
(C) $B\propto\frac{1}{x}$ for $x>r$
(D) B is maximum for $x=r$

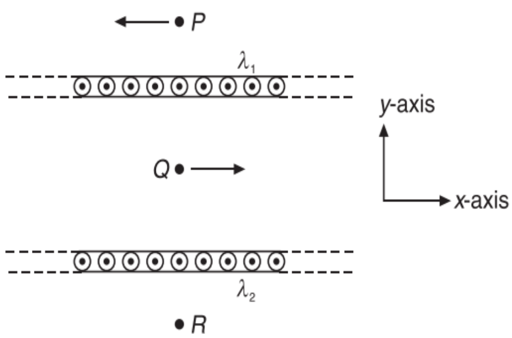
16. Two concentric circular coils of radii R and $r(\ll R)$ carry currents of I_1 and I_2 respectively. When the smaller coil, of mass m, is rotated slightly about one of its diameter, it starts oscillating. If T is the period of oscillation, then



(A) $T \propto \frac{1}{\sqrt{I_1 I_2}}$ (B) $T \propto r^0$

(C) $T \propto \frac{1}{\sqrt{m}}$ (D) $T \propto \sqrt{R}$

17. The figure shows two infinite parallel sheets of current, with current per unit length λ_1 and λ_2. If B_P, B_Q and B_R represent the magnetic field at the points P, Q and R respectively, then



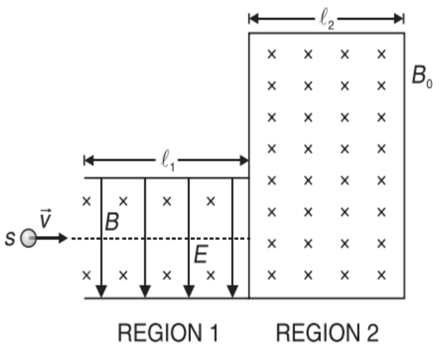
(A) $B_P = \left(\frac{\lambda_1 + \lambda_2}{2}\right)\mu_0$, along x-axis

(B) $B_Q = \left(\frac{\lambda_1 - \lambda_2}{2}\right)\mu_0$, along x-axis

(C) $B_R = \left(\frac{\lambda_1 + \lambda_2}{2}\right)\mu_0$, along x-axis

(D) $B_Q = \left(\frac{\lambda_1 - \lambda_2}{2}\right)\mu_0$, along $-x$-axis

18. A charged particle of specific charge s passes through a region of space shown.



(A) Velocity of the particle in REGION 1 is $v = \frac{E}{B}$.

(B) Work done to move the charged particle in REGION 1 and REGION 2 is ZERO.

(C) The radius of the trajectory of the charged particle in REGION 2 is $\frac{E}{sBB_0}$.

(D) The particle emerges from REGION 2 with a velocity $\vec{v}'$ where $\vec{v}' = -\vec{v}$ for $\ell_2 > \frac{E}{sBB_0}$.

19. A charged particle of unit mass and unit charge at some instant has velocity $\vec{v} = \left(8\hat{i} + 6\hat{j}\right)$ ms^{-1} in magnetic field $\vec{B} = \left(2\hat{k}\right)$ tesla. (Neglect all other forces). Select the correct option(s).

(A) The path of particle may be $x^2 + y^2 - 4x - 21 = 0$

(B) The path of particle may be $x^2 + y^2 = 25$

(C) The path of particle may be $y^2 + z^2 = 25$

(D) Time period of particle will be 3.14 s

20. Two long thin parallel conductors of mass density m_1 and m_2 carry currents I_1 and I_2 respectively. They are placed at a distance d. The force acting on a unit length of the first conductor is F. Assuming second conductor to be fixed.

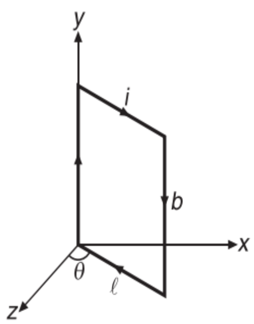
(A) $F \propto I_1 I_2$ and attractive for I_1 and I_2 flowing in the same direction.

(B) $F \propto I_1 I_2$ and repulsive for I_1 and I_2 flowing in the opposite direction.

(C) $F \propto \frac{1}{d}$

(D) The first conductor moves towards/away from the second with an acceleration $a = \frac{\mu_0 I_1 I_2}{2\pi m_1 d}$

21. A rectangular loop of dimensions $l \times b$ carries a current i. A uniform magnetic field $\vec{B} = B_0\hat{i}$ exists in space. Then select the correct statement(s).

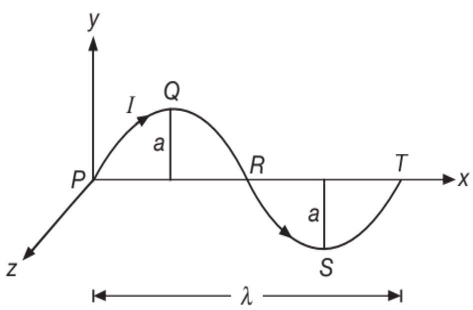


(A) Torque on the loop is $ilbB_0 \sin\theta$
(B) Torque on the loop is in negative y-direction
(C) When free to move, the loop turns so as to increase θ
(D) When free to move, the loop turns so as to decrease θ

22. A charged particle moves in a gravity free space where an electric field of strength E and a magnetic field of induction B exist. Which of the following statements are correct?

(A) If $E \neq 0$ and $B \neq 0$, velocity of the particle may remain constant
(B) If $E \neq 0$, particle cannot trace a circular path
(C) If $E \neq 0$, kinetic energy of the particle remains constant
(D) None of the above

23. A conductor $PQRST$, shaped as shown, carries a current I. It is placed in the xy plane with the ends P and T on the x-axis. A uniform magnetic field of magnitude B exists in the region. The force acting on it will be

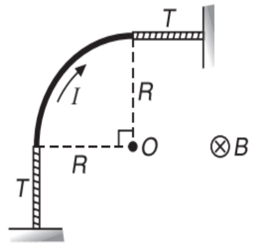


(A) zero, if B is in the x-direction
(B) λIb in the z-direction, if B is in the y-direction
(C) λIb in the negative y-direction, if B is in the z-direction
(D) $2BIa$ if B is in the x-direction

24. The magnetic field due to a current carrying toroidal solenoid

(A) is independent of the radius of the solenoid
(B) depends on the number of turns and the current in the solenoid
(C) is constant in magnitude inside the solenoid
(D) is always radial inside the solenoid

25. A wire carrying current I, bent in the form of a quarter circle is held at rest on a smooth table with two threads as shown. A uniform magnetic field exists in the region directed into the plane select the correct alternatives



(A) Net force on wire is zero
(B) Net magnetic force on wire is $\sqrt{2}BIR$
(C) Tension in each thread is BIR
(D) Tension in each thread is $\sqrt{2}BIR$

26. Two long, thin, parallel conductors are kept very close to each other, without touching. One carries a current I, and the other has charge λ per unit length. An electron moving parallel to the conductors is undeflected. Let c = velocity of light.

(A) $v = \dfrac{\lambda c^2}{I}$

(B) $v = \dfrac{I}{\lambda}$

(C) $c = \dfrac{I}{\lambda}$

(D) The electron may be at any distance from the conductor

27. The force $\vec{F}$ experienced by a particle of charge q moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}$ is given by $\vec{F} = q(\vec{v} \times \vec{B})$. Which pairs of vectors are at right angles to each other?

(A) $\vec{F}$ and $\vec{v}$
(B) $\vec{F}$ and $\vec{B}$
(C) $\vec{B}$ and $\vec{v}$
(D) $\vec{F}$ and $(\vec{v} \times \vec{B})$

28. Two circular coils of radii 5 cm and 10 cm carry currents of 2 A. The coils have 50 and 100 turns respectively and are placed in such a way that their planes as well as their centres coincide. Magnitude of magnetic field at the common centre of coils is

(A) $8\pi \times 10^{-4}$ T, if currents in the coils are in same sense
(B) $4\pi \times 10^{-4}$ T, if currents in the coils are in opposite sense
(C) Zero, if currents in the coils are in opposite sense
(D) $8\pi \times 10^{-4}$ T, if currents in the coils are in opposite sense

29. A charged particle is fired at an angle θ with the uniform field directed along x-axis. If the pitch of the helical path is equal to the maximum distance of the particle from the x-axis, then which of the following are not correct?

(A) $\cos\theta = \frac{1}{\pi}$ (B) $\sin\theta = \frac{1}{\pi}$

(C) $\tan\theta = \frac{1}{\pi}$ (D) $\tan\theta = \pi$

30. Consider three physical quantities $x = \frac{E}{B}$, $y = \sqrt{\frac{1}{\mu_0\varepsilon_0}}$ and $z = \frac{l}{CR}$. Here, l is the length of a wire, C is capacitance and R is resistance. All other symbols have standard meanings.

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

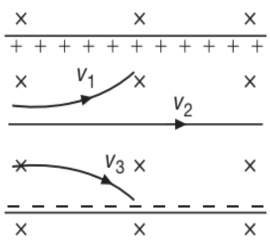
31. A circular coil of radius R, carries a current I. The magnetic field at the centre of the coil is B. Then B equals.

(A) $\frac{I}{2c^2\varepsilon_0 R}$ (B) $\frac{\mu_0 I}{2\pi R}$

(C) $\frac{\mu_0 I}{2R}$ (D) $\frac{Ic^2}{2\varepsilon_0 R}$

where c is the speed of light in vacuum.

32. In a region of crossed fields as shown, the strength of electric field is E and that of magnetic field is B. Three positively charged particles with speeds v_1, v_2 and v_3 are projected and their paths are shown. From this we conclude that



(A) $v_1 > \frac{E}{B}$ (B) $v_2 = \frac{E}{B}$

(C) $v_3 < \frac{E}{B}$ (D) None of these

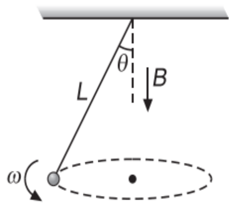
33. The velocity and acceleration vector of a charged particle moving in a magnetic field at some instant are given by $\vec{v} = 6\hat{i} + 4\hat{j}$ and $\vec{a} = 2\hat{i} + x\hat{j}$. Then

(A) $x = -1.5$
(B) $x = -3$
(C) Magnetic field is along z-direction
(D) Kinetic energy of the particle is constant

34. A straight thin walled tube of radius a has a current I flowing through it. If $B(r)$ is the magnitude of the magnetic field at a distance r from the axis of the tube then,

(A) $B(r) = 0$ for $0 \le r < a$
(B) $B(r) \propto \frac{1}{r}$ for $0 \le r < a$
(C) $B(r) \propto \frac{1}{r}$ for $r > a$
(D) $B(r) = 0$ for $r > a$

35. A conical pendulum of length L making an angle θ with vertical rotating with angular velocity ω has a bob whose charge to mass ratio is β. If a magnetic field B is directed vertically downwards as shown in Figure, then select the correct statement(s).



(A) $B = \frac{1}{\beta}\left(\omega - \frac{g}{\omega L\cos\theta}\right)$
(B) Angular momentum of the bob about the point of suspension remains constant
(C) If the direction of B were reversed maintaining same ω and L, then θ will remain unchanged
(D) Rate of change of angular momentum of the bob about the point of suspension is not a constant vector.

36. The cyclotron frequency of a particle in a magnetic field is independent of

(A) the mass of the particle
(B) the charge of the particle
(C) the speed of the particle
(D) the radius of the circular path of the particle

37. The current density in a wire of radius a varies with radial distance r as $J = kr^2$, where k is a constant.

(A) Total current passing through the cross section of the wire is $I = \frac{\pi k a^4}{2}$
(B) Total current passing through the cross section of the wire is $I = \frac{3\pi k a^3}{2}$
(C) The field at a distance $r > a$ is $B = \frac{\mu_0 k a^4}{4r}$
(D) The field at a distance $r < a$ is $B = \frac{\mu_0 k r^3}{4}$

38. A particle of specific charge α is projected from origin at $t = 0$ with a velocity $\vec{v} = v_0(\hat{i} + \hat{k})$ in a magnetic field $\vec{B} = -B_0\hat{k}$. Then select the correct statement(s).

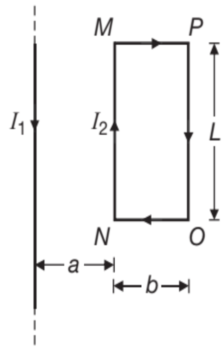
(A) At $t = \dfrac{\pi}{\alpha B_0}$, velocity of the particle is $\vec{v}' = -v_0(\hat{i} - \hat{k})$

(B) At $t = \dfrac{\pi}{4\alpha B_0}$, speed of the particle is v_0

(C) At $t = \dfrac{2\pi}{\alpha B_0}$, magnitude of displacement of the particle is more than $\dfrac{2v_0}{\alpha B_0}$

(D) At $t = \dfrac{2\pi}{\alpha B_0}$, distance travelled by the particle is less than $\dfrac{2\sqrt{2}\pi v_0}{\alpha B_0}$

39. For the situation shown, the correct statement(s) is/are



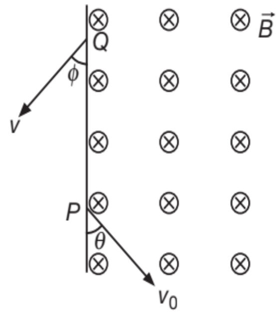
(A) The net force on the long straight wire is $F = \dfrac{\mu_0 I_1 I_2 L}{2\pi}\left[\dfrac{1}{a} - \dfrac{1}{a+b}\right]$ and is repulsive.

(B) The loop will be compressed.

(C) No torque will be acting on the loop as the forces experienced by the wires of the loop lie in the plane of the loop.

(D) No torque will be acting on the loop as the forces experienced by the wires of the loop are normal to the plane of the loop.

40. A particle of mass m, charge $-q$ enters a uniform magnetic field $\vec{B}$ (perpendicular to paper inwards) at P with velocity v_0 at an angle θ and leaves the field at Q with velocity v at angle ϕ as shown in Figure. Then



(A) $v = v_0$

(B) $\theta = \phi$

(C) particle remains in the field for time $t = \dfrac{2m(\pi - \theta)}{qB}$

(D) $PQ = \dfrac{2mv_0 \sin\theta}{qB}$

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

(A) maximum at the axis of the wire

(B) minimum at the axis of the wire

(C) maximum at the surface of the wire

(D) minimum at the surface of the wire

42. A charged particle P leaves the origin with speed $v = v_0$ at some inclination with the x-axis. There is a uniform magnetic field B along the x-axis. P strikes a fixed target T on the x-axis for a minimum value of $B = B_0$. P will also strike T if

(A) $B = 2B_0$, $v = 2v_0$ (B) $B = 2B_0$, $v = v_0$

(C) $B = B_0$, $v = 2v_0$ (D) $B = \dfrac{B_0}{2}$, $v = 2v_0$

43. In a region having a uniform field $\vec{B} = B_0\hat{j}$, a proton is fired from origin with velocity $\vec{v} = v_0\hat{j} + v_0\hat{k}$. The subsequent motion of the proton has the best description given by the following statement(s).

(A) Its x and z co-ordinates cannot be zero at the same time

(B) Its y co-ordinate will be proportional to its time of flight

(C) Its z co-ordinate can never be negative

(D) Its x co-ordinate can never be positive

44. Non-zero uniform electric field and magnetic field coexist in a region of space. The path of a charged particle in this region

(A) may be a circle (B) cannot be a circle
(C) may be a helix (D) may be a straight line

45. A charged particle having mass m, charge q is moving with velocity $\vec{v} = \alpha\hat{i} + \beta\hat{j}$ in a magnetic field $\vec{B} = \beta\hat{i} + \alpha\hat{j}$ and experiences a force $\vec{F}$. Which one of the following statement(s) is/are correct?

(A) $\vec{F} = \vec{0}$ for $\alpha = \beta$

(B) $|\vec{F}| \propto \alpha^2 - \beta^2$ for $\alpha > \beta$

(C) $\vec{F}$ acts along z-axis for $\alpha > \beta$

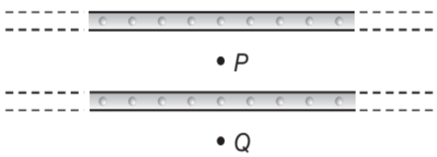
(D) $\vec{F}$ acts along y-axis for $\alpha < \beta$

46. A uniform linear charge density λ exists over a straight wire of length $2a$ having a charge Q. The wire is rotating about an axis passing through its centre and perpendicular to its length with an angular velocity 3ω. The equivalent dipole moment is

(A) $m = \lambda\omega a^3$ (B) $m = \frac{1}{2}Q\omega a^2$

(C) $m = \frac{3}{2}\lambda\omega a^3$ (D) $m = \frac{3}{2}Q\omega a^2$

47. Two infinite plates carry j ampere of current out of the page per unit width of the plate as shown. B_P and B_Q represent magnitude of field at points P and Q respectively.



(A) $B_P = 0$ (B) $B_P = \mu_0 j$

(C) $B_Q = 0$ (D) $B_Q = \mu_0 j$

48. A cylindrical rod of radius a carries a current I distributed uniformly over the entire wire. If $B(r)$ is the magnetic field due to the rod at distance r from the centre, then

(A) $B(r) \propto r$ for $0 < r \le a$

(B) $B(r) = 0$ at the axis

(C) $B(r) \propto \frac{1}{r}$ for $r > a$

(D) $B(r)$ is maximum at $r = a$ i.e., the surface.

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

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

50. An electron (mass $= m_e$) and a proton (mass $= m_p$) initially at rest move through a certain distance in a uniform electric field in times t_1 and t_2. Neglect the effect of gravity.

(A) The acceleration of electron is much greater than that of proton

(B) The acceleration of proton is much greater than that of electron

(C) $\frac{t_1}{t_2} = \left(\frac{m_e}{m_p}\right)^{1/2}$

(D) $\frac{t_1}{t_2} = \left(\frac{m_p}{m_e}\right)^{1/2}$

REASONING BASED QUESTIONS

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.
Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.
Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.
Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. **Statement-1:** If a charged particle passes through a region without getting any change in its velocity implies that the region is free from electric field as well as magnetic field.
Statement-2: Whenever a charged particle is placed in magnetic field or (and) electric field it may experience a net force.

2. **Statement-1:** Acceleration of a moving charged particle in a magnetic field is non-zero.
Statement-2: Inside magnetic field region, the particle may be moving on curved path.

3. A charge is projected in a region of magnetic field. (no other field is present)

Statement-1: Kinetic energy of charge particle will remain constant.
Statement-2: Work done by magnetic force on moving charge particle is zero.

4. **Statement-1:** A beam of electron passes undeflected through a region.
Statement-2: In the region, $\vec{E}$ and $\vec{B}$, both are present and perpendicular to each other and the particle is moving perpendicular to both of them.

5. **Statement-1:** Magnetic monopoles do not exist.

Statement-2: $\oint \vec{B} \cdot d\vec{A} = 0$

Symbols have their usual meanings.

6. **Statement-1:** Magnitude of $\vec{B}$ is constant along a magnetic field line.

Statement-2: $\vec{B}$ is tangent to a magnetic field line.

7. **Statement-1:** A rectangular current loop is in an arbitrary orientation in an external uniform magnetic field. No work is required to rotate the loop about an axis perpendicular to its plane.
Statement-2: All positions represent the same level of energy.

8. **Statement-1:** For a charged particle describing uniform circular motion in a magnetic field $T^2 \propto r^3$ (symbols have their usual meanings).

Statement-2: The relation $T^2 \propto r^3$ is valid only when $F \propto \frac{1}{r^2}$.

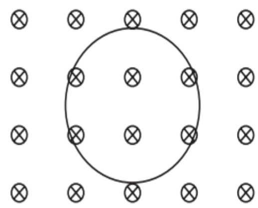
9. **Statement-1:** A loosely bound helix made of stiff wire is suspended vertically with the lower end just touching a dish of mercury. When a current is passed though the wire, the wire executes oscillatory motion with the lower end jumping out of and into the mercury.
Statement-2: When electric current is passed through helix, a magnetic field is produced both inside and outside the helix.

10. **Statement-1:** Two parallel wires carrying current in same direction, attract each other while two similar charges moving parallel to each other repel each other.
Statement-2: Electric force is stronger than magnetic force.

11. **Statement-1:** Magnetic field at a point on the surface of long cylindrical wire is maximum.
Statement-2: For any other point, closed loop perpendicular to the wire and of radius equal to the distance between axis of wire and given point will enclose less current.

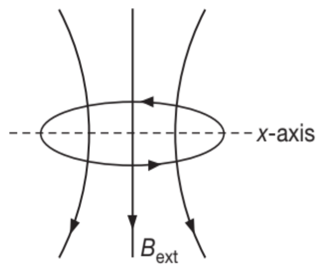
12. **Statement-1:** When radius of a circular loop carrying current is doubled its magnetic moment becomes four times.
Statement-2: Magnetic moment depends on area of the loop.

13. **Statement-1:** A charged particle is moving in a circular path under the action of a uniform magnetic field as shown in the figure. During motion kinetic energy of charged particle is constant.



Statement-2: During the motion magnetic force acting on the particle is perpendicular to instantaneous velocity.

14. **Statement-1:** A closed current carrying loop behave like a magnetic dipole.
Statement-2: Force and torque on the loop is zero as shown in figure.



15. **Statement-1:** A linear solenoid carrying current is equivalent to a bar magnet.
Statement-2: The magnetic field lines of both are same.

16. **Statement-1:** The Lorentz force $\vec{F} = q(\vec{v} \times \vec{B})$ is a non-conservative force.
Statement-2: The work done by the Lorentz force is always zero.

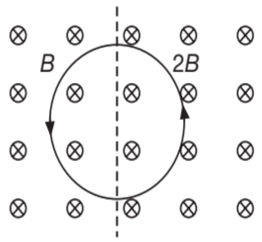
17. **Statement-1:** Any current carrying loop is considered as a magnetic dipole.
Statement-2: The net force on a current loop in a uniform magnetic field is zero.

18. **Statement-1:** If a proton and an α-particle enter a uniform magnetic field perpendicularly with the same speed, the time period of revolution of α-particle is double than that of proton.
Statement-2: In a magnetic field, the period of revolution of a charged particle is directly proportional to the mass of the particles and inversely proportional to charge of particle.

19. **Statement-1:** In electric circuits, wires carrying currents in opposite directions are often twisted together.
Statement-2: If the wires are not twisted together, the combination of wires forms a current loop. The magnetic field generated by the loop might affect adjacent circuits or components.

20. **Statement-1:** A charged particle moves perpendicular to magnetic field. Its kinetic energy will remain constant but momentum charges.
Statement-2: Force acts perpendicular to velocity of particle.

21. **Statement-1:** The magnetic field on the closed loop in figure is zero.
Statement-2: Force (magnetic) on the wire is $\int dF = \int I d\vec{l} \times \vec{B}$



22. **Statement-1:** The current constituted by electrons in a metallic wire creates only electric field while electron beam creates both, electric and magnetic fields.
Statement-2: The electron beam contains only electrons while metallic wire carries both positive and negative charges and also the wire is electrically neutral.

23. A semicircular ring is present in the uniform magnetic field. Magnetic field is perpendicular to loop of ring.
Statement-1: Force $\vec{F}$ on each element of ring is different.
Statement-2: Net force on ring must be perpendicular to magnetic field.

24. **Statement-1:** A current I flows along the length of an infinitely long straight and thick-walled pipe. Then the magnetic field at any point inside the pipe is zero.
Statement-2: $\oint \vec{B} \cdot d\vec{l} = \mu_0 I$

25. **Statement-1:** Magnitude of force acting on a current carrying loop placed in uniform magnetic field will be equal to zero whether magnetic field is in the plane or perpendicular to the plane of loop.
Statement-2: Magnitude of force does not depend upon the direction of magnetic field.

26. **Statement-1:** The poles of magnet cannot be separated by breaking into two pieces.
Statement-2: The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.

27. **Statement-1:** The magnetic field at the ends of a very long current carrying solenoid is half of that at the centre.
Statement-2: If the solenoid is sufficiently long, the field with in it is uniform.

28. **Statement-1:** A magnetic field independent of time can change the velocity of a charged particle.
Statement-2: It is not possible to change the velocity of a particle in a magnetic field as magnetic field does not work on charged particle.

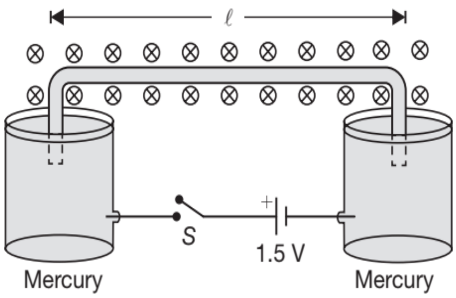
29. **Statement-1:** The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.
Statement-2: Soft iron has a high magnetic permeability and cannot be easily magnetized or demagnetized.

LINKED COMPREHENSION TYPE QUESTIONS

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct (For the sake of competitiveness there may be a few questions that may have more than one correct options).

Comprehension I

An insulated wire with mass $m = 5.4 \times 10^{-5}$ kg is bent into the shape of an inverted U such that the horizontal part has a length $l = 15$ cm. The bent ends of the wire are partially immersed in two pools of mercury, with 2.5 cm of each end below the mercury's surface. The entire structure is in a region containing a uniform 0.0065 T magnetic field directed into the page. An electrical connection from the mercury pools is made through the ends of the wires. The mercury pools are connected to a 1.5 V battery and a switch S. When switch S is closed, the wire jumps 35 cm into the air, measured from its initial position. Based on the facts provided, answer the following questions.



1. The speed v of the wire as it leaves the mercury is
   (A) $5.2\ ms^{-1}$ (B) $2.5\ ms^{-1}$
   (C) $70\ cms^{-1}$ (D) $7\ cms^{-1}$

2. Assuming that the current I through the wire was constant from the time the switch was closed until the wire left the mercury, then I equals.
   (A) 7.6 A (B) 6.5 A
   (C) 6.7 A (D) 5.6 A

3. Ignoring the resistance of the mercury and the circuit wires, the resistance of the moving wire is
   (A) $0.4\ \Omega$ (B) $0.3\ \Omega$
   (C) $0.2\ \Omega$ (D) $0.1\ \Omega$

Comprehension 2

Consider a particle, having charge of magnitude q, mass 4×10^{-15} kg, to be moving in a region containing a uniform magnetic field $\vec{B}=-(0.4\hat{k})$ tesla. At any instant, velocity of the particle is $\vec{v}=(8\hat{i}-6\hat{j}+4\hat{k})\times10^{6}\ ms^{-1}$ and force acting on it has a magnitude 1.6 N. Based on the information given answer the following questions.

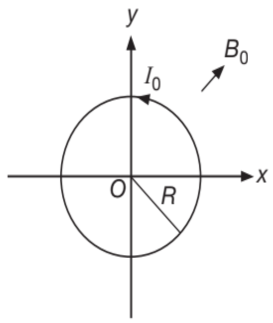
4. Magnitude of charge on the particle, q is
   (A) $0.7\ \mu C$ (B) $0.5\ \mu C$
   (C) $0.4\ \mu C$ (D) $0.25\ \mu C$

5. Motion of charged particle will be along helical path with
   (A) a translational component along x-direction and a circular component in the y-z plane
   (B) a translational component along y-direction and a circular component in the x-z plane.
   (C) a translational component along z-axis and a circular component in the x-y plane.
   (D) direction of translational component and plane of circular component will be uncertain.

6. If the coordinate of the particle at $t=0$ are $(2\text{ m}, 1\text{ m}, 0)$, then the coordinates at a time $t=3\text{ T}$ (where T is the time period of circular component of motion) will be
   (A) $(2, 1, 400)$ m (B) $(0.142, 130, 0)$ m
   (C) $(2, 1, 1.884)$ m (D) $(142, 130, 628)$ m

Comprehension 3

A uniform constant magnetic field $\vec{B}_0$ is directed at an angle of 45° to the x-axis in xy plane. A circular ring of mass M, radius R is carrying a steady current I_0, with its centre at the origin O. At time $t=0$, the ring is at rest in the position shown in the figure with the plane of the ring in xy plane. Based on the facts provided, answer the following questions.

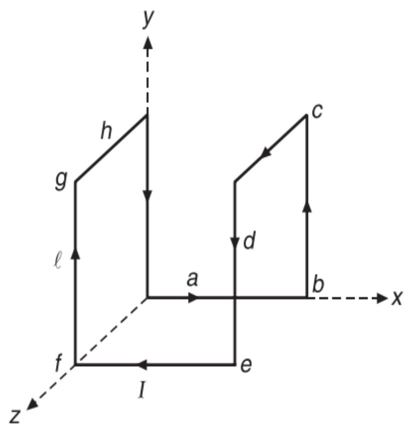


7. Torque $|\vec{\tau}|$ about O acting on the ring is
   (A) $I_0\pi R^2B_0$ (B) $\dfrac{I_0\pi R^2B_0}{2}$
   (C) $\dfrac{I_0\pi R^2B_0}{\sqrt{2}}$ (D) $\sqrt{2}I_0\pi R^2B_0$

8. The angle by which the ring rotates in a very short interval of time Δt is
   (A) $\dfrac{\pi I_0B_0}{2M}(\Delta t)^2$ (B) $\dfrac{\pi I_0B_0}{\sqrt{2}M}(\Delta t)^2$
   (C) $\dfrac{2\pi I_0B_0}{M}(\Delta t)^2$ (D) $\dfrac{\pi I_0B_0}{M}(\Delta t)^2$

Comprehension 4

A current I flows through a loop $abcdefgha$ along the edge of a cube of length l as shown in Figure.



One corner a of the loop lies at origin. Based on the facts provided, answer the following questions.

9. The current path $abcdefgha$ can be treated as a superposition of three-square loops carrying current I. Select the correct option.

(A) $fghaf$, $fabef$, $ebcde$ (B) $fghaf$, $fabef$, $fgdef$

(C) $fghaf$, $abcha$, $ebcde$ (D) $fgdef$, $fabef$, $ebcde$

10. The unit vector in the direction of magnetic field at the centre of cube $abcdefgh$ is

(A) $\hat{i}$ (B) $-\hat{j}$

(C) $\frac{2\hat{i}-\hat{j}}{\sqrt{5}}$ (D) $\hat{k}$

11. Now if a uniform external magnetic field $\vec{B} = B_0\hat{j}$ is switched on, then the torque due to external magnetic field $(\vec{B})$ acting on the current carrying loop $(abcdefgha)$ is

(A) $(Il^2B_0)\hat{k}$ (B) $-(Il^2B_0)\hat{i}$

(C) $-(Il^2B_0)\hat{k}$ (D) $\vec{0}$

Comprehension 5

A very large parallel-plate capacitor caries charge with uniform charge per unit area $+\sigma$ on the upper plate and $-\sigma$ on the lower plate. The plates are horizontal and both move horizontally with speed v to the right. Based on the information given answer the following questions.

12. The magnetic field between the plates is

(A) $\mu_0\sigma v$ (B) $2\mu_0\sigma v$

(C) $\frac{\mu_0\sigma v}{2}$ (D) ZERO

13. The magnetic field close to the plates but outside of the capacitor is

(A) $\mu_0\sigma v$ (B) $2\mu_0\sigma v$

(C) $\frac{\mu_0\sigma v}{2}$ (D) ZERO

14. The magnetic force per unit area acting on the upper plate is

(A) $\mu_0\sigma v^2$ (B) $\mu_0\sigma^2 v^2$

(C) $\frac{1}{2}\mu_0\sigma v^2$ (D) $\frac{1}{2}\mu_0\sigma^2 v^2$

15. The electric force per unit area acting on the upper plate is

(A) $\frac{\sigma^2}{\varepsilon_0}$ (B) $\frac{\sigma^2}{2\varepsilon_0}$

(C) $\frac{\sigma}{\varepsilon_0}$ (D) $\frac{\sigma^2}{3\varepsilon_0}$

16. At some hypothetical speed v (say), the magnetic force on a plate balances the electric force on the plate. Then v equals

(A) $\frac{c}{3}$ (B) $\frac{c}{2}$

(C) c (D) $\frac{c}{4}$

Comprehension 6

A particle having charge $q = 10\ \mu C$ moves in uniform magnetic field with velocity $v_1 = 10^6\ ms^{-1}$ at angle 45° with x-axis in the x-y plane and experiences a force $F_1 = 5\sqrt{2}$ mN along the negative z-axis. When the same particle moves with velocity $v_2 = 10^6\ ms^{-1}$ along the z-axis it experiences a force F_2 in y direction. Based on the information given, answer the following questions.

17. The magnetic field $\vec{B}$ (in tesla) is

(A) $(10^{-3})(\hat{i}+\hat{j})$ (B) $(2\times10^{-3})\hat{i}$

(C) $(10^{-3})\hat{i}$ (D) $(2\times10^{-3})(\hat{i}+\hat{j})$

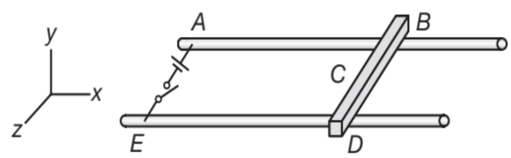
18. The magnitude of the force F_2 (in newton) is

(A) 10^{-2} (B) 10^{-3}

(C) 10^{-4} (D) 10^{-5}

Comprehension 7

Rail guns have been suggested for launching projectiles into space without chemical rockets, and for ground-to-air antimissile weapons of war. A tabletop model rail gun consists of two long parallel horizontal rails 2.5 cm apart, bridged by a bar BD of mass 5 g. The bar is originally at rest at the midpoint of the rails and is free to slide without friction. When the switch is closed, electric current is quickly established in the circuit $ABCDEA$. The rails and bar have low electric resistance, and the current is limited to a constant 25 A by the power supply. Based on the facts provided, answer the following questions.



19. The magnitude of the magnetic field, 1.25 cm from a single very long straight wire carrying current 24 A is
(A) 100 μT (B) 200 μT
(C) 300 μT (D) 400 μT

20. The magnitude of the magnetic field at point C in the diagram, the midpoint of the bar, immediately after the switch is closed.
(A) 400 μT, along $-y$ axis
(B) 300 μT, along $-x$ axis
(C) 200 μT, along x axis
(D) 400 μT, along $+y$ axis

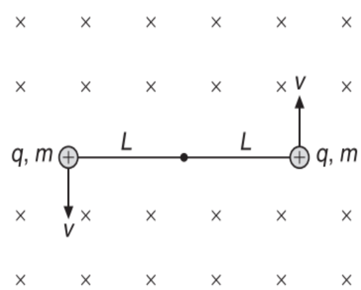
21. At other points along the bar BD, the field is in the same direction as at point C, but larger in magnitude. Assume that the average effective magnetic field along BD is five times larger than the field at C. With this assumption, the magnitude and direction of the force on the bar is
(A) 1.25×10^{-4} N, along $-x$ axis
(B) 1.25×10^{-3} N, along $+x$ axis
(C) 1.25×10^{-6} N, along $+y$ axis
(D) 1.25×10^{-5} N, along $-y$ axis

22. The acceleration of the bar when it is in motion is
(A) 0.25 cms^{-2} (B) 0.125 cms^{-2}
(C) 25 cms^{-2} (D) 12.5 cms^{-2}

23. The velocity of the bar after it has travelled 120 cm to the end of the rails is
(A) 30 cms^{-1} (B) 40 cms^{-1}
(C) 50 cms^{-1} (D) 60 cms^{-1}

Comprehension 8

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 $v=\dfrac{q\alpha L}{m}$ (where α 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, answer the following questions.

24. The magnitude of the magnetic field, such that no tension is developed in the string is
(A) $\dfrac{\alpha}{2}$ (B) α
(C) 2α (D) 0

25. If the actual magnitude of magnetic field is half the value calculate above, then tension in the string will be
(A) $\dfrac{3}{4}\dfrac{q^2\alpha^2L}{m}$ (B) ZERO
(C) $\dfrac{q^2\alpha^2L}{2m}$ (D) $\dfrac{2q^2\alpha^2L}{m}$

26. If the string breaks when the tension is $T=\dfrac{3}{4}\dfrac{q^2\alpha^2L}{m}$ and the magnetic field is reduced to a value such that the string just breaks, then the maximum separation between the two particles during their motion is
(A) $16L$ (B) $4L$
(C) $14L$ (D) $2L$

Comprehension 9

A current carrying ring with its centre at origin and moment of inertia 2×10^{-2} kgm^2 about an axis passing through its centre and perpendicular to its plane has magnetic moment $\vec{M}=(3\hat{i}-4\hat{j})$ Am^2. At time $t=0$ a magnetic field $\vec{B}=(4\hat{i}+3\hat{j})$ T is switched on. Based on the facts provided, answer the following questions.

27. The initial angular acceleration of the ring, in rads^{-2} is
(A) ZERO (B) 1250
(C) 2500 (D) 5000

28. The maximum angular velocity of the ring in rads^{-1} is
(A) $25\sqrt{2}$ (B) $50\sqrt{2}$
(C) $100\sqrt{2}$ (D) $200\sqrt{2}$

Comprehension 10

The cyclotron is a device which is used to accelerate charged particles such as protons, deuterons, alpha particles, etc. to very high energy. The principle on which a cyclotron works is based on the fact that an electric field can accelerate a charged particle and a magnetic field can throw it into a circular orbit. A particle of charge $+q$ experiences a force qE in an electric field E and this force is independent of velocity of particle. The particle is accelerated in the direction of the magnetic field. On the other hand, a magnetic field at right angles to the direction of motion of the particle throws the particle in a circular orbit in which the particle revolves with a frequency that does not depend on its speed. A modest potential difference is used as a source of electric field. If a charged particle is made to pass through this potential difference a number of times, it will acquire an enormous by large velocity and hence kinetic energy.

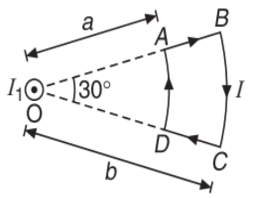
29. Which of the following cannot be accelerated in a cyclotron?
(A) Protons (B) Deuterons
(C) Alpha particles (D) Neutrons

30. The working of a cyclotron is based on the fact that
(A) The force experienced by a charged particle in an electric field is independent of its velocity.
(B) The radius of the circular orbit of a charged particle in a magnetic field increase with increase in its speed.
(C) At a given speed, the radius of the circular orbit is the same for particles having same charge to mass ratio.
(D) The frequency of revolution of the particle along the circular path does not depend on its speed.

31. Cyclotron is not suitable for accelerating
(A) Electrons (B) Protons
(C) Deuterons (D) Alpha particles

Comprehension 11

A current loop $ABCD$ is held fixed on the plane of the paper as shown in Figure. The arcs BC $(\text{radius} = b)$ and DA $(\text{radius} = a)$ of the loop are joined by two straight wires AB and CD. A steady current I is flowing in the loop. Angle made by AB and CD at the origin O is $30°$. Another straight thin wire with steady current I_1 flowing out of the plane of the paper is kept at the origin. Based on the information given answer the following questions.



32. The magnitude of the magnetic field (B) due to the loop $ABCD$ at the origin (O) is
(A) zero
(B) $\dfrac{\mu_0 I(b-a)}{24ab}$
(C) $\dfrac{\mu_0 I}{4\pi}\left[\dfrac{b-a}{ab}\right]$
(D) $\dfrac{\mu_0 I}{4\pi}\left[2(b-a)+\dfrac{\pi}{3}(a+b)\right]$

33. Due to the presence of the current I_1 at the origin
(A) The forces on AB and DC are zero
(B) The forces on AD and BC are zero
(C) The magnitude of the net force on the loop is given by $\dfrac{I_1 I}{4\pi}\mu_0\left[2(b-a)+\dfrac{\pi}{3}(a+b)\right]$
(D) The magnitude of the net force on the loop is given by $\dfrac{\mu_0 I I_1}{24ab}(b-a)$

34. Force on wire AB is
(A) zero (B) $\dfrac{\mu_0 I I_1}{2\pi}\log_e\left(\dfrac{b}{a}\right)$
(C) $\dfrac{\mu_0 I I_1}{2\pi}\log_e\left(\dfrac{b+a}{a}\right)$ (D) $\dfrac{\mu_0 I I_1}{\pi}\log_e\left(\dfrac{b}{a}\right)$

Comprehension 12

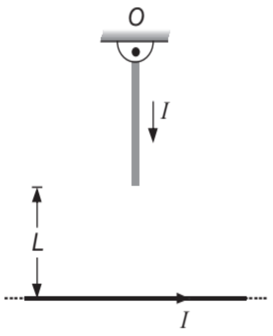
Consider a particle having specific charge α released from the origin with velocity $\vec{v} = v_0\hat{i}$ in a region of uniform electric and magnetic field both parallel to y-axis given by $\vec{E} = E_0\hat{j}$ and $\vec{B} = B_0\hat{j}$. Based on the facts provided, answer the following questions.

35. The path followed by the particle is
(A) a circle
(B) a straight line
(C) a helix with non-uniform pitch
(D) a helix with uniform pitch

36. The y-coordinate of particle when it crosses the y-axis for the nth time is
(A) $\dfrac{n^2 E_0}{B_0^2\alpha}$ (B) $\dfrac{2n^2\pi^2 E_0}{B_0^2\alpha}$
(C) $\dfrac{B_0^2\alpha}{n^2 E_0}$ (D) $\dfrac{B_0^2\alpha}{2n^2\pi^2 E_0}$

Comprehension 13

A wire of length L, mass m and carrying a current I is suspended from point O as shown. An another infinitely long wire carrying the same current I is at a distance L below the lower end of the wire. Given $I = 2\text{ A}$, $L = 1\text{ m}$ and $m = 0.1\text{ kg}$ $(\log_e 2 = 0.7)$



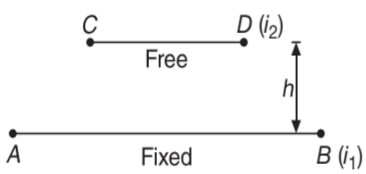
37. The angular acceleration of the wire just after it is released from the position shown is
(A) 6.4×10^{-5} rads^{-2} (B) 3.2×10^{-4} rads^{-2}
(C) 1.6×10^{-6} rads^{-2} (D) 9.6×10^{-6} rads^{-2}

38. It is desired to keep the suspended wire stationary by placing a third infinitely long wire carrying an upward current. Then this wire should be placed
(A) to the right of suspended wire
(B) to the left of suspended wire
(C) we can keep it either to the right or to the left. It will depend on the magnitude of the current in the third wire
(D) we can't keep suspended wire stationary be placing a third wire to the right or to the left of it

39. The distance r, from the suspended wire where the new wire (having the same current) should be placed to keep it stationary is
(A) 2.5 m (B) 2 m
(C) 1.25 m (D) 3 m

Comprehension 14

The force per unit length between two parallel current carrying wires $=\dfrac{\mu_0 i_1 i_2}{2\pi r}$. The force is attractive when the current is in same direction and repulsive, when they are in opposite directions. The force between the wires depends on the distance between them. An arrangement of two parallel wires is shown. We can determine the equilibrium position. Then we displace upper wire by a small distance, keeping lower wire fixed. If the wire returns to or tries to return to its equilibrium position, its equilibrium is stable. We can thus show that upper wire can execute linear simple harmonic motion or not. The length of wire AB is large as compared to separation between the wires.



40. If wire CD is in equilibrium position then which of the following may represent the directions of current in the wires
(A) $A\to B$ in AB and $C\to D$ in CD
(B) $A\to B$ in AB and $D\to C$ in CD
(C) $B\to A$ in AB and $D\to C$ in CD
(D) None of these

41. If λ is mass per unit length of wire CD, then the equilibrium separation h is given by
(A) $h=\dfrac{\mu_0 i_1 i_2}{2\pi\lambda g}$ (B) $h=\dfrac{2\mu_0 i_1 i_2}{2\pi\lambda g}$
(C) $h=\dfrac{2\pi\lambda g}{\mu_0 i_1 i_2}$ (D) $h=\dfrac{4\pi\lambda g}{\mu_0 i_1 i_2}$

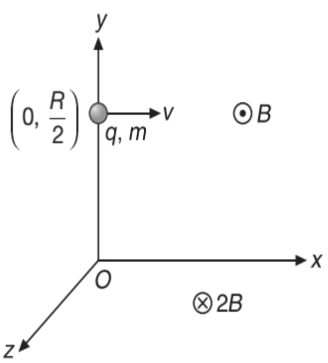
42. If wire CD is displaced upward to increase the separation by dh, the magnitude of net force per unit length acting on the wire CD becomes
(A) $\dfrac{\mu_0 i_1 i_2}{2\pi(h+dh)}$ (B) $\dfrac{\mu_0 i_1 i_2}{2\pi h^2}$
(C) $\dfrac{\mu_0 i_1 i_2 dh}{2\pi}$ (D) $\dfrac{\lambda g dh}{h}$

Comprehension 15

Magnetic field in a region is given by

$$\vec{B}=\begin{cases} B\hat{k}, \text{ for } x>0,\ y>0 \\ -(2B)\hat{k}, \text{ for } x>0,\ y<0 \\ \text{zero, for all other cases} \end{cases}$$

A particle of charge q, mass m, moving with a speed v parallel to x-axis enters in the region at $\left(0, \dfrac{R}{2}\right)$, where $R=\dfrac{mv}{qB}$ as shown in Figure.



Based on the information given, answer the following questions.

43. Time taken by the particle to hit the x-axis first time is

(A) $\frac{\pi m}{qB}$ (B) $\frac{\pi m}{3qB}$

(C) $\frac{\pi m}{2qB}$ (D) $\frac{4\pi m}{3qB}$

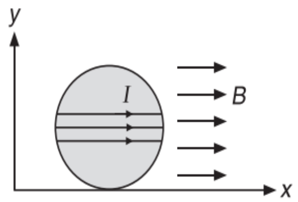
44. Time taken by the particle when its velocity becomes parallel to x-axis first time after entering the magnetic field is

(A) $\frac{\pi m}{qB}$ (B) $\frac{\pi m}{3qB}$

(C) $\frac{\pi m}{2qB}$ (D) $\frac{4\pi m}{3qB}$

Comprehension 16

A person wants to roll a solid non-conducting spherical ball of mass m and radius r on a surface whose coefficient of static friction is μ. He placed the ball on the surface wrapped with n turns of closely packed conducting coils of negligible mass at the diameter. By some arrangement he makes a current I to pass through the coils either in the clockwise direction or in the anti-clockwise direction. A constant horizontal magnetic field $\vec{B}$ is present throughout the space as shown in the figure. Assume μ is sufficient enough to ensure pure rolling motion. Based on the facts provided, answer the following questions.



45. The maximum torque in the coil is

(A) $-(\pi n I r^2 B)\hat{k}$ (B) $(\pi n I r^2 B)\hat{j}$

(C) $-(\pi n I r^2 B)\hat{j}$ (D) $(\pi n I r^2 B)\hat{k}$

46. Angular acceleration of the ball after it has rotated through an angle $\theta(\theta < 180°)$, is

(A) $\frac{5}{7}\left(\frac{\pi n I B}{m}\right)\cos\theta$ (B) $\frac{2}{5}\left(\frac{\pi n I B}{m}\right)\cos\theta$

(C) $\frac{7}{5}\left(\frac{\pi n I B}{m}\right)\cos\theta$ (D) $\frac{5}{2}\left(\frac{\pi n I B}{m}\right)\cos\theta$

47. The angular velocity of the ball when it has rotated through an angle θ is $(\theta < 180°)$, is

(A) $\sqrt{\frac{10}{7}\left(\frac{\pi n I B}{m}\right)\sin\theta}$ (B) $\sqrt{\frac{5}{14}\left(\frac{\pi n I B}{m}\right)\sin\theta}$

(C) $\sqrt{\frac{5}{14}\left(\frac{\pi n I B}{m}\right)\cos\theta}$ (D) $\sqrt{\frac{5}{7}\left(\frac{\pi n I B}{m}\right)\sin\theta}$

48. The minimum value of μ for which the rolling motion is possible, is

(A) $\left(\frac{14\pi}{5g}\right)\left(\frac{nIB}{m}\right)r$ (B) $\left(\frac{5\pi}{7g}\right)\left(\frac{nIB}{m}\right)r$

(C) ZERO (D) $\left(\frac{7\pi}{5g}\right)\left(\frac{nIB}{m}\right)r$

49. If the surface is frictionless, then the sphere will

(A) only translate
(B) only rotate
(C) undergo pure rolling
(D) undergo rolling with sliding

Comprehension 17

A uniform and constant magnetic field $\vec{B} = (6\hat{i} - 8\hat{j} + 24\hat{k})$ T exists in space. A particle with charge to mass ratio $\frac{1}{13} \times 10^3$ Ckg^{-1} enters this region at time $t = 0$ with a velocity $\vec{v} = (6\hat{i} + 24\hat{j} + 8\hat{k})$ ms^{-1}. Assuming that the charged particle always remains in space having the given magnetic field, answer the following questions.

50. During the further motion of the particle in the magnetic field, the angle between the magnetic field and velocity of the particle

(A) remains constant
(B) increases
(C) decreases
(D) may increase or decrease

51. The frequency of the revolution of the particle is

(A) 636 Hz (B) 318 Hz

(C) 159 Hz (D) 1272 Hz

52. The pitch of the helical path followed by the particle is approximately

(A) $\frac{1}{100}$ m (B) $\frac{1}{120}$ m

(C) $\frac{1}{260}$ m (D) $\frac{1}{130}$ m

Comprehension 18

Each of two long parallel wires carries a current I along the same direction. The wires are placed at $(-L, 0)$ and $(L, 0)$. Both wires carry current along $+z$ direction. Based on the information given answer the following questions.

53. The magnetic field midway between the wires at the point $(0, y, 0)$ is given by

(A) $\frac{\mu_0 I}{2\pi}\left(\frac{y}{\sqrt{L^2+y^2}}\right)$ (B) $\frac{\mu_0 I}{\pi}\left(\frac{y}{L^2+y^2}\right)$

(C) $\frac{2\mu_0 I}{\pi}\left(\frac{y}{\sqrt{L^2+y^2}}\right)$ (D) $\frac{\mu_0 I}{4\pi}\left(\frac{y}{\sqrt{L^2+y^2}}\right)$

54. The value of y for which magnitude of magnetic induction in the symmetry plane of the system located midway between the wires is maximum is

(A) $\frac{L}{2}$ (B) $\frac{L}{3}$

(C) $\frac{L}{4}$ (D) L

55. The maximum magnitude of magnetic field in the symmetry plane of the system located between the wires is

(A) $\frac{\mu_0 I}{\pi L}$ (B) $\frac{\mu_0 I}{2\pi L}$

(C) $\frac{\mu_0 I}{4\pi L}$ (D) $\frac{2\mu_0 I}{\pi L}$

Comprehension 19

A particle having unit mass and charge (in SI system) is released from rest from the origin of the coordinate system. There are electric and magnetic fields given by

$$\vec{E}=(10\hat{i})\ NC^{-1} \text{ for } 0\le x\le 1.8m \text{ and}$$

$$\vec{B}=(-5\hat{k})T \text{ for } 1.8m\le x\le 2.4m$$

A screen is placed parallel to yz plane at $x=3$ m. Neglecting forces due to gravity answer the following questions.

56. The speed with which the particle will collide the screen in ms^{-1} is

(A) 12 (B) 9

(C) 6 (D) 3

57. The particle collides the screen at $P(x, y)$, where x and y are in metre. Then

(A) $x=3$, $y=1.9$ (B) $x=3$, $y=0.5$

(C) $x=3$, $y=0$ (D) $x=2.4$, $y=1.5$

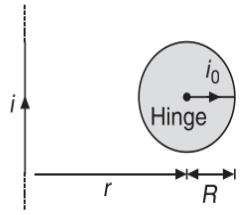
58. The time after which the particle will collide the screen is

(A) $\frac{1}{5}\left(3+\frac{\pi}{6}+\frac{1}{\sqrt{3}}\right)$ s (B) $\frac{1}{5}\left(6+\frac{\pi}{3}+\sqrt{3}\right)$ s

(C) $\frac{1}{5}\left(5+\frac{\pi}{6}+\frac{1}{\sqrt{3}}\right)$ s (D) $\frac{1}{5}\left(6+\frac{\pi}{18}+\sqrt{3}\right)$ s

Comprehension 20

A long straight conductor carrying current i and a wooden disc of mass m, radius R is placed near each other such that conductor lies in the plane of the disc as shown in Figure.



The distance between the wire and centre of disc is $r(>R)$. A wire of length R and carrying current i_0 is pasted on the disc such that the wire is initially perpendicular to the long straight conductor. The disc is hinged at the centre. Neglecting mass of conducting wire, answer the following questions.

59. Angular acceleration of the disc at that instant is

(A) $\frac{\mu_0 i i_0}{\pi m r^2}\left[R-r\log_e\left(\frac{r}{R+r}\right)\right]$

(B) $\frac{\mu_0 i i_0}{\pi m R^2}\left[R-r\log_e\left(1+\frac{R}{r}\right)\right]$

(C) $\frac{\mu_0 i i_0}{\pi m r^2}\left[R-r\log_e\left(1+\frac{R}{r}\right)\right]$

(D) $\frac{\mu_0 i i_0}{\pi m R^2}\left[R-r\log_e\left(1+\frac{R^2}{r^2}\right)\right]$

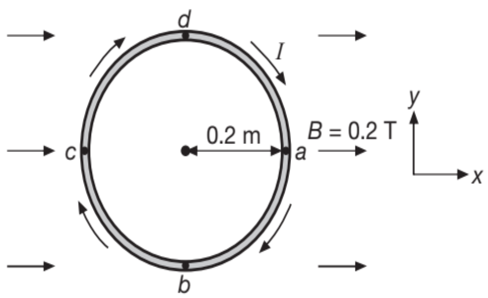
60. Reaction at the hinge at that instant is

(A) $\frac{\mu_0 i i_0}{2\pi}\log_e\left(1+\frac{r}{R}\right)$ (B) $\frac{\mu_0 i i_0}{2\pi}\log_e\left(1+\frac{R^2}{r^2}\right)$

(C) $\frac{\mu_0 i i_0}{4\pi}\log_e\left(1+\frac{r}{R}\right)$ (D) $\frac{\mu_0 i i_0}{2\pi}\log_e\left(1+\frac{R}{r}\right)$

Comprehension 21

A rigid circular loop has a radius of 0.2 m and is in the x-y plane. A clockwise current I is carried by the loop, as shown. The magnitude of the magnetic moment of the loop is $0.75\ Am^2$. A uniform external magnetic field, $B=0.2$ T in the positive x-directions is present



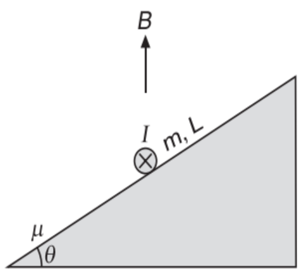
61. In figure, the magnitude of the magnetic torque exerted on the loop is closest to
(A) 0.55 Nm (B) 0.15 Nm
(C) 0.45 Nm (D) 0.35 Nm

62. In figure the loop is released from rest. The initial motion of the loop is described by
(A) point a move out of the plane, point c moves into the plane
(B) points a, b, c and d move counter clockwise
(C) points a, b, c and d move clockwise
(D) point c moves out of the plane, point a move into the plane.

63. In figure, an external torque changes the orientation of loop from one of lowest potential energy to one of highest potential energy. The work done by the external torque is closest to
(A) 0.5 J (B) 0.2 J
(C) 0.3 J (D) 0.4 J

Comprehension 22

On an inclined plane, a conducting rod of mass m, length L is placed so that it is horizontal. A vertically upward uniform magnetic field B is present in the region as shown in Figure.



A current I flows through the rod. The coefficient of friction between the rod and the incline is μ. Assuming that $\mu > \tan\theta$, answer the following questions

64. The minimum value of B for which the rod stays in equilibrium is
(A) $\frac{mg}{IL}\left(\frac{\sin\theta-\mu\cos\theta}{\sin\theta+\mu\cos\theta}\right)$ (B) $\frac{mg}{IL}\left(\frac{\sin\theta-\mu\cos\theta}{\cos\theta+\mu\sin\theta}\right)$
(C) $\frac{mg}{IL}\left(\frac{\sin\theta+\mu\cos\theta}{\cos\theta-\mu\sin\theta}\right)$ (D) $\frac{mg}{IL}\left(\frac{\cos\theta+\mu\sin\theta}{\cos\theta-\mu\sin\theta}\right)$

65. The maximum value of B for which the rod stays in equilibrium is
(A) $\frac{mg}{IL}\left(\frac{\cos\theta-\mu\sin\theta}{\sin\theta+\mu\cos\theta}\right)$ (B) $\frac{mg}{IL}\left(\frac{\sin\theta-\mu\cos\theta}{\cos\theta+\mu\sin\theta}\right)$
(C) $\frac{mg}{IL}\left(\frac{\sin\theta+\mu\cos\theta}{\cos\theta-\mu\sin\theta}\right)$ (D) $\frac{mg}{IL}\left(\frac{\cos\theta+\mu\sin\theta}{\cos\theta-\mu\sin\theta}\right)$

Comprehension 23

A particle of mass m, charge q is released from the origin O with velocity $\vec{v}=v_0\hat{i}$ in a uniform magnetic field $\vec{B}=\frac{B_0}{2}\hat{i}+\frac{\sqrt{3}B_0}{2}\hat{j}$. Assuming that the field extends all over the space, answer the following questions.

66. The path followed by the particle is a/an
(A) circle (B) helix
(C) ellipse (D) cycloid

67. Pitch of the helical path described by the particle is
(A) $\frac{2\pi mv_0}{qB_0}$ (B) $\frac{\pi mv_0}{qB_0}$
(C) $\frac{2\sqrt{3}\pi mv_0}{qB_0}$ (D) $\frac{\sqrt{3}\pi mv_0}{2qB_0}$

68. z-component of velocity is $\frac{\sqrt{3}v_0}{2}$ after time $t=$ ......
(A) $\frac{\pi m}{4qB_0}$ (B) $\frac{\pi m}{2qB_0}$
(C) $\frac{\pi m}{qB_0}$ (D) $\frac{2\pi m}{qB_0}$

69. Maximum z-coordinate of the particle is
(A) $\frac{mv_0}{qB_0}$ (B) $\frac{2mv_0}{qB_0}$
(C) $\frac{\sqrt{3}mv_0}{qB_0}$ (D) $\frac{2\sqrt{3}mv_0}{qB_0}$

70. When z-co-ordinate has its maximum value
(A) $v_y=\frac{\sqrt{3}}{2}v_0$
(B) $v_x=-\frac{v_0}{2}$
(C) Both (A) and (B) are correct
(D) Both (A) and (B) are incorrect

Comprehension 24

In the region between the plane $z=0$ and $z=a$ $(a>0)$, the uniform electric and magnetic fields are given by $\vec{E}=E_0(\hat{j}-\hat{k})$, $\vec{B}=B_0\hat{i}$. The region defined by $a\le z\le b$ contains only magnetic field $\vec{B}=-B_0\hat{i}$. Beyond $z>b$ no field exits. A positive point charge q is projected from the origin with velocity $v_0\hat{k}$ such that the particle moves undeviated up to the plane $z=a$. Assuming the mass of the particle to be $\frac{2}{3}\left(\frac{qE_0a}{v_0^2}\right)$ and ignoring gravitational force everywhere, answer the following questions.

71. The value of E_0 is

(A) $\dfrac{B_0 v_0}{\sqrt{2}}$ (B) $B_0 v_0$

(C) $\sqrt{2} B_0 v_0$ (D) $\dfrac{B_0 v_0}{2}$

72. The minimum value of b such that the particle reverses its direction completely is

(A) $\dfrac{4E_0 a}{3v_0 B_0}$ (B) $a\left(1+\dfrac{4E_0}{3v_0 B_0}\right)$

(C) $\dfrac{2E_0 a}{2v_0 B_0}$ (D) $a\left(1+\dfrac{2E}{3v_0 B_0}\right)$

73. When the particle just reverses its direction, all the fields are switched off. Time taken by the particle to touch the plane $z=0$ from that instant is

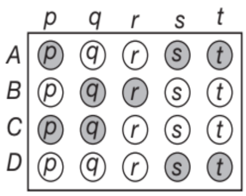
(A) $\dfrac{a}{v_0}$ (B) $\dfrac{a}{2v_0}$

(C) $\dfrac{a}{3v_0}$ (D) $\dfrac{a}{4v_0}$

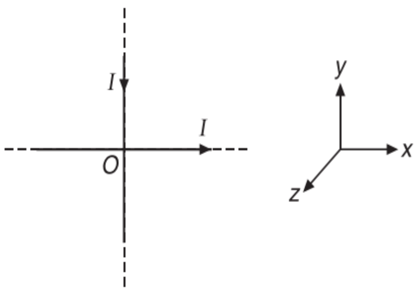
MATRIX MATCH/COLUMN MATCH TYPE QUESTIONS

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

If the correct matches are A → p, s and t; B → q and r; C → p and q; and D → s and t; then the correct darkening of bubbles will look like the following:



1. Equal currents are flowing in two infinitely long wires lying along x and y-axes in the directions shown in Figure. Match the following two columns.



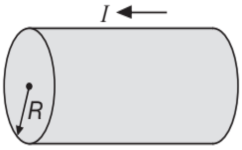
COLUMN-I	COLUMN-II
(A) Magnetic field at $(a,\ a)$	(p) along positive y-axis
(B) Magnetic field at $(-a,\ -a)$	(q) along positive z-axis
(C) Magnetic field at $(a,\ -a)$	(r) along negative z-axis
(D) Magnetic field at $(-a,\ a)$	(s) ZERO

(Continued)

2. Match the force/field in **COLUMN-I** to the best respective properties in **COLUMN-II**

COLUMN-I	COLUMN-II
(A) Electric field	(p) Stationary charge
(B) Magnetic field	(q) Moving charge
(C) Electric force	(r) Changes the kinetic energy
(D) Magnetic force	(s) Does not change kinetic energy

3. A long straight conductor of radius R carries a current I as shown. The current density j varies as a function of radius according to $j = br$ where b is a constant. Match the quantities in **COLUMN-I** with those in **COLUMN-II**

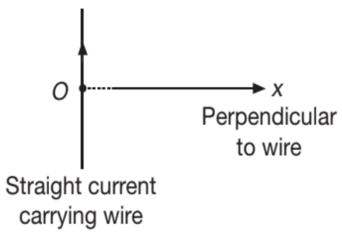
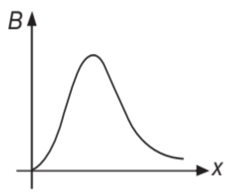
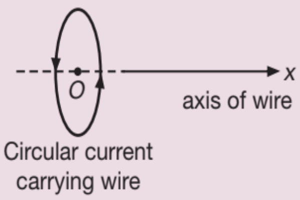
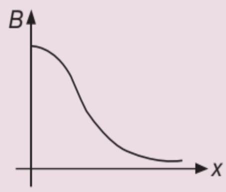


COLUMN-I	COLUMN-II
(A) B_{inside}	(p) Maximum
(B) B_{surface}	(q) $\dfrac{\mu_0 br^2}{3}$
(C) B_{outside}	(r) $\dfrac{2\pi br^3}{3}$
(D) I_{inside}	(s) $\dfrac{\mu_0 bR^3}{3r}$
	(t) Continuous

4. An electron is moving along positive x-direction. Match the following two columns for deflection of electron just after the electric field E_0 (in magnitude) and magnetic field B_0 (in magnitude) are switched on.

COLUMN-I	COLUMN-II
(A) When only magnetic field $\vec{B} = B_0\hat{j}$ is switched on	(p) Negative y-axis
(B) When only magnetic field $\vec{B} = B_0\hat{k}$ is switched on	(q) Positive y-axis
(C) When both magnetic field $\vec{B} = B_0\hat{i}$ and electric field $\vec{E} = E_0\hat{j}$ are switched on	(r) Negative z-axis
(D) When only electric field $\vec{E} = E_0\hat{k}$ is switched on	(s) Positive z-axis

5. The entries in **COLUMN-I** depict certain current distributions, while the entries in **COLUMN-II** depict the variation of the magnetic field (B) as one moves along the x-axis for each of these distributes, but in a different order. Match the entries in **COLUMN-I** with the proper entries in **COLUMN-II**

COLUMN-I	COLUMN-II
(A) 	(p) 
(B) 	(q) 

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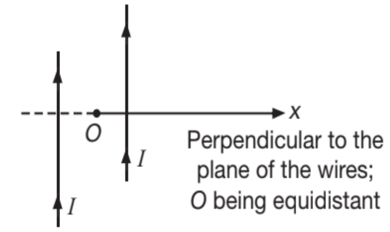
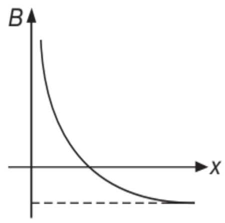
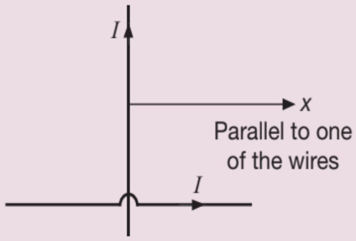
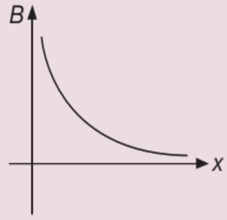
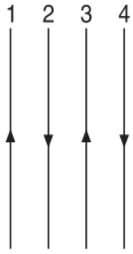
COLUMN-I	COLUMN-II
(C)  Parallel current carrying wires in the same plane	(r) 
(D)  Two perpendicular current carrying wires in the same plane	(s) 

6. Match the following

COLUMN-I	COLUMN-II
(A) Magnetic field inside a long straight solenoid is	(p) Not constant
(B) Magnetic field inside a toroidal solenoid is	(q) ZERO
(C) Magnetic field inside a conducting hollow pipe having current parallel to its axis	(r) Constant
(D) Magnetic field due to current carrying wire on its surface is	(s) Maximum

7. Equal currents are flowing in four infinitely long wires. Distance between two wires is same and directions of currents are shown in Figure. Match the forces in **COLUMN-I** to respective match in **COLUMN-II**.

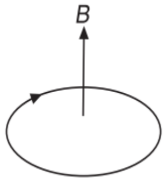
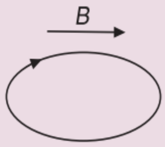
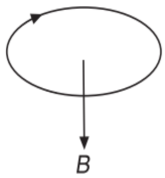
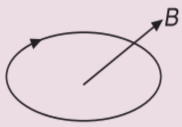


COLUMN-I	COLUMN-II
(A) Force on wire-1	(p) inwards
(B) Force on wire-2	(q) leftwards
(C) Force on wire-3	(r) rightwards
(D) Force on wire-4	(s) ZERO

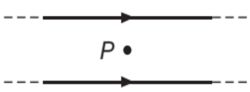
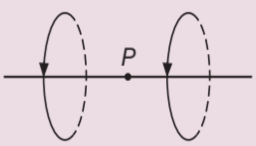
8. For a charged particle of charge q, mass m that enters a region of space the field options are given in **COLUMN-I**. Match those to the trajectories in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Electric field	(p) Straight line path
(B) Magnetic field	(q) Circular path
(C) In crossed field for $v = \frac{E}{B}$	(r) Helical path
(D) In mutually perpendicular electric and magnetic field, charge initially at rest	(s) Cycloidal path
	(t) Parabolic path

9. In **COLUMN-I**, a current carrying loop and a uniform external applied magnetic field are shown. Match the situations in **COLUMN-I** with conclusions in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) 	(p) Force = 0
(B) 	(q) Maximum torque
(C) 	(r) Minimum potential energy
(D) 	(s) Positive potential energy

10. Two wires each carrying a steady current I are shown in four configurations in **COLUMN-I**. Some of the resulting effects are described in **COLUMN-II**. Match the statements in **COLUMN-I** with the statements in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Point P is situated midway between the wires. 	(p) The magnetic field (B) at P due to the currents in the wires are in the same direction.
(B) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii. 	(q) The magnetic fields (B) at P due to the currents in the wires are in opposite directions.

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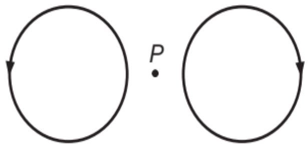
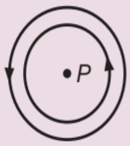
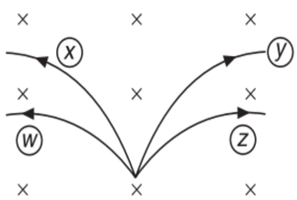
COLUMN-I	COLUMN-II
(C) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii. 	(r) There is no magnetic field at P.
(D) Point P is situated at the common center of the wires. 	(s) The wires repel each other.

11. Match the physical quantities in **COLUMN-II** with the respective SI units in **COLUMN-I**

COLUMN-I	COLUMN-II
(A) $NA^{-1}m^{-1}$	(p) Magnetic permeability (μ_0)
(B) Am^2	(q) Magnetic flux
(C) NmA^{-1}	(r) Magnetic potential energy
(D) NA^{-2}	(s) Magnetic flux density
	(t) Magnetic dipole moment

12. Four charged particles, $(-q, m)$, $(-3q, 4m)$, $(+q, m)$ and $(+2q, m)$ enter in uniform magnetic field directed inwards (away from the reader) with same kinetic energy as shown in Figure. Their paths are shown inside the magnetic field. Match the particles in **COLUMN-I** with their respective paths (w, x, y, z) in **COLUMN-II**

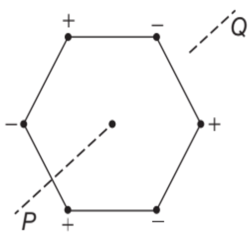
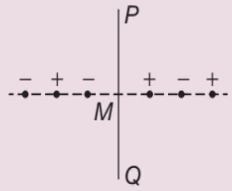
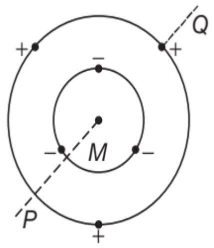
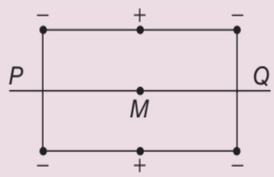
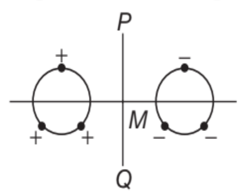


COLUMN-I	COLUMN-II
(A) Particle $(-q, m)$	(p) w
(B) Particle $(-3q, 4m)$	(q) x
(C) Particle $(+q, m)$	(r) y
(D) Particle $(+2q, m)$	(s) z

13. A current flow along the length of a long thin cylindrical shell of radius R. Match the fields in different regions given in **COLUMN-I** to their respective matches in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) $B(r < R)$	(p) $B \propto \frac{1}{r}$
(B) $B(r > R)$	(q) ZERO
(C) $B(r = R)$	(r) $B \propto r$
(D) $B(r = 0)$	(s) Maximum
	(t) Discontinuous

14. Six-point charges, each of the same magnitude q, are arranged in different manners as shown in **COLUMN-II**. In each case, a point M and a line PQ passing through M are shown. Let E be the electric field and V be the electric potential at M (potential at infinity is zero) due to the given charge distribution when it is at rest. Now, the whole system is set into rotation with a constant angular velocity about the line PQ. Let B be the magnetic field at M and μ be the magnetic moment of the system in this condition. Assume each rotating charge to be equivalent to a steady current.

COLUMN-I	COLUMN-II
(A) $E = 0$	(p) Charges are at the corners of a regular hexagon. M is at the centre of the hexagon. PQ is perpendicular to the plane of the hexagon. 
(B) $V \neq 0$	(q) Charges are on a line perpendicular to PQ at equal intervals. M is the midpoint between the two innermost charges. 
(C) $B = 0$	(r) Charges are placed on two coplanar insulating rings at equal intervals. M is the common centre of the rings. PQ is perpendicular to the plane of rings. 
(D) $\mu \neq 0$	(s) Charges are placed at the corners of a rectangle of sides a and $2a$ and at the mid points of the longer sides. M is at the centre of the rectangular. PQ is parallel to the longer sides. 
	(t) Charges are placed on two coplanar, identical insulating rings at equal intervals. M is the mid-point between the centres of the rings. PQ is perpendicular to the line joining the centres and coplanar to the rings. 

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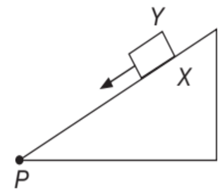
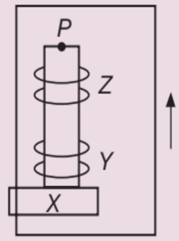
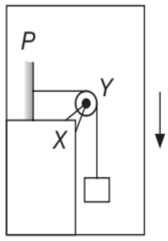
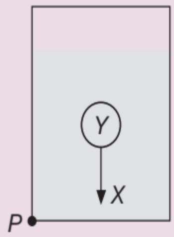
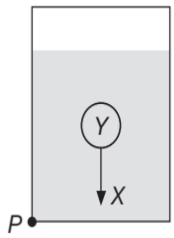
15. **COLUMN-II** shows five systems in which two objects are labelled as X and Y. Also, in each case a point P is shown. **COLUMN-I** gives some statements about X and/or Y. Match these statements to the appropriate system(s) from **COLUMN-II**.

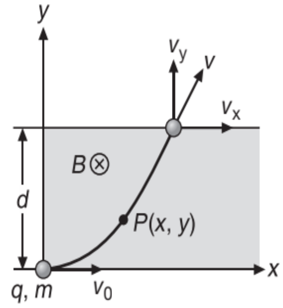
COLUMN-I	COLUMN-II
(A) The force exerted by X on Y has a magnitude Mg.	(p) Block Y of mass M left on a fixed inclined plane X, slides on it with a constant velocity. 
(B) The gravitational potential energy of X is continuously increasing.	(q) Two ring magnets Y and Z, each of mass M, are kept in frictionless vertical plastic stand so that they repel each other. Y rests on the base X and Z hangs in air in equilibrium. P is the topmost point of the stand on the common axis of the two rings. The whole system is in a lift that is going up with a constant velocity. 
(C) Mechanical energy of the system $X+Y$ is continuously decreasing.	(r) A pulley Y of mass m_0 is fixed to a table through a clamp X. A block of mass M hangs from a string that goes over the pulley and is fixed at point P of the table. The whole system is kept in a lift that is going down with a constant velocity. 
(D) The torque of the weight of Y about point P is zero.	(s) A sphere Y of mass M is put in a non-viscous liquid X kept in a container at rest. The sphere is released and it moves down in the liquid. 
	(t) A sphere Y of mass M is falling with its terminal velocity in a viscous liquid X kept in a container. 

INTEGER/NUMERICAL ANSWER TYPE QUESTIONS

In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

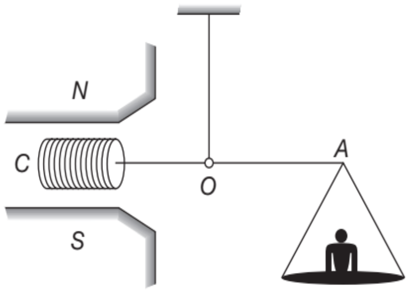
1. In a certain region surrounding the origin of the coordinates, $\vec{B} = 5\times10^{-4}$ T and $\vec{E} = 5\hat{k}$ Vm^{-1}. A proton enters the fields at the origin with an initial velocity $\vec{v}_0 = 2.5\times10^{5}\hat{i}$ ms^{-1}. Describe the proton's motion and give its position, in metre, after three complete revolution.

2. A non-uniform magnetic field $\vec{B} = B_0\left(1+\frac{y}{d}\right)\hat{k}$ is present in region of space in between $y=0$ and $y=d$. The lines are shown in Figure.



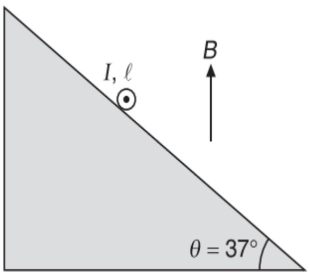
A particle of mass m and positive charge q enters the field with an initial velocity $v = v_0\hat{i}$. The x-component of velocity of the particle is $v_x = v_0 - \dfrac{kqB_0d}{m}$ when it leaves the field. Then find the value of k.

3. A small coil C with $N = 200$ turns is mounted on one end of a balance beam and introduced between the poles of an electromagnet as shown in Figure.



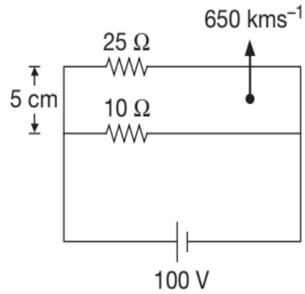
The cross-sectional area of the coil is $A = 1\text{ cm}^2$, the length of the arm OA of the balance beam is $l = 30$ cm. When there is no current in the coil the balance is in equilibrium. On passing a current $I = 22$ mA through the coil the equilibrium is restored by putting the additional counterweight of mass $\Delta m = 60$ mg on the balance pan. Calculate the magnetic induction, in millitesla, at the spot where the coil is located.

4. Two conducting rails are connected to a source of emf and form an incline as shown in Figure. A rod of mass 50 g slides without friction down the incline through a vertical uniform magnetic field B as shown in Figure.



If the length of the rod is 50 cm and a current of 2.5 A is flowing through it, then calculate the value of B in millitesla for which the bar slides at a constant velocity. Take $g = 10\text{ ms}^{-2}$.

5. The battery branch of the circuit is very far from the two horizontal segments containing two resistors as shown in Figure.



These horizontal segments are separated by 5 cm, and they are much longer than 5 cm. A proton (charge $+e$) is fired at 650 kms^{-1} from a point midway between the upper two horizontal segments of the circuit. The initial velocity of the proton is in the plane of the circuit and is directed towards the upper wire. It is calculated that the initial magnetic force on the proton comes to be $x \times 10^{-18}$ N, where x happens to be a single digit integer. Find x. Take $e = 1.6 \times 10^{-19}$ C.

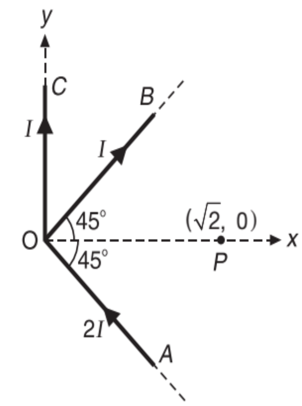
6. A charged particle is accelerated through a potential difference of 12 kV and acquires a speed of 10^6 ms^{-1}. It is projected perpendicularly into the magnetic field of strength 0.2 T. Calculate the radius of circle described by the particle in cm.

7. The magnitude of the earth's magnetic field at either pole is approximately 7×10^{-5} T. If this field is obtained from a current loop around the equator (without considering any contribution from the magnetic materials inside the earth). Calculate the current, in mega ampere, that would generate the field. Take the radius of the earth to be 6.37×10^6 m.

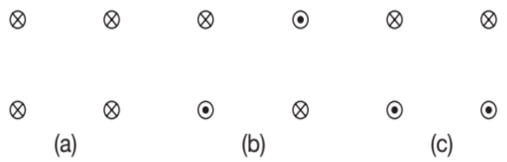
8. A current $I = 10$ A flows in a ring of radius $r_0 = 15$ cm made of a very thin wire. The tensile strength of the wire is equal to $T = 1.5$ N. The ring is placed in a magnetic field, which is perpendicular to the plane of the ring so that the forces tend to break the ring. Find B (in tesla) at which the ring is broken.

9. A wire having a linear mass density of 1 gcm^{-1} is placed on a horizontal surface that has a coefficient of kinetic friction of 0.75. The wire carries a current of 2 A toward the east and slides horizontally to the north. What is the magnitude and direction of the smallest magnetic field that enables the wire to move in this fashion? $\left(\text{Take } g = 10\text{ ms}^{-2},\ \sin(37) = \dfrac{3}{5}\right)$. Give the value of field in millitesla.

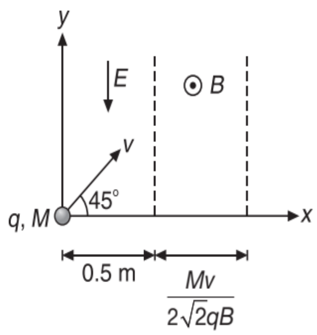
10. Figure shows three sections of a long current carrying wire. At origin, the current is divided in two equal parts. All section lies in xy plane. If the net magnetic field at P is $\frac{\mu_0 I x}{8\pi}(\sqrt{2}+1)^2$, then calculate x.



11. Four long, parallel power lines each carry 100 A currents. A cross-sectional diagram of these lines is a square, 20 cm on each side. For each of the three cases shown in figure, calculate the magnetic field at the centre of the square for all the situations (a), (b) and (c) shown. Give all the answers in microtesla.

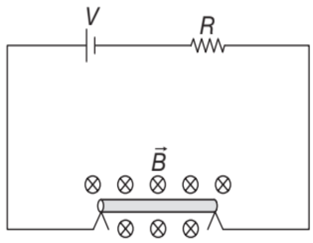


12. A charge particle of charge q and mass M is projected in a region which contains electric (from $x = 0$ to $x = 0.5$ m) and magnetic field from $x = 0.5$ m to $x = \left(0.5 + \frac{Mv}{2\sqrt{2}qB}\right)$ m as shown in Figure with velocity v making at an angle of 45° with x-direction.



If $v = \sqrt{\frac{qE}{M}}$, then the total deviation for the particles motion will be (neglect the effect of gravity) in clockwise direction in radian is $\frac{x\pi}{y}$. Calculate x and y.

13. A thin, 50 cm long metal bar with mass 750 g rests on, but is not attached to, two metallic supports in a uniform 0.5 T magnetic field, as shown in Figure.

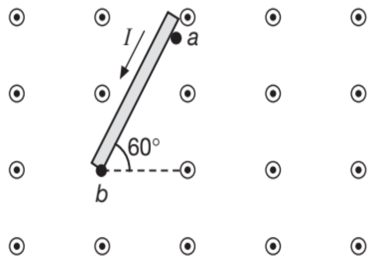


A battery and a 25 Ω resistor in series are connected to the supports. Take $g = 10$ ms^{-2}

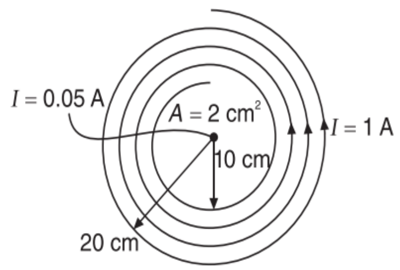
(a) What is the highest voltage, in volt, that the battery can have without breaking the circuit at the supports?

(b) The battery voltage has the maximum value calculated in part (a). If the resistor suddenly gets partially short-circuited, decreasing its resistance to 2Ω, find the initial acceleration, in ms^{-2}, of the bar.

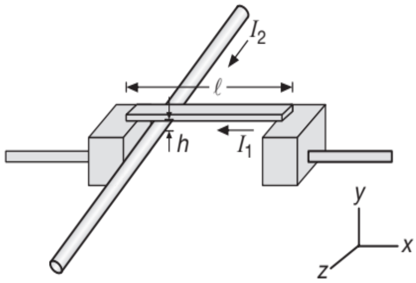
14. A uniform, 500 g metal bar 100 cm long carries a current I in a uniform, horizontal, 0.5 T magnetic field as shown in figure. The bar is hinged at b but rests unattached at a. What is the largest current, in ampere, that can flow from a to b without breaking the electrical contact at a? Assume that the wire be inclined to the horizontal at an angle of 60° as shown. (Take $g = 10$ ms^{-2}).



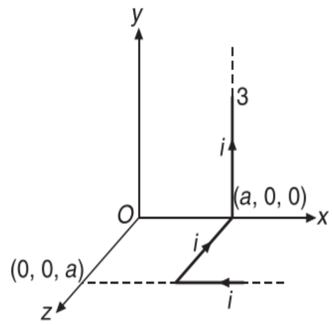
15. A spiral loop has inner radius 10 cm and outer radius 20 cm and carries current 1 A in each turn. The total number of turn in loop is 100. A small rectangular loop of area 2 cm^2 carries current 0.05 A is placed at the centre of loop. If magnitude of potential energy of rectangular loop is $\frac{\mu_0 \ln 2}{x}$ J, Calculate x.



16. A thin copper bar of length $l = 10$ cm is supported horizontally by two (non-magnetic) contacts. The bar carries current $I_1 = 100$ A in the $-x$ direction, as shown in figure. At a distance $h = 0.5$ cm below one end of the bar, a long straight wire carries a current $I_2 = 200$ A in the z-direction. Determine the magnetic force exerted on the bar, in milli newton. Take $\log_e(401) = 0.6$.

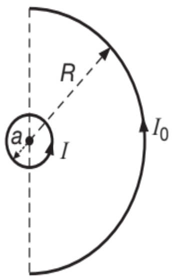


17. An infinite current carrying conductor is bent into three segments as shown in Figure. If it carries current i, the magnetic field at the origin is found to be $\frac{\mu_0 i}{4\pi a}\left[\left(\sqrt{x}-1\right)\hat{j}+\hat{k}\right]$. Calculate x.



18. Two protons move parallel to each other with an equal velocity $v = 300$ kms^{-1}. The ratio of forces of magnetic and electrical interaction of the protons is found to be $x \times 10^{-6}$. Find x.

19. A small current carrying loop having current I_0 is placed in the plane of paper as shown. Another semi-circular loop having current I_0 is placed concentrically in the same plane as that of small loop, the radius of semi-circular loop is $R\,(R \gg a)$. Find the force applied by the smaller ring on bigger ring in newton. (Given $R = 1$ m, $I = I_0 = \frac{40}{\sqrt{\mu_0}}$ A, $a = 0.1$ m)



20. Consider a wire to be placed in a magnetic field which varies with distance x from the origin as

$$\vec{B} = B_0\left(1+\frac{x}{a}\right)\hat{k}$$

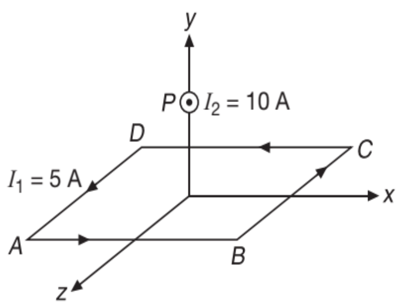
The ends of wire are at $(a, 0)$ and $(2a, 0)$ and it carries a current I. If force on wire is calculated to be

$$\vec{F} = -\left(\frac{kB_0 aI}{2}\right)\hat{j}$$

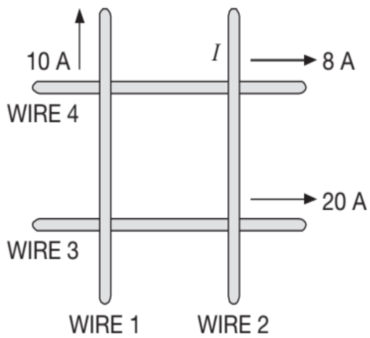
then find the value of k.

21. A current I flows in a rectangular shaped wire whose centre lies at $(x_0, 0, 0)$ and whose vertices are located at the points $A(x_0 + d, -a, -b)$, $B(x_0 - d, a, -b)$, $C(x_0 - d, a, +b)$ and $D(x_0 + d, -a, +b)$ respectively. Assume that $a, b, d \ll x_0$. Find the magnitude of magnetic dipole moment vector of the rectangular wire frame in SI units. (Given $b = 10$ m, $I = 0.01$ A, $d = 4$ m, $a = 3$ m)

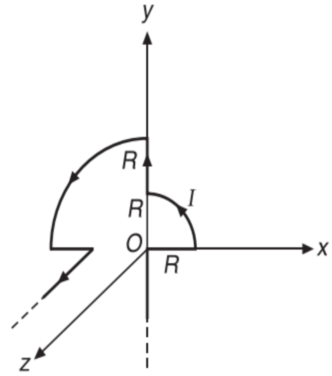
22. A square loop, 16 cm on each side lies in the x-z plane with its centre at the origin. The loop carries a current of 5 A. Above the loop at $y = 6$ cm is an infinitely long straight wire (P) parallel to the z-axis carrying a current of 10 A. The net force on the loop is $F \times 10^{-7}$ N. Find F.



23. Four very long, current carrying wires 1, 2, 3 and 4 in the same plane intersect to form a square 40 cm on each side, as shown in figure. Find the magnitude and direction of the current I in wire 2, so that the magnetic field at the centre of the square is zero. Assume that there are no cross-contacts between any pair of wires. Give your answer in ampere.

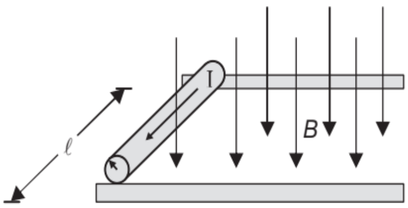


24. In the arrangement shown, if magnetic field at origin is given by $\frac{\mu_0 I}{4R}\left(\frac{a}{4}\hat{k}+\frac{b}{\pi}\hat{j}\right)$.

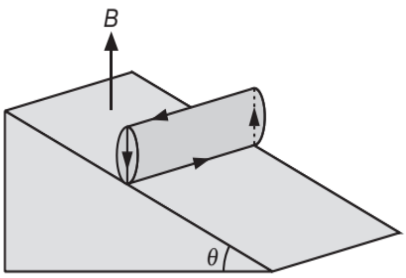


Calculate ab.

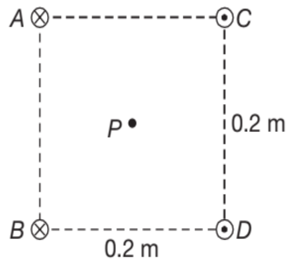
25. A rod of mass 0.72 kg and radius 6 cm rests on two parallel rails that are $l = 12$ cm apart and $L = 45$ cm long. The rod carries a current of $I = 48$ A (in the direction shown) and rolls along the rails without slipping. A uniform magnetic field of magnitude 0.24 T is directed perpendicular to the rod and the rails. If it starts from rest, what is the speed of the rod, in cms^{-1}, it leaves the rails?



26. A wooden cylinder of mass $m = 0.250$ kg and length $L = 0.100$ m, has $N = 10$ turns of the wire wrapped around it longitudinally, so that the plane of the coil contains the long central axis of the cylinder. The cylinder is released on a plane inclined at an angle θ to the horizontal, with the plane of the coil parallel to the inclined plane. If there is a vertical uniform magnetic field of magnitude 0.500 T, what is the least current i through the coil that prevents the cylinder from rolling down the plane.

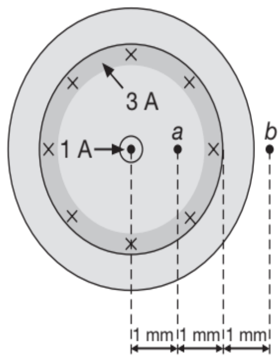


27. Four long, parallel conductors carry equal currents of $I = 5$ A. The figure is an end view of the conductors. The current direction is into the page at points A and B (indicated by the crosses) and out of the page at C and D (indicated by the dots). Calculate the magnitude, in μT and direction of the magnetic field at point P, located at the centre of the square of edge length $l = 0.2$ m.



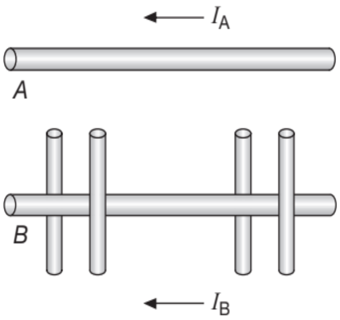
28. A constant homogeneous electric field of 100 Vm^{-1} exists in the region $x = 0$ and $x = 0.167$ m directed along the positive x-direction. A constant homogeneous magnetic field B exists in the region from $x = 0.167$ m to $x = 0.334$ m directed along the z-direction. A proton lying at rest at the origin (0, 0) is released. Calculate the minimum strength of the magnetic field in millitesla so that the proton will strike the point $(0,\ 0.167\ \text{m})$. Given that the mass of proton is 1.67×10^{-27} kg.

29. Figure is a cross-sectional view of a coaxial cable. The centre conductor is surrounded by a rubber layer, which is surrounded by an outer conductor, which is surrounded by another rubber layer. In a particular application, the current in the inner conductor is 1 A out of the page and the current in the outer conductor is 3 A into the page. Determine the magnitude and direction of the magnetic field at points a and b. Give your answer in μT.



30. A long conducting cylinder or radius R carries a current I. The current density J varies with radial distance r as $J = br$, where b is a constant. The magnetic field at a distance $r > R$ measured from the axis of cylinder is $B = \frac{\mu_0 b R^x}{y r_2}$. Calculate the ratio of x and y.

31. Two long, parallel conductors are carrying currents in the same direction as in figure. Conductor A carries a current of 100 A and is held firmly in position. Conductor B carries a current I_B and is allowed to slide freely up and down (parallel to A) between a set of non-conducting guides. If the linear density of conductor B is $0.15\ \text{gcm}^{-1}$, what value of current I_B, in A, will result in equilibrium when the distance between the two conductors is 2 cm?



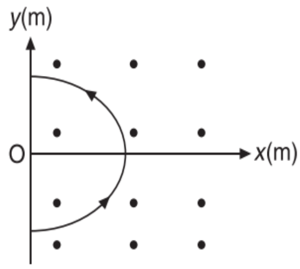
32. The rotor in a certain electric motor is a flat rectangular coil with 1000 turns of wire and dimensions 2.5 cm by 4 cm. The rotor rotates in a uniform magnetic field of 0.8 T. When the plane of the rotor is perpendicular to 10 mA. In this orientation, the magnetic moment of the rotor is directed opposite the magnetic field. The rotor then turns through one-half revolution. This process is repeated to cause the rotor to turn steadily at $600\ \text{rev min}^{-1}$.

(a) Find the maximum torque, in milli newton metre, acting on the rotor.
(b) Find the peak power output of the motor, in watt.
(c) Determine the amount of work performed, in milli joule, by the magnetic field on the rotor in every full revolution.
(d) What is the average power of the motor, in milli watt?
(e) Also, we have that Peak

$$\text{Power} = \frac{(*)^2}{16}(\text{Average Power}),$$

where $*$ is not readable. Find $*$.

33. A wire carrying a current of 3 A is bent in the form of a parabola $y^2 = 4 - x$ as shown in Figure, where x and y are in metre.



The wire is placed in a uniform magnetic field $\vec{B} = 5\hat{k}$ tesla. Calculate the force acting on the wire in newton.

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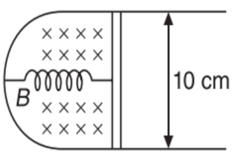
1. **[Online April 2019]**
A thin strip 10 cm long is on a U shaped wire of negligible resistance and it is connected to a spring of spring constant $0.5\ \text{Nm}^{-1}$ (see figure). The assembly is kept in a uniform magnetic field of 0.1 T. If the strip is pulled from its equilibrium position and released, the number of oscillations it performs before its amplitude decreases by a factor of e is N. If the mass of the strip is 50 g, its resistance 10 Ω and air drag negligible, N will be close to

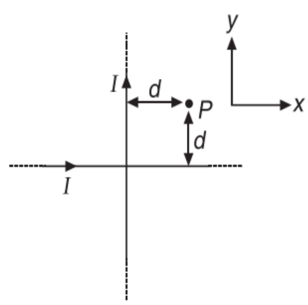


(A) 1000 (B) 5000
(C) 50000 (D) 10000

2. **[Online April 2019]**
A circular coil having N turns and radius r carries a current I. It is held in the XZ plane in a magnetic field $B\hat{i}$. The torque on the coil due to the magnetic field is

(A) $\dfrac{B\pi r^2 I}{N}$ (B) $\dfrac{Br^2 I}{\pi N}$
(C) $B\pi r^2 IN$ (D) ZERO

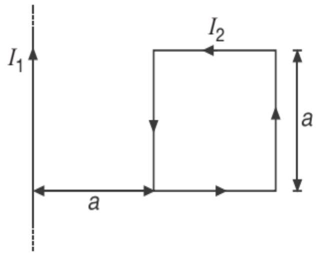
3. **[Online April 2019]**
Two very long, straight and insulated wires are kept at 90° angle from each other in xy-plane as shown in Figure.



These wires carry current of equal magnitude I, whose directions are shown in Figure. The net magnetic field at point P will be

(A) ZERO
(B) $\frac{+\mu_0 I}{\pi d}(\hat{z})$
(C) $-\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$
(D) $\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$

4. [Online April 2019]
A rigid square loop of side a and carrying current I_2 is lying on a horizontal surface near a long current I_1 carrying wire in the same plane as shown in Figure. The net force on the loop due to the wire will be

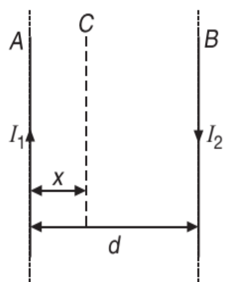


(A) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{4\pi}$
(B) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{2\pi}$
(C) ZERO
(D) Attractive and equal to $\frac{\mu_0 I_1 I_2}{3\pi}$

5. [Online April 2019]
A moving coil galvanometer has a coil with 175 turns and area 1 cm^2. It uses a torsion band of torsion constant 10^{-6} Nm/rad. The coil is placed in a magnetic field B parallel to its plane. The coil deflects by 1° for a current of 1 mA. The value of B (in Tesla) is approximately

(A) 10^{-4}
(B) 10^{-2}
(C) 10^{-1}
(D) 10^{-3}

6. [Online April 2019]
Two wires A and B are carrying currents I_1 and I_2 as shown in Figure. The separation between them is d. A third wire C carrying a current I is to be kept parallel to them at a distance x from A such that the net force acting on it is zero. The possible values of x are



(A) $x = \pm\frac{I_1 d}{(I_1 - I_2)}$
(B) $x = \left(\frac{I_1}{I_1+I_2}\right)d$ and $x = \left(\frac{I_2}{I_1-I_2}\right)d$
(C) $x = \left(\frac{I_2}{I_1+I_2}\right)d$ and $x = \left(\frac{I_2}{I_1-I_2}\right)d$
(D) $x = \left(\frac{I_1}{I_1-I_2}\right)d$ and $x = \left(\frac{I_2}{I_1+I_2}\right)d$

7. [Online April 2019]
A proton, an electron and a Helium nucleus, have the same energy. They are in circular orbits in a plane due to magnetic field perpendicular to the plane. Let r_p, r_e and r_{He} be their respective radii, then,

(A) $r_e < r_p < r_{He}$
(B) $r_e > r_p = r_{He}$
(C) $r_e < r_p = r_{He}$
(D) $r_e > r_p > r_{He}$

8. [Online April 2019]
The magnitude of the magnetic field at the centre of an equilateral triangular loop of side 1 m which is carrying a current of 10 A is [Take $\mu_0 = 4\pi\times10^{-7}$ NA^{-2}]

(A) 18 μT
(B) 1 μT
(C) 3 μT
(D) 9 μT

9. [Online April 2019]
A square loop is carrying a steady current I and the magnitude of its magnetic dipole moment is m. If this square loop is changed to a circular loop and it carries the same current, the magnitude of the magnetic dipole moment of circular loop will be

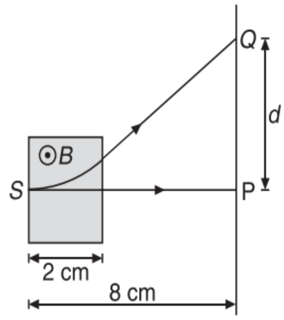
(A) $\frac{2m}{\pi}$
(B) $\frac{4m}{\pi}$
(C) $\frac{m}{\pi}$
(D) $\frac{3m}{\pi}$

10. [Online April 2019]
A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of 40π $rads^{-1}$ about its axis, perpendicular to its plane. If the magnetic field at its centre is 3.8×10^{-9} T, then the charge carried by the ring is close to $\left(\mu_0 = 4\pi\times10^{-7}\ NA^{-2}\right)$.

(A) 4×10^{-5} C
(B) 3×10^{-5} C
(C) 7×10^{-6} C
(D) 2×10^{-6} C

11. [Online April 2019]

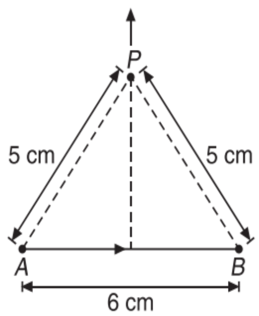
An electron, moving along the x-axis with an initial energy of 100 eV, enters a region of magnetic field $\vec{B} = (1.5\times10^{-3}\text{ T})\hat{k}$ at S (see figure). The field extends between $x = 0$ and $x = 2\text{ cm}$. The electron is detected at the point Q on a screen placed 8 cm away from the point S. The distance d between P and Q (on the screen) is (electron's charge $= 1.6\times10^{-19}\text{ C}$, mass of electron $= 9.1\times10^{-31}\text{ kg}$)



(A) 11.65 cm (B) 12.87 cm
(C) 2.25 cm (D) 1.22 cm

12. [Online April 2019]

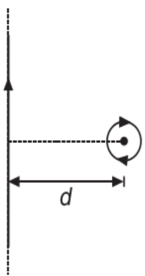
Find the magnetic field at point P due to a straight line segment AB of length 6 cm carrying a current of 5 A. (see figure) $(\mu_0 = 4\pi\times10^{-7}\text{ NA}^{-2})$



(A) $2.5\times10^{-5}\text{ T}$ (B) $1.5\times10^{-5}\text{ T}$
(C) $3.0\times10^{-5}\text{ T}$ (D) $2.0\times10^{-5}\text{ T}$

13. [Online January 2019]

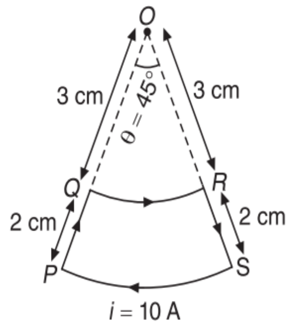
An infinitely long current carrying wire and a small current carrying loop are in the plane of the paper as shown. The radius of the loop is a and distance of its centre from the wire is $d (d \gg a)$. If the loop applies a force F on the wire then



(A) $F = 0$ (B) $F \propto \left(\frac{a}{d}\right)^2$
(C) $F \propto \left(\frac{a}{d}\right)$ (D) $F \propto \left(\frac{a^2}{d^3}\right)$

14. [Online January 2019]

A current loop, having two circular arcs joined by two radial lines is shown in Figure. It carries a current of 10 A. The magnetic field at point O will be close to



(A) $1.5\times10^{-7}\text{ T}$ (B) $1.0\times10^{-5}\text{ T}$
(C) $1.5\times10^{-5}\text{ T}$ (D) $1.0\times10^{-7}\text{ T}$

15. [Online January 2019]

One of the two identical conducting wires of length L is bent in the form of a circular loop and the other one into a circular coil of N identical turns. If the same current is passed in both, the ratio of the magnetic field at the central of the loop (B_L) to that at the centre of the coil (B_C), i.e. $\frac{B_L}{B_C}$ will be

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

16. [Online January 2019]

A particle having the same charge as of electron moves in a circular path of radius 0.5 cm under the influence of a magnetic field of 0.5 T. If an electric field of 100 Vm^{-1} makes it to move in a straight path, then the mass of the particle is (Given charge of electron $= 1.6\times10^{-19}\text{ C}$)

(A) $9.1\times10^{-31}\text{ kg}$ (B) $1.6\times10^{-27}\text{ kg}$
(C) $1.6\times10^{-19}\text{ kg}$ (D) $2.0\times10^{-24}\text{ kg}$

17. [Online January 2019]

A solid metal cube of edge length 2 cm is moving in a positive y-direction at a constant speed of 6 ms^{-1}. There is a uniform magnetic field of 0.1 T in the positive z-direction. The potential difference between the two faces of the cube perpendicular to the x-axis, is

(A) 12 mV (B) 2 mV
(C) 6 mV (D) 1 mV

18. [Online January 2019]
In an experiment, electrons are accelerated, from rest, by applying a voltage of 500 V. Calculate the radius of the path if a magnetic field 100 mT is then applied. [Charge of the electron $=1.6\times10^{-19}\text{ C}$, Mass of the electron $=9.1\times10^{-31}\text{ kg}$]

(A) $7.5\times10^{-3}\text{ m}$ (B) 7.5 m
(C) $7.5\times10^{-2}\text{ m}$ (D) $7.5\times10^{-4}\text{ m}$

19. [Online January 2019]
The region between $y=0$ and $y=d$ contains a magnetic field $\vec{B}=B\hat{k}$. A particle of mass m and charge q enters the region with a velocity $\vec{v}=v\hat{i}$. If $d=\frac{mv}{2qB}$, the acceleration of the charged particle at the point of its emergence at the other side is

(A) $\frac{qvB}{m}\left(\frac{1}{2}\hat{i}-\frac{\sqrt{3}}{2}\hat{j}\right)$ (B) $\frac{qvB}{m}\left(\frac{\sqrt{3}}{2}\hat{i}+\frac{1}{2}\hat{j}\right)$
(C) $\frac{qvB}{m}\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$ (D) $\frac{qvB}{m}\left(\frac{-\hat{j}+\hat{i}}{\sqrt{2}}\right)$

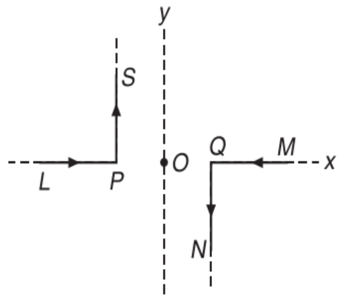
20. [Online January 2019]
A particle of mass m and charge q is in an electric and magnetic field given by $\vec{E}=2\hat{i}+3\hat{j}$; $\vec{B}=4\hat{j}+6\hat{k}$
The charged particle is shifted from the origin to the point $P(x=1,\ y=1)$ along a straight path. The magnitude of the total work done is

(A) $(0.15)q$ (B) $5q$
(C) $(0.35)q$ (D) $(2.5)q$

21. [Online January 2019]
A proton and an α-particle (with their masses in the ratio of $1:4$ and charges in the ratio of $1:2$) are accelerated from rest through a potential difference V. If a uniform magnetic field (B) is set up perpendicular to their velocities, the ratio of the radii $r_p:r_\alpha$ of the circular paths described by them will be

(A) $1:3$ (B) $1:2$
(C) $1:\sqrt{3}$ (D) $1:\sqrt{2}$

22. [Online January 2019]
As shown in Figure, two infinitely long, identical wires are bent by $90°$ and placed in such a way that the segments LP and QM are along the x-axis, while segments PS and QN are parallel to the y-axis. If $OP=OQ=4\text{ cm}$ and the magnitude of the magnetic field at O is 10^{-4} T and the two wires carry equal currents (see figure), the magnitude of the currents in each wire and the direction of the magnetic field at O will be $\left(\mu_0=4\pi\times10^{-7}\text{ NA}^{-2}\right)$



(A) 40 A, perpendicular into the page
(B) 20 A, perpendicular into the page
(C) 40 A, perpendicular out of the page
(D) 20 A, perpendicular out of the page

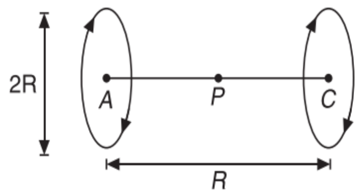
23. [2018]
An electron, a proton and an alpha particle having the same kinetic energy are moving in circular orbits of radii r_e, r_p, r_α respectively in a uniform magnetic field B. The relation between r_e, r_p, r_α is

(A) $r_e>r_p=r_\alpha$ (B) $r_e<r_p=r_\alpha$
(C) $r_e<r_p<r_\alpha$ (D) $r_e<r_\alpha<r_p$

24. [2018]
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

(A) 2 (B) $\sqrt{3}$
(C) $\sqrt{2}$ (D) $\frac{1}{\sqrt{2}}$

25. [Online 2018]
A Helmholtz coil has a pair of loops, each with N turns and radius R. They are placed coaxially at distance R and the same current I flows through the loops in the same direction. The magnitude of magnetic field at P, midway between the centres A and C, is given by [Refer to given figure]



(A) $\dfrac{4N\mu_0 I}{5^{\frac{1}{2}}R}$ (B) $\dfrac{4N\mu_0 I}{5^{\frac{3}{2}}R}$

(C) $\dfrac{8N\mu_0 I}{5^{\frac{3}{2}}R}$ (D) $\dfrac{8N\mu_0 I}{5^{\frac{1}{2}}R}$

26. [Online 2018]

A current of 1 A is flowing in the sides of an equilateral triangle of side 4.5×10^{-2} m. The magnetic field at the centre of the triangle will be

(A) 4×10^{-5} Wbm^{-2} (B) 8×10^{-5} Wbm^{-2}

(C) 2×10^{-5} Wbm^{-2} (D) ZERO

27. [Online 2018]

A charge q is spread uniformly over an insulated loop of radius r. If it is rotated with an angular velocity ω with respect to normal axis then the magnetic moment of the loop is

(A) $\frac{1}{2}q\omega r^2$ (B) $q\omega r^2$

(C) $\frac{3}{2}q\omega r^2$ (D) $\frac{4}{3}q\omega r^2$

28. [Online 2018]

A galvanometer with its coil resistance 25 Ω requires a current of 1 mA for its full deflection. In order to construct an ammeter to read up to a current of 2A, the approximate value of the shunt resistance should be

(A) 1.25×10^{-3} Ω (B) 1.25×10^{-2} Ω

(C) 2.5×10^{-3} Ω (D) 2.5×10^{-2} Ω

29. [2017]

When a current of 5 mA is passed through a galvanometer having a coil of resistance 15 Ω, it shows full scale deflection. The value of the resistance to be put in series with the galvanometer to convert it into a voltmeter of range 0 – 10 V is

(A) 1.985×10^{3} Ω (B) 2.045×10^{3} Ω

(C) 2.535×10^{3} Ω (D) 4.005×10^{3} Ω

30. [Online 2017]

In a certain region static electric and magnetic fields exist. The magnetic field is given by $\vec{B}=B_0(\hat{i}+2\hat{j}-4\hat{k})$. If a test charge moving with a velocity $\vec{v}=v_0(3\hat{i}-\hat{j}+2\hat{k})$ experiences no force in that region, then the electric field in the region, in SI units, is

(A) $\vec{E}=-v_0B_0(14\hat{j}+7\hat{k})$

(B) $\vec{E}=v_0B_0(14\hat{j}+7\hat{k})$

(C) $\vec{E}=-v_0B_0(\hat{i}+\hat{j}+7\hat{k})$

(D) $\vec{E}=-v_0B_0(3\hat{i}-2\hat{j}-4\hat{k})$

31. [Online 2017]

A magnetic dipole in a constant magnetic field has

(A) zero potential energy when the torque is maximum.

(B) minimum potential energy when the torque is maximum.

(C) maximum potential energy when the torque is maximum.

(D) zero potential energy when the torque is minimum.

32. [Online 2017]

A negative test charge is moving near a long straight wire carrying a current. The force acting on the test charge is parallel to the direction of the current. The motion of the charge is

(A) parallel to the wire opposite to the current

(B) parallel to the wire along the current

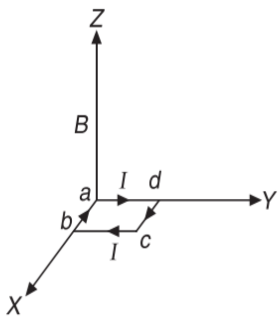
(C) away from the wire

(D) towards the wire

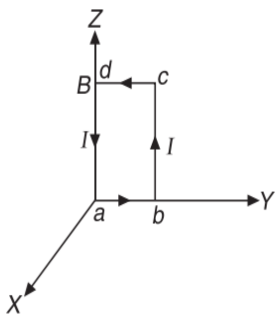
33. [Online 2017]

A uniform magnetic field B of 0.3 T is along the positive Z-direction. A rectangular loop $(abcd)$ of sides 10 cm × 5 cm carries a current I of 12 A. Out of the following different orientations which one corresponds to stable equilibrium?

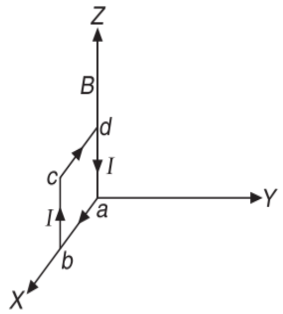
(A)



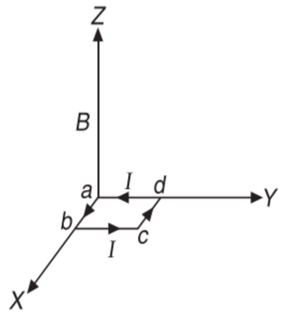
(B)



(C)



(D)



34. **[2016]**

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

(A) $\frac{\pi^2}{8}$ (B) $\frac{\pi^2}{16\sqrt{2}}$

(C) $\frac{\pi^2}{16}$ (D) $\frac{\pi^2}{8\sqrt{2}}$

35. **[2016]**

A galvanometer having a coil resistance of $100\ \Omega$ gives a full-scale deflection, when a current of 1 mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full-scale deflection for a current of 10 A, is

(A) $0.01\ \Omega$ (B) $2\ \Omega$

(C) $0.1\ \Omega$ (D) $3\ \Omega$

36. **[Online 2016]**

To know the resistance G of a galvanometer by half deflection method, a battery of emf V_E and resistance R is used to deflect the galvanometer by angle θ. If a shunt of resistance S is needed to get half deflection then G, R and S are related by the equation

(A) $S(R+G)=RG$ (B) $2S(R+G)=RG$

(C) $2G=S$ (D) $2S=G$

37. **[Online 2016]**

A $50\ \Omega$ resistance is connected to a battery of 5 V. A galvanometer of resistance $100\ \Omega$ is to be used as an ammeter to measure current through the resistance, for this a resistance r_s is connected to the galvanometer. Which of the following connections should be employed if the measured current is within 1% of the current without the ammeter in the circuit?

(A) $r_s = 0.5\ \Omega$ in series with the galvanometer

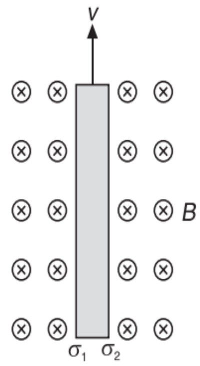
(B) $r_s = 1\ \Omega$ in series with the galvanometer

(C) $r_s = 1\ \Omega$ in parallel with the galvanometer

(D) $r_s = 0.5\ \Omega$ in parallel with the galvanometer

38. **[Online 2016]**

Consider a thin metallic sheet perpendicular to the plane of the paper moving with speed v in a uniform magnetic field B going into the plane of the paper (see figure). If charge densities σ_1 and σ_2 are induced on the left and right surfaces, respectively, of the sheet then (ignore fringe effects)



(A) $\sigma_1 = \frac{-\varepsilon_0 vB}{2}$, $\sigma_2 = \frac{\varepsilon_0 vB}{2}$

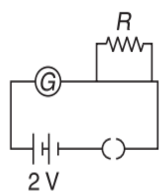
(B) $\sigma_1 = \varepsilon_0 vB$, $\sigma_2 = -\varepsilon_0 vB$

(C) $\sigma_1 = \frac{\varepsilon_0 vB}{2}$, $\sigma_2 = \frac{-\varepsilon_0 vB}{2}$

(D) $\sigma_1 = \sigma_2 = \varepsilon_0 vB$

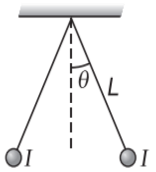
39. **[Online 2016]**

A galvanometer has a 50 division scale. Battery has no internal resistance. It is found that there is deflection of 40 divisions when $R = 2400\ \Omega$. Deflection becomes 20 divisions when resistance taken from resistance box is $4900\ \Omega$. Then we can conclude



(A) current sensitivity of galvanometer is 20 μA/division
(B) resistance of galvanometer is 200 Ω
(C) resistance required on R.B. for a deflection of 10 divisions is 9800 Ω
(D) full scale deflection current is 2 mA

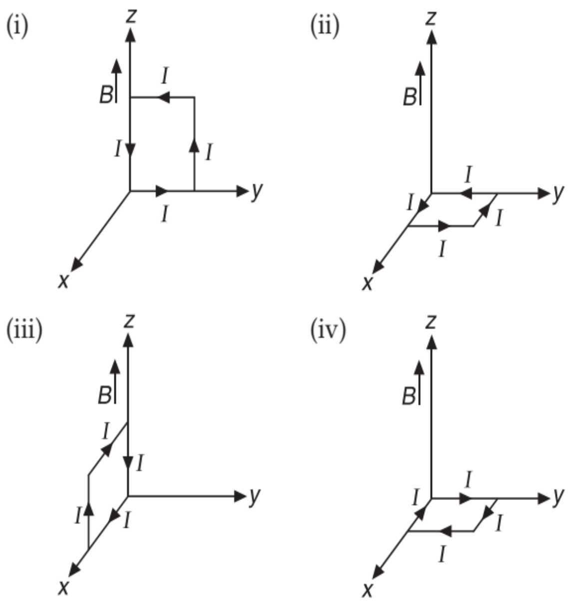
40. [2015]
Two long current carrying thin wires, both with current I, are held by insulating threads of length L and are in equilibrium as shown in Figure, with threads making an angle θ with the vertical. If wires have mass λ per unit length then the value of I is
(g = gravitational acceleration)



(A) $2\sqrt{\frac{\pi g L}{\mu_0}\tan\theta}$ (B) $\sqrt{\frac{\pi \lambda g L}{\mu_0}\tan\theta}$

(C) $\sin\theta\sqrt{\frac{\pi\lambda g L}{\mu_0\cos\theta}}$ (D) $2\sin\theta\sqrt{\frac{\pi\lambda g L}{\mu_0\cos\theta}}$

41. [2015]
A rectangular loop of sides 10 cm and 5 cm carrying a current I of 12 A is placed in different orientations as shown in the figure below.



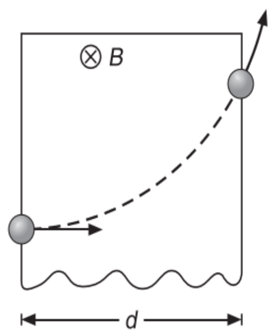
If there is a uniform magnetic field of 0.3 T in the positive z direction, then the orientations in which the loop would be in stable and unstable equilibrium respectively are

(A) (ii) and (iv), respectively
(B) (ii) and (iii), respectively
(C) (i) and (ii), respectively
(D) (i) and (iii), respectively

42. [2015]
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

(A) $\vec{F}_1$ is radially inwards and $\vec{F}_2 = 0$
(B) $\vec{F}_1$ is radially outwards and $\vec{F}_2 = 0$
(C) $\vec{F}_1 = \vec{F}_2 = 0$
(D) $\vec{F}_1$ is radially inwards and $\vec{F}_2 = 0$ is radially outwards

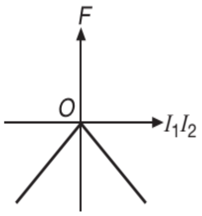
43. [Online 2015]
A Proton (mass m) accelerated by a potential difference V flies through a uniform transverse magnetic field B. The field occupies a region of space by width d. If α be the angle of deviation of proton from initial direction of motion (see figure), the value of $\sin\alpha$ will be

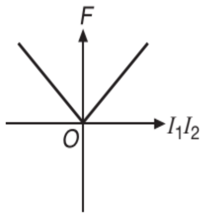


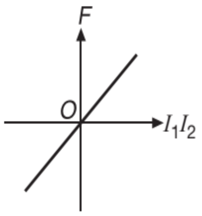
(A) $\frac{B}{2}\sqrt{\frac{qd}{mV}}$ (B) $\frac{B}{d}\sqrt{\frac{q}{2mV}}$

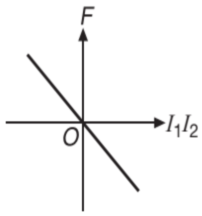
(C) $Bd\sqrt{\frac{q}{2mV}}$ (D) $qV\sqrt{\frac{Bd}{2m}}$

44. [Online 2015]
Two long straight parallel wires, carrying (adjustable) currents I_1 and I_2, are kept at a distance d apart. If the force F between the two wires is taken as positive when the wires repel each other and negative when the wires attract each other, the graph showing the dependence of F, on the product I_1I_2, would be

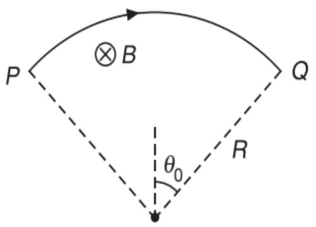
(A) 

(B) 

(C) 

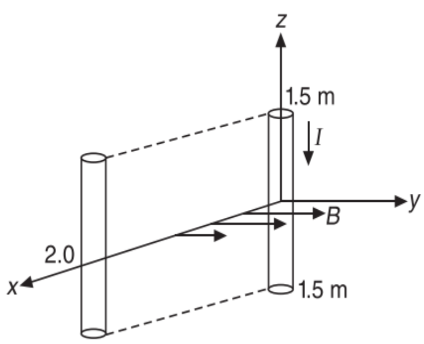
(D) 

45. [Online 2015]
A wire carrying current I is tied between points P and Q and is in the shape of a circular arc of radius R due to a uniform magnetic field B (perpendicular to the plane of the paper, inwards) in the vicinity of the wire. If the wire subtends an angle $2\theta_0$ at the centre of the circle (of which it forms an arc) then the tension in the wire is



(A) IBR
(B) $\frac{IBR}{\sin\theta_0}$
(C) $\frac{IBR}{2\sin\theta_0}$
(D) $\frac{IBR\theta_0}{\sin\theta_0}$

46. [2014]
A conductor lies along the z-axis at $-1.5 \le z < 1.5$ m and carries a fixed current of 10.0 A in $-\hat{a}_z$ direction shown in Figure.



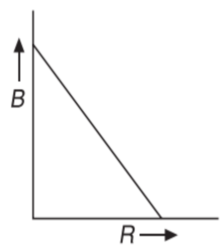
For a field $\vec{B} = 3.0\times10^{-4}e^{-0.2x}\hat{a}_y$ T, find the power required to move the conductor at constant speed to $x = 2.0$ m, $y = 0$ m in 5×10^{-3} s. Assume parallel motion along the x-axis.

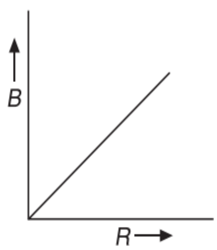
(A) 29.7 W
(B) 1.57 W
(C) 2.97 W
(D) 14.85 W

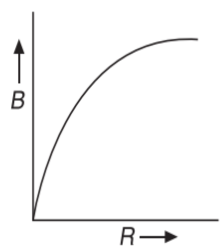
47. [2013]
This question has Statement-I and Statement-II. Of the four choices given after the Statements, choose the one that best describes the two Statements.
Statement-I: Higher the range, greater is the resistance of ammeter.
Statement-II: To increase the range of ammeter, additional shunt needs to be used across it.
(A) Statement-I is false, Statement-II is true.
(B) Statement-I is true, Statement-II is true, Statement-II is the correct explanation of Statement-I.
(C) Statement-I is true, Statement-II is true, Statement-II is not the correct explanation of Statement-I.
(D) Statement-I is true, Statement-II is false.

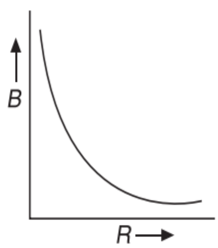
48. [2012]
Proton, deuteron and alpha particle of the same kinetic energy are moving in circular trajectories in a constant magnetic field. The radii of proton, deuteron and alpha particle are respectively r_p, r_d and r_α. Which one of the following relations is correct?
(A) $r_\alpha = r_p < r_d$
(B) $r_\alpha > r_d > r_p$
(C) $r_\alpha = r_d > r_p$
(D) $r_\alpha = r_p = r_d$

49. [2012]
A charge Q is uniformly distributed over the surface of non-conducting disc of radius R. The disc rotates about an axis perpendicular to its plane and passing through its centre with an angular velocity ω. As a result of this rotation a magnetic field of induction B is obtained at the centre of the disc. If we keep both the amount of charge placed on the disc and its angular velocity to be constant and vary the radius of the disc then the variation of the magnetic induction at the centre of the disc will be represented by the figure

(A) 

(B) 

(C) 

(D) 

50. [2011]

A current I flows in an infinitely 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

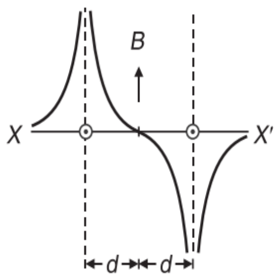
(A) $\frac{\mu_0 I}{\pi^2 R}$ (B) $\frac{\mu_0 I}{2\pi^2 R}$

(C) $\frac{\mu_0 I}{2\pi R}$ (D) $\frac{\mu_0 I}{4\pi R}$

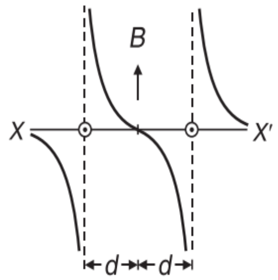
51. [2010]

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 line XX' is given by

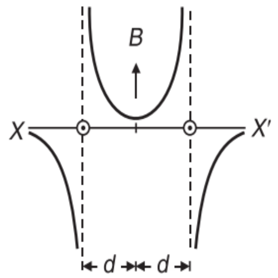
(A)



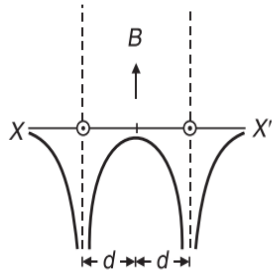
(B)



(C)



(D)



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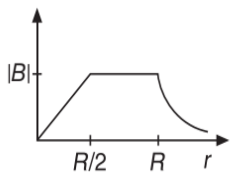
Single Correct Choice Type Problems

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

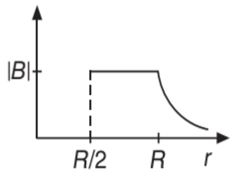
1. [IIT-JEE 2012]

An infinitely long hollow conducting cylinder with inner radius $\frac{R}{2}$ and outer radius R carries a uniform current density along its length. The magnitude of the magnetic field, $|\vec{B}|$ as a function of the radial distance r from the axis is best represented by

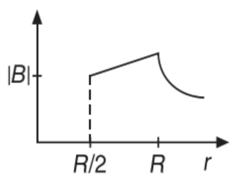
(A)



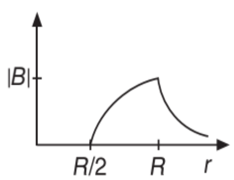
(B)



(C)

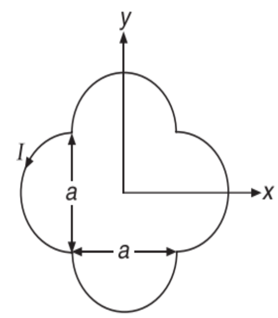


(D)



2. [IIT-JEE 2012]

A loop carrying current I lies in the x-y plane as shown in Figure.



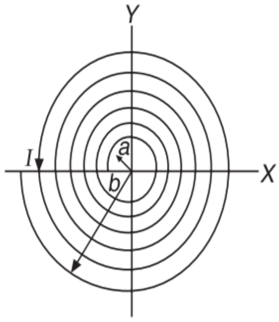
The unit vector $\vec{k}$ is coming out of the plane of the paper. The magnetic moment of the current loop is

(A) $a^2 I\vec{k}$ (B) $\left(\frac{\pi}{2}+1\right)a^2 I\vec{k}$

(C) $-\left(\frac{\pi}{2}+1\right)a^2 I\vec{k}$ (D) $(2\pi+1)a^2 I\vec{k}$

3. [IIT-JEE 2011]

A long-insulated copper wire is closely wound as a spiral of N turns. The spiral has inner radius a and outer radius b. The spiral lies in the X-Y plane and a steady current I flows through the wire. The Z-component of the magnetic field at the centre of the spiral is

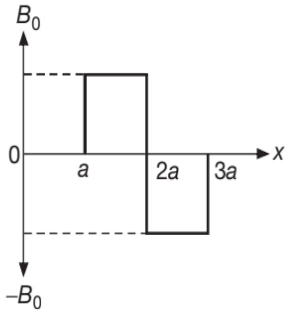


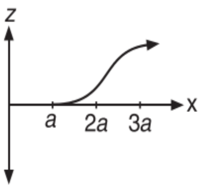
(A) $\frac{\mu_0 NI}{2(b-a)}\ln\left(\frac{b}{a}\right)$ (B) $\frac{\mu_0 NI}{2(b-a)}\ln\left(\frac{b+a}{b-a}\right)$

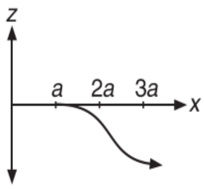
(C) $\frac{\mu_0 NI}{2b}\ln\left(\frac{b}{a}\right)$ (D) $\frac{\mu_0 NI}{2b}\ln\left(\frac{b+a}{b-a}\right)$

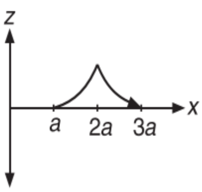
4. [IIT-JEE 2007]

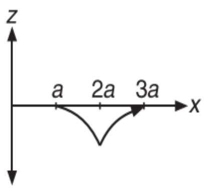
A magnetic field $\vec{B} = B_0\hat{j}$ exists in the region $a < x < 2a$ and $\vec{B} = -B_0\hat{j}$, in the region $2a < x < 3a$, where B_0 is a positive constant. A positive point charge moving with a velocity $\vec{v} = v_0\hat{i}$, where v_0 is a positive constant, enters the magnetic field at $x = a$. The trajectory of the charge in this region can be like



(A)


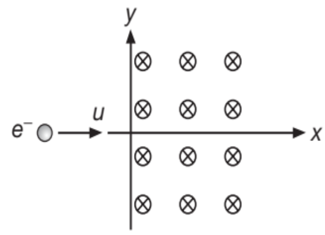
(B)


(C)


(D)


5. [IIT-JEE 2004]

An electron moving with a speed u along the positive x-axis at $y = 0$ enters a region of uniform magnetic field $\vec{B} = -B_0\hat{k}$ which exists to the right of y-axis. The electron exits from the region after some time with the speed v at co-ordinate y, then

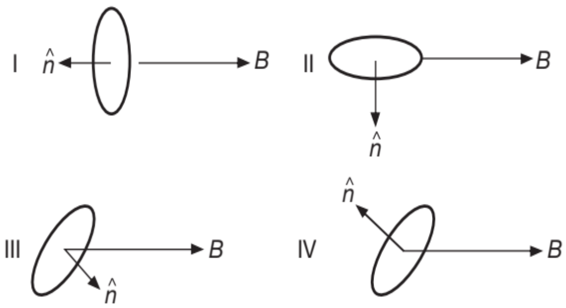


(A) $v > u$, $y < 0$ (B) $v = u$, $y > 0$

(C) $v > u$, $y > 0$ (D) $v = u$, $y < 0$

6. [IIT-JEE 2003]

A current carrying loop is placed in a uniform magnetic field in four different orientations, I, II, III & IV, arrange them in the decreasing order of Potential Energy.

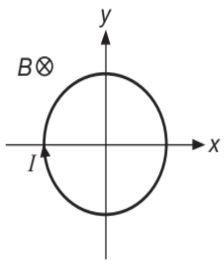


(A) I > III > II > IV (B) I > II > III > IV

(C) I > IV > II > III (D) III > IV > I > II

7. [IIT-JEE 2003]

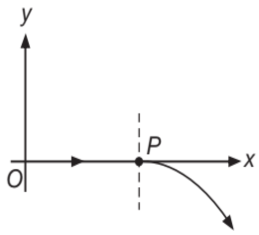
A conducting loop carrying a current I is placed in a uniform magnetic field pointing into the plane of the paper as shown. The loop will have a tendency to



(A) contract
(B) expand
(C) move towards +ve x-axis
(D) move towards −ve x-axis

8. [IIT-JEE 2003]

For a positively charged particle moving in a x-y plane initially along the x-axis, there is a sudden change in its path due to the presence of electric and/or magnetic fields beyond P. The curved path is shown in the x-y plane and is found to be non-circular. Which one of the following combinations is possible?



(A) $\vec{E}=0\,;\ \vec{B}=b\hat{j}+c\hat{k}$ (B) $\vec{E}=a\hat{i}\,;\ \vec{B}=c\hat{k}+a\hat{i}$

(C) $\vec{E}=0\,;\ \vec{B}=c\hat{j}+b\hat{k}$ (D) $\vec{E}=a\hat{i}\,;\ \vec{B}=c\hat{k}+b\hat{j}$

9. [IIT-JEE 2002]

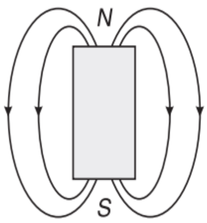
A particle of mass m and charge q moves with a constant velocity v along the positive x direction. It enters a region containing a uniform magnetic field B directed along the negative z direction, extending from $x=a$ to $x=b$. The minimum value of v required so that the particle can just enter the region $x>b$ is

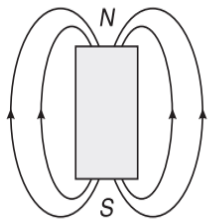
(A) $\dfrac{qbB}{m}$ (B) $\dfrac{q(b-a)B}{m}$

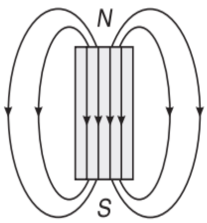
(C) $\dfrac{qaB}{m}$ (D) $\dfrac{q(b+a)B}{2m}$

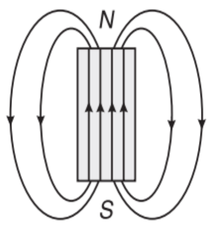
10. [IIT-JEE 2002]

The magnetic field lines due to a bar magnet are correctly shown in

(A)


(B)


(C)


(D)


11. [IIT-JEE 2002]

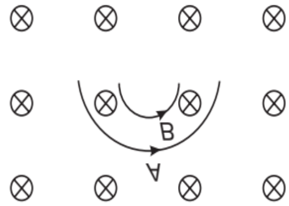
A long straight wire along the z-axis carries a current I in the negative z direction. The magnetic vector field $\vec{B}$ at a point having coordinates (x, y) on the $z=0$ plane is

(A) $\dfrac{\mu_0 I}{2\pi}\left(\dfrac{y\hat{i}-x\hat{j}}{x^2+y^2}\right)$ (B) $\dfrac{\mu_0 I}{2\pi}\left(\dfrac{x\hat{i}+y\hat{j}}{x^2+y^2}\right)$

(C) $\dfrac{\mu_0 I}{2\pi}\left(\dfrac{x\hat{j}-y\hat{i}}{x^2+y^2}\right)$ (D) $\dfrac{\mu_0 I}{2\pi}\left(\dfrac{x\hat{i}-y\hat{j}}{x^2+y^2}\right)$

12. [IIT-JEE 2001]

Two particles A and B of masses m_A and m_B respectively and having the same charge are moving in a plane. A uniform magnetic field exists perpendicular to this plane. The speed of the particles are v_A and v_B respectively and the trajectories are as shown in Figure. Then



(A) $m_A v_A < m_B v_B$

(B) $m_A v_A > m_B v_B$

(C) $m_A < m_B$ and $v_A < v_B$

(D) $m_A = m_B$ and $v_A = v_B$

13. [IIT-JEE 2001]

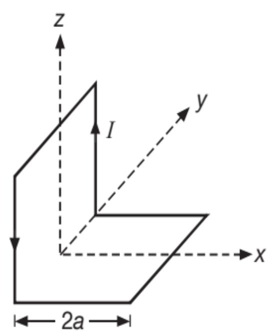
A coil having N turns is wound tightly in the form of a spiral with inner and outer radii a and b respectively. When a current I passes through the coil, the magnetic field at the centre will be

(A) $\dfrac{\mu_0 NI}{b}$ (B) $\dfrac{2\mu_0 NI}{a}$

(C) $\dfrac{\mu_0 NI}{2(b-a)}\log_e\left(\dfrac{b}{a}\right)$ (D) $\dfrac{\mu_0 NI}{(b-a)}\log_e\left(\dfrac{b}{a}\right)$

14. [IIT-JEE 2001]

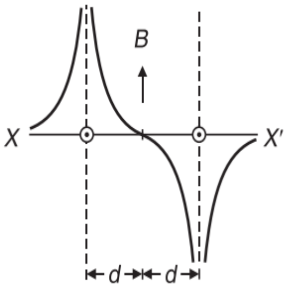
A non-planar loop of conducting wire carrying a current I is placed as shown in Figure. Each of the straight sections of the loop is of length $2a$. The magnetic field due to this loop at the point $P(a, 0, a)$ points in the direction

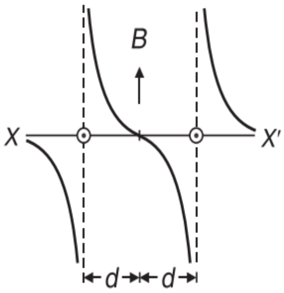


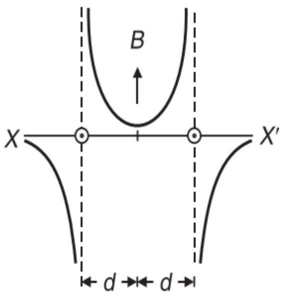
(A) $\dfrac{1}{\sqrt{2}}\left(-\hat{j}+\hat{k}\right)$ (B) $\dfrac{1}{\sqrt{3}}\left(-\hat{i}-\hat{j}+\hat{k}\right)$

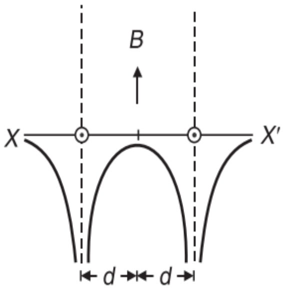
(C) $\dfrac{1}{\sqrt{3}}\left(\hat{i}+\hat{j}+\hat{k}\right)$ (D) $\dfrac{1}{\sqrt{2}}\left(\hat{i}+\hat{k}\right)$

15. [IIT-JEE 2000]
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 line XX' is given by

(A)


(B)


(C)


(D)


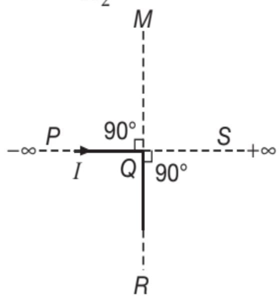
16. [IIT-JEE 2000]
A particle of charge q and mass m moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on

(A) ω and q (B) ω, q and m
(C) q and m (D) ω and m

17. [IIT-JEE 2000]
An ionised gas contains both positive and negative ions. If it is subjected simultaneously to an electric field along the $+x$ direction and a magnetic field along the $+z$ direction then,

(A) positive ions deflect towards $+y$ direction and negative ions towards $-y$ direction.
(B) all ions deflect towards $+y$ direction.
(C) all ions deflect towards $-y$ direction.
(D) positive ions deflect towards $-y$ direction and negative ions towards $+y$ direction.

18. [IIT-JEE 2000]
An infinitely long conductor PQR is bent to form a right angle as shown. A current I flows through PQR. The magnetic field due to this current carrying conductor at the point M is H_1. Now, another infinitely long straight conductor QS, is connected at Q so that the current is $\frac{1}{2}I$ in QR as well as in QS, the current in PQ remaining unchanged. The magnetic field at M is now H_2. The ratio $\frac{H_1}{H_2}$ is given by



(A) $\frac{1}{2}$ (B) 1
(C) $\frac{2}{3}$ (D) 2

19. [IIT-JEE 1999]
A circular loop of radius R, carrying current I, lies in x-y plane with its centre at origin. The total magnetic flux through x-y plane is

(A) directly proportional to I
(B) directly proportional to R
(C) inversely proportional to R
(D) ZERO

20. [IIT-JEE 1999]
A charged particle is released from rest in a region of steady and uniform electric and magnetic fields which are parallel to each other. The particle will move in a

(A) straight line (B) circle
(C) helix (D) cycloid

21. [IIT -JEE 1998]
Two very long, straight, parallel wires carry steady currents I and $-I$ respectively. The distance between the wires is d. At a certain instant of time, a point charge q is at a point equidistant from the two wires, in the plane

of the wires. Its instantaneous velocity $\vec{v}$ is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is

(A) $\frac{\mu_0 Iqv}{2\pi d}$ (B) $\frac{\mu_0 Iqv}{\pi d}$

(C) $\frac{2\mu_0 Iqv}{\pi d}$ (D) 0

22. [IIT-JEE 1998]
Two particles, each of mass m and charge q, are attached to the two ends of a light rigid rod of length $2R$. The rod is rotated at constant angular speed about a perpendicular axis passing through its centre. The ratio of the magnitudes of the magnetic moment of the system and its angular momentum about the centre of the rod is

(A) $\frac{q}{2m}$ (B) $\frac{q}{m}$

(C) $\frac{2q}{m}$ (D) $\frac{q}{\pi m}$

23. [IIT-JEE 1997]
A proton, a deuteron and an α-particle having the same kinetic energy are moving in circular trajectories in a constant magnetic field. If r_p, r_d and r_α denote respectively the radii of the trajectories of these particles, then

(A) $r_\alpha = r_p < r_d$ (B) $r_\alpha > r_d > r_p$

(C) $r_\alpha = r_d > r_p$ (D) $r_p = r_d = r_\alpha$

24. [IIT-JEE 1995]
A battery is connected between two points A and D on the circumference of a uniform conducting ring of radius r and resistance R. One of the arcs AD of the ring subtends an angle θ at the centre. The value of the magnetic induction at the centre due to the current in the ring is

(A) proportional to $(180° - \theta)$
(B) inversely proportional to r
(C) zero, only if $\theta = 180°$
(D) zero for all values of θ

25. [IIT-JEE 1993]
A current I flows along the length of an infinitely long, straight, thin-walled pipe. Then

(A) the magnetic field at all points inside the pipe is the same, but not zero
(B) the magnetic field at any point inside the pipe is zero
(C) the magnetic field is zero only on the axis of the pipe
(D) the magnetic field is different at different points inside the pipe

26. [IIT-JEE 1988]
Two particles X and Y having equal charges, after being accelerated through the same potential difference, enter a region of uniform magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of the mass of X to that of Y is

(A) $\left(\frac{R_1}{R_2}\right)^{\frac{1}{2}}$ (B) $\frac{R_2}{R_1}$

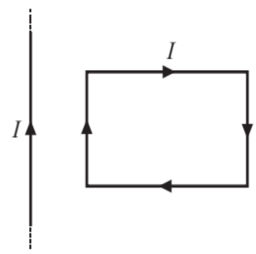
(C) $\left(\frac{R_1}{R_2}\right)^2$ (D) $\frac{R_1}{R_2}$

27. [IIT-JEE 1986]
Two thin long parallel wires separated by a distance b are carrying a current I ampere each. The magnitude of the force per unit length exerted by one wire on the other is

(A) $\frac{\mu_0 I^2}{b^2}$ (B) $\frac{\mu_0 I^2}{2\pi b}$

(C) $\frac{\mu_0 I}{2\pi b}$ (D) $\frac{\mu_0 I}{2\pi b^2}$

28. [IIT-JEE 1985]
A rectangular loop carrying a current I is situated near a long straight wire such that the wire is parallel to one of the sides of the loop and is in the plane of the loop. If steady current I is established in the wire as shown in Figure, the loop will



(A) rotate about an axis parallel to the wire
(B) move away from the wire
(C) move towards the wire
(D) remain stationary

29. [IIT-JEE 1983]
A conducting circular loop of radius r carries a constant current I. It is placed in a uniform magnetic field $\vec{B}_0$ such that $\vec{B}_0$ is perpendicular to the plane of the loop. The magnetic force acting on the loop is

(A) $2\pi Ir\vec{B}_0$ (B) $Ir\vec{B}_0$

(C) $\pi Ir\vec{B}_0$ (D) ZERO

30. **[IIT-JEE 1982]**

A magnetic needle is kept in a non-uniform magnetic field. It experiences

(A) a force and a torque

(B) a force but not a torque

(C) a torque but not a force

(D) neither a force nor a torque

Multiple Correct Choice Type Problems

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

1. **[JEE (Advanced) 2018]**

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?

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

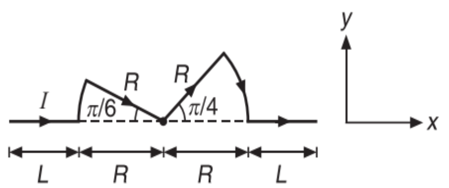
(B) If $I_1 > 0$ and $I_2 < 0$, then $\vec{B}$ can be equal to zero at the origin (0, 0, 0)

(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 $\left(-\frac{\mu_0 I}{2R}\right)$

2. **[JEE (Advanced) 2015]**

A conductor (shown in 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 statements is/are



(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 $\hat{z}$, $F = 0$

3. **[JEE (Advanced) 2013]**

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

(A) the direction of the magnetic field is $-z$ direction.

(B) the direction of the magnetic field is $+z$ direction.

(C) the magnitude of the magnetic field is $\frac{50\pi M}{3Q}$ units.

(D) the magnitude of the magnetic field is $\frac{100\pi M}{3Q}$ units.

4. **[JEE (Advanced) 2013]**

A steady current I flows along an infinitely long hollow cylindrical conductor of radius R. This cylinder is placed coaxially inside an infinite solenoid of radius $2R$. The solenoid has n turns per unit length and carries a steady current I. Consider a point P at a distance r from the common axis. The correct statement(s) is (are)

(A) In the region $0 < r < R$, the magnetic field is non-zero

(B) In the region $R < r < 2R$, the magnetic field is along the common axis

(C) In the region $R < r < 2R$, the magnetic field is tangential to the circle of radius r, centred on the axis

(D) In the region $r > 2R$, the magnetic field is non-zero

5. **[IIT-JEE 2012]**

Consider the motion of a positive point charge in a region where there are simultaneous uniform electric and magnetic fields $\vec{E} = E_0\hat{j}$ and $\vec{B} = B_0\hat{j}$. At time $t = 0$, this charge has velocity $\vec{v}$ in the x-y plane, making an angle θ with the x-axis. Which of the following option(s) is(are) correct for time $t > 0$?

(A) If $\theta = 0°$, the charge moves in a circular path in the x-z plane.

(B) If $\theta = 0°$, the charge undergoes helical motion with constant pitch along the y-axis

(C) If $\theta = 10^\circ$, the charge undergoes helical motion with its pitch increasing with time, along the y-axis.

(D) If $\theta = 90^\circ$, the charge undergoes linear but accelerated motion along the y-axis.

6. [JEE (Advanced) 2011]

An electron and a proton are moving on straight parallel paths with same velocity. They enter a semi-infinite region of uniform magnetic field perpendicular to the velocity. Which of the following statement(s) is/are true?

(A) They will never come out of the magnetic field region

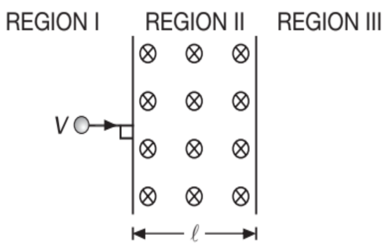
(B) They will come out travelling along parallel paths

(C) They will come out at the same time

(D) They will come out at different times

7. [IIT-JEE 2008]

A particle of mass m and charge q, moving with velocity V enters REGION II normal to the boundary as shown in the figure. REGION II has a uniform magnetic field B perpendicular to the plane of the paper. The length of the REGION II is l. Choose the correct choice(s)



(A) The particle enters REGION III only if its velocity $V > \dfrac{qlB}{m}$

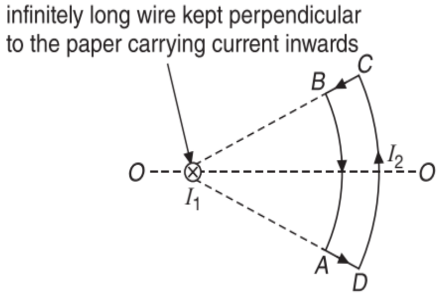
(B) The particle enters REGION III only if its velocity $V < \dfrac{qlB}{m}$

(C) Path length of the particle in REGION II is maximum when velocity $V = \dfrac{qlB}{m}$

(D) Time spent in REGION II is same for any velocity V as long as the particle returns to REGION I

8. [IIT-JEE 2006]

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

9. [IIT-JEE 1994]

H^+, He^+ and O^{++} all having the same kinetic energy pass through a region in which there is a uniform magnetic field perpendicular to their velocity. The masses of H^+, He^+ and O^{++} are $1\ \text{u}$, $4\ \text{u}$ and $16\ \text{u}$ respectively.

(A) H^+ will be deflected the most.

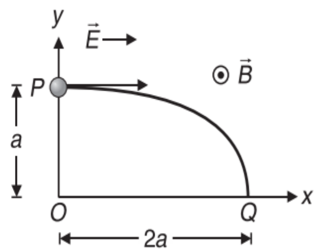
(B) O^{++} will be deflected the most.

(C) He^+ and O^{++} will be deflected equally.

(D) All will be deflected equally.

10. [IIT-JEE 1991]

A particle of mass m, charge q is moving under the influence of a uniform electric field $E\hat{i}$ and a uniform magnetic field $B\hat{k}$. It follows a trajectory from P to Q as shown. The velocities at P and Q are $v\hat{i}$ and $-2v\hat{j}$.



(A) $E = \dfrac{3}{4}\dfrac{mv^2}{qa}$

(B) The rate of work done by the electric field at P is $\dfrac{3}{4}\dfrac{mv^3}{a}$

(C) The rate of work done by the electric field at P is zero

(D) The rate of work done by both the fields at Q is zero

11. [IIT-JEE 1985]
A proton moving with a constant velocity passes through a region of space without any change in its velocity. If E and B represent the electric and magnetic fields respectively, this region of space may have

(A) $E=0$, $B=0$ (B) $E=0$, $B\neq 0$
(C) $E\neq 0$, $B=0$ (D) $E\neq 0$, $B\neq 0$

Reasoning Based Questions

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.
Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.
Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.
Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

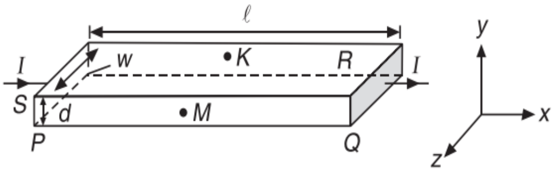
1. [IIT-JEE 2008]
Statement-1: The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.
Statement-2: Soft iron has a high magnetic permeability and cannot be easily magnetized or demagnetized.

Linked Comprehension Type Questions

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct. (For the sake of competitiveness there may be a few questions that may have more than one correct options)

Comprehension 1

In a thin rectangular metallic strip a constant current I flows along the positive x-direction, as shown in Figure. The length, width and thickness of the strip are l, w and d, respectively. A uniform magnetic field $\vec{B}$ is applied on the strip along the positive y-direction. Due to this, the charge carriers experience a net deflection along the z-direction. This results in accumulation of charge carriers on the surface $PQRS$ and appearance of equal and opposite charges on the face opposite to $PQRS$. A potential difference along the z-direction is thus developed. Charge accumulation continues until the magnetic force is balanced by the electric force. The current is assumed to be uniformly distributed on the cross section of the strip and carried by electrons.



1. [JEE (Advanced) 2015]
Consider two different metallic strips (1 and 2) of the same material. Their lengths are the same, widths are w_1 and w_2 and thicknesses are d_1 and d_2, respectively. Two points K and M are symmetrically located on the opposite faces parallel to the x-y plane (see figure). V_1 and V_2 are the potential differences between K and M in strips 1 and 2, respectively. Then, for a given current I flowing through them in a given magnetic field strength B, the correct statements is/are

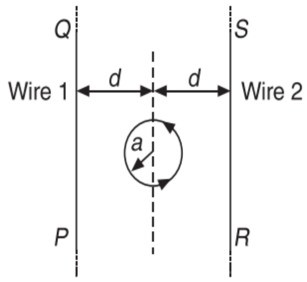
(A) If $w_1 = w_2$ and $d_1 = 2d_2$, then $V_2 = 2V_1$
(B) If $w_1 = w_2$ and $d_1 = 2d_2$, then $V_2 = V_1$
(C) If $w_1 = 2w_2$ and $d_1 = d_2$, then $V_2 = 2V_1$
(D) If $w_1 = 2\omega_2$ and $d_1 = d_2$, then $V_2 = V_1$

2. [JEE (Advanced) 2015]
Consider two different metallic strips (1 and 2) of same dimensions (length l, width w and thickness d) with carrier densities n_1 and n_2, respectively. Strip 1 is placed in magnetic field B_1 and strip 2 is placed in magnetic field B_2, both along positive y-directions. Then V_1 and V_2 are the potential differences developed between K and M in strips 1 and 2, respectively. Assuming that the current I is the same for both the strips, the correct options is/are

(A) If $B_1 = B_2$ and $n_1 = 2n_2$, then $V_2 = 2V_1$
(B) If $B_1 = B_2$ and $n_1 = 2n_2$, then $V_2 = V_1$
(C) If $B_1 = 2B_2$ and $n_1 = n_2$, then $V_2 = 0.5V_1$
(D) If $B_1 = 2B_2$ and $n_1 = n_2$, then $V_2 = V_1$

Comprehension 2

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.

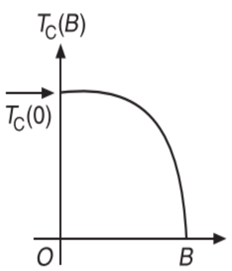


3. **[JEE (Advanced) 2014]**
When $d \approx a$ but wires are not touching the loop, it is found that the net magnetic field on the axis of the loop is zero at a height h above the loop. In that case
(A) current in wire 1 and wire 2 is the direction PQ and RS, respectively and $h \approx a$
(B) current 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 $h \approx 1.2a$
(D) current in wire 1 and wire 2 is the direction PQ and RS, respectively and $h \approx 1.2a$

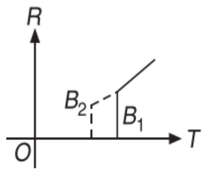
4. **[JEE (Advanced) 2014]**
Consider $d \gg a$ and the loop is rotated about its diameter parallel to the wires by $30°$ from the position shown in Figure. If the currents in the wires are in the opposite directions, the torque on the loop at its new position will be (assume that the net field due to the wires is constant over the loop)
(A) $\dfrac{\mu_0 I^2 a^2}{d}$ (B) $\dfrac{\mu_0 I^2 a^2}{2d}$
(C) $\dfrac{\sqrt{3}\mu_0 I^2 a^2}{d}$ (D) $\dfrac{\sqrt{3}\mu_0 I^2 a^2}{2d}$

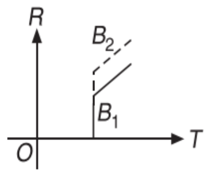
Comprehension 3

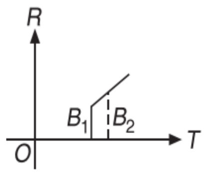
Electrical resistance of certain materials, known as superconductors, changes abruptly from a non-zero value to zero as their temperature is lowered below a critical temperature $T_C(0)$. An interesting property of superconductors is that their critical temperature becomes smaller than $T_C(0)$ if they are placed in a magnetic field i.e. the critical temperature $T_C(B)$ is a function of the magnetic field strength B. The dependence of $T_C(B)$ on B is shown in Figure.

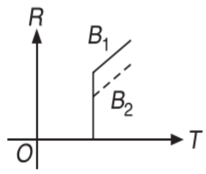


5. **[IIT-JEE 2010]**
In the graphs below, the resistance R of a superconductor is shown as a function of its temperature T for two different magnetic fields B_1 (solid line) and B_2 (dashed line). If B_2 is larger than B_1, which of the following graphs shows the correct variation of R with T in these fields?

(A)


(B)


(C)


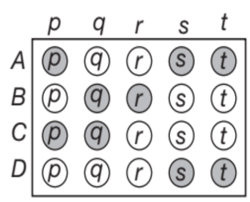
(D)


6. **[IIT-JEE 2010]**
A superconductor has $T_C(0) = 100$ K. When a magnetic field of 75 T is applied, its T_C decreases to 75 K. For this material one can definitely say that when (Note T = Tesla)
(A) $B = 5$ T, $T_C(B) = 80$ K
(B) $B = 5$ T, $75\text{ K} < T_C(B) < 100$ K
(C) $B = 10$ T, $75\text{ K} < T_C(B) < 100$ K
(D) $B = 10$ T, $T_C(B) = 70$ K

Matrix Match/Column Match Type Questions

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

If the correct matches are A → p, s and t; B → q and r; C → p and q; and D → s and t; then the correct darkening of bubbles will look like the following:



Directions (Question Numbers 1-4):
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 columns I, II and III, respectively. The quantities E_0, B_0 are positive in magnitude.

COLUMN-I	COLUMN-II	COLUMN-III
(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) $\vec{B} = B_0\hat{z}$

1. [JEE (Advanced) 2017]

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) (II) (iii) (q)
(C) (III) (ii) (r) (D) (III) (ii) (p)

2. [JEE (Advanced) 2017]

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

(A) (II) (iii) (s) (B) (III) (iii) (p)
(C) (IV) (i) (s) (D) (III) (ii) (r)

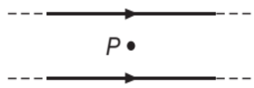
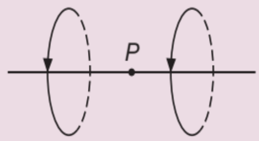
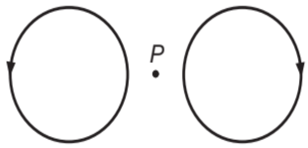
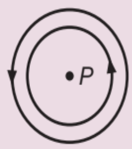
3. [JEE (Advanced) 2017]

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

(A) (II) (ii) (r) (B) (III) (iii) (p)
(C) (IV) (i) (s) (D) (IV) (ii) (r)

4. [IIT-JEE 2007]

Two wires each carrying a steady current I are shown in four configurations in **COLUMN-I**. Some of the resulting effects are described in **COLUMN-II**. Match the statements in **COLUMN-I** with the statements in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Point P is situated midway between the wires. 	(p) The magnetic field (B) at P due to the currents in the wires are in the same direction.
(B) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii. 	(q) The magnetic fields (B) at P due to the currents in the wires are in opposite directions.
(C) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii. 	(r) There is no magnetic field at P.
(D) Point P is situated at the common center of the wires. 	(s) The wires repel each other.

5. [IIT-JEE 2007]

COLUMN-I gives certain situations in which a straight metallic wire of resistance R is used and **COLUMN-II** gives some resulting effects. Match the statements in **COLUMN-I** with the statements in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) A charged capacitor is connected to the ends of the wire.	(p) A constant current flow through the wire.

(Continued)

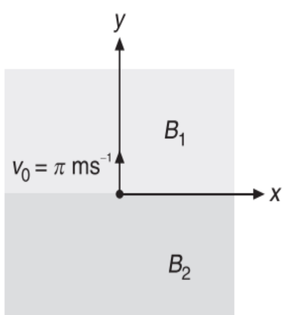
COLUMN-I	COLUMN-II
(B) The wire is moved perpendicular to its length with a constant velocity in a uniform magnetic field perpendicular to the plane of motion.	(q) Thermal energy is generated in the wire.
(C) The wire is placed in a constant electric field that has a direction along the length of the wire.	(r) A constant potential difference develops between the ends of the wire.
(D) A battery of constant emf is connected to the ends of the wire.	(s) Charges of constant magnitude appear at the ends of the wire.

Integer/Numerical Answer Type Questions

In this section, the answer to each question is a numerical value obtained after series of calculations based on the data provided in the question(s).

1. [JEE (Advanced) 2018]

In the xy-plane, the region $y > 0$ has a uniform magnetic field $B_1\hat{k}$ and the region $y < 0$ has another uniform magnetic field $B_2\hat{k}$. A positively charged particle is projected from the origin along the positive y-axis with speed $v_0 = \pi\ \text{ms}^{-1}$ at $t = 0$, as shown in 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_______.



2. [JEE (Advanced) 2018]

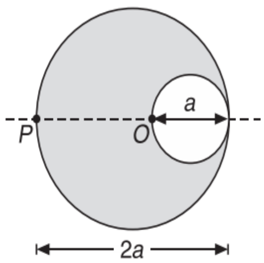
A moving coil galvanometer has 50 turns and each turn has an area $2 \times 10^{-4}\ \text{m}^2$. The magnetic field produced by the magnet inside the galvanometer is $0.02\ \text{T}$. The torsional constant of the suspension wire is $10^{-4}\ \text{Nmrad}^{-1}$. When a current flow through the galvanometer, a full-scale deflection occurs if the coil rotates by $0.2\ \text{rad}$. The resistance of the coil of the galvanometer is $50\ \Omega$. This galvanometer is to be converted into an ammeter capable of measuring current in the range $0 - 1.0\ \text{A}$. For this purpose, a shunt resistance is to be added in parallel to the galvanometer. The value of this shunt resistance, in ohms, is_______.

3. [JEE (Advanced) 2014]

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________.

4. [IIT-JEE 2012]

A cylindrical cavity of diameter a exists inside a cylinder of diameter $2a$ as shown in the figure. Both the cylinder and the cavity are infinitely long. A uniform current density J flows along the length. If the magnitude of the magnetic field at the point P is given by $\frac{N}{12}\mu_0 aJ$, then the value of N is



5. [IIT-JEE 2009]

A steady current I goes through a wire loop PQR having shape of a right angle triangle with $PQ = 3x$, $PR = 4x$ and $QR = 5x$. If the magnitude of the magnetic field at P due to this loop is $k\left(\frac{\mu_0 I}{48\pi x}\right)$, find the value of k.

ANSWER KEYS–TEST YOUR CONCEPTS AND PRACTICE EXERCISES

Test Your Concepts-I (Based on Force and Fleming's Left Hand Rule)

1. LT^{-1}
2. (a) 0
   (b) 0
   (c) $v^2\vec{B}$
3. 4
4. $0.33\ \text{ms}^{-2}$, along $-z$ axis
5. (a) $v_y = -48.6\ \text{ms}^{-1}$
   $v_x = -106\ \text{ms}^{-1}$
   (b) Yes, $v_z = 0$
   (c) $\frac{\pi}{2}$
6. $3.7\ \text{T}$, perpendicular to the initial velocity of the coin inwards.
7. $1.25\ \text{ms}^{-2}$
8. $\vec{B} = (-0.4\hat{j})\ \text{T}$
9. (a) $\frac{F_2}{qv_1}$, along $-y$ -direction
   (b) $F_1 = \frac{F_2}{\sqrt{2}}$
10. $3.8\hat{k}\ \text{ms}^{-2}$
11. 1.5 mT, 30° ccw from $+x$-axis
12. $F_x = 0$, $F_y = 2.49\times10^{-3}$ N, $F_z = 1.32\times10^{-3}$ N
13. $\sqrt{\ell^2 - \frac{1}{\left(\frac{4\pi^2}{gT_0^2} + \frac{2\pi qB}{mgT_0}\right)^2}}$

Test Your Concepts-II (Based on Charged Particle in a Magnetic Field)

2. Along $+z$ -axis.
3. Yes, No
4. (a) electron
   (b) electron
5. (a) 0.501 m
   (b) 45°
6. (a) 5.14 m
   (b) 1.72×10^{-6} s
   (c) 6.08×10^{-3} m
   (d) 0.0304 m
7. $\vec{v} = v_x\hat{i} + v_y\cos\left(\frac{eBt}{m}\right)\hat{j} - v_y\sin\left(\frac{eBt}{m}\right)\hat{k}$
8. 8
9. $\sin^{-1}\left(\frac{qBd}{mv}\right)$
10. $\frac{2\pi}{d}\left(\frac{2m_e\Delta V}{e}\right)^{1/2}$
11. $r_\alpha = r_d = \sqrt{2}r_p$
12. 115 keV
13. $\left(\sqrt{\frac{2qV}{m}}\right)\cos\theta$, $\frac{2\pi m}{qB}$, $\frac{2\pi\cos\theta}{B}\sqrt{\frac{2mV}{q}}$
14. $\frac{eB(b^2-a^2)}{2mb}$
15. (a) 5 cm , (b) $9\times10^6\ \text{ms}^{-1}$
16. $\left(\frac{m}{qB}\right)\sin^{-1}\left(Bd\sqrt{\frac{q}{2mV}}\right)$
17. 0.6 cm , 2.2 cm
18. (a) 3.7 mT , (b) 6.7 mT

Test Your Concepts-III (Based on Charged Particle in Magnetic and Electric Field)

1. (a) $(3.52\hat{i} - 1.6\hat{j})\times10^{-18}$ N
   (b) 24.4°
2. $244\ \text{kVm}^{-1}$
4. $\frac{25m}{2qE_0}$
5. $\sqrt{3}\left(\frac{mv_0}{qE}\right)$
6. $\frac{\varepsilon_0\ell B}{\sigma}$
8. $\frac{2\pi m}{qB_0}\left(v_0 + \frac{\pi E_0}{B_0}\right)$
9. $\frac{3}{4}\left(\frac{mv^2}{qa}\right)$, zero and $\frac{3}{4}\left(\frac{mv^3}{a}\right)$, zero and zero
10. $E = 0$, $B = 0$ OR $E = 0$, $B \neq 0$ OR $E \neq 0$, $B \neq 0$

Test Your Concepts-IV (Based on Biot Savart's Law and Applications)

1. (a) 6.3 μT
   (b) 2.3 μT
2. $n\left(\frac{\mu_0 I}{2\pi R}\right)\tan\left(\frac{\pi}{n}\right)$, $\frac{\mu_0 I}{2R}$
3. $2\sqrt{3}\times10^{-5}$ T, 2×10^{-5} T
4. $\frac{\mu_0 I}{2\pi R}(\pi-\theta+\tan\theta)$, $\odot$
5. $\frac{\mu_0 I}{8}\left(\frac{3}{a}+\frac{1}{b}\right)$, $\otimes$
6. $\frac{\mu_0 I}{4\pi}\left(\frac{3\pi}{2a}+\frac{\sqrt{2}}{b}\right)$, $\otimes$
7. $\left(\frac{\mu_0 I}{2\pi a}\right)\hat{k}$, $\frac{\mu_0 I}{8\pi a}(-\hat{j}+\hat{k})$, $\frac{\mu_0 I}{4\pi a}\left(1-\frac{1}{\sqrt{2}}\right)\hat{k}$
8. $\frac{\mu_0 I}{r}\left(\frac{1}{2}-\frac{1}{\pi}\right)$, inwards
9. $\frac{\mu_0 I}{4R}$, $\otimes$
10. $\frac{\mu_0 I}{4\pi R}\left(1+\frac{3\pi}{2}\right)$, $\otimes$
11. $\frac{\mu_0 I}{4\pi R}(2+\pi)$, $\otimes$
12. $\sqrt{2}\left(\frac{\mu_0 I}{4\pi\ell}\right)$
13. $-\left(\frac{\mu_0 I}{4\pi R}\right)(\pi\hat{i}+2\hat{k})$, $\frac{\mu_0 I}{4\pi R}\sqrt{\pi^2+4}$
14. $-\left(\frac{\mu_0 I}{4\pi R}\right)[(1+\pi)\hat{i}+\hat{k}]$, $\frac{\mu_0 I}{4\pi R}\sqrt{2+2\pi+\pi^2}$
15. $-\left(\frac{\mu_0 I}{4\pi R}\right)\left[\left(\frac{3\pi}{2}\right)\hat{i}+\hat{j}+\hat{k}\right]$, $\frac{\mu_0 I}{4\pi R}\sqrt{\frac{9\pi^2}{4}+2}$
16. 13 μT, along $-y$ axis
17. 12.5 T
18. (a) $I_2=2I_1$, out of the paper
    (b) $I_2=6I_1$, into the paper
19. (a) $y=1$ m, below wire 1
    (b) 14.4×10^{-3} N$(-\hat{j})$
20. $\frac{2\mu_0 Q\omega}{5\sqrt{5}\pi R}$
21. $\frac{qv\mu_0 I}{2\pi mg}$
22. $\frac{9\mu_0 I}{32R}$
23. $\frac{4}{\pi^2}\left(\sqrt{2}+\frac{1}{\sqrt{2}}\right)$
24. $y=\left(\frac{I_1}{I_2}\right)x$
25. $I=\left(\frac{\pi D}{R}\right)I_0 a$

Test Your Concepts-V (Based on Ampere's Circuital Law and Applications)

1. (a) $2\pi b\delta\left(1-e^{-a/\delta}\right)$
   (b) $B=\frac{\mu_0 I_0}{2\pi r}$
   (c) $I(r)=I_0\frac{\left(e^{r/\delta}-1\right)}{\left(e^{a/\delta}-1\right)}$
   (d) $B=\frac{\mu_0 I_0\left(e^{r/\delta}-1\right)}{2\pi r\left(e^{a/\delta}-1\right)}$
2. (a) $B=0$
   (b) $B=\frac{\mu_0 I\left(r^2-a^2\right)}{2\pi r\left(b^2-a^2\right)}$
   (c) $B=\frac{\mu_0 I}{2\pi r}$
3. (a) 6.34×10^{-3} Nm^{-1}, inwards
   (b) greatest at the outer surface.
4. $\mu_0(I_1+I_2-I_3)$
5. (a) $\frac{\mu_0 b r_1^2}{3}$
   (b) $\frac{\mu_0 b R^3}{3r_2}$
6. (a) $\mu_0\sigma v$
   (b) 0
   (c) $\frac{1}{2}\mu_0\sigma^2 v^2$, up
   (d) 3×10^8 ms^{-1}
7. (a) 0
   (b) $\frac{\mu_0 NI}{2\pi r_2}$
   (c) 4 mT
8. (a) $\frac{\mu_0 Ir}{2\pi a^2}$, (b) $\frac{\mu_0 I}{2\pi r}\left(\frac{c^2-r^2}{c^2-b^2}\right)$

9. ZERO, $\frac{\mu_0 I}{2\pi R}$, $\frac{\mu_0 I^2}{4\pi^2 R^2}$ (inwards)

10. $\frac{1}{2}\mu_0 n^2 I^2$

Test Your Concepts-VI (Based on Force on Current Carrying Conductor)

1. (a) $I(\vec{h}\times\vec{B})$, in the direction of $\vec{\ell}$

   (b) $j\ell B$

2. (a) a

   (b) 3.21 kg

3. 39.2 mT

4. $\frac{\lambda g}{I}\tan\theta$

5. 0.245 T, eastward

6. Force on ab is 0

   Force on bc is $BI\ell(-\hat{i})$

   Force on cd is $BI\ell(-\hat{k})$

   Force on da is $BI\ell(\hat{k}+\hat{i})$

7. $(2BIR)\hat{j}$, BIR

8. 0.588 T

9. 0.109 A, to the right.

10. $\frac{2\lambda g}{\sqrt{3}I}$

11. $\frac{\mu_0 I_0 I}{4\pi^2 r}$

12. $-3aB_0 I\hat{j}$

13. $\frac{\mu mg}{B\ell(\cos\phi-\mu\sin\phi)}$

Test Your Concepts-VII (Based on Magnetic Moment and Torque)

1. 3.7×10^{-24} Nm

2. $MB\left(1-\frac{1}{\sqrt{2}}\right)$

3. (a) 5.41×10^{-3} Am^2

   (b) 4.33×10^{-3} Nm

4. 9.98 Nm, CW sense

5. (a) 4°

   (b) 3.39×10^{-3} Nm

6. (a) 80×10^{-3} Nm

   (b) 0.104 Nm

   (c) 0.132 Nm

   (d) The circular loop experiences the largest torque

7. (a) 118 μNm

   (b) $-118\ \mu J \le U \le +118\ \mu J$

8. $\sqrt{\frac{4\pi iB}{m}}$

9. $I\left(\frac{\pi R^2}{4}\right)\hat{i}+I\left(\frac{R^2}{2}\right)\hat{j}+I(R^2)\hat{k}$

10. 1.71×10^{-7} Nmrad^{-1}

11. $\frac{neh}{4\pi m}$, $\frac{\mu_0\pi m^2 e^7}{8\varepsilon_0 h^5 n^5}$

12. $\vec{F}_{AB}=-\vec{F}_{CD}=-N(BI\ell\sin\theta)\hat{k}$

    $\vec{F}_{BC}=-\vec{F}_{DA}=N(BIb\sin\theta)\hat{j}$

    $\vec{\tau}=(\sqrt{2}NI\ell bB\cos\theta\sin\theta)\hat{k}$

13. $-(0.04\pi)\hat{k}$ Am^2, $0.18(\hat{i}-\hat{j})$ Nm

14. (a) $\mu_0\pi n I I_0 r^2$

    (b) $2\pi\sqrt{\frac{2m}{5\pi\mu_0 n I_0 I}}$

15. Zero, $(0.1\hat{i}+0.05\hat{j}+0.05\hat{k})$ Am^2, $(-0.1\hat{i}-0.4\hat{k})$ Nm

Test Your Concepts-VIII (Based on Force Between Current Carrying Conductors)

1. 2.7×10^{-5} N, towards left

2. (a) 1×10^{-5} T, out of the page

   (b) 8×10^{-5} N, towards first wire

   (c) 1.6×10^{-5} T, into the page

   (d) 8×10^{-5} N, towards second wire

3. 0.167 m, below the upper wire

4. 12 cm, left of wire 1

   2.4 A, down

5. $\frac{\mu_0 I_1 I_2 \ell}{2\pi}\ln\left(\frac{a+b}{a}\right)$

6. (a) 2.46 N, upwards

   (b) 107 ms^{-2}, upwards

7. 82 A

8. 3 A, 2.88×10^{-6} Nm^{-1}

Single Correct Choice Type Questions

1. A	2. C	3. D	4. B	5. B	6. D	7. D	8. B	9. D	10. D
11. D	12. D	13. B	14. A	15. C	16. A	17. D	18. A	19. C	20. D
21. D	22. C	23. A	24. D	25. B	26. C	27. C	28. D	29. D	30. D
31. A	32. D	33. A	34. C	35. C	36. C	37. D	38. C	39. D	40. B
41. C	42. D	43. A	44. A	45. C	46. C	47. D	48. A	49. D	50. A
51. A	52. C	53. C	54. D	55. A	56. C	57. A	58. D	59. D	60. A
61. D	62. D	63. B	64. C	65. C	66. D	67. B	68. C	69. A	70. C
71. C	72. A	73. D	74. B	75. C	76. A	77. D	78. B	79. B	80. B
81. C	82. C	83. A	84. B	85. C	86. D	87. C	88. C	89. A	90. A
91. B	92. B	93. A	94. B	95. A	96. C	97. B	98. B	99. C	100. C
101. B	102. D	103. A	104. B	105. B	106. B	107. D	108. D	109. C	110. D
111. A	112. C	113. C	114. C	115. D	116. D	117. D	118. D	119. B	120. C
121. D	122. B	123. B	124. B	125. C	126. B	127. D	128. C	129. C	130. D
131. C	132. A	133. A	134. A	135. B	136. B	137. C	138. B	139. D	140. D
141. B	142. D	143. D	144. C	145. D	146. C	147. B	148. A	149. B	150. C
151. B	152. C	153. B	154. C	155. B	156. A	157. A	158. B	159. C	160. D
161. B	162. D	163. D	164. B	165. A	166. C	167. C	168. B	169. B	170. A
171. D	172. D	173. A	174. B	175. B	176. C	177. C	178. B	179. B	180. B
181. B	182. B	183. B							

Multiple Correct Choice Type Questions

1. B, C, D	2. A, C	3. B, C	4. B, C, D	5. A, B, C
6. A, B, D	7. B, D	8. A, B, D	9. C, D	10. A, B, D
11. A, D	12. A, B, C, D	13. B, C, D	14. B, D	15. A, B, C, D
16. A, B, D	17. B, C	18. A, B, C, D	19. A, B, D	20. A, B, C, D
21. A, B, D	22. A, C	23. A, C	24. A, B, C	25. A, B, C
26. A, D	27. A, B	28. A, C	29. A, B, C	30. A, B, C
31. A, C	32. A, B, C	33. A, C, D	34. A, C	35. A, D
36. C, D	37. A, C, D	38. A, C	39. A, B, C	40. A, B, C, D
41. B, C	42. A, B	43. B, D	44. B, C, D	45. A, B, C
46. A, B	47. A, D	48. A, B, C, D	49. B, C,	50. A, C

Reasoning Based Questions

1. D	2. A	3. A	4. A	5. A	6. D	7. A	8. D	9. B	10. A
11. C	12. A	13. A	14. B	15. A	16. B	17. B	18. A	19. A	20. A
21. D	22. D	23. B	24. D	25. C	26. B	27. B	28. C	29. C	

Linked Comprehension Type Questions

1. B	2. A	3. C	4. C	5. C	6. C	7. A	8. D	9. A	10. B
11. D	12. A	13. D	14. D	15. B	16. C	17. C	18. A	19. D	20. A
21. B	22. C	23. D	24. B	25. C	26. C	27. C	28. B	29. D	30. D
31. A	32. B	33. B	34. B	35. C	36. B	37. D	38. B	39. C	40. B
41. A	42. D	43. B	44. C	45. A	46. A	47. A	48. B	49. A	50. A
51. B	52. C	53. B	54. D	55. B	56. C	57. B	58. A	59. B	60. D
61. B	62. A	63. C	64. B	65. C	66. B	67. B	68. B	69. C	70. C
71. B	72. B	73. B							

Matrix Match/Column Match Type Questions

1. A → (q)	B → (r)	C → (q)	D → (r)
2. A → (p, q)	B → (q)	C → (p, q, r)	D → (q, s)
3. A → (q)	B → (p, t)	C → (s)	D → (r)
4. A → (r)	B → (q)	C → (p)	D → (r)
5. A → (s)	B → (q)	C → (p)	D → (r)
6. A → (r)	B → (p)	C → (q, r)	D → (s)
7. A → (q)	B → (r)	C → (q)	D → (r)
8. A → (p, t)	B → (p, q, r)	C → (p)	D → (s)
9. A → (p, s)	B → (p, q)	C → (p, r)	D → (p, s)
10. A → (q, r)	B → (p)	C → (q, r)	D → (q)
11. A → (s)	B → (t)	C → (q)	D → (p)
12. A → (r)	B → (s)	C → (q)	D → (p)
13. A → (q)	B → (p)	C → (s, t)	D → (q)
14. A → (p, r, s)	B → (r, s)	C → (p, q, t)	D → (r, s)
15. A → (p, t)	B → (q, s, t)	C → (p, r, t)	D → (q)

Integer/Numerical Answer Type Questions

1. 37	2. 1.5	3. 400	4. 300	5. 5
6. 12	7. 2000	8. 1	9. 300	10. 2
11. 400	12. $x = 5, y = 12$	13. (a) 750, (b) 115	14. 5	15. 200
16. 12	17. 2	18. 1	19. 8	20. 5
21. 2	22. 256	23. 2	24. 3	25. 107
26. 25	27. 20	28. 7	29. 133	30. 1
31. 147	33. (a) 8, (b) 3, (c) 32, (d) 1920, (e) 5		33. 60	

ARCHIVE: JEE MAIN

1. B	**2.** C	**3.** A	**4.** A	**5.** D	**6.** A	**7.** C	**8.** A	**9.** B	**10.** B
11. B	**12.** B	**13.** B	**14.** D	**15.** D	**16.** D	**17.** A	**18.** D	**19.** *	**20.** B
21. D	**22.** B	**23.** B	**24.** C	**25.** C	**26.** A	**27.** A	**28.** B	**29.** A	**30.** A
31. A	**32.** D	**33.** D	**34.** D	**35.** A	**36.** A	**37.** D	**38.** B	**39.** A	**40.** D
41. A	**42.** C	**43.** C	**44.** D	**45.** A	**46.** C	**47.** A	**48.** A	**49.** D	**50.** A
51. B									

* No given option is correct

ARCHIVE: JEE ADVANCED

Single Correct Choice Type Problems

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

Multiple Correct Choice Type Problems

1. A, B, D	**2.** A, B, C	**3.** A, C	**4.** A, D	**5.** C, D
6. B, D	**7.** A, C, D	**8.** A, C	**9.** A, C	**10.** A, B, D
11. A, B, D				

Reasoning Based Questions

1. C

Linked Comprehension Type Questions

1. A, D	**2.** A, C	**3.** C	**4.** B	**5.** A	**6.** B

Matrix Match/Column Match Type Questions

1. C	**2.** A	**3.** C	
4. A → (q, r)	B → (p)	C → (q, r)	D → (q)
5. A → (q)	B → (r, s)	C → (s)	D → (p, q, r)

Integer/Numerical Answer Type Questions

1. 2	**2.** 5.5.6	**3.** 3	**4.** 5	**5.** 7