PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

MAGNETIC FIELD AND MAGNETIC FORCES

Illustration

1. A particle having mass m and charge q is released from the origin in a region in which electric field and magnetic field are given by

$\vec{B} = -B_0\vec{J}$ and $\vec{E} = E_0\vec{K}$.

Find the speed of the particle as a function of its z-coordinate.

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2. A charge $q = -4\mu C$ has an instantaneous velocity $\vec{v} = \left(2\hat{i} - 3\hat{j} + \hat{k}\right) \times 10^{6} ms^{-1}$ in a uniform magnetic field $\vec{B} = \left(2\hat{i} + 5\hat{j} - 3\hat{k}\right) \times 10^{-2} T$. What is the force on the charge?

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3. Doubly ionized helium ions are projected with a speed of $10 kms^{-1}$ in a direction perpendicular to a uniformmagnetic field of magnitude 1.0 T. Find (a) the force acting on an ion, (b) the radius of the circle in which it ciruclates and (c) the time taken by an ion to complete the circle.

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4. A stream of protons and deuterons in a vacuum chamber enters a uniform magnetic field. Both protons and deuterons have been subjected to same accelerating potential, hence the kinetic energies of the particles are the same. If the ion-stream is perpendicular to the magnetic field and the protons move in a circular path of radius 15 cm, find the radius of the path traversed by the deuterons. Given that mass of deuteron is twice that of a proton.

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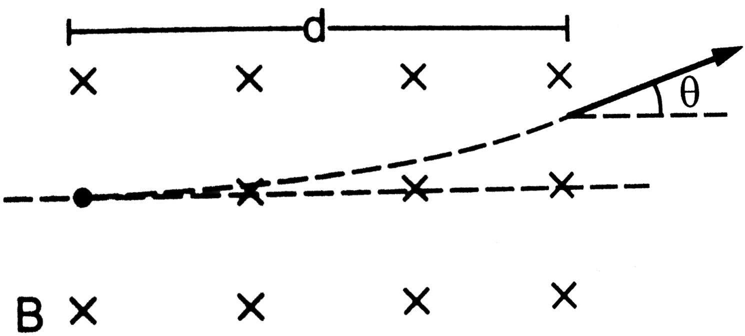
5. A particle of mass m and charge q is projected into a region having a perpendicular magnetic field B. Find the angle of deviation fo the particle as it comes out of the magnetic field if the width d of the regions is very smaller then



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6. An $\alpha -$ particle is accelerated by a potential difference of $10^4 V$. Find the change in its direction of motion, if it enters normally in a region of thickness 0.1 m having transverse magnetic induction of 0.1 tesla. (Given: mass of $\alpha -$ particle 6.4×10^{-27}kg).

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7. A charged particle of mass m and charge q is accelerated through a potential difference of V volts. It enters a region of uniform magnetic field which is directed perpendicular to the direction of motion of the particle. Find the radius of circular path moved by the particle in magnetic field.

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8. A beam of charged particle, having kinetic energy $10^3 eV$, contains masses $8 \times 10^{-27} kg$ and $1.6 \times 10^{-26} kg$ emerge from the end of an accelerator tube. There is a plate at distance $10^2 m$ from the end of the tube and placed perpendicular to the beam. Calculate the magnitude of the smallest magnetic field which can prevent the beam from striking the plate.

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9. A proton (charge $1.6 \times 10^{-19} C, mass = 1.67 \times 10^{-27} kg)$ is shot with a speed $8 \times 10^6 ms^{-1}$ at an angle of 30° with the X-axis. A uniform magnetic field $B = 0.30T$ exists along the X-axis. Show that path of the proton is a helix. Find the radius and pitch of the helix.

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10. An electron accelerated by a potential difference $V = 1.0kV$ moves in a uniform magnetic field at an angle $\alpha = 30^\circ$ to the vector B whose modulus is $B = 29mT$. Find the pitch of the helical trajectory of the electron.

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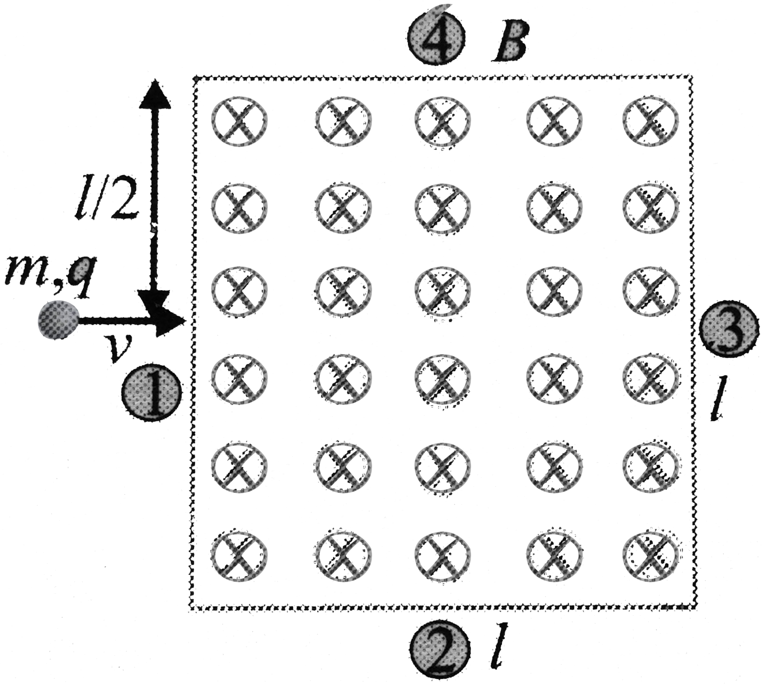
11. The magnetic field is confirmed in a square region. A positive charged particle of charge q and mass m the limiting velocities of the particles so that it may come out of face (1), (2), (3), and (4).



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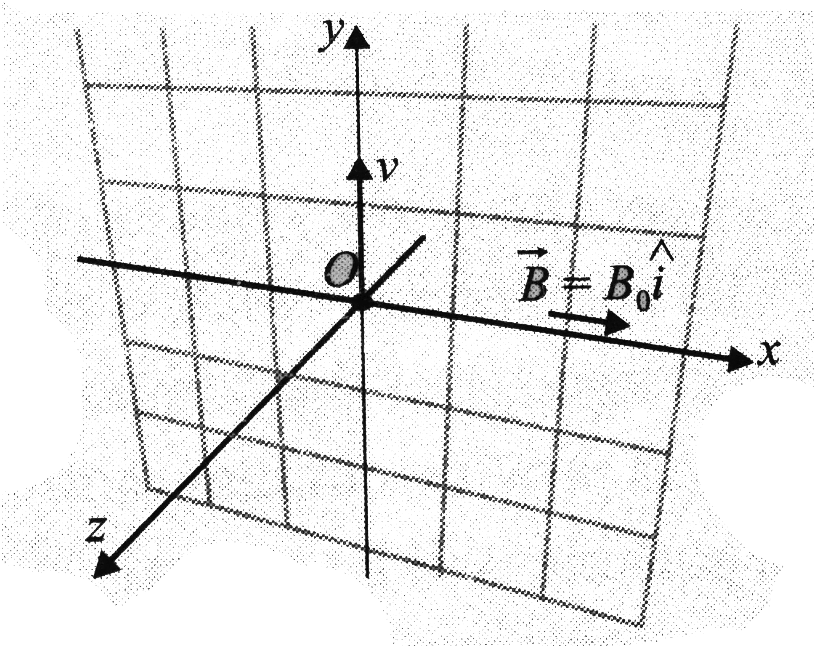
12. A charge particle of mass m and charge q is projected with velocity v along y-axis at $t = 0$.



Find the velocity vector and position vector of the particle $\vec{v}(t)$ and $\vec{r}(t)$ in relation with time.

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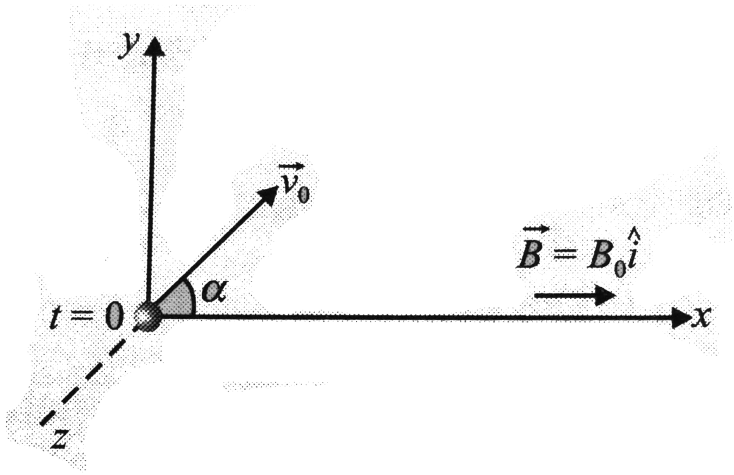
13. If in previous illustration, The charge particle is projected at angle α with x-axis with magnitude of velocity. Find

a. velocity vector in function of time $\vec{v}(t)$.

b. position vector in function of time $\vec{r}(t)$.



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14. An electron accelerated by a potential difference 2.5 kV moves horizontally into a region of space in which there is a downward directed uniform electric field of magnitude $10kVm^{-1}$.

(a) In what direction must a magnetic field be applied so that the electron moves undeflected? Ignore the gravitational force. What is the magnitude of the smallest magnetic field possible in this case?

(b) What happens if the charge is a proton that passes through the same combination of fields ?

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15. A proton beam passes without deviation through a region of space, where there are uniform tranverse mutully perpendicular electric and magnetic field with E = 220 kV/m and B = 50 mT.Then the beam strikes a grounded target.Find the force imparted by the beam on the target, if beam current is equal to i = 0.80 mA

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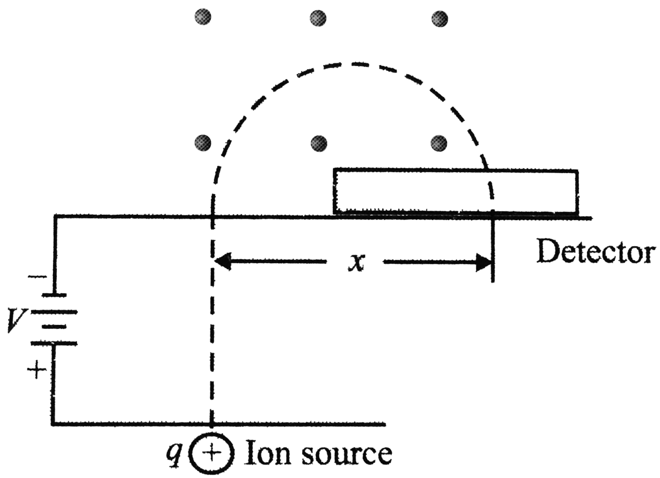
16. A mass spectrometer separates ions according to their ratio of charge to mass. Such devices are widely used in silence and engineering to analyze unknown mixtures and to separate isotopes of chemical elements. Figure 1.24 shows ions of charge q and mass m first being accelerated from rest through a potential difference V and then entering a region of uniform magnetic field B pointing out of the page. Only the magnetic force acts on the ions in this region, so they undergo circular motion and, after half an orbit, land on a detector. Find an expression for the horizontal distancexxfrom the entrance slit to the point where an ion lands on the detector.



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

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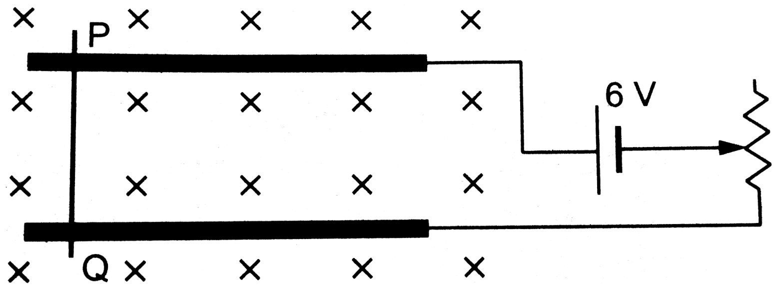
18. A matel wire PQ of mass 10g lies at rest on two horizontal metal rails separated by 4.90 cm . A vertically downward magnetic field of magnitude 0.800 T exists in the space. The resistance of the circuit is slowly decreased and it is found that when the resistance goes below20.0Ω, the wire PQ starts sliding on the rails. Find the coefficient of friction.



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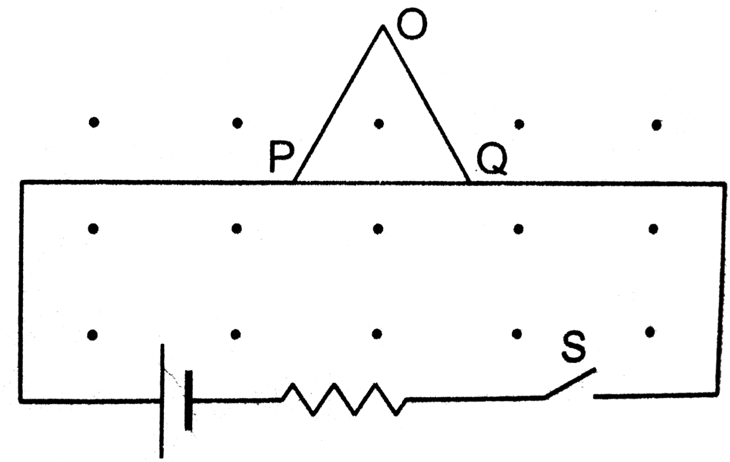
19. Shows a rod PQ of length 20.0 cm and mass 200g suspended through a fixed point O by two threads of lengths 20.0 cm each. A magnetic field of strenght 0.500 T exists in the vicinity of the wire PQ as shown in the figure. The exists in the vicinity of the wire PQ as shown in the figure. The wires conecting PQ with the battery are loose and exert no force on PQ. (a) find the tension in the threads when the switch S is open. (b) A current of 2.0 A is established when the switch S is closed. Find the tension in the threads now.



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20. The magnetic field existing in a region is given by

$$B = B_0\left[1 + \frac{x}{l}\right]\hat{k}$$

A square loop of edge l and carrying current I is placed with its edges parallel to the X and Y-axes. The magnitude of the net magnetic force experienced by the loop is

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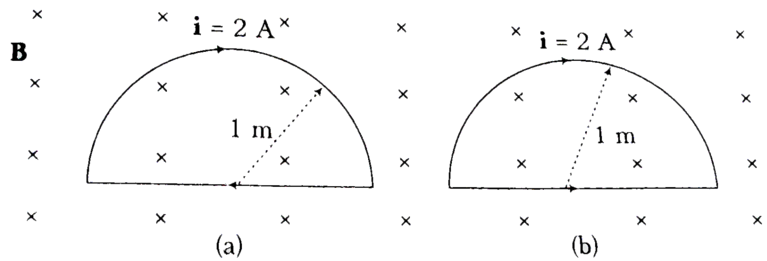
21. In the figure shown a semicircular wire loop is placed in a uniform magnetic field B = 0.1 T.The plane loop in a uniform magnetic field Current I = 2 A flows in the loop in the direction force in both the (a) amd (b) . The redius of the loop 1.0 m



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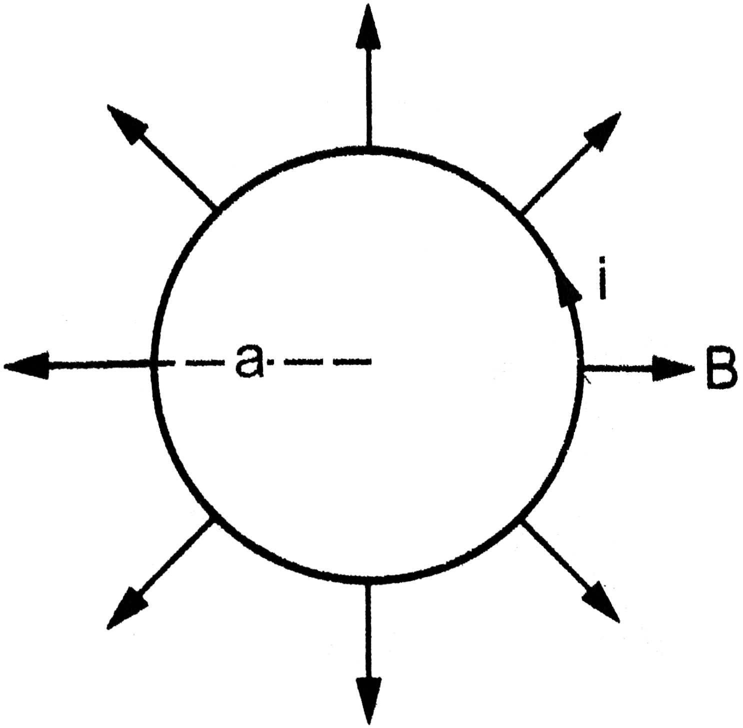
22. A circular loop of radius a, carrying a current I, is placed in a tow dimensional magnetic field. The centre of the loop coincides with the centre of the filed The strenght of the magnetic field at the pariphery of the loop is B. find the magnetic force on the wire.



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23. A hypthetical magnetic field existing in a region is given by $\vec{B} = B_0 \vec{e}_r$, where $\vec{e}_r$ denotes the uit vector along the redial direction. A circular loop of radus a, carrying a current I, is placed with its plane parallel to the x-y plane and the centre at (0,0, d) .Find the magnitude of the magnetic force acting on the loop.

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24. A conducting wire of length l is placed on a rough horizontal surface, where a uniform horizontal magnetic field B perpendicular to the length of the wire exists. Least values of the forces required to move the rod when a current I is established in the rod are observed to be F_1 and $F_2(< F_1)$ for the two possible directions of the current through the rod, respectively. Find the weight of the rod and the coefficient of friction between the rod and the surface.

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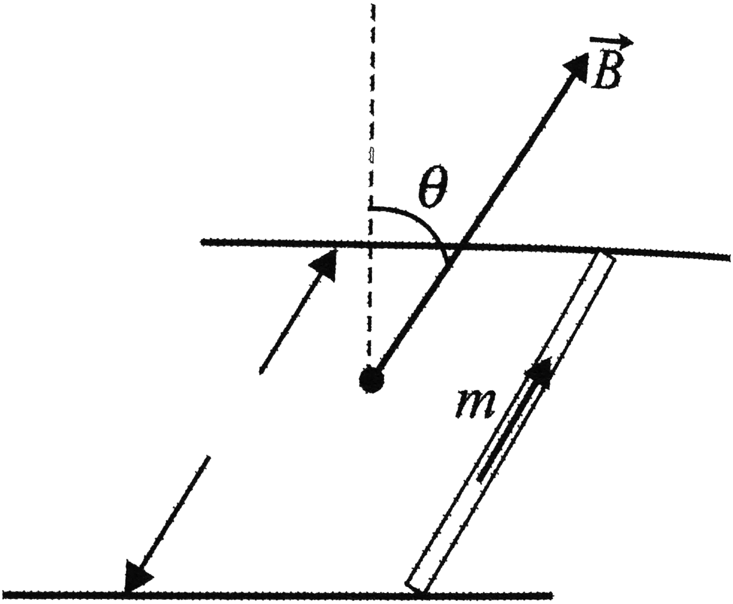
25. A conductor (rod) of mass m, length l carrying a current i is subjected to a magnetic field of induction B. If the coefficients of friction between the conducting rod and rail is μ, find the value of I if the rod starts sliding.



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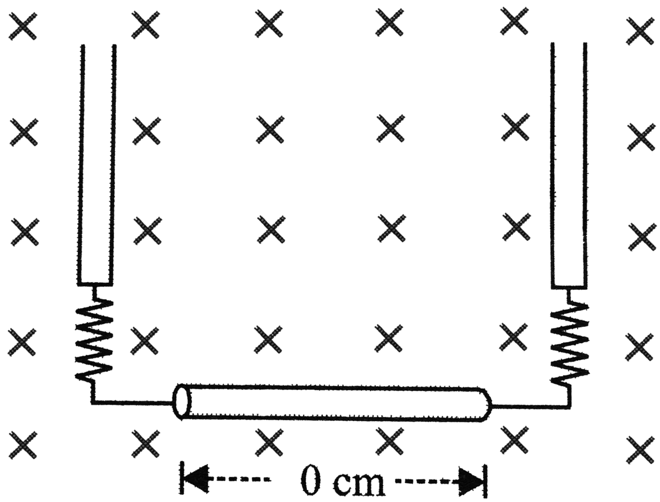
26. A wire of 60 cm length and mass 16 gm is suspended by a pair of flexible leads in a magnetic field of induction 0.40 T. What are the magnitude and direction of the current required to remove the tension in the supporting leads?



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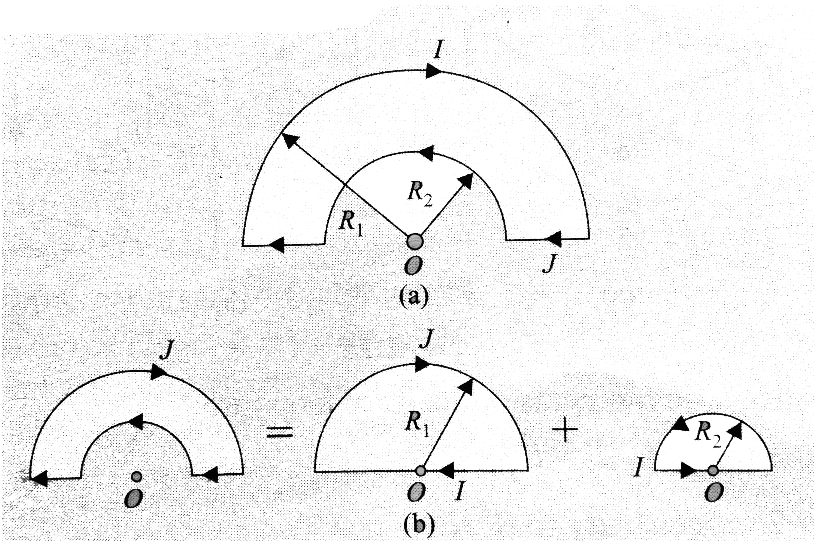
27. Compute the magnetic dipole moment of the loop shown in Fig. 1.69



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28. A circular loop of wire of radius R is bent about its diameter along two mutually perpendicular planes as shown in Fig. If the loop carries a current I, then determine its magnetic moment.

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29. A conductor carries a constant current I along the closed path abcdefgha involving 8 of the 12 edges of length l. Find the magnetic dipole moment of the closed path.

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30. Consider a nonconducting plate of radius r and mass m which has a charge q distributed uniformly over it. The ring is rotated about its axis with an angular speed ω Show that the magnetic moment μ and the angular momentum I of the plate are rlated as $\mu = \frac{q}{2m}l.$

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31. A coil in the shape of an equilateral triangle of side 0.02 m is suspended from a vertex such that it is hanging in a vertical plane between the pole pieces of a permanent magnet producing a horizontal magnetic field of $5 \times 10^{-2} T$. Find the couple acting on the coil when a current of 0.1 A is passed through it and the magnetic field is parallel to its plane.

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32. A circular coil of wire 8 cm in diameter has 12 turns and carries a current of 5 A. The coil is in a field where the magnetic induction is 0.6 T.

a. What is the maximum torque on the coil?

b. In what position would the torque be half as great as in (i) ?

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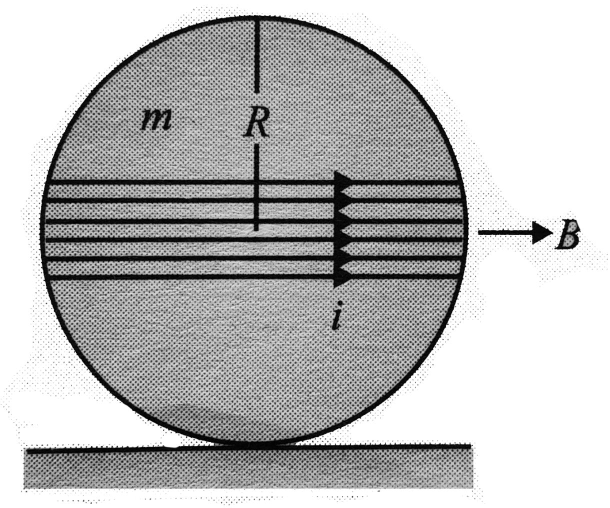
33. A wire is wrapped N times over a solid sphere of mass m which is place on a smooth horizontal surface. A horizontal magnetic field of induction $\vec{B}$ is present. Find the (a) torque (b) angular acceleration experienced by the sphere. Assume that the mass of the wire is negligible compared to the mass of the sphere.



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34. A galvanometer having 30 divisions has current sensitivity of $20\mu A / \text{division}$. Find the maximum current it can measure.

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35. A rectangular coil of area $5.0 \times 10^{-4} m^2$ and 60 turns is pivoted about one of its vertical sides. The coil is in a radial horizontal field of 90 G (radial here means the field liners are in the plane of the coil for any rotation). What is the torsional constant of the hair spring connected to the coil if a current of 2.0 mA produces an angular deflection of 18°?

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36. The coil of a galvanometer is $0.02 \times 0.8 m^2$. It consists of 200 turns of the wire and is in a magnetic field of 0.20 T. The restoring torque constant of suspension fibre is $10^{-5} Nm / degree$. Assuming magnetic field to be radial

(a) What is the maximum current that can be measured by this galvanometer if scale can accommodate 45° deflection?

(b) What is the smallest current that can be detected if minimum observed deflection is 0.1°?

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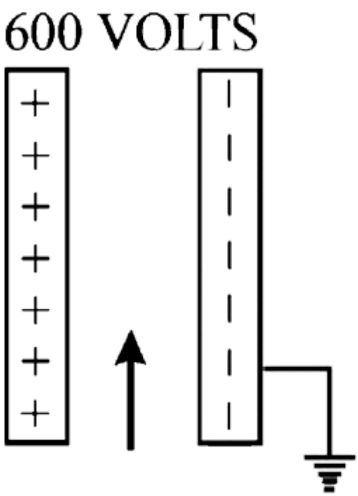
Solved Example

1. A potential difference of $600vo < s$ is applied across the plates of a parallel plate consenser . The separation between the plates is $3mm$. An electron projected vertically, parallel to the plates , with a velocity of $2 \times 10^6 m / \sec$ moves underflected between the plates. Find the magnitude and direction of the magnetic field in the region between the condenser plates. (Neglect the edge effects). (Charge of the electron `= -1.6xx10^(-19) coulomb)



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2. A particle of mass $1 \times 10^{-26} kg$ and charge $+1.6 \times 10^{-19} C$ travelling with a velocity $1.28 \times 10^{6} ms^{-1}$ in the $+x$ direction enters a region in which uniform electric field E and a uniform magnetic field of induction B are present such that $E_x = E_y = 0, E_z = -102.4 kVm^{-1}$, and $B_x = B_z = 0, B_y = 8 \times 10^{-2}$. The particle enters this region at time $t = 0$. Determine the location (x,y,z coordinates) of the particle at $t = 5 \times 10^{-6} s$. If the electric field is switched off at this instant (with the magnetic field present), what will be the position of the particle at $t = 7.45 \times 10^{-6} s$?

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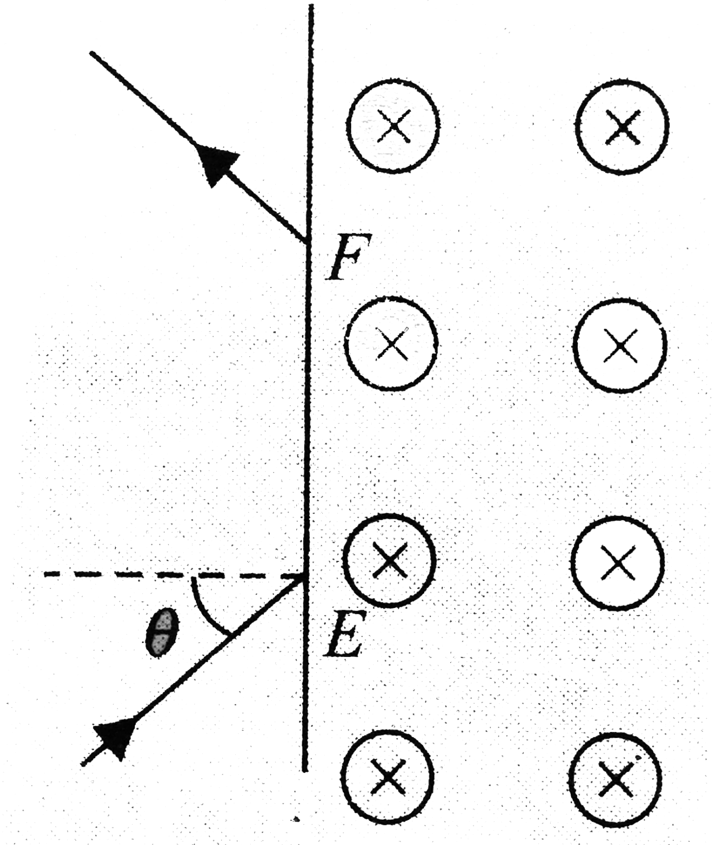
3. A particle of mass m and charge +q enters a region of magnetic field with a velocity v, as shown in Fig. 1.93.

a. Find the angle subtended by the circular arc described by it in the magnetic field.

b. How long does the particle stay inside the magnetic field?

c. If the particle enters at E, what is the intercept EF?



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4. A beam of proton with a velocity of $4 \times 10^5 ms^{-1}$ enters a uniform magnetic field of 0.3 T at an angle of 60° to the magnetic field/The radius of helical path taken by proton beam is

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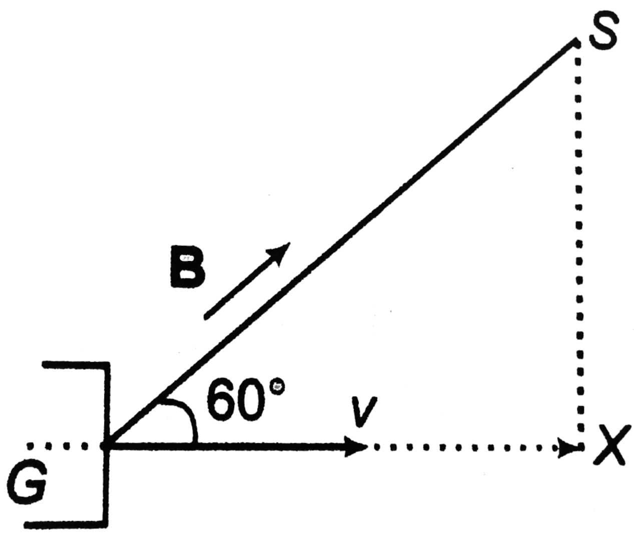
5. An electron gun G emits electons of energy $2keV$ travelling in the positive x-direction. The electons are required to hit the spot S where $GS = 0.1m$, and the line GS makes an angle of 60° with the x-axis as shown in figure. A uniform magnetic field B parallel to GS exists in the region outside the electron gun.



find the minimum value of B needed to make the electrons hit S.

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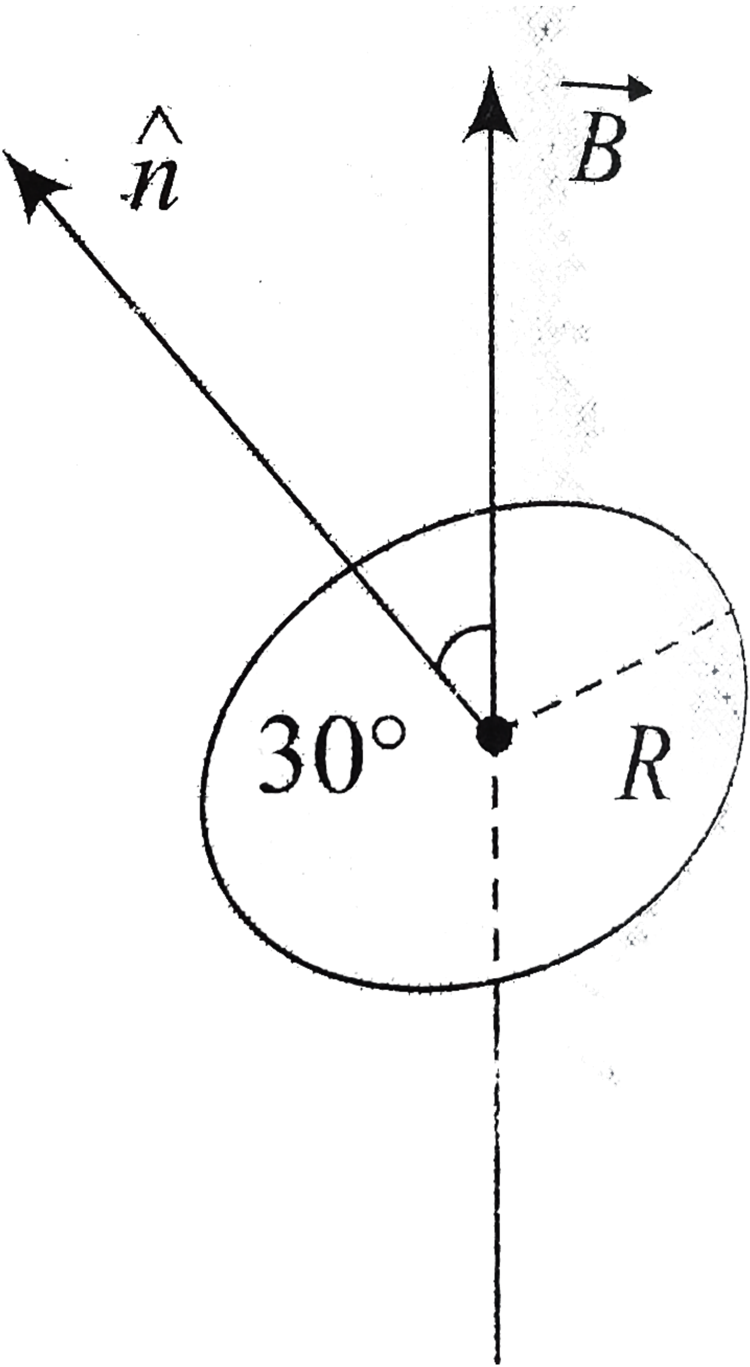
6. An electron in the ground state of hydrogen atom is removing in unanticlockwise direction in a circle orbit of radius R



a. Obtain an expression for the orbital magnetic dipole moment of the electron .

b. The atom is placed in a uniform magnetic indution $\overline{B}$ such that the plane normal to the electron orbitmakes an angle of 30° with the magnetic induction. Find the tarque experienced by the orbiting electron .

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7. A particle of mass m and charge q is moving in a region where uniform, constant electric and mangetic fields $\overrightarrow{E}$ and $\overrightarrow{B}$ are present. $\overrightarrow{E}$ and $\overrightarrow{B}$ are parallel to each other. At time $t = 0$, the velocity $\overrightarrow{v}_0$ of the particle is perpendicular to $\overrightarrow{E}$ (Assume that its speed is always $< < c$, the speed of light in vacuum). Find the velocity $\overrightarrow{v}$ of the particle at time t. You must express your answer in terms of $t, q, m,$ the vector $\overrightarrow{v}_0, \overrightarrow{E}$ and $\overrightarrow{B}$ and their magnitudes $\overrightarrow{v}_0, \overrightarrow{E}$ and $\overrightarrow{B}$.

8. A uniform constant magnetic field B is directed at an angle of 45° to the $xa\xi s$ in the xy- plane . $PQRS$ is a rigid, square wire frame carrying a steady current I_0, with its centre at the origin O. At time $t=0$, the frame is at rest in the position as shown in figure , with its sides parallel to the x and y axis. Each side of the frame is of mass M and length L.

(a) What is the torque τ about O acting on the frame due to the magnetic field?

(b) Find the angle by which the frame rotates under the action of this torque in a short interval of time Δt, and the axis about this rotation occurs .

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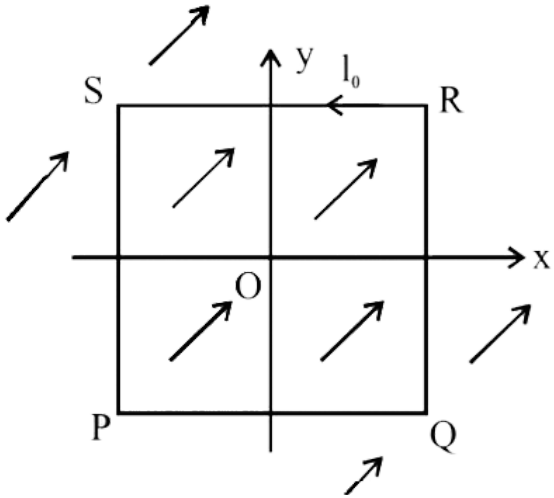
(4)/(3) ML^(2)`.



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9. The region between $x = 0$ and $x = L$ is filled with uniform steady magnetic field $B_0 \hat{k}$. A particle of mass m, positive charge q and velocity $v_0 \hat{i}$ travels along x-axis and enters the region of the magnetic field. Neglect the gravity throughout the question.

a. Find the value of l if the particle emerges from the region of magnetic field with its final velocilty at an angel 30° to its initial velocity.

b. Find the final velocity of the particle and the time spent by it in the magnetic field, if themagnetic field now extends upto 2.1L.

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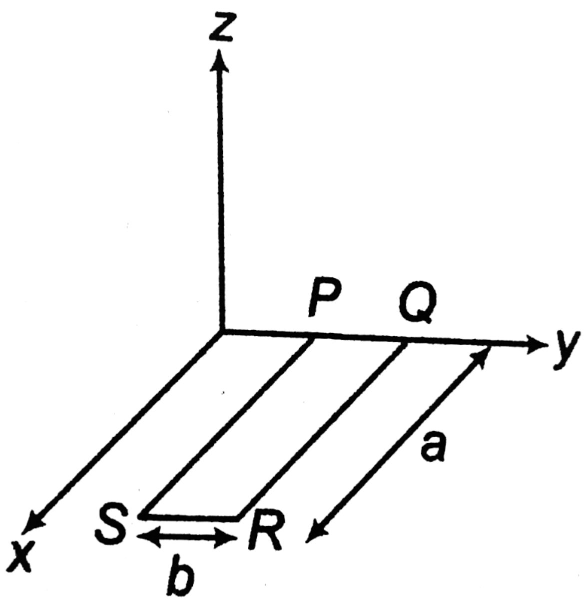
10. A rectangular loop $PQRS$ made from a uniform wire has length a, width b and mass m.It is free to rotate about the arm PQ which remasins hinged along a horizontal line taken as the y-axis (see figure). Take the vertically upward direction as the z-axis. A uniform magnetic fiedl $B=\left(3\hat{i}+3\hat{k}\right)B_0$ exists in the region. The lop is held in the xy-plane and a current I is passed through it. The loop in now released and is found to stay in the horizontal position in equilibrium.



a. What is the direction of the current I in PQ?

b. Find the magnetic force on the arm RS.

c. Find the expression for I in terms of B_0, a, b and m.

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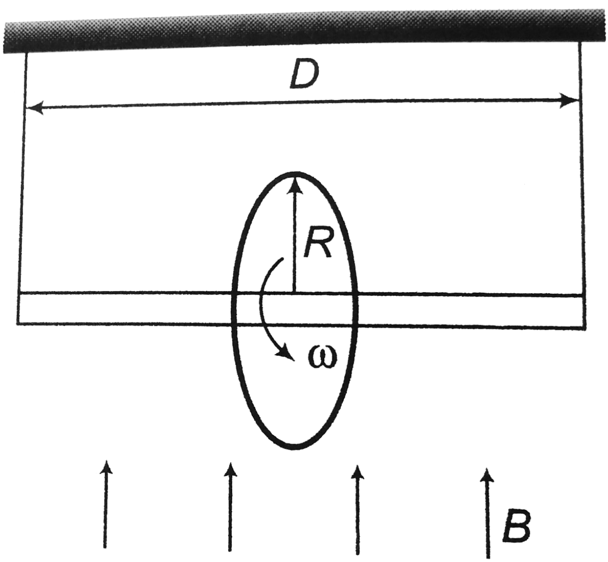
11. A ring of radius R having uniformly distributed charge Q. is mounted on a rod suspended by two identical strings. The tension in strings in equilibrium is T_0. Now, a vertical magnetic field is switched on and ring is rotated at constant angular velocity co. Find the maximum value of co h which the ring can be rotated if the strings can withstand a maximum tension of $\frac{3T_0}{2}$



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12. In a moving coil galvanometer, torque on the coil can be experessed as $\tau = ki$, where i is current through the wire and k is constant . The rectangular coil of the galvanometer having number of turns N , area A and moment of interia I is placed in magnetic field B. Find

(a) k in terms of given parameters $N, I, A \text{ and } B$

(b) the torsion constant of the spring , if a current i_0 produces a deflection of $(\pi)/(2)$ in the coil .

(c) the maximum angle through which the coil is deflected, if charge Q is passed through the coil almost instaneously. (ignore the daming in mechinal oscillations).

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13. A slightly divergent beam of charged particles accelerated by a Potential difference V propogates from a point A along the axis of a solenoid. The beam is brought into focus at a distance l from the point A at two successive values of magnetic induction B_1 and B_2. Find the specific charge q/m of the particles.

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14. A small charged ball having mass m and charge q is suspended from a rigid support by means of an inextensible thread of length l. It is made to rotate on a horizontal circular path in a uniform, time independent magnetic field of induction B which is directed upward. The time period of revolution of the ball is T_0. If the thread is always stretched, calculate the radius of circular path on which the ball moves.

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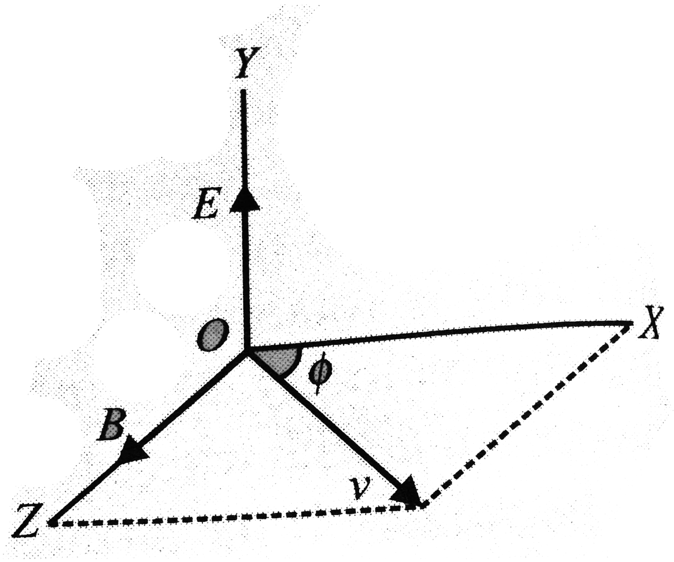
15. Non-relativistic protons move reactilinearly in the region of space where there are uniform mutually perpendicular electric and magnetic fields with E and B. The trajectory of the protons lie in the plane X-Y as shown in Fig. 1.107 and forms an angle ϕ with X-axis. Find the pitch of the helical trajectory along which the protons will move after the electric field is switched off.



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16. A current i, indicated by the crosses in figure, is established in a strip of copper of height h and width w. A uniform field of magnetic induction B is applied at right angle to the strip.

(a) Calculate the drift velocity v_d of the electrons.

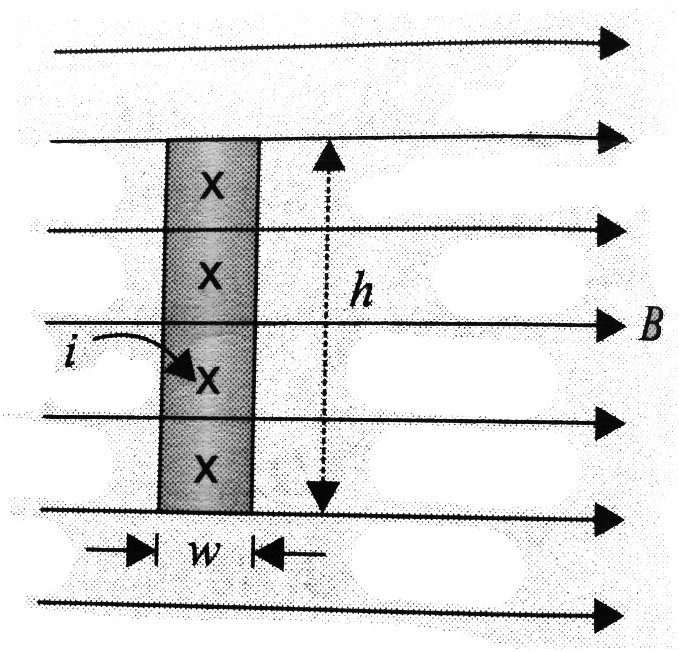
(b) What are the magnitude and direction of the magnetic force F acting on the electrons?

(c) What should the magnitude and direction of a homogeneous electric field E be in order to counterbalance the effect of mangetic field?

(d) Calculate voltage V necessary between two sides of the conductor in order to creat this field E Between which sides of the conductor would this voltage have to be applied?

(e) If no electric field is applied from the outside, the electrons will be pushed somewhat to one side and therefore will give rise to a uniform electric field E_H across the conductor until the forces of this electrostatic field E_H balance the magnetic forces encountered in part (b). What will be the magnitude and direction of field E_H?

Assume that n, the number of conductor electrons per unit volume is $1.1 \times 10^{29} m^{-3}$, $h = 0.02m$, $w = 0.1cm$, $i = 50A$, and $B = 2T$.



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17. A straight conductor of weight 1 N and length 0.5 m, is located in a plane making an angle 30° with the horizontal so that it is perpendicular to a uniform mangetic field of induction $B = 0.109T$. Given that the conductor carries a current of 10 A away from the reader, and coefficient of static friction is 0.1, find the force needed to be applied parallel to the plane to sustain the conductor at rest.

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18. There is a constant homogeneous electric field of $100Vm^{-1}$ within the region $x = 0$ and $x = 0.167m$ pointing in x-direction. There is a constant homogeneous mangetic field B within the region $x = 0.167m$ and $x = 0.334m$ pointing in the z-direction. A proton at rest at the origin is released in positive x-direction. Find the minimum strength of the magnetic field B, so that the proton is detected back at $x = 0, y = 0.167m$. (mass of proton $= 1.67 \times 10^{-27}kg)$

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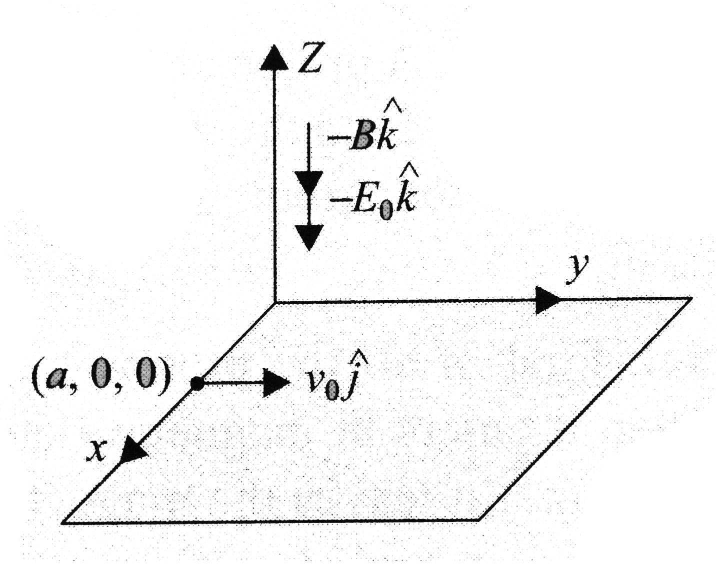
19. A positively charged particle of mass m and charge q is projected on a rough horizontal x-y plane surface with z-axis in the vertically upward direction. Both electric and magnetic fields are acting in the region and given by $\vec{E} = -E_0\hat{k}$ and $\vec{B} = -B_0\hat{k}$, respectively. The particle enters into the field at $(a_0, 0, 0)$ with velocity $\vec{v} = v_0\hat{j}$. The particle starts moving in some curved path on the plane. If the coefficient of friction between the particle and the plane is μ. Then calculate the

(a) time when the particle will come to rest

(b) distance travelled by the particle when it comes to rest.



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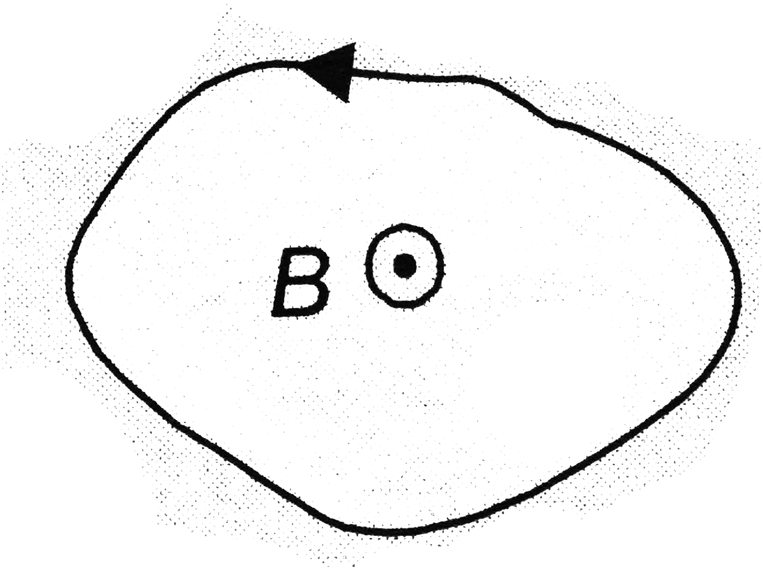
20. A loop of flexible conducting wire of length 0.5 m lies in a magnetic field of 1.0 T perpendicular to the plane of the loop. Show that when a current as shown in Fig. 1.112 is passed through the loop, it opens into a circle. Also calculate the tension developed in the wire if the current is 1.57 A.



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21. A circular coil of 100 turns has an effective radius of 0.05 m and carries a current of 0.1 A. How much work is required to turn it in an external magnetic field of $1.5Wbm^{-2}$ through 180° about an axis perpendicular to the magnetic field. The plane of the coil is initially perpendicular to the magnetic field.

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22. A positively charged particle of charge $1C$ and mass $40g$, is revolving along a circle, of radius $40cm$ with velocity $5\frac{m}{s}$ in a uniform magnetic field with centre at origin O in xy-plane. At $t=0$, the particle was at ($0, 0.4m, 0$) and velocity was directed along positive x-direction. Another particle having charge $1C$ and mass $10g$ moving uniformly parallel to z-direction 40 with velocity $\frac{40}{\pi}\frac{m}{s}$collides with revolving particle at $t=0$ andgets stuck with it. Neglecting $7C$ gravitational force and colombians force, calculate x, y and z-coordinates of the combined particle at $t=\frac{\pi}{40}\sec$

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23. An electron accelerated by a potential difference $V = 3$ volt first enters into a uniform electric field of a parallel plate capacitor whose plates extend over a length $l = 6cm$ in the direction of initial velocity. The electric field is normal to the direction of initial velocity and its strength varies with time as $E = \alpha t$, where $\alpha = 3600 V m^{-1} s^{-1}$. Then the electron enters into a uniform magnetic field of induction $B = \pi \times 10^{-9} T$. Direction of magnetic field is same as that of the electric field. Calculate pitch of helical path traced by the electron in the magnetic field. (Mass of electron, $m = 9 \times 10^{-31} kg$)

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24. A particle having mass m and charge q is released from the origin in a region in which ele field and magnetic field are given by $B = -B_0 \hat{j}$ and $E = E_0 \hat{k}$.

Find the y- component of the velocity and the speed of the particle as a function of it z-coordinate.

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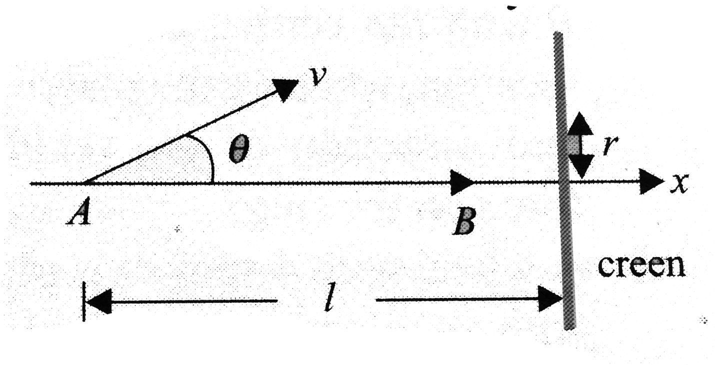
25. A non-relativistic charge q of mass m originates at a point A lying on x-axis and moves with velocity v at an angle to the x-axis. A screen is located at a distance l from A. Find the distance r from the x-axis to the point on the screen into which the charge strikes.



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Exercise 1.1

1. A charged particle of mass 5 mg and charge $q = +2\mu C$ has velocity $\vec{v} = 2\hat{i} - 3\hat{j} + 4\hat{k}$. Find out the magnetic force on the charged particle and its acceleration at this instant due to magnetic field $\overrightarrow{B} = 3\hat{j} - 2\hat{k}$. $\overrightarrow{v}$ and $\overrightarrow{B}$ are in ms^{-1} and Wbm^{-2}, respectively.

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2. A charged particle has acceleration $\overrightarrow{a} = 2\hat{i} + x\hat{j}$ in a megnetic field $\overrightarrow{B} = -3\hat{i} + 2\hat{j} - 4\hat{k}$. Find the value of x.

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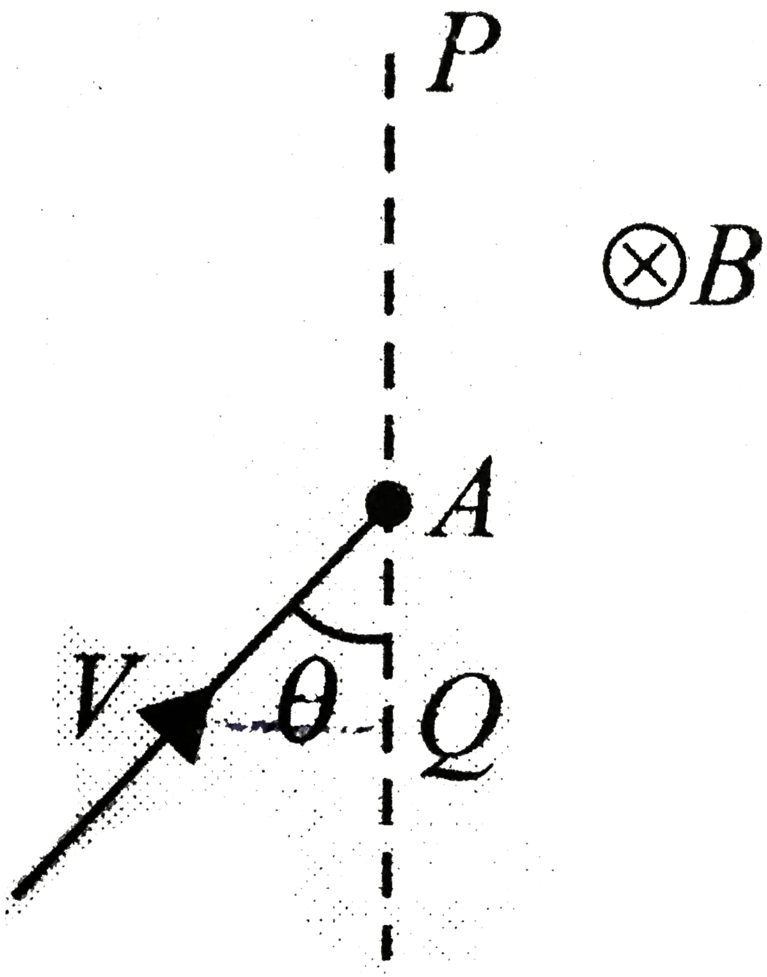
3. A positive charge particle of charge q and mass m enters into a uniform magnetic field with velocity v as shown in Fig. There is no magnetic field to the left of PQ. Find (a) time spent, (b) distance travelled in the magnetic field, (c) impulse of magnetic force.



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4. Repeat above Question 3, if the charge is negative and the angle made by the boundary with the velocity is $\theta = \frac{\pi}{6}$.

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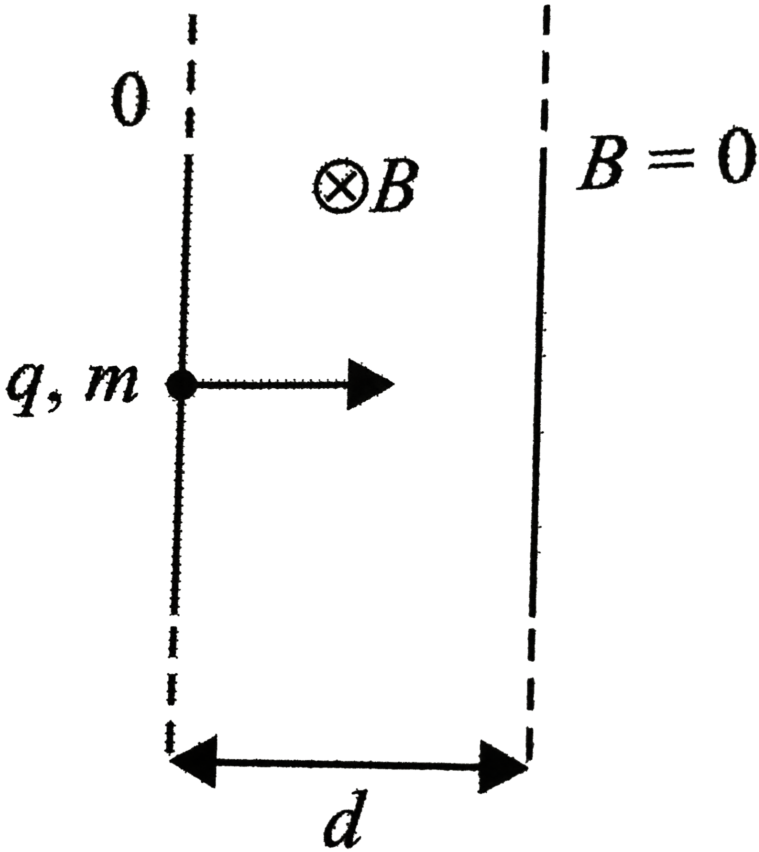
5. A uniform mangetic field of strength B exists in a region of width d. A particle of charge q and mass m is shot perpendicularly (as shown in Fig.) into the magnetic field. Find the time spent by the particle in the magnetic field if

(a) $d > \frac{mu}{qB}$

(b) $d < \frac{mu}{qB}$



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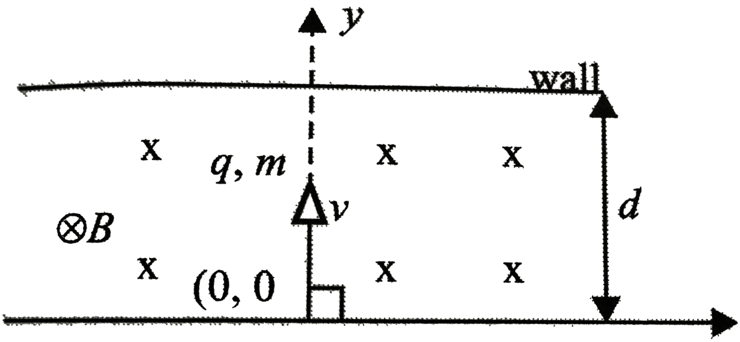
6. In Fig. what should be the speed of the charged particle so that it cannot collide with the upper wall? Also, find the coordinates of the point where the particle strikes the lower plate in the limiting case of velocity.



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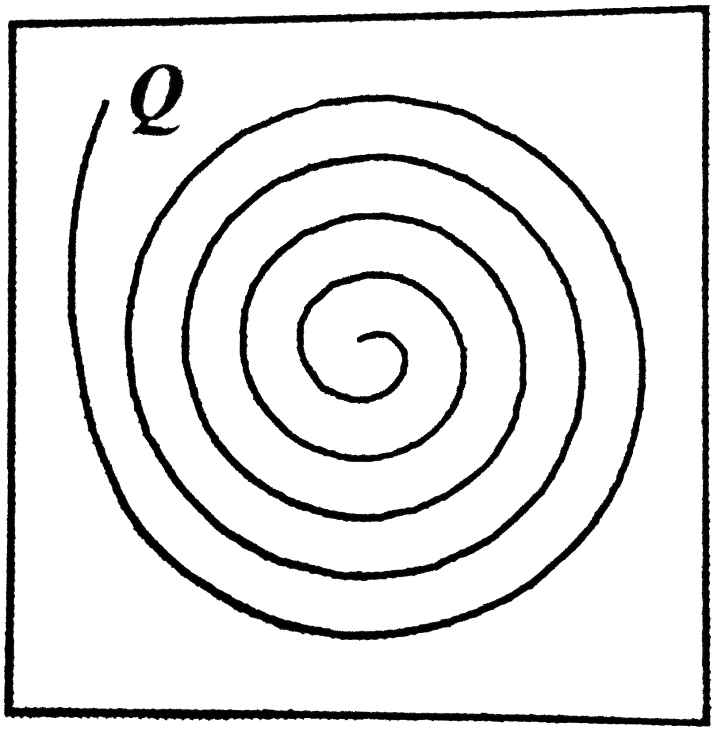
7. A charged particle enters a region which offers a resistance against its motion and a uniform mangetic field exists in the region. The particle traces a spiral path as shown in Fig. 1.29. State the following statements as True or False.

(a) Component of magnetic field in the plane of spiral is zero.

(b) Particle enters the region at Q.

(c) If magnetic field is outwards, then the particle is positively charged.

(d) All of these.



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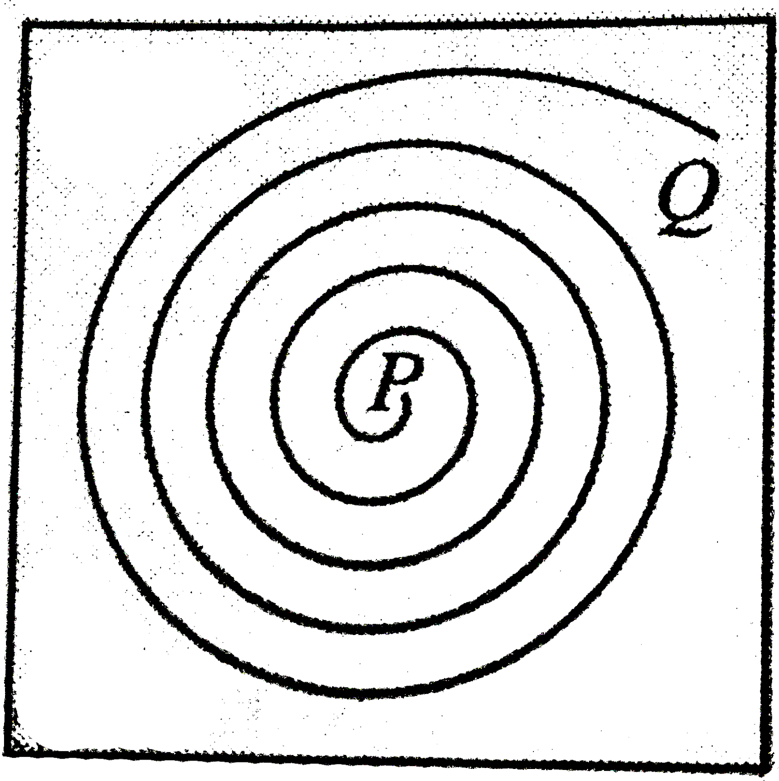
8. An electron moves in a uniform magnetic field and follows a spiral path as shown in Fig. 1.30. State the following statements as True or False.

a. Angular velocity of the electron remains constant.

b. Magnitude of velocity of the electron decreases continuously.

c. Net force on the particle is always perpendicular to its direction of motion.

d. Magnitude of net force on the electron decreases continuously.



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9. A charged particle moves in a gravity free space where an electric field of strength E and a magnetic field of induction B exist. State the following statements as True of False.

a. If $E\pi 0$ and $B\pi 0$, velocity of the particle may remain constant.

b. If $E = 0$, the particle cannot trace a circular path.

c. If $E = 0$, kinetic energy of the particle remains constant.

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10. A particle with charge $-5.60nC$ is moving in a uniform magnetic field $\overrightarrow{B} = -(1.25T)\hat{k}$. The magnetic force on the particle is measured to be $\overrightarrow{F} = -\left(3.36 \times 10^{-7}N\right)\hat{i} + \left(7.42 \times 10^{-7}N\right)\hat{j}$.

a. Calculate all components of the velocity of the particle from this information.

b. Are there components of the velocity that cannot be determined by the measurement of the force? Explain.

c. Calculate the scalar product $\overrightarrow{v}.\overrightarrow{F}$. What is the angle between v and F?

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11. A particle with charge $7.00\mu C$ is moving with velocity $\overrightarrow{v} = -\left(4 \times 10^3 ms^{-1}\right)\hat{j}$. The magnetic force on the particle is measured to be $\overrightarrow{F} = +\left(8.4 \times 10^{-2} N\right)\hat{i} - \left(5.60 \times 10^{-2} N\right)\hat{k}$.

a. Calculate all the components of the magnetic field you can from this information.

b. Are there components of the magnetic field that cannot be determined by measurement of the force? Explain.

c. Calculate the scalar product $\overrightarrow{B}.\overrightarrow{F}$. What is the angle between $\overrightarrow{B}$ and $\overrightarrow{F}$?

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12. A particle with charge $6.40 \times 10^{-19} C$ travels in a circular orbit with radius 4.68 mm due to the force exerted on it by a magnetic field of magnitude 1.65 T and perpendicular to the orbit.

a. What is the magnitude of the linear momentum $\overrightarrow{P}$ of the particle?

b. What is the magnitude of the angular momentum $\overrightarrow{L}$ of the particle?

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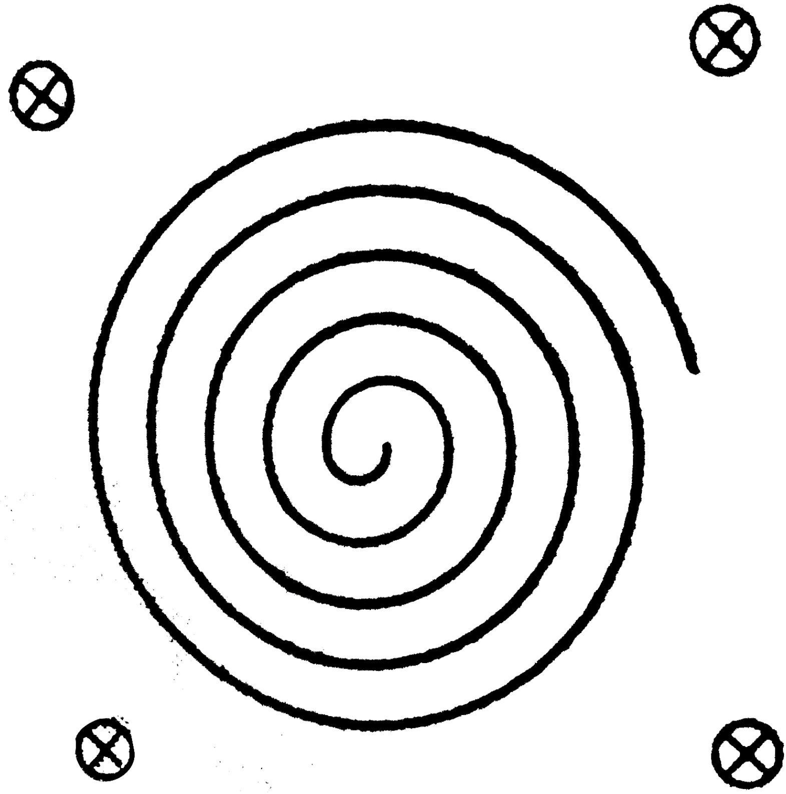
13. Figure 1.31 shows the trace of the path of a charged particle in a bubble chamber. Assume that the magnetic field is into the plane of the paper with magnitude 0.4 T. The smooth spiral path occurs because the particle loses energy in ionizing molecules along the path.

a. Which part of the path corresponds to higher kinetic energy for the particle? Inner or outer part of spiral.

b. Is the charge positive or negative?

c. The radius of curvature ranges from 70 mm to 10 mm. What is the range of values of the magnitude of momentum if the magnitude of the charge is e?



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14. A charged particle of mass m and charge q is accelerated through a potential difference of V volts. It enters a region of uniform magnetic field which is directed perpendicular to the direction of motion of the particle. Find the radius of circular path moved by the particle in magnetic field.

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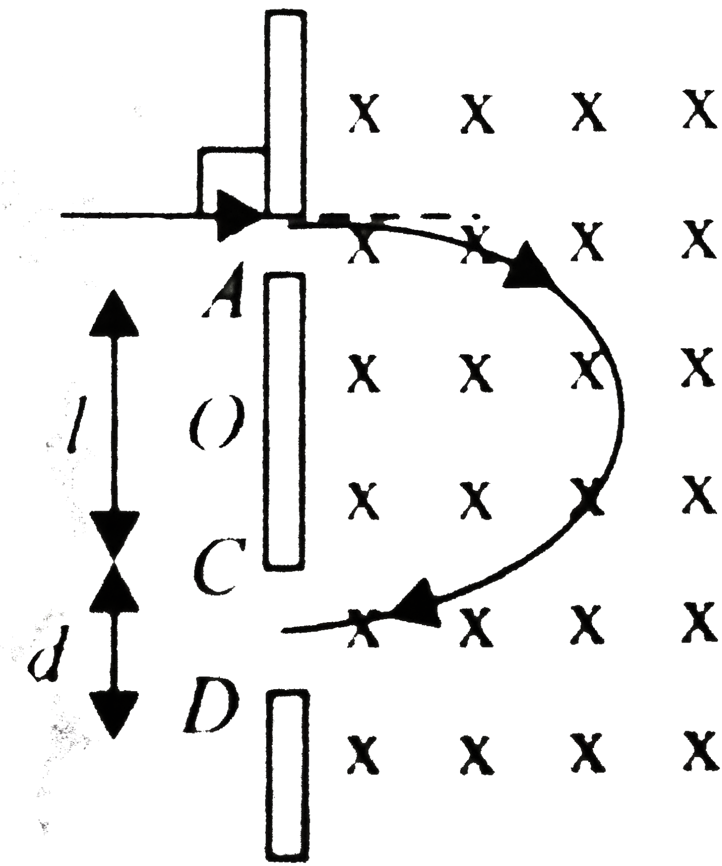
15. A beam of equally charged particles after being accelerated through a voltage V enters into a magnetic field B as shown in Fig. 1.31. It is found that all the particles hit the plate between C and D. Find the ratio between the masses of the heaviest and lightest particles of the beam.



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16. A proton and an alpha particle are projected in a magnetic field which exists in the width of region d. Compare the angles of deviation suffered by the proton and the alpha particle if before entering the magnetic field both the particles.

a. have the same momentum,

b. have the same kinetic energy, and

c. are accelerated through the same potential difference. Take $m_{\alpha} = 4m_p, q_{\alpha} = 2q_p$.

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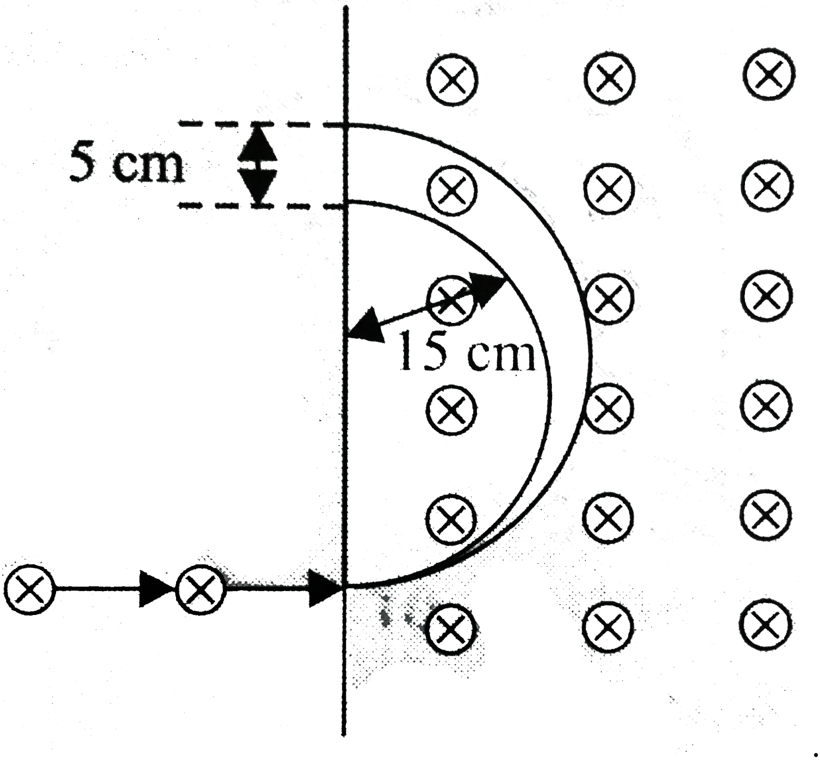
17. A beam of singly ionized atoms of carbon (each charge +e) all have the same speed enters a mass spectrometer, as shown in Fig. The ions strike the photographic plate in two different locations 5 cm apart. The $._{12} C_6$ isotope traces a path of smaller radius, $15.0 cm$. What is the atomic mass number of other isotope ?



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18. When a proton has a velocity

$v = \left(2\hat{i} + 3\hat{}\right) \times 10^6 ms^{-1},$ ti experiences a force $F = -\left(1.28 \times 10^{-13}\hat{k}\right)N.$ When its velocity is along the Z-axis then it experiences a force along the X-axis.What is the magnetic field ?

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19. The force on a charged particle moving in a magnetic field can be computed as the vector sum of the force due to each separate component of the magnetic field. As an example, a particle with charge q is moving with speed v in the -y direction. It is moving in a uniform magnetic field $\overrightarrow{B}=B_x\hat{i}+B_y\hat{j}+B_z\hat{k}$.

a. What are the components of the force $\overrightarrow{F}$ exerted on the particle by the magnetic field?

b. If $q>0$, what must the signs of the components of $\overrightarrow{B}$ be if the components of $\overrightarrow{F}$ are all non-negative?

c. If $q<0$ and $B_x=B_y=B_z>0$, find the direction and magnitude of $\overrightarrow{F}$ in terms of $|q|$, v and B_x.

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20. A particle of charge $q>0$ is moving at speed v in the +z direction through a region of uniform magnetic field. The magnetic force on the particle $\vec{F} = F_0(3\hat{i} + 4\hat{j})$, where F_0 is a positive constant.

(a) Determine the components B_x, B_y and B_z or at least as many of the three components as is possible from the information given.

(b) If it is given in addition that the magnetic field has magnitude $6\frac{F_0}{qv}$, determine the magnitude of B_z.

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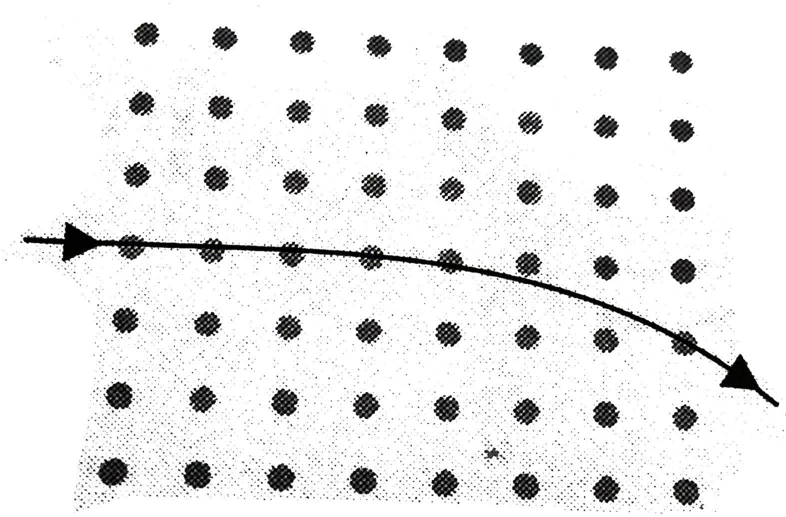
21. Protons having a kinetic energy of 50 eV are moving in the positive x-direction and enter a magnetic field $B = 0.5m\hat{k}T$ directed out of the plane of the page and extending from $x = 0 \rightarrow x = 1m$ as shown in Fig. 1.34.

a. Calculate the y-component of the protons' momentum as they leave the magnetic field.

b. Find the angle ϕ between the initial velocity vector of the proton beam and the velocity vector after the beam emerges from the field. Ignore relativistic effects and note that $1eV = 1.60 \times 10^{-19} J$.



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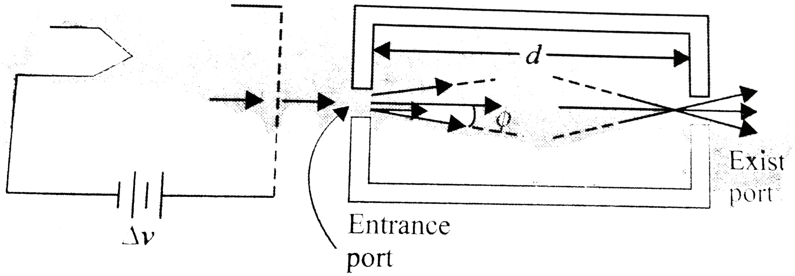
22. Electrons in a beam are accelerated from rest through a potential difference ΔV. The beam enters an experimental chamber through a small hole. As shown in Fig. 1.35, the electron velocity vector lie within a narrow cone of half angle ϕ oriented along the beam axis. We wish to use a uniform magnetic field directed parallel to the axis to focus the beam, so that all of the electrons can pass through a small exit port on the opposite side of the chamber after they travel the length d of the chamber. What is the required magnitude of the magnitude field?



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Exercise 1.2

1. A wire is bent in the form of an equilateral triangle PQR of side 10 cm and carries a current of 5.0 A. It is placed in a magnetic field B of magnitude 2.0 T directed perpendicularly to the plane of the loop. Find the forces on the three sides of the triangle.

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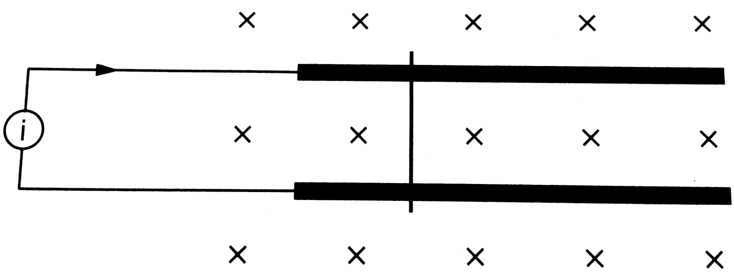
2. Shows two long metal rails placed horizontally and parallel to each other at a separation i. A uniform magnetic field b exists in the vertically downward direction. A wire of mass m can slide on the rails. The rails are connected to a constant current source which drives a current I in the circuirt. The friction coefficient between the rails and the wire is μ. (a) What should be the minimum value of μ which can prevent the wire from sliding on the rails? (b) Describe the motion of the wire if the value of μ is half the value found in the previous part.



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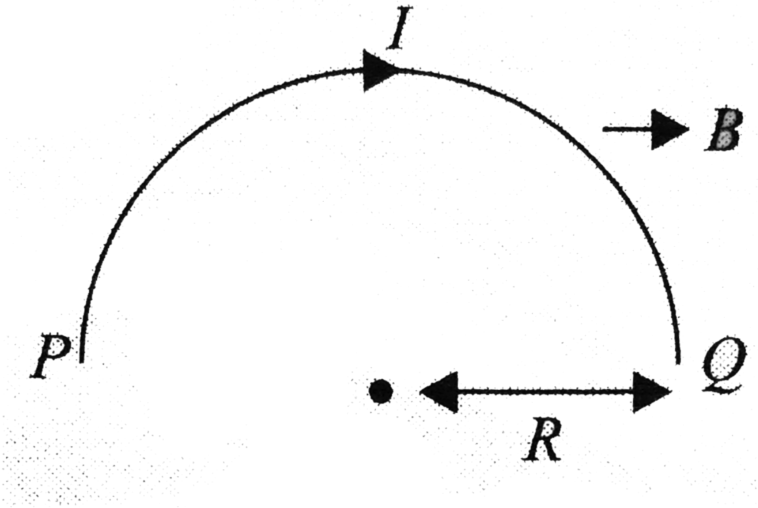
3. In Fig., a semicircular wire is placed in a uniform field $\overrightarrow{B}$ directed towards right. Find the resultant magnetic force and torque on it.



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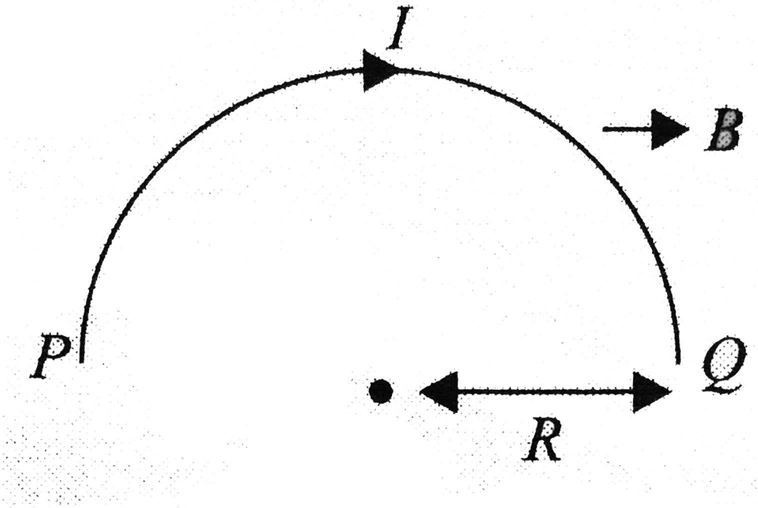
4. In Fig., a semicircular wire is placed in a uniform field $\vec{B}$ directed towards right. Find the resultant magnetic force and torque on it.



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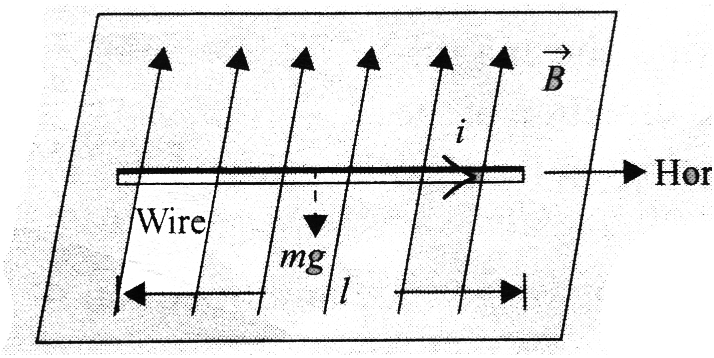
5. A straight wire of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid-air by a uniform horizontal magnetic field B. What is the magnitude of the magnetic field?



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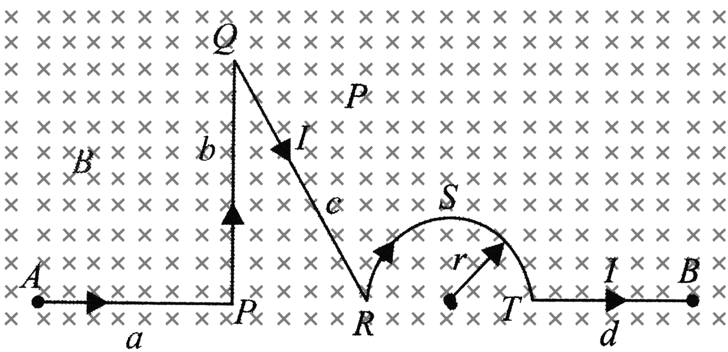
6. Calculate the force on a current carrying wire in a uniform magnetic field as shown in Fig. 1.59.



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7. The horizontal component of the earth's magnetic field at a certain place is $3 \times 10^{-5} T$ and the direction of the field is from the geographic south to the geographic north. A very long straight conductor is carrying a steady current of 1 A. What is the force per unit length on it when it is placed on a horizontal table and the direction of the current is

(a) east to west,

(b) south to north?

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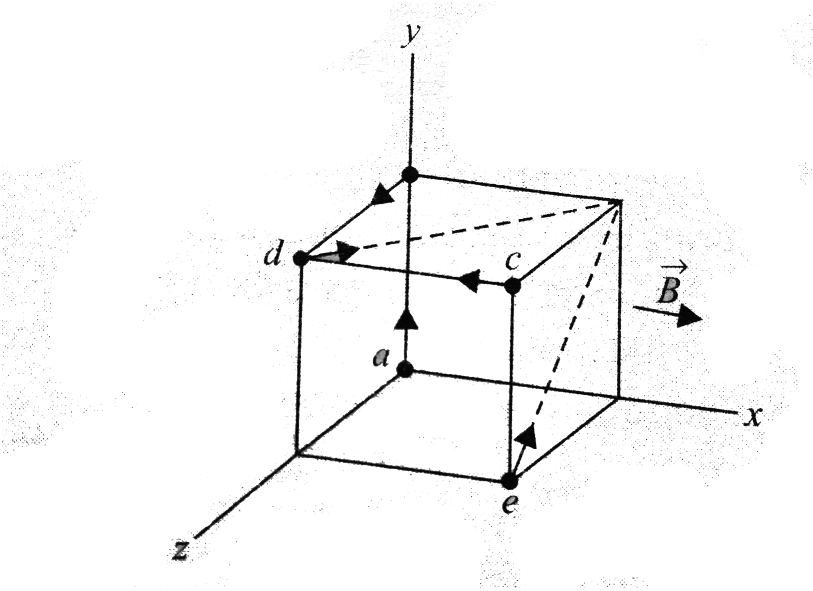
8. Each of the lettered points at the corners of the cube as shown in Fig. 1.60 represents a positive charge q moving with a velocity of magnitude v in the direction indicated. The region in the figure is in a uniform magnetic field $\vec{B}$, parallel to the x-axis and directed toward right. Copy the figure, find the magnitude and direction of the force on each charge and show the force in your diagram.



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9. The cube as shown in Fig. 1.61, 75.0 cm on a side, is placed in a uniform magnetic field of 0.860 T parallel to the x-axis. The wire abcdef carries a current of 6.58 A in the direction indicated.

(a) Determine the magnitude and direction of the force acting on the segment ab.

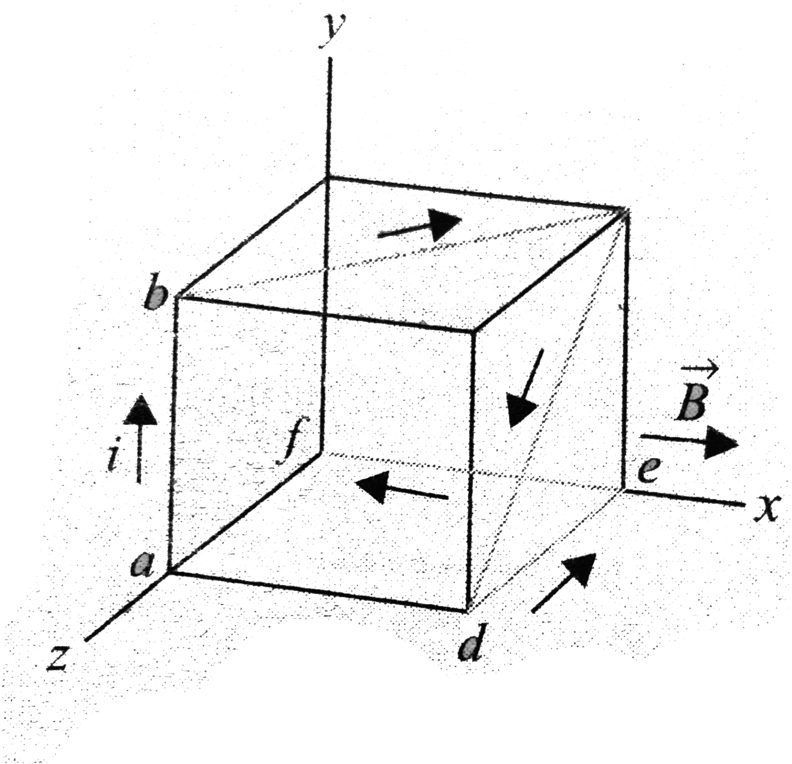
(b) Determine the magnitude and direction of the force acting on the sement bc.

(c) Determine the magnitude and direction of the force acting on the segment cd.

(d) Determine the magnitude and direction of the force acting on the segment de.

(e) Determine the magnitude and direction of the force acting on the segment ef.

(f) What are the magnitude and direction of the total force on the wire ?



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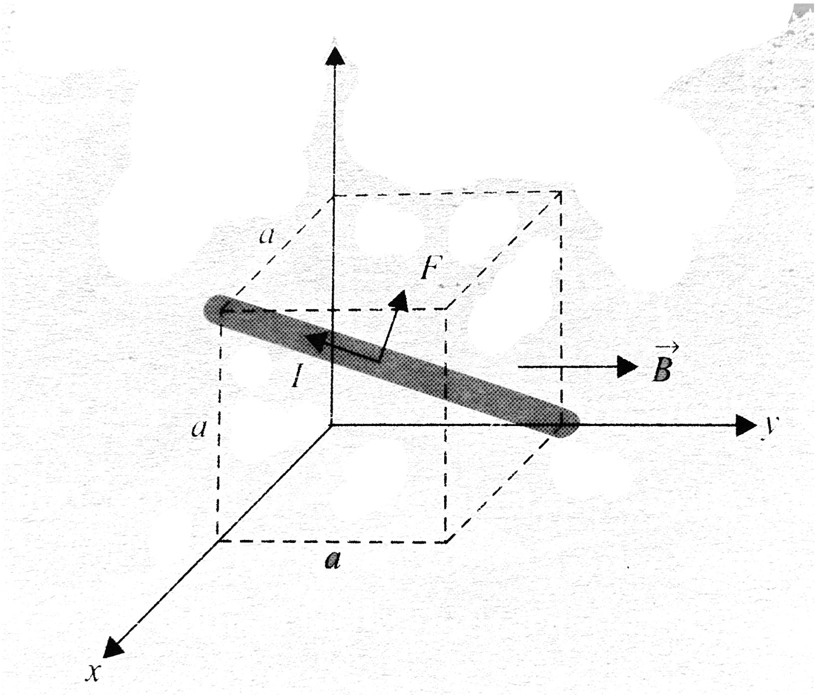
10. A straight wire lies along a body diagonal of an imaginary cube of side $a = 20cm,$ and carries a current of 5 A (as shown in Fig. 1.61). Find the force on it due to a uniform field $\overrightarrow{B} = 0.6\hat{j}T$.



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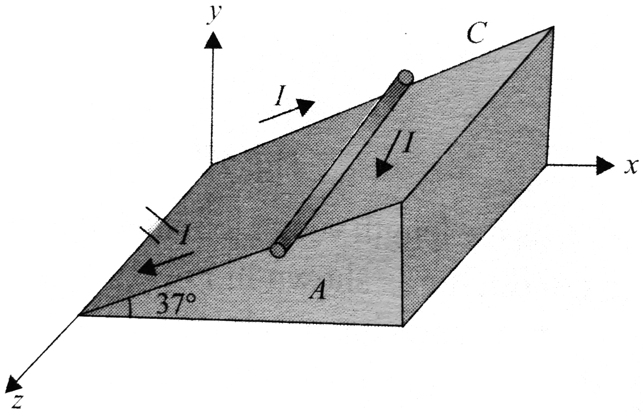
11. In Fig. the bar AC has a mass of 50 g. It slides frictionlessly on the metal strips 40 cm apart at the edges of the incline. A current I flows through these strips and the bar, as shown. There is a magnetic field

$|B_x| = 0.02T$ directed in the -y direction. How much must I be if the rod is to remain motionless? Neglect the slight overhang of the rod.



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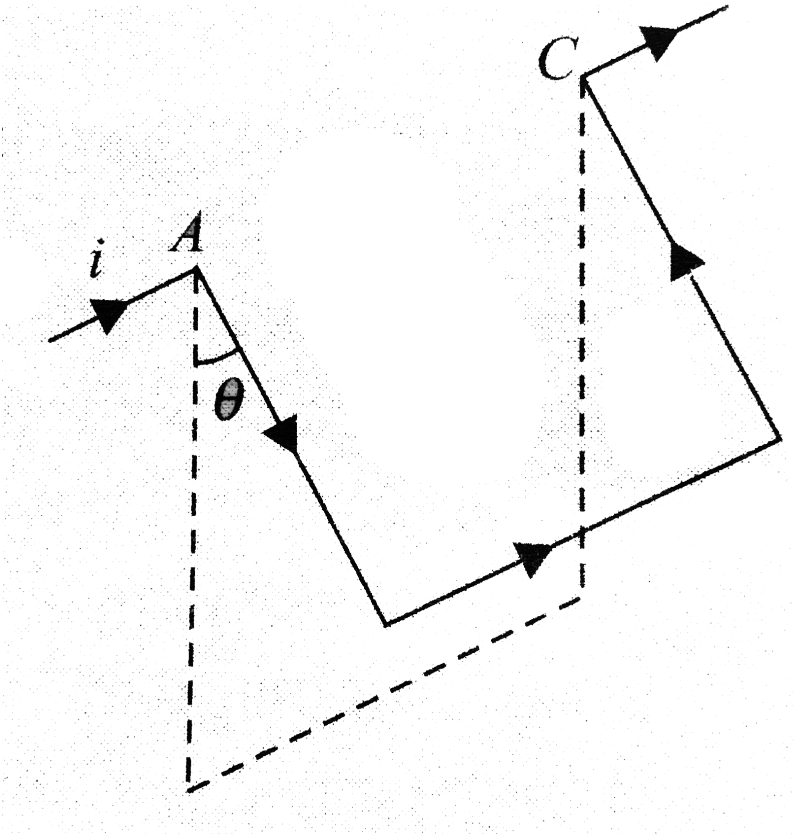
12. In Fig. a three-side frame is pivoted at AC and hangs vertically. Its sides are each of the same length and have a linear density of $0.10 kg m^{-1}$. A current of 10.0 A is sent through the frame, which is in a uniform magnetic field of 10 mT directed upward. Through what angle will the frame be deflected?



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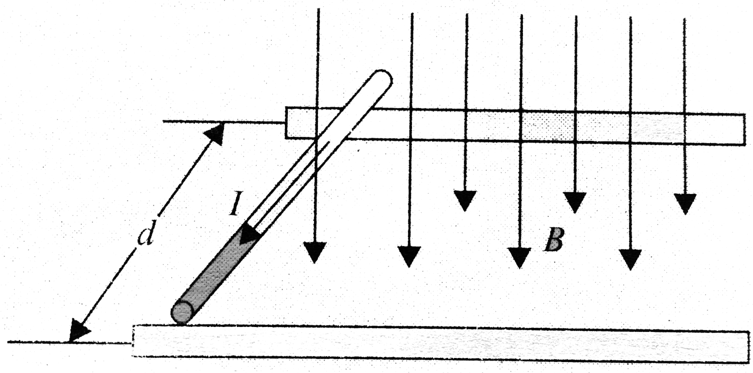
13. A rod of mass 0.720 kg and radius 6 cm rests on two parallel rails that are $d = 12cm$ apart and length of rails is $L = 49cm$. The rod carried a current of $I = 48A$ Fig. and rolls along the rails without slipping. A uniform magnetic field of magnetude 0.240 T is directed perpendicular to the rod and the rails. If it starts from rest, what is the speed of the rod as it leaves the rails?



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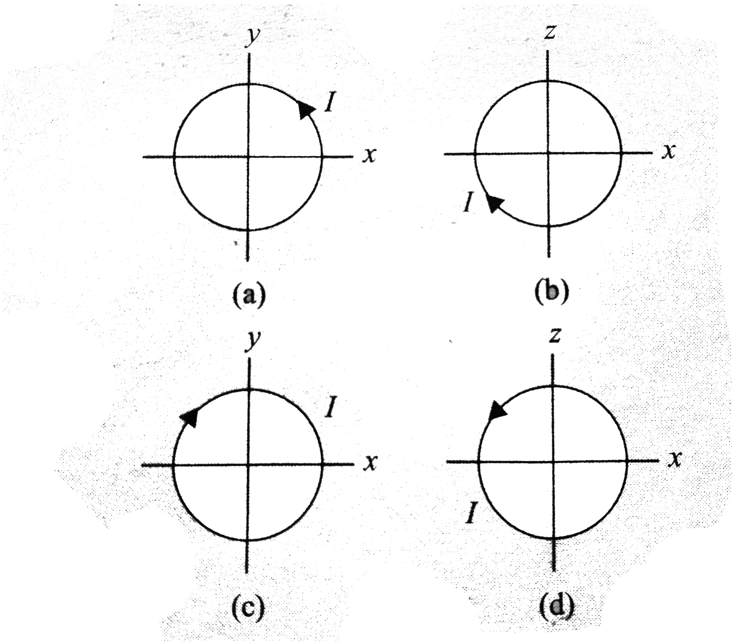
Exercise1.3

1. A circular coil with area A and N turns is free to rotate about a diameter that coincides with the x-axis. Current I is circulating in the coil. There is a uniform magnetic field $\overrightarrow{B}$ in the the positive y direction. Calculate the magnitude and direction of the torque $\overrightarrow{\tau}$ and the value of the potential energy U, when the coil is oriented as shown in parts (a) through (d) of

Fig. 1.79.



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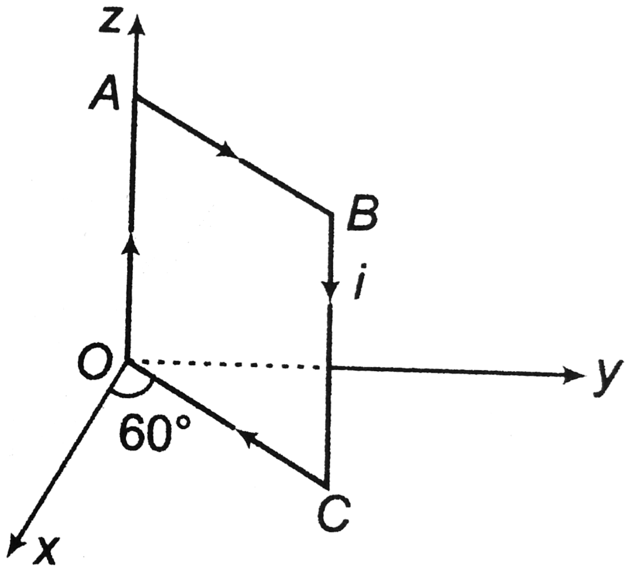
2. A square loop $OABCO$ of side of side l carries a current i. It is placed as shown in figure. Find the magnetic moment of loop.



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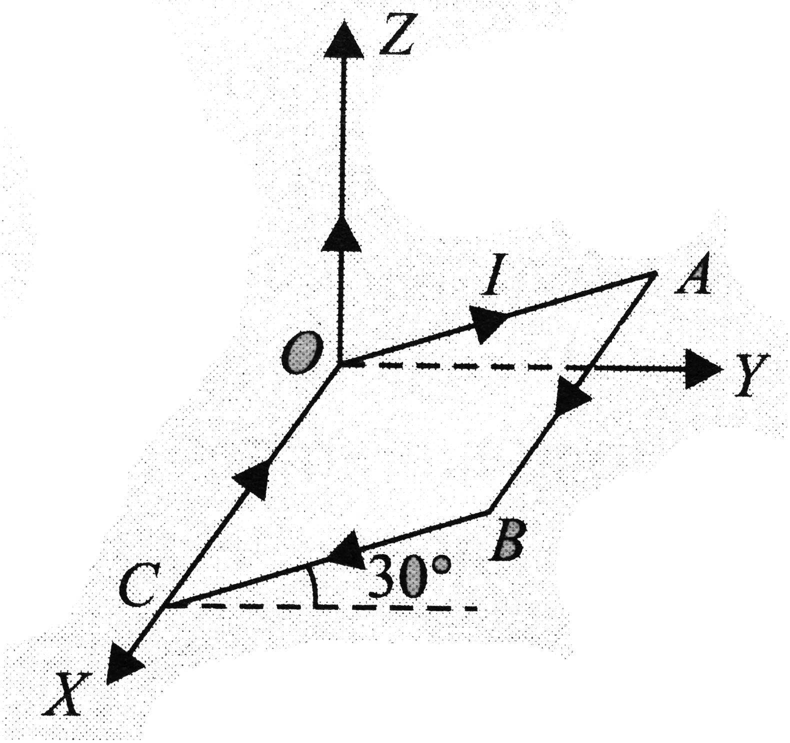
3. Find the magnetic moment of the current carrying loop OABCO as shown in Fig. 1.81. Given that $i = 4A, OA = 20cm, \text{ and } AB = 10cm.$



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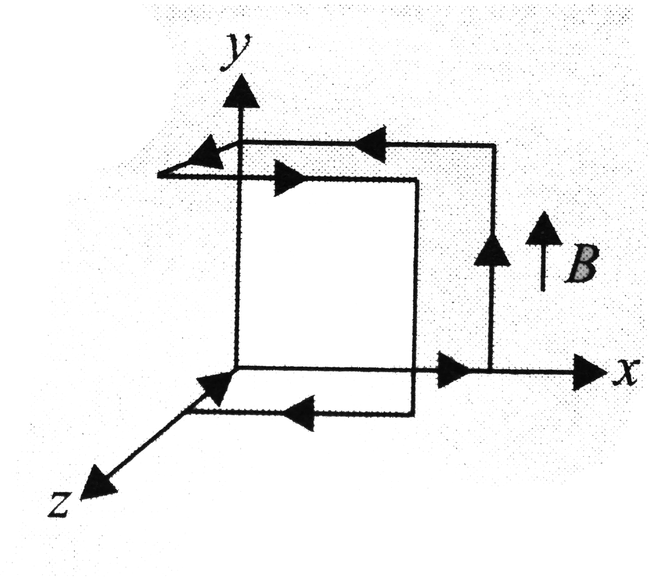
4. Figure shows a bent coil with all edges of length 1m and carrying a current 1 A.

a. Find the magnetic moment of the loop.

b. Find the torque acting on the loop.



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5. An electron is in a circular orbit about the nucleus of an atom. Find the ratio between the orbital magnetic dipole moment $\overrightarrow{\mu}$ and the angular momentum $\overrightarrow{L}$ of the electron about the center of its orbit.

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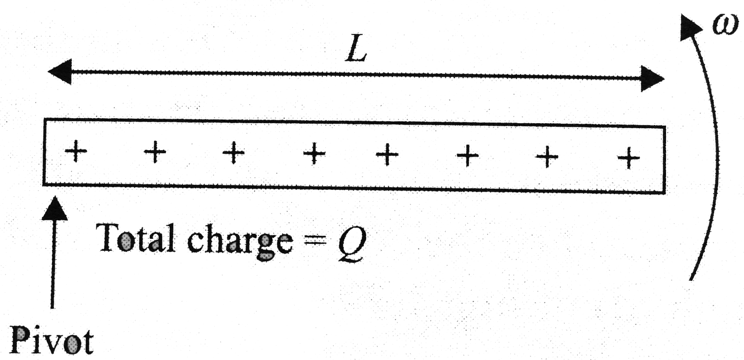
6. A rod has a total charge Q uniformly distributed along its length L. If the rod rotates with angular velocity ω about its end, compute its magnetic moment.



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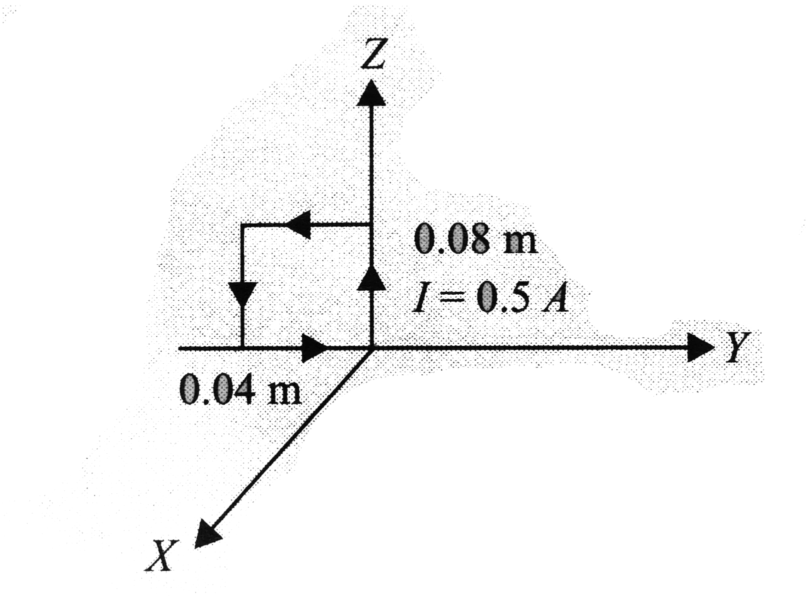
7. The rectangular coil having 100 turns is placed in a uniform magnetic field of $\left(\frac{0.05}{\sqrt{2}}\right)\hat{j}$ tesla as shown in Fig. 1.84. Find the torque acting on the loop.



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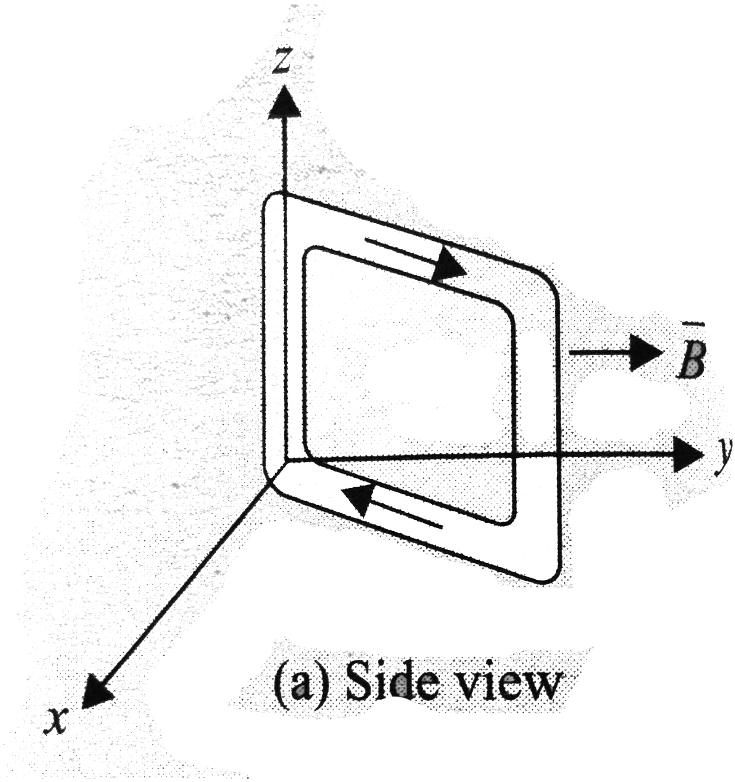
8. The square loop in Fig. has sides of length 20 cm. It has 5 turns and carries a current of 2 A. The normal to the loop is at 37° to a uniform field $\overrightarrow{B} = 0.5\hat{j}T$.

a. Find the magnetic moment of the loop.

b. Find the work needed to rotate the loop from its position of minimum energy to the given orientation.



(a) Side view

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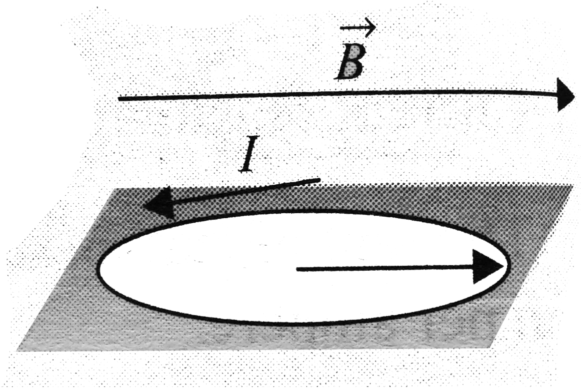
9. A circular wire loop of radius R, mass m carrying current I lies on a rough surface (as shown in Fig. 1.86). There is a horizontal magnetic field $\vec{B}$. How large can the current I be before one edge of the loop will lift off the surface?



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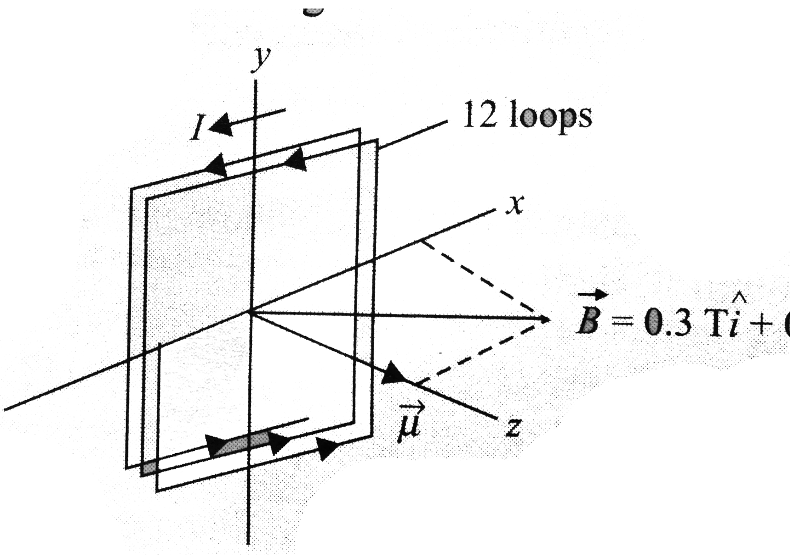
10. A square 12-turn coil with sides of length 40 cm carries a current of 3 A. It lies in the x-y plane as shown in Fig. in a uniform magnetic field.



(a) Find the magnetic moment of the coil.

(b) Find the torque exerted on the coil.

(c) Find the potential energy of the coil.

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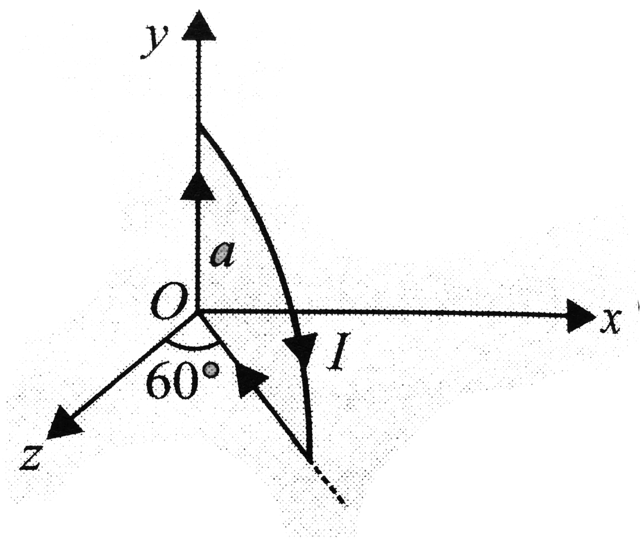
11. Figure. shows one quarter of a simple circular loop of wire that carries a current of 14 A. Its radius is $a = 5cm$. A uniform magnetic field, $B = 300G$, is directed in the +x direction. Find the torque on the entire loop and the direction in which it will rotate.



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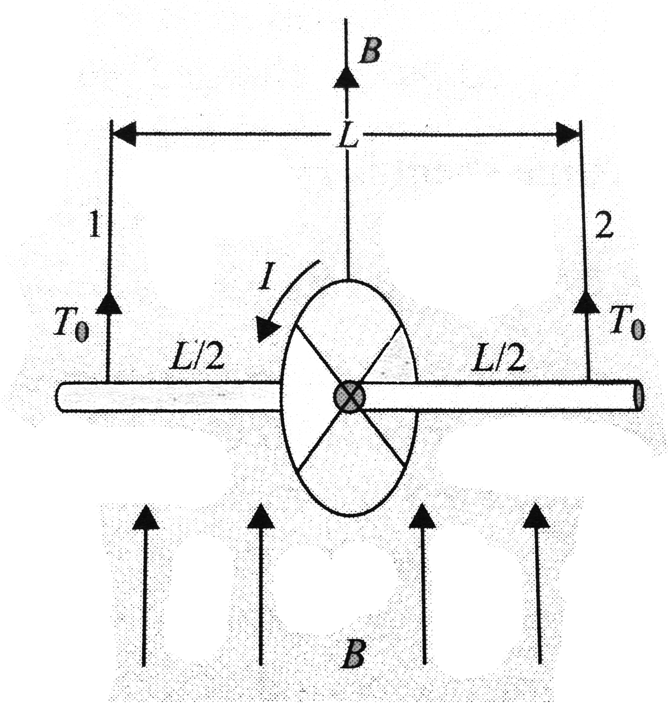
12. The circular current loop of radius b shown in Fig. is mounted rigidly on the axle, midway between the two supporting cords. In the absence of an external magnetic field, the tensions in the cords are equal and are T_0.

a. What will be the tensions in the two cords when the vertical magnetic field B is present?

b. Repeat if the field is parallel to the axis.



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13. A wire is formed into a circle having a diameter of 10.0 cm and placed in a uniform magnetic field of 3.00 mT. The wire carries a current of 5.00 A. Find

a. the maximum torque on the wire, and

b. the range of potential energies of the wire-field system for different orientations of the circle.

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14. A galvanometer coil is replaced by another coil of diameter one-fourth of the original diameter and the total number of turns as ten times the original number. What will be the new diflection if the same current is passed through it? Old deflection is θ.

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Exercises Subjective

1. An $\alpha -$ particle is describing a circle of radius 0.45 m in a field of magnetic induction of 1.2 T. Find its speed, frequency of rotation and kinetic energy. What potential difference will be required to accelerate the particle so as to give this much of the energy to it? The mass of $\alpha -$ particle is $6.8 \times 10^{-27} kg$ and its charge is twice the charge of proton, i.e., $3.2 \times 10^{-19} C$.

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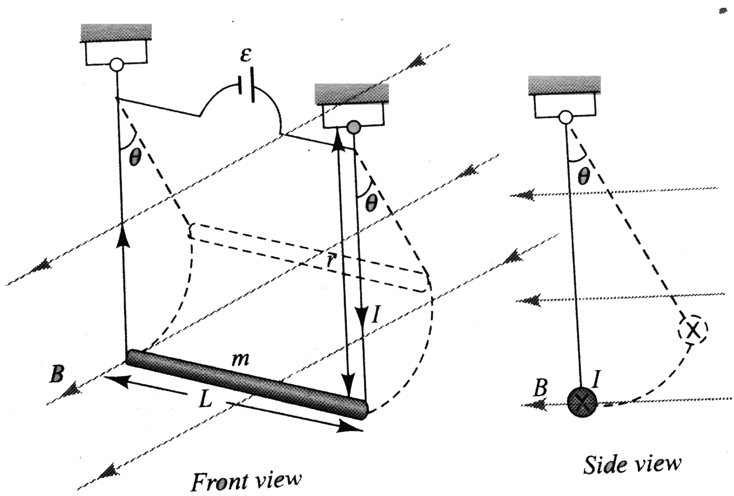
2. In a trapeze-shaped structure, two rigid wires of negligble mass support a conducting bar of mass m and length L as shown in Fig. A source of emf is applied to the wires so that a current I flows through the bar. A uniform magnetic field $\vec{B}$ is perpendicular to the plane of the wires and bar.

a. Compute the current that the source of emf must provide so that there is no tension in the wires.

b. If the current is reduced to half the value computed in (a) and the plane of the structure is moved through an angle θ, compute the tension in the wires and the magnitude of the net unbalanced force on the bar at the instant it is released from this angle.



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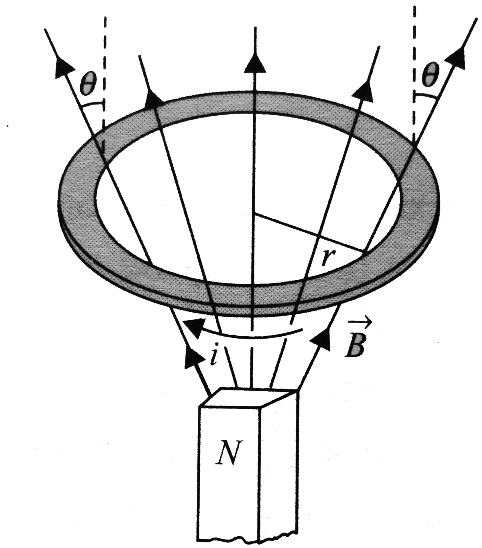
3. A strong magnet is placed under a horizontal conducting ring of radius r that carries current i as shown in Fig. If the magnetic field makes an angle θ with the vertical at the ring's location, what are the magnitude and direction of the resultant force on the ring?



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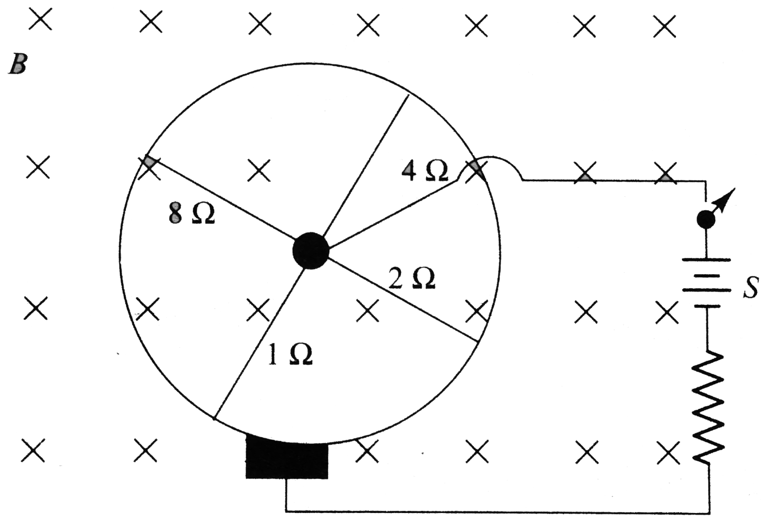
4. A wheel with 4 spokes is placed with its plane perpendicular to a uniform magnetic field B of magnitude 0.5 T. The field is directed into the plane of the paper and is present over the entire region of the wheel as shown in Fig. When the switch S is closed, there is initial current of 6 A between the axis and the rim and the wheel begins to rotate. Resistances of the spokes are 1, 2, 4 and 8 Ω, respectively. Resistance of rim is



negligible.

a. What is the direction of rotation of the wheel?

b. Radius of the wheel is 0.2 m. Calculate initial torque acting on the wheel.

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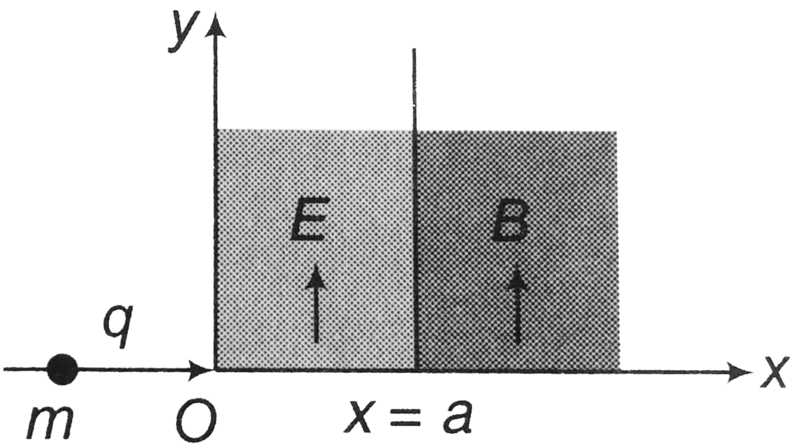
5. A positively charged particle having charge q is accelerated by a potential difference V. This particle moving along the x-axis enters a region where an electric field E exists. The direction of the electric field is along positive y-axis. The electric field exists in the region bounded by the lines $x = 0$ and $x = a$. Beyond the line $x = a$ (i.e. in the region$x \geq a$ there exists a magnetic field of strength B, directed along the positive y-axis. Find

(a) at which point does the particle meet the line $x = a$

(b) the pitch of the helix formed after the particle enters the region x ?_ a.

Mass of the particle is m.



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6. A charged particle +q of mass m is placed at a distanced from another charged particle -2q of mass 2m in a uniform magnetic field B as shown in

Fig. 1.28. If the particles are projected towards each other with same speed v,

a. find the maximum value of projected speed v_m so that the two particles do not collide.

b. find the time after which collision occurs between the particles if projection speed equals $2v_m$.

c. Assuming the collision to be perfectly inelastic, find the radius of the particle in subsequent motion. (Neglect the electric force between the charges.)

View Text Solution

7. A conducting wire of length l is placed on a rough horizontal surface, where a uniform horizontal magnetic field B perpendicular to the length of the wire exists. Least values of the forces required to move the rod when a current I is established in the rod are observed to be F_1 and $F_2(\, < F_1)$ for the two possible directions of the current through the rod, respectively. Find the weight of the rod and the coefficient of friction between the rod and the surface.

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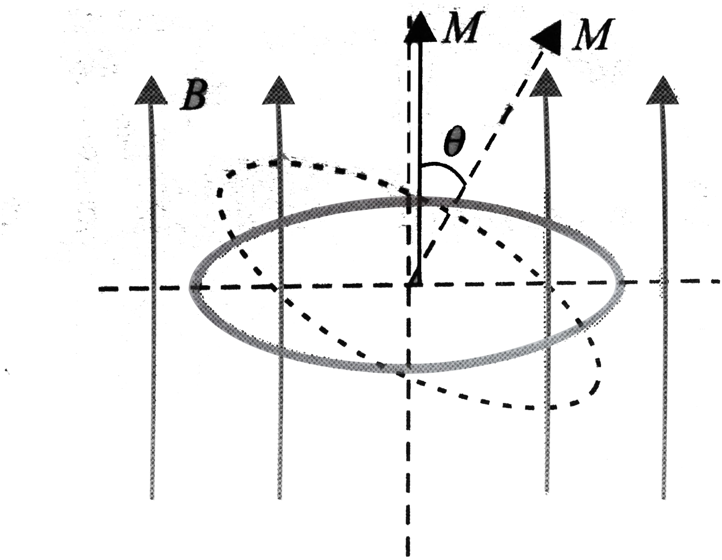
8. A small circular coil with a mass of m consists of N turns of fine wire and carries a current of I. The coil is located in a uniform magnetic field of B with the coil axis orginally parallel to the field direction.



a. What is the period of small angle oscilations of the coil axis around its equilibrium position, assuming no friction and no mechanical force?

b. If the coil is rotated through an angle of θ from its equilibrium position and then released, what will be its angular speed when it passes through equilibrium position?

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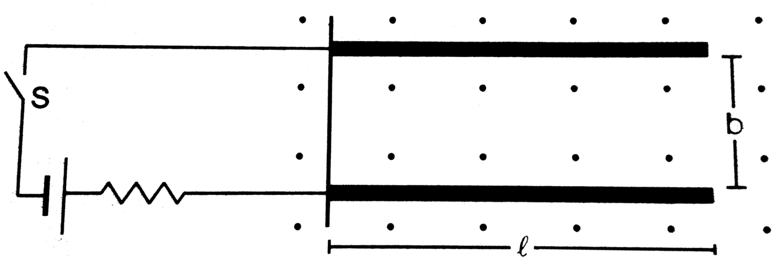
9. Two metal strips, each of length, each of length l, are clamped parallel to each other on a horizontal floor with a separation b between them. A wire of mass m line on them perpendicularly as shown in figure. A vertically upward magnetic field of strenght B exists in the space. The matal strips are smooth but the cofficient of freiction between the wire and the floor is μ. A current i is established when the switch S is closed at the instant $t = 0$. Discuss the motion of the wire after the switch is closed. How far away from the strips will the wire reach?



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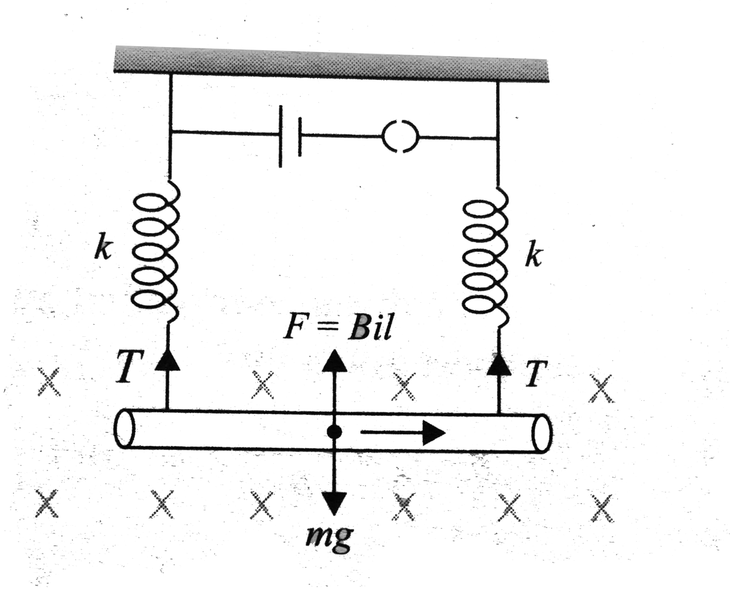
10. A metal rod of mass 10 gm and length 25 cm is suspended on two springs as shown in Fig. 1.131. The springs are extended by 4 cm. When a 20 A current passes through the rod, it rises by 1 cm. Determine the magnetic field assuming acceleration due to gravity to be $10ms^{-1}$.



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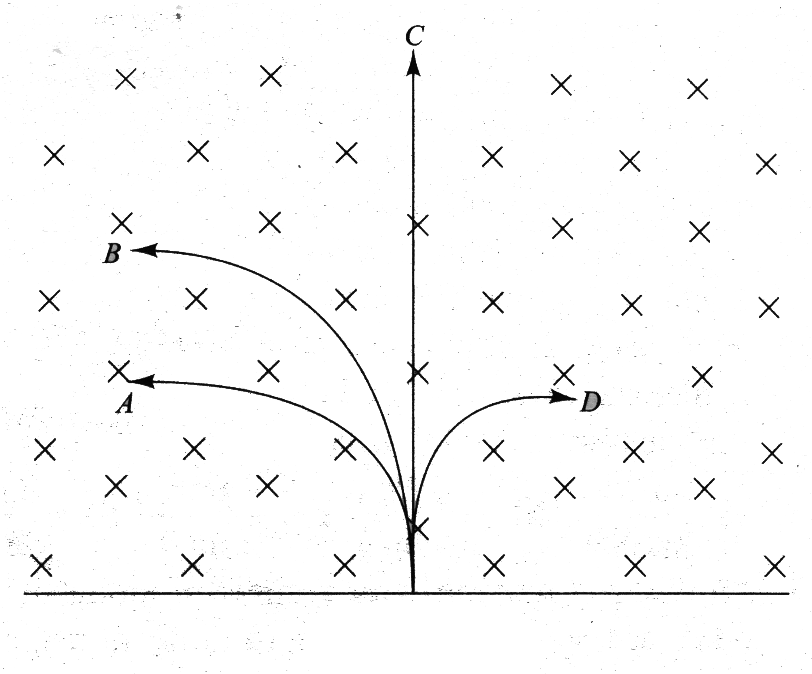
Exercises Single Correct

1. A neutron, a proton, an electron and an $\alpha -$ particle enter a region of uniform magnetic field with equal velocities. The magnetic field is perpendicular to the paper and directed into it. The tracks of particles are labeled in Fig. 1.132. The neutron follows the track



A. A

B. B

C. C

D. D

Answer: c

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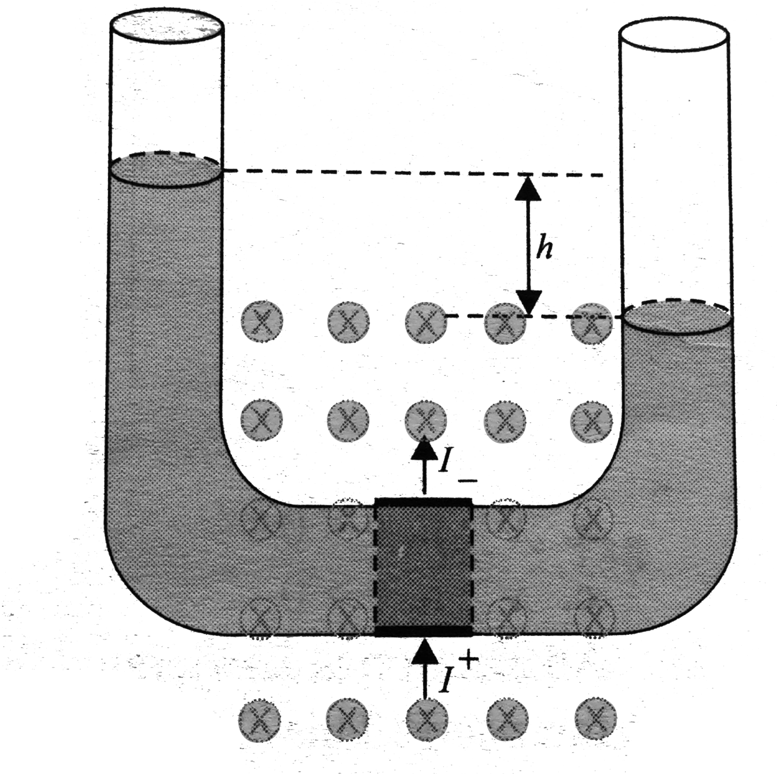
2. A U tube of uniform square cross-sectional side a has mercury in it. Current I is passed between sealed electrodes x and y. A magnetic field B is applied across horizontal section perpendicular to the plane of diagram. The difference in mercury levels is [Given: ρ = density of mercury]



A. $\frac{2}{3}\frac{BI}{\rho ga}$

B. $\frac{2BI}{\rho ga}$

C. $\frac{BI}{\rho ga}$

D. $\frac{4BI}{\rho ga}$

Answer: c

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3. When an electron is accelerated through a potential difference V, it experience a force F through as uniform transverse magnetic field. If the potential difference is increased to $2V$, the force experoenced by the electron in the same magnetic field is

A. F

B. $F/2$

C. $\sqrt{2}F$

D. 2F

Answer: c

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4. An electron is moving along positive x-axis. To get it moving on an anticlockwise circular path in x-y plane, a magnetic field is applied

A. along positive y-axis

B. along positive z-axis

C. along negative y-axis

D. along negative z-axis

Answer: b

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5. 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 masses of X and Y is

A. $(R_1 / R_2)^{1/2}$

B. (R_2 / R_1)

C. $(R_1 / R_2)^2$

D. (R_1 / R_2)

Answer: c

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6. An electron of mass 0.90×10^{-30} kg under the action of a magnetic field moves in a circle of 2.0 cm radius at a speed $3.0 \times 10^6 ms^{-1}$. If a proton of mass $1.8 \times 10^{-27} kg$ was to move in a circle of the same radius in the same magnetic field, then its speed will be

A. $3.0 \times 10^6 ms^{-1}$

B. $1.5 \times 10^3 ms^{-1}$

C. $6.0 \times 10^4 ms^{-1}$

D. cannot be estimated from the given data

Answer: b

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7. A charged particle of mass $10^{-3} kg$ and charge $10^{-5} C$ enters a magnetic field of induction 1 T. If $g = 10 ms^{-2}$, for what value of velocity will it pass straight through the field without deflection?

A. $10^{-3} ms^{-1}$

B. $10^3 ms^{-1}$

C. $10^6 ms^{-1}$

D. $1 ms^{-1}$

Answer: b

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8. A particle of mass $2 \times 10^{-5} kg$ moves horizontally between two horizontal plates of a charged parallel plate capacitor between which there is an electric field of $200NC^{-1}$ acting upward. A magnetic induction of 2.0 T is applied at right angles to the electric field in a direction normal to both $\vec{B}$ and $\vec{v}$. If g is $9.8ms^{-2}$ and the charge on the particle is $10^{-6}C$, then find the velocity of charge particle so that it continues to move horizontally

A. $2ms^{-1}$

B. $20ms^{-1}$

C. $0.2ms^{-1}$

D. $100ms^{-1}$

Answer: a

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9. A charged particle moves along a circle under the action of possible constant electric and magnetic fields. Which of the following are possible?

A. $E = 0, B = 0$

B. $E = 0, B \neq 0$

C. $E \neq 0, B = 0$

D. $E \neq 0, B \neq 0$

Answer: b

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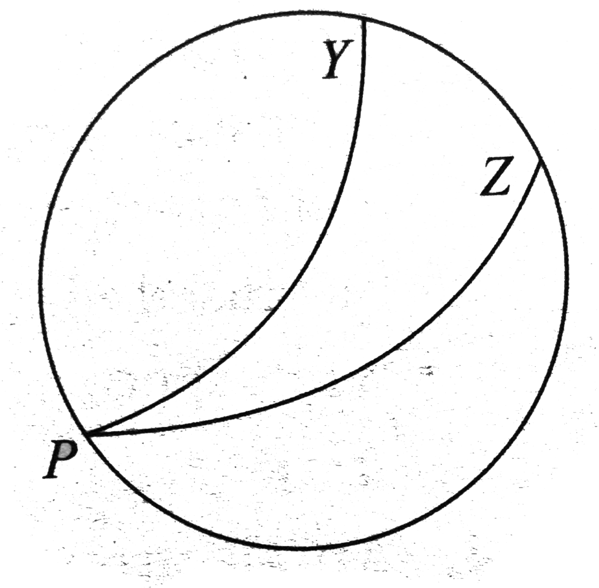
10. Two particles Y and Z emitted by a radioactive source at P made tracks in a chamber as illustrated in the Fig. 1.134. A magnetic field acts downward into the paper. Careful measurements showed that both tracks were circular, the radius of Y track being half that of the Z track. Which one of the following statements is certainly true?



A. Both particles Y and Z carried a positive charge

B. The mass of particle Z was one half that of particle Y

C. The mass of particle Z was twice that of particle Y

D. The charge of particle Z was twice that of particle Y

Answer: a

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11. A proton and an $\alpha -$ particle enter a uniform magnetic field moving with the same speed. If the proton takes $25 \mu s$ to make 5 revolutions, then the periodic time for the $\alpha -$ particle would be

A. $50 \mu s$

B. $25 \mu s$

C. $10 \mu s$

D. $5 \mu s$

Answer: c

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12. An electron is launched with velocity $\overrightarrow{v}$ in a uniform magnetic field $\overrightarrow{B}$. The angle θ between $\overrightarrow{v}$ and $\overrightarrow{B}$ lies between 0 and $\frac{\pi}{2}$. Its velocity vector $\overrightarrow{v}$ returns to its initial value in a time interval of

A. $\frac{2\pi m}{eB}$

B. $\frac{2 \times 2\pi m}{eB}$

C. $\frac{\pi m}{eB}$

D. depends upon between $\vec{v}$ and $\vec{B}$

Answer: a

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13. A charged particle is whirled in a horizontal circle on a frictionless table by attaching it to a string fixed at one pint. If a magnetic field is switched on in the vertical direction, the tension in the string

A. will increase

B. will decrease

C. remains same

D. may increase or decrease

Answer: d

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14. A charged particle moves with velocity $\overrightarrow{v} = a\hat{i} + d\hat{j}$ in a magnetic field $\overrightarrow{B} = A\hat{i} + D\hat{j}$. The force acting on the particle has magnitude F. Then,

A. $F = 0, \quad \text{if} \quad aD = dA.$

B. $F = 0, \quad \text{if} \quad aD = -dA.$

C. $F = 0, \quad \text{if} \quad aA = -dD.$

D. $f \propto \left(a^2 + b^2\right)^{1/2} \times \left(A^2 + D^2\right)^{1/2}$

Answer: a

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15. A particle with a specific charge s is fired with a speed v toward a wall at a distance d, perpendicular to the wall. What minimum magnetic field must exist in this region for the particle not to hit the wall?

A. v / sd

B. $2v / sd$

C. $v / 2sd$

D. $v / 4sd$

Answer: a

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16. A charged particle begins to move from the origin in a region which has a uniform magnetic field in the x-direction and a uniform electric field in the y-direction. Its speed is v when it reaches the point (x, y, z). Then, v will depend

A. only on x

B. only on y

C. on both x and y, but not z

D. on x,y and z

Answer: b

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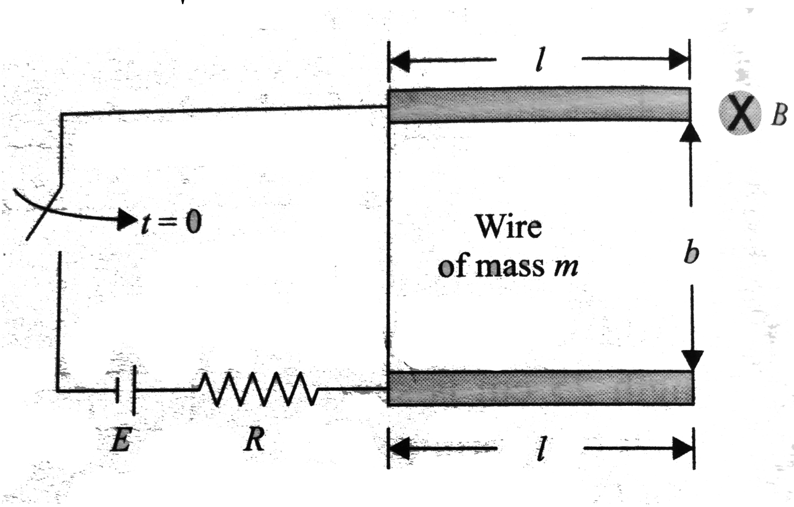
17. Two metal strips of length l each are placed parallel to each other in contact with an electric circuit as shown in Fig. 1.135. The entire structure is placed on a smooth horizontal floor in a region in which magnetic field is existing in vertical direction. The distance travelled by the wire as a function of time is best given by

where $t_0 = \sqrt{\dfrac{2lmR}{EBb}}$



A. $\dfrac{1}{2} \times \dfrac{EBb}{Rm} \times t^2$ for $t < t_0$ and $\left(l + \dfrac{EBb}{Rm}(t - t_0)\right)$ for $t \geq t_0$

B. $\frac{1}{2} \times \frac{Ebb}{Rm} \times t^2$ for all t

C. $\frac{1}{2} \times \frac{Ebb}{Rm} \times t^2$ for $t \leq t_0$ and the wire stops

D. $\frac{1}{2} \times \frac{Ebb}{Rm} \times t^2$ for $t \leq t_0$ and $l + \frac{EBb}{Rm} \times t$ for$t \geq t_0$

Answer: a

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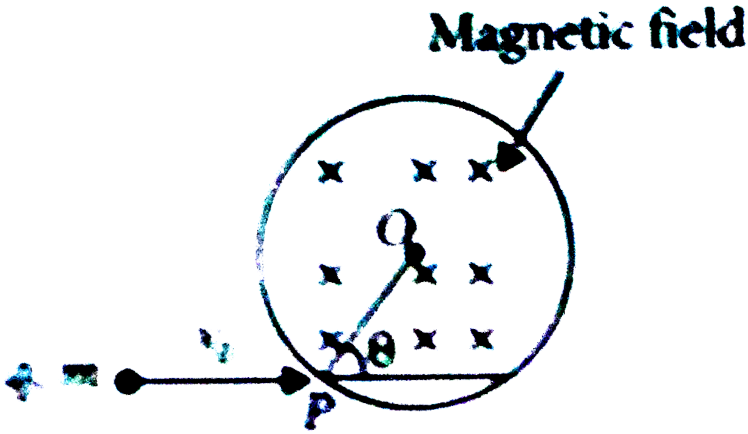
18. A particle of charge q and mass m is projected with a velocity v_0 towards circular region having uniform magnetic field B perpendicular and into the plane of paper, from point Pas shown in figure. R is the radius and O is the centre of the circular region. If the line OP makes an angle θ with the 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. $\dfrac{3qBR}{2m\sin\theta}$

Answer: b

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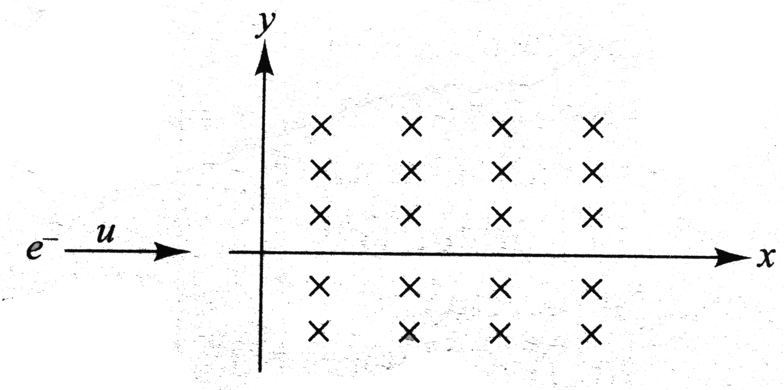
19. An electron moving with a speed u along the positive x-axis at $y = 0$ enters a region of uniform magnetic field which exists to the right of y-axis. The electron exits from the region after some time with the speed v at coordinate y, then



A. $v > u, y < 0$

B. $v = u, y > 0$

C. $v > u, y > 0$

D. $v = u, y < 0$

Answer: d

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20. An electron is accelerated from rest through a potential difference V. This electron experiences a force F in a uniform magnetic field. On increasing the potential difference to V', the force experienced by the electron in the same magnetic field becomes 2F. Then, the ratio (V' / V) is equal to

A. $1/4$

B. $2/1$

C. $1/2$

D. $1/4$

Answer: a

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21. A particle of charge q and mass m starts moving from the origin under the action of an electric field $\overrightarrow{E} = E_0\hat{i}$ and a magnetic field $\overrightarrow{B} = B_0\hat{i}$

with a velocity $\vec{v} = v_0\hat{j}$. The speed of the particle will become $2v_0$ after a time

A. $t = \frac{2mv_0}{qE}$

B. $t = \frac{2Bq}{mv_0}$

C. $t = \frac{\sqrt{3}Bq}{mv_0}$

D. $t = \frac{\sqrt{2}mv_0}{qE}$

Answer: d

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22. A conducting rod of mass m and length l is placed over a smooth horizontal surface . A unifrom magnetic field B is acting perpendicular to the rod. Charge q is suddenly passed throught the red it accquire an initnal velocity on the surface , then q is equal to

A. $\frac{2mv}{bl}$

B. $\frac{Bl}{2mv}$

C. $\frac{mv}{bl}$

D. $\frac{Blv}{2m}$

Answer: c

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23. Choose the correct option:

A particle of charge per unit mass α is released from origin with a velocity

$\vec{v} = v_0\hat{i}$ in a magnetic field

$\vec{B} = -B_0\hat{k}$ for $x \leq \frac{\sqrt{3}}{2}\frac{v_0}{B_0\alpha}$

and $\vec{B} = 0$ for $x > \frac{\sqrt{3}}{2}\frac{v_0}{B_0\alpha}$

The x-coordinate of the particle at time $t\left(\frac{\pi}{3B_0\alpha}\right)$ would be

A. $\frac{\sqrt{3}}{2}\frac{v_0}{B_0\alpha} + \frac{\sqrt{3}}{2}v_0\left(t - \frac{\pi}{B_0\alpha}\right)$

B. $\frac{\sqrt{3}}{2}\frac{v_0}{B_0\alpha} + v_0\left(t - \frac{\pi}{3B_0\alpha}\right)$

C. $\frac{\sqrt{3}}{2}\frac{v_0}{B_0\alpha} + \frac{v_0}{2}\left(t - \frac{\pi}{3B_0\alpha}\right)$

D. $\frac{\sqrt{3}}{2}\frac{v_0}{B_0\alpha} + \frac{v_0 t}{2}$

Answer: c

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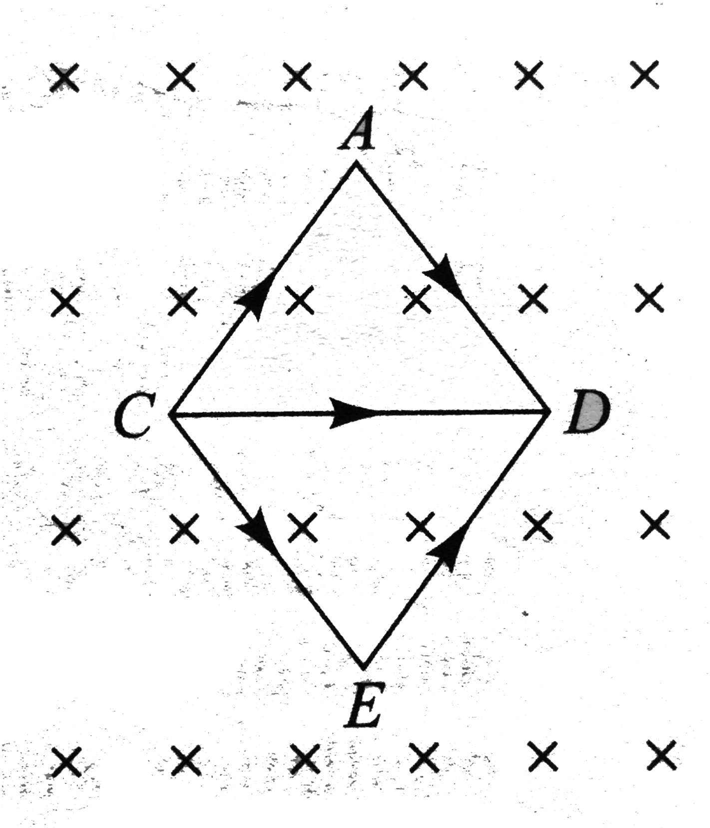
24. Let current $i = 2A$ be flowing in each part of a wire frame as shown in Fig. 1.138. The frame is a combination of two equilateral triangles ACD and CDE of side 1 m. It is placed in uniform magnetic field $B = 4T$ acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is



A. 24 N

B. zero

C. 16 N

D. 8 N

Answer: a

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

A. $\frac{p}{\sqrt{2}\pi}$

B. $\sqrt{2}p$

C. $\frac{p}{2\pi}$

D. $\frac{\sqrt{2}p}{\pi}$

Answer: c

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26. A charge praticule of sepeific charge (charge/ mass) α is realsed from origin at time t=0 with velocity $v = v_0\left(\hat{i} + \hat{j}\right)$ in unifrom magnetic fields $B = B_0\hat{i}$. Co-ordinaties of the particle at time $t = \frac{\pi}{B_0\alpha}$ are

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

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

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

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

Answer: d

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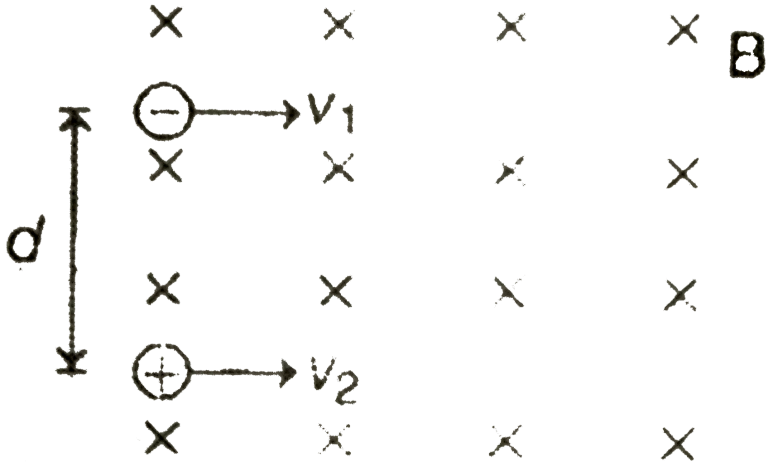
27. Two identical particles having the same mass m and charges $+q$ abnd $-q$ separeted by a distance d enter in a unifrom magentic field B directed perpendicular to paper inwards with speeds v_1 and v_2 as shown in figure.

The particles will not collide if (Ignore electrosatatic force)



A. $d > \frac{m}{Bq}(v_1 + v_2)$

B. $d < \frac{m}{Bq}(v_1 + v_2)$

C. $d > \frac{2m}{Bq}(v_1 + v_2)$

D. $v_1 = v_2$

Answer: c

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28. The plane of a rectangular loop of wire with sides 0.05 m and 0.08 m is parallel to a uniform magnetic field of induction $1.5 \times 10^{-2} T$. A current of 10.0 ampere flows through the loop. If the side of length 0.08 m is normal and the side of length 0.05 m is parallel to the lines of induction, then the torque acting on the loop is

A. $6000 Nm$

B. zero

C. $1.2 \times 10^{-2} Nm$

D. $6 \times 10^{-4} Nm$

Answer: d

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29. A loop of flexible conducting wire of length l lies in magnetic field B which is normal to the plane of loop. A current I is passed through the loop. The tension developed in the wire to open up is

A. $\frac{\pi}{2}Bil$

B. $\frac{Bil}{2}$

C. $\frac{Bil}{2\pi}$

D. Bil

Answer: c

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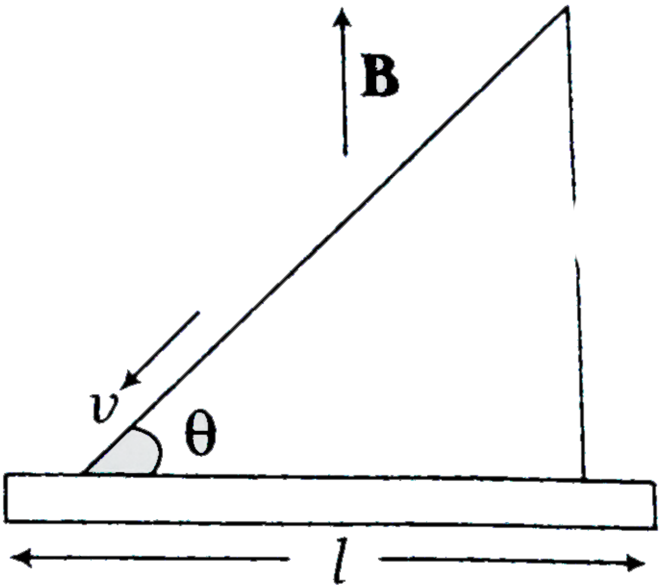
30. A conducting rod of length and mass m is moving down a smooth inclined plane of inclination θ with constant velocity V. A current I is flowing in the conductor in a direction perpenducular to paper inwards.A veticallly upwards magnetic field B exists in space.Then find magnitude of magnetic field b



A. $\frac{mg}{il}\sin\theta$

B. $\frac{mg}{il}\tan\theta$

C. $\frac{mg\cos\theta}{il}$

D. $\frac{mg}{il\sin\theta}$

Answer: b

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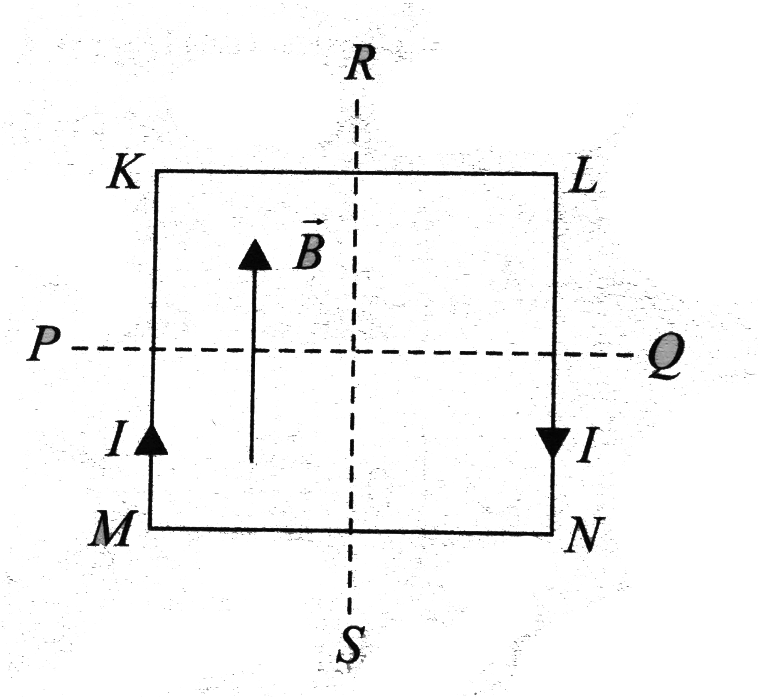
31. A square loop of wire carrying current I is lying in the plane of paper as shown in Fig. 1.141. The magnetic field is present in the region as shown. The loop will tend to rotate



A. about PQ with KL coming out of the page

B. about PQ with KL going into the page

C. about RS with MK coming out of the page

D. about RS with MK going into the page

Answer: a

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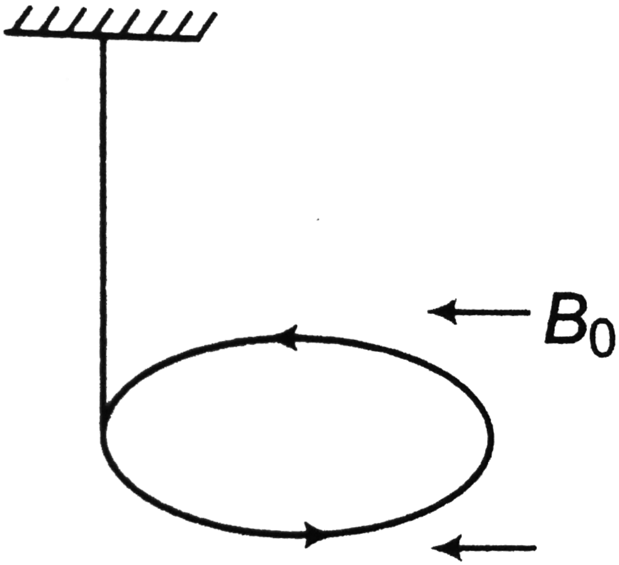
32. A uniform current carrying ering of mass m and radius R is connected by as massless string as shown. A uniform megnetic field B_0 exists in the region to keep the ring in horizontal position, then the current in the ring is



A. $\frac{mg}{\pi R B_0}$

B. $\frac{mg}{R B_0}$

C. $\dfrac{mg}{3\pi RB_0}$

D. $\dfrac{mgl}{\pi R^2 B_0}$

Answer: a

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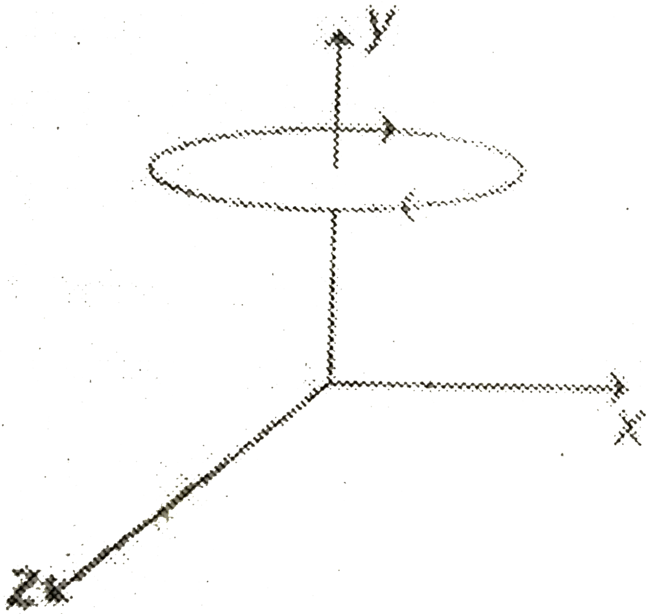
33. A circular coil having mass m is kept above the ground (x-z plane) at show height . Coil carries a curretn i in the direaction shown is figure. In which direaction a unifrom magnetic field B be applied so that the magnetic force balances the weight of the coil



A. Positive x-direction

B. Negative x-direction

C. Positive z-direction

D. None of these

Answer: d

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

A. $\dfrac{v \cos \theta}{Bd}$

B. $\dfrac{v \tan \theta}{Bd}$

C. $\dfrac{v}{Bd}$

D. $\dfrac{v \sin \theta}{Bd}$

Answer: d

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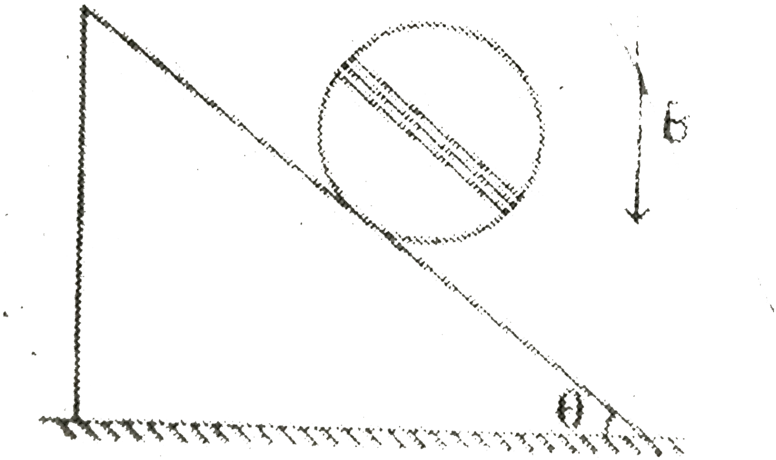
35. In the figure shown a coil of single turns is would on a sphere of radius R and mass m .The palne the coil is parallel to the planes and lies in the equatorial plane of the sphere . Current in the coil is i. The vaule of

B if the sphere is in equailibrum is



A. $\frac{mg}{\pi i r}$

B. $\frac{mg\sin\theta}{\pi i}$

C. $\frac{mg\sin\theta}{\pi i}$

D. None of these

Answer: a

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36. Three paticles, an electron (e), a proton (p) and a helium atom (He) are moving in circular paths with constant speeds in the x-y plane in a region where a uniform magnetic field B exists along z-axis. The times taken by e, p and He inside the field to complete one revolution are t_e, t_p and t_He respectively. Then,

A. $t_{He} > t_p = t_e$

B. $t_{He} > t_p > t_e$

C. $t_{He} = t_p = t_e$

D. None of these

Answer: b

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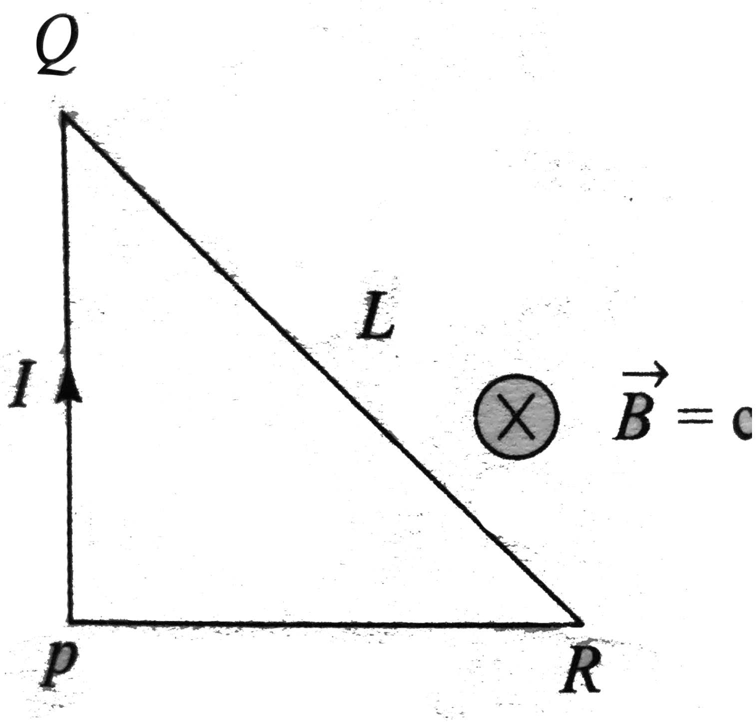
37. The rigid conducting thin wire frame carries an electric current I and this frame is inside a uniform magnetic field $\vec{B}$ as shown in Fig. 1.146.

Then,



A. The net magnetic force on the frame is zero but the torque is not zero

B. The net magnetic force on the frame and the torque due to magnetic field are both zero.

C. the net magnetic force on the frame is not zero and the torque is also not zero.

D. None of these

Answer: b

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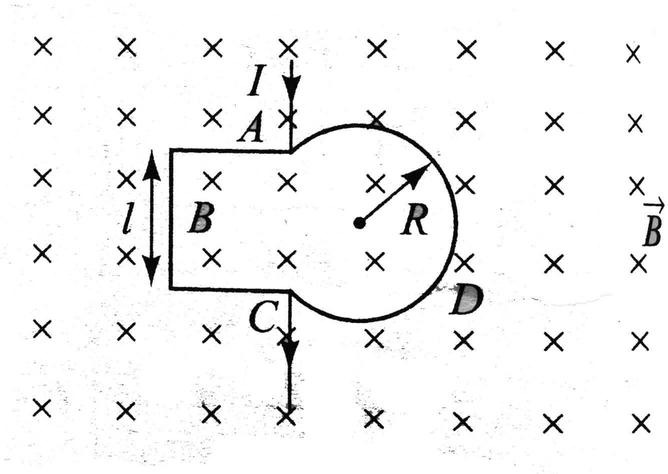
38. Figure. shows a conducting loop ABCDA placed in a uniform magnetic field (strength B) perpendicular to its plane. The part ABC is the (three-fourth) portion of the square of side length l. The part ADC is a circular arc of radius R. The points A and C are connected to a battery which supplies a current I to the circuit. The magnetic force on the loop due to the field B is



A. zero

B. BIl

C. $2BIlR$

D. $\dfrac{BIlR}{I+R}$

Answer: b

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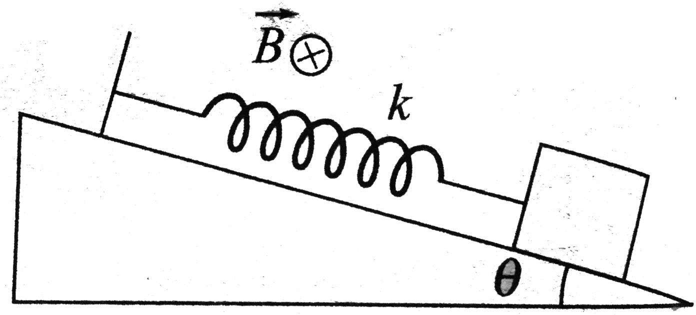
39. A small block of mass m, having charge q, is placed on a frictionless inclined plane making an angle θ with the horizontal. There exists a uniform magnetic field B parallel to the inclined plane but perpendicular to the length of spring. If m is slightly pulled on the incline in downward direction, the time period of oscillation will be (assume that the block does not leave contact with the plane)



A. $2\pi\sqrt{\frac{m}{K}}$

B. $2\pi\sqrt{\frac{2m}{K}}$

C. $2\pi\sqrt{\frac{qB}{K}}$

D. $2\pi\sqrt{\frac{qB}{2K}}$

Answer: a

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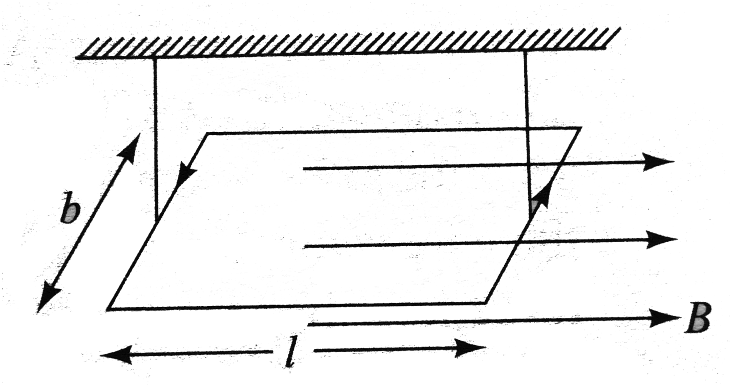
40. A uniform conducting rectangular loop of sides l, b and mass m carrying current i is hanging horizontally with the help of two vertical strings. There exists a uniform horizontal magnetic field B which is parallel to the longer side of loop. The value of tension which is least is



A. $\dfrac{mg - Bb}{2}$

B. $\dfrac{mg + Bb}{2}$

C. $\dfrac{mg - 2iBb}{2}$

D. $\dfrac{mg + 2Bb}{2}$

Answer: c

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41. A particle of specific charge $\frac{q}{m} = \pi C kg^{-1}$ is projected from the origin toward positive x-axis with a velocity of $10 ms^{-1}$ in a uniform magnetic field $\overrightarrow{B} = -2\hat{k}T$. The velocity $\overrightarrow{v}$ of particle after time $t = \frac{1}{12}s$ will be (in ms^{-1})

A. $5\left[\hat{i} + \sqrt{3}\hat{j}\right]$

B. $5\left[\sqrt{3}\hat{i} + \hat{j}\right]$

C. $5\left[\sqrt{3}\hat{i} - \hat{j}\right]$

D. $5\left[\hat{i} + \hat{j}\right]$

Answer: b

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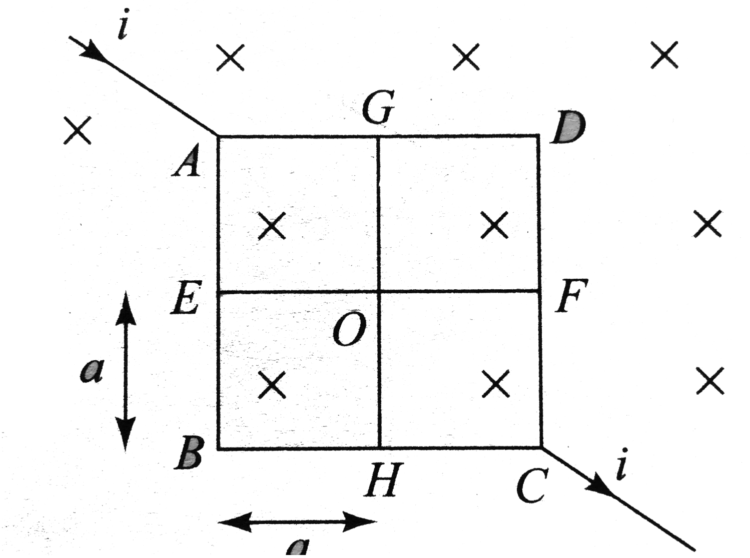
42. In Fig. there is a uniform conducting structure in which each small square has side a. The structure is kept in a uniform magnetic field B.

Then the magnetic force on the structure will be



A. $2\sqrt{2}iBa$

B. $\sqrt{2}iBa$

C. $2iBa$

D. iBa

Answer: a

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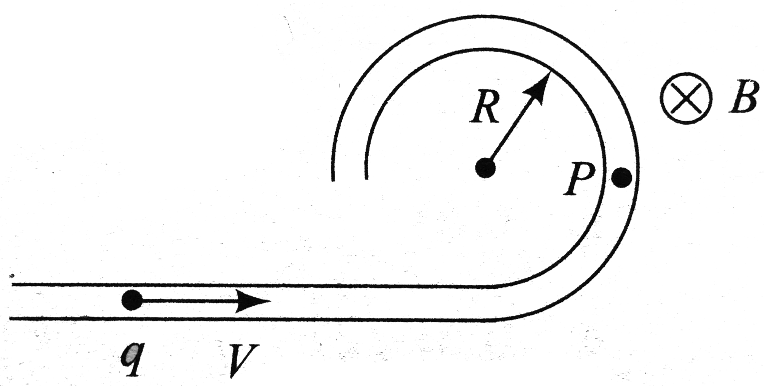
43. A charged particle moves insides a pipe which is bent as shown in Fig. 1.151. If $R < \frac{mv}{qB}$, then force exerted by the pipe on charged particle at P is (Neglect gravity)



A. towards center

B. away from centre

C. zero

D. None of these

Answer: a

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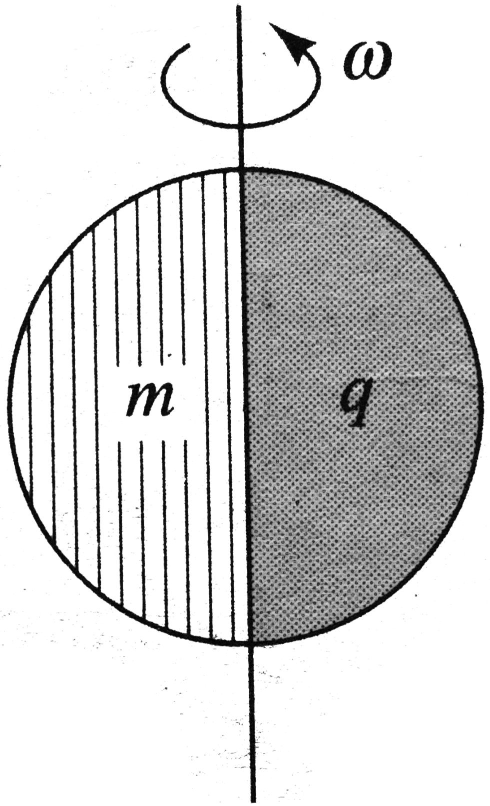
44. Consider a hypothetic spherical body. The body is cut into two parts about the diameter. One of hemispherical portion has mass distribution m while the other portion has indentical charge distribution q. The body is rotated about the axis with constant speed ω. Then, the ratio of magnetic moment to angular momentum is



A. $\frac{q}{2m}$

B. $> \frac{q}{2m}$

C. $< \frac{q}{2m}$

D. cannot be calculated

Answer: a

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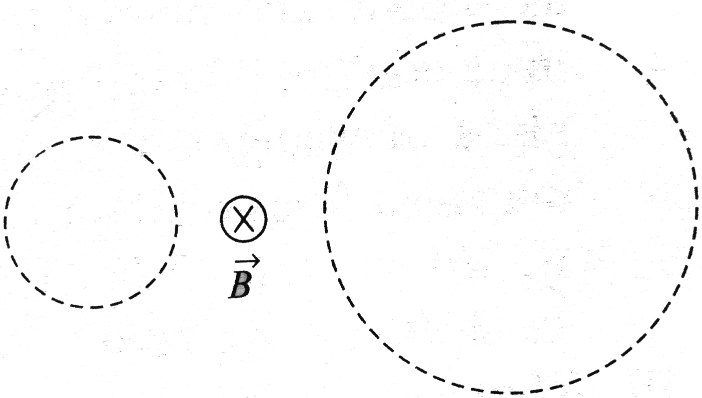
45. An electron and a proton each travel with equal speeds around circular orbits in the same uniform magnetic field as indicated (not to scale) in Fig. The field is into the page on the diagram. The electron travels ___ arount the ____circle.



A. clockwise, smaller,couterclockwise, larger

B. couterclockwise, larger,clockwise,smaller

C. clockwise,larger,couterclockwise,smaller

D. couterclockwise,larger,clockwise,smaller

Answer: a

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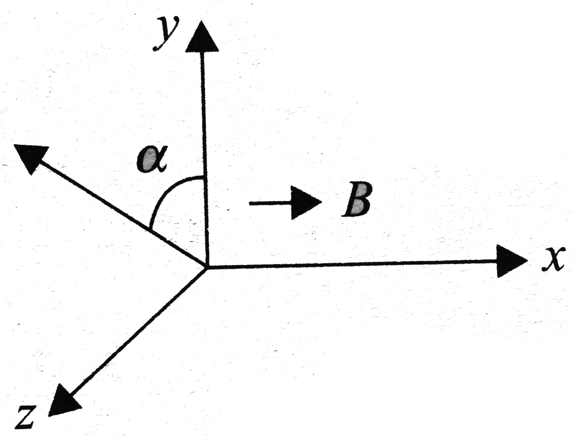
46. In a region of space, a uniform magnetic field B exists in the x-direction. An electron is fired from the origin with its initial velocity u making an angle α with the y direction in the y-z plane. In the subsequent motion of the electron,



A. y-coordinate of the electron will never be negative

B. z-coordinate of the electron will never be negative

C. x-coordinate of the electron will never be negative

D. trajectory of the electron would be helical

Answer: c

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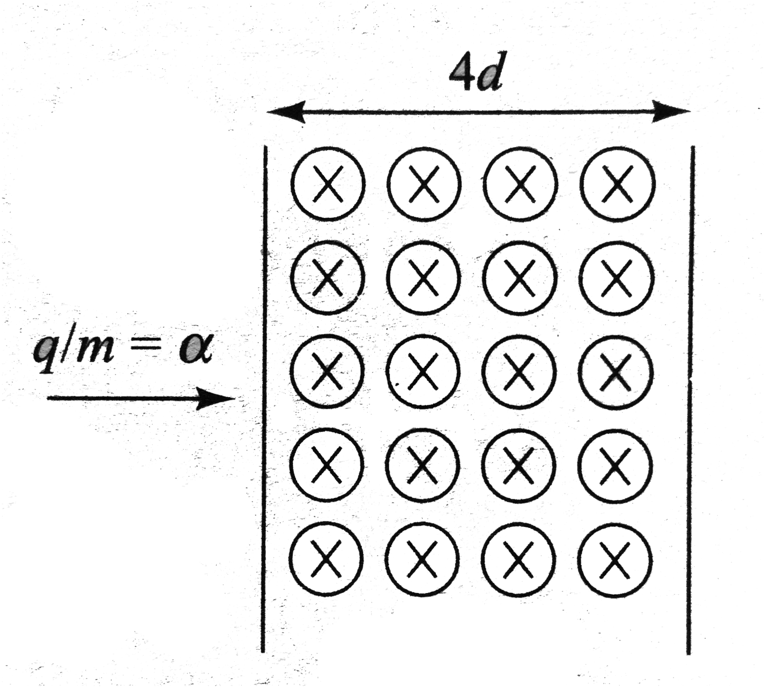
47. If a charged particle of charge to mass ratio $\left(\frac{q}{m}\right) = \alpha$ centers in a magnetic field of strength B at a speed $v = (2\alpha d)(B),$ then



A. angle subtended by the path of charged particle in magnetic field at the centre of circular path is 2π

B. The charge will move on a circular path and then will come out from magnetic field at some distance from the point of indertion

C. The time for which particle will be in the magnetic field is $\frac{2\pi}{\alpha B}$

D. Angle subtended by the path of charged particle in magnetic field at the centre of circular path is $\pi/2$

Answer: b

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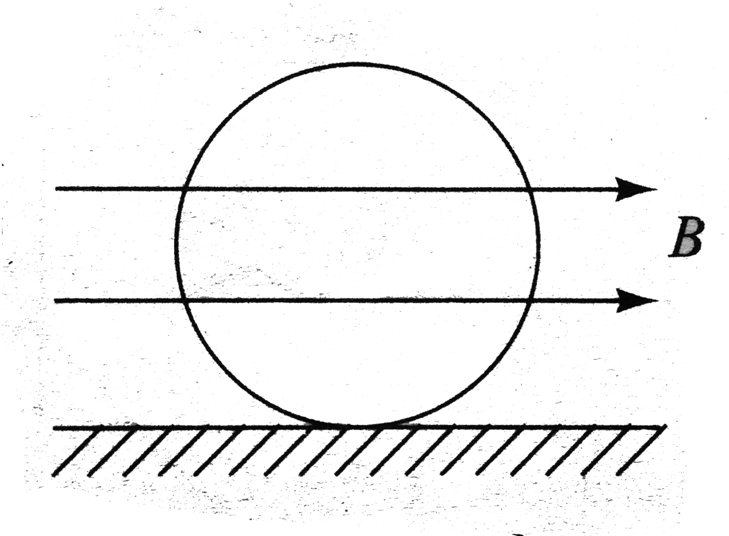
48. A conducting ring of mass 2kg and radius $0.5m$ is placed on a smooth plane. The ring carries a current of $i = 4A$. A horizontal magnetic field $B = 10T$ is switched on at time $t = 0$ as shown in fig The initial angular acceleration of the ring will be



A. $40\pi rads^{-2}$

B. $20\pi rads^{-2}$

C. $5\pi rads^{-2}$

D. $15\pi rads^{-2}$

Answer: a

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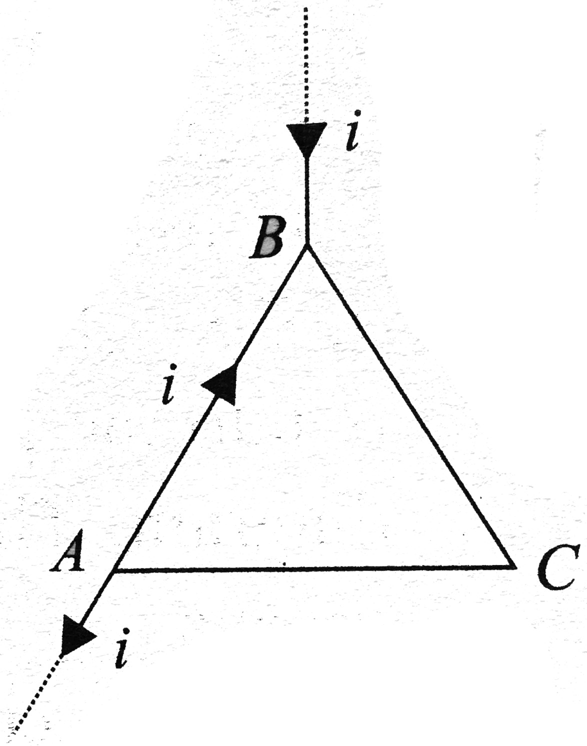
49. Figure shows an equilateral triangle ABC of side l carrying currents as shown, and placed in a uniform magnetic field B perpendicular to the plane of triangle. The magnitude of magnetic force on the triangle is



A. ilB

B. $2ilB$

C. $3ilB$

D. zero

Answer: a

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50. There exist uniform magnetic and electric fields of manitudes 1T and $1Vm^{-1}$ respectively, along positive y-axis. A charged particle of mass 1kg and charge 1C is having velocity $1ms^{-1}$ along x-axis and is at origin at t=0. Then, the coordinates of the particle at time πs will be

A. $(0, 1, 2)m$

B. $\left(0, -\pi^2/2, -2\right)m$

C. $\left(2, \pi^2/2, 2\right)m$

D. $\left(0, \pi^2/2, 2\right)m$

Answer: d

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51. A uniform magnetic field exist in a region which forms an equilateral triangle of side a. The magnetic field is perpendicular to the plane of the triangle . A charged q enters into this magnetic field perpendicular to a side with speed v. The charge enters from midpoint and leaves the field from midpoint of other side. Magnetic induction in the triangles is

A. $\frac{mv}{qa}$

B. $\frac{2mv}{qa}$

C. $\frac{mv}{2qa}$

D. $\frac{mv}{4qa}$

Answer: b

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52. A particle of positive charge q and mass m enters with velocity $V\hat{j}$ at the origin in a magnetic field $B\left(-\hat{k}\right)$ which is present in the whole space. The charge makes a perfectely inelastic collision with an identical particle (having same charge) ar rest but free to move at its maximum positive y-coordinate. After collision, the combined charge will move on trajectory where $r = \frac{mV}{qB}$.

A. $y = \frac{mv}{qB}x$

B. $(x + r)^2 + (y - r/2)^2 = r^2/4$

C. $(x + r)^2 + (y - r/2)^2 = r^2/8$

D. $(x - r)^2 + (y + r/2)^2 = r^2/4$

Answer: b

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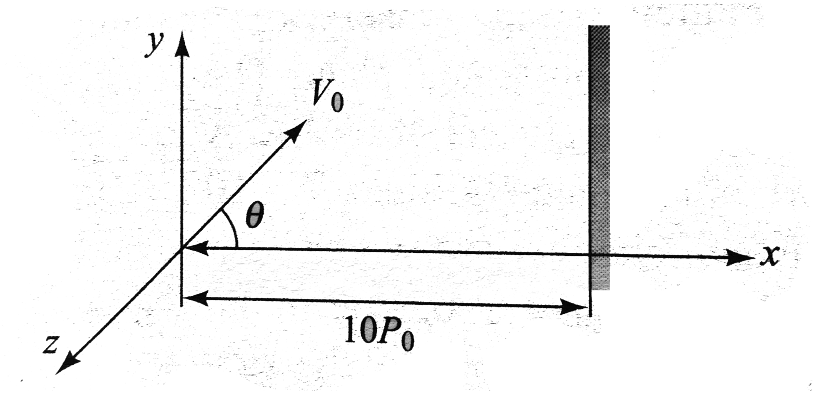
53. In the plane mirror, the coordinates of image of a charged particle (initially at origin as shown in fig. after two and a half time periods are (initial velocity of charge particle v_0 in the x-y plane and the plane mirror is perpendicular to the x-axis. A uniform magnetic field $B\hat{i}$ exists in the space. P_0 is pitch of helix, R_0 is raduis of helix.)



A. $17P_0, 0, \; -2R_0$

B. $3P_0, 0, \; -2R_0$

C. $17.5P_0, 0, \; -2R_0$

D. $3P_0, 0, 2R_0$

Answer: c

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54. A uniform magnetic field of 1.5T exists in a cylinderical region of radius 10.0 cm, its direction being parallel to the axis along east to west. A current carrying wire in north-south direction passes through this region. The wire intersects the axis and experience a force of 1.2N downwards. If the wire is turned from north south to northest-southwest direction. then magnitude and direction of force is

A. 1.2 N, upward

B. $1.2\sqrt{2}$, downward

C. $1.2N$, downward

D. $\frac{1.2}{\sqrt{2}}N$, downward

Answer: c

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55. An insulating rod of length l carries a charge q distrubuted uniformly on it. The rod is pivoted at its mid-point and is rotated at a frequency f about a fixed axis perpendicular to the the rod and passing through the pivot . The magnetic moment of the rod system is

A. $\frac{1}{12}\pi qfl^2$

B. πqfl^2

C. $\frac{1}{6}\pi qfl^2$

D. $\frac{1}{3}\pi qfl^2$

Answer: a

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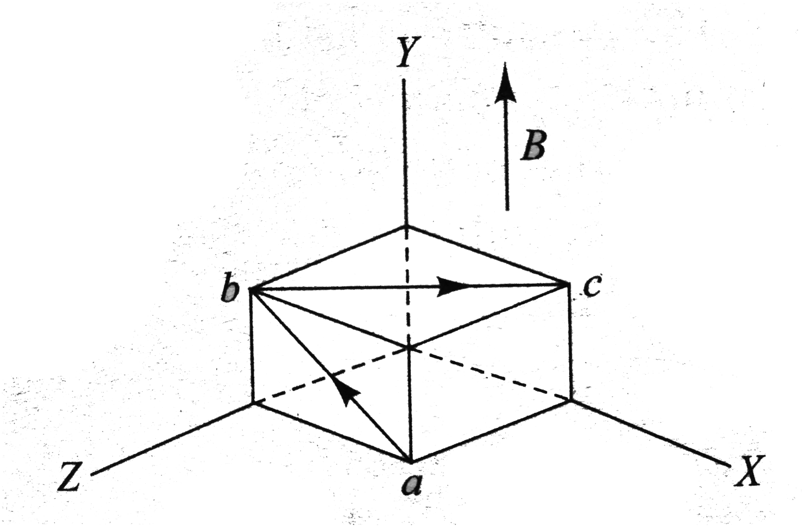
56. Two straight segments of wire ab and bc each carrying current I, are placed as shown in fig. The cube edge is 50 cm and magnetic field is uniform along y-axis having magnitude 0.4T. If I=3A, the force experienced by the wire abc in the presence of magnetic field



A. $0.6\hat{i}$

B. $1.2\left(\hat{i}+\hat{k}\right)$

C. $0.6\left(\sqrt{2}\hat{i}+\hat{j}-\sqrt{2}\hat{k}\right)$

D. $0.6\left(\sqrt{2}\hat{i}-\hat{k}\right)$

Answer: a

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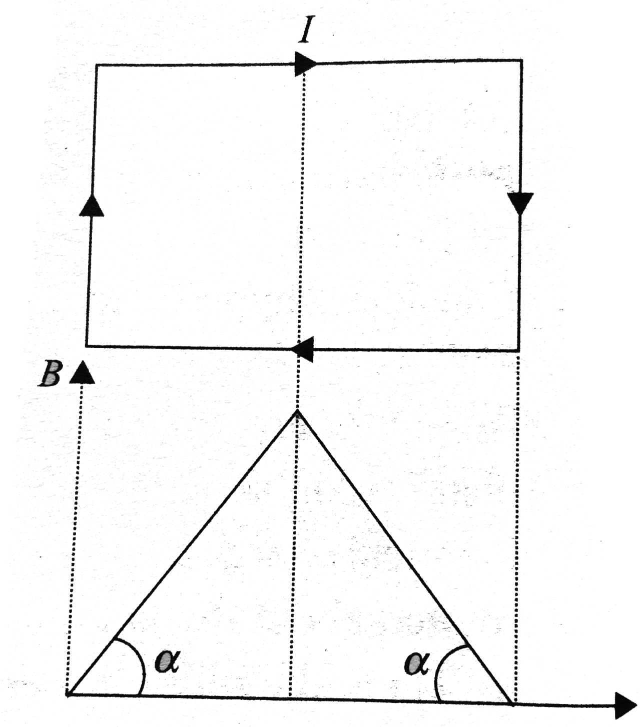
57. A current carrying loop is placed in the non-uniform magnetic field whose variation in space is shown in fig. Direction of magnetic field is into the plane of paper. The magnetic force experienced by the loop is



A. non-zero

B. zero

C. cannot say anything

D. None of these

Answer: b

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58. A current carrying loop lies on a smooth horizontal plane. Then,

A. it is possible to establish a uniform magnetic field in the region so that the loop starts rotating about its own axis.

B. it is possible to establish a uniform magnetic field in the region so that the loop will tip over over about any of the point.

C. it is not possible that loop will tip over about any of the point whatever be the direction of established magnetic field (uniform).

D. both (a) and (b) are correct.

Answer: b

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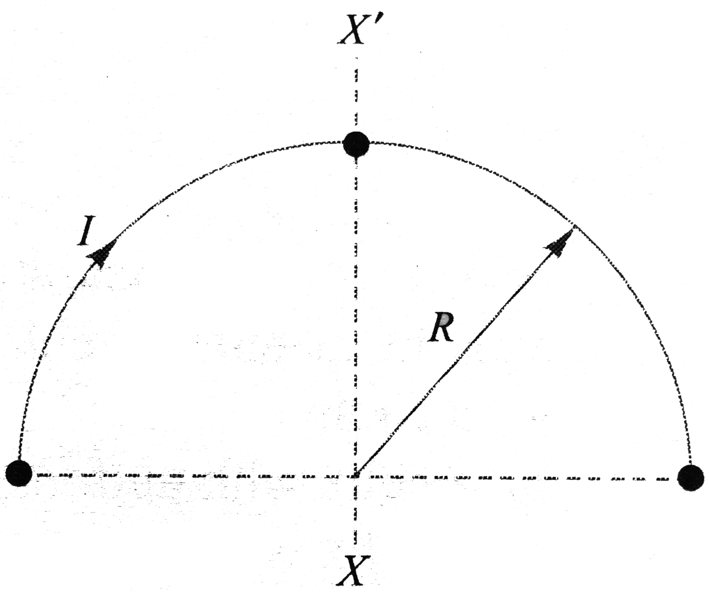
59. A semicircular wire of radius R, carrying current I, is placed in a magnetic field as shown in Fig. On left side of X'X, magnetic field strength B_0. On right side of X'X, magnetic field strength $2B_0$Both fields are directed inside the page. The magnetic force experienced by the wire would be



A. $3IB_0R$

B. $2IB_0R$

C. $\sqrt{10}IB_0R$

D. $\sqrt{5}IB_0R$

Answer: c

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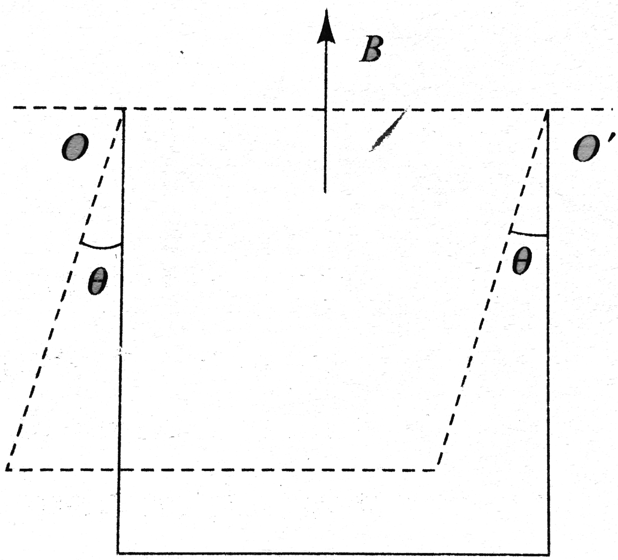
60. A wire of cross-sectional area A forms three sides of a square and is free to rotate about axis OO'. If the structure is deflected by an angle θ from the vertical when current i is passed through it in a magnetic field B acting vertically upward and density of the wire is ρ, then the value of θ is given by



A. $\frac{2A\rho g}{iB} = \cot\theta$

B. $\frac{2A\rho g}{iB} = \tan\theta$

C. $\frac{A\rho g}{iB} = \sin\theta$

D. $\frac{A\rho g}{2iB} = \cos\theta$

Answer: a

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61. A proton of mass 1.67×10^{-27} kg charge $1.6 \times 10^{-19} C$ is projected in xy-plane with a speed of $2 \times 10^{6} m/s$ at an angle of 60° to the X-axis. If a uniform magnetic field of 0.14 T is applies along the Y-axis, then the path of the proton is

A. a circle of radius 0.2m and time period $\pi \times 10^{-7} s$

B. a circle of radius 0.1m and time period $2\pi \times 10^{-7} s$

C. a helix of radius 0.1m and time period $2\pi \times 10^{-7} s$

D. a helix of radius 0.2m and time period $4\pi \times 10^{-7} s$

Answer: c

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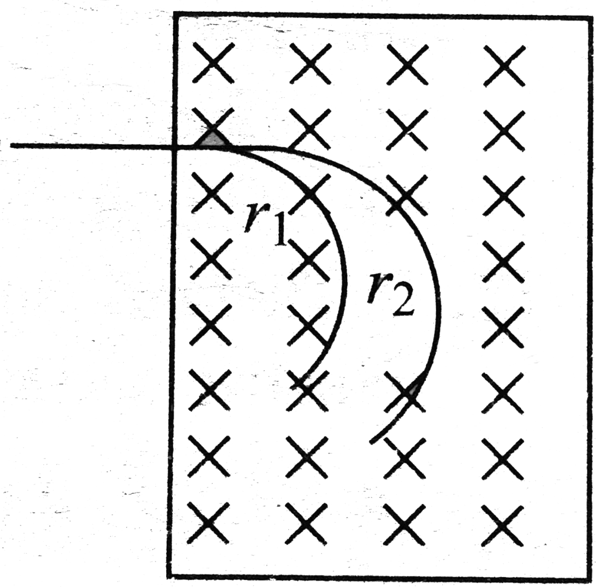
62. A beam of mixture of α particle and protons are accelerted through same potential difference before entering into the magnetic field of strength B. if $r_1 = 5$ cm then r_2 is



A. $5cm$

B. $5\sqrt{2}cm$

C. $10\sqrt{2}cm$

D. $20cm$

Answer: b

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63. An electron is projected at an angle θ with a uniform magnetic field. If the pitch of the helical path is equal to its radius, then the angle of projection is

A. $\tan^{-1}\pi$

B. $\tan^{-1}2\pi$

C. $\cot^{-1}\pi$

D. $\cot^{-1}2\pi$

Answer: b

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64. A charged particle moves in a uniform magnetic field perpendicular to it, with a radius of curvature 4 cm. On passing through a metallic sheet it loses half of its kinetic energy. Then, the radius of curvature of the particle is

A. $2cm$

B. $4cm$

C. $8cm$

D. $2\sqrt{2}cm$

Answer: d

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65. A particle of specific charge α is projected from origin with velocity $v = v_0\hat{i} - v_0\hat{k}$ in a uniform magnetic field $B = -B_0\hat{k}$. Find time dependence of velocity and position of the particle.

A. $\overrightarrow{v}(t) = v_0 \cos(\alpha B_0 t)\hat{i} + v_0 \sin(\alpha B_0 t)\hat{j} - v_0 \hat{k}$

B. $\overrightarrow{v}(t) = -v_0 \cos(\alpha B_0 t)\hat{i} + v_0 \sin(\alpha B_0 t)\hat{j} + v_0 \hat{k}$

C. $\overrightarrow{v}(t) = -v_0 \cos(\alpha B_0 t)\hat{i} + v_0 \sin(\alpha B_0 t)\hat{j} - v_0 \hat{k}$

D. $\overrightarrow{v}(t) = v_0 \cos(\alpha B_0 t)\hat{i} + v_0 \sin(\alpha B_0 t)\hat{j} + v_0 \hat{k}$

Answer: a

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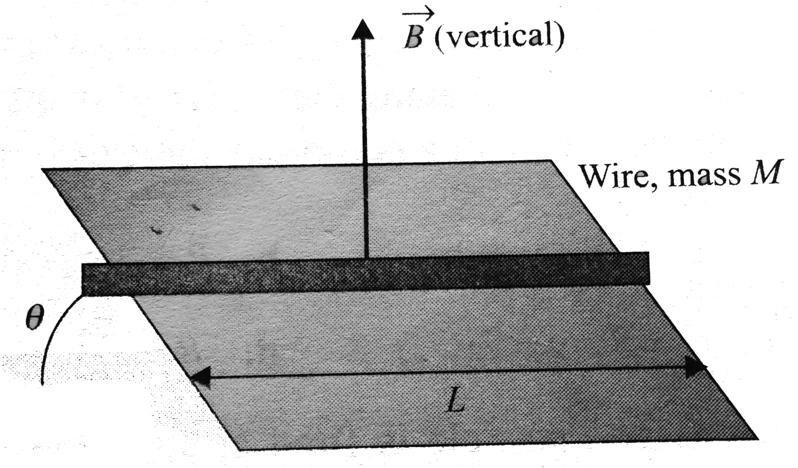
66. A straight peice of conducting wire with mass M and length L is placed on a frictionless incline tilited at an angle θ from the horizontal (as shown in fig) There is a uniform. Vertical magnetic field at all points (produced by an arrangement of magnets not shown in fig. To keep the wire from sliding down the incline, a voltage source is



attached to the ends of the wire. When just the right amount of current flows through the wire, the wire remains at rest. Determine the magnitude and direction of the current in the wire that will cause the wire to remain at rest.

A. $\frac{Mg\tan\theta}{2LB}$ to the left

B. $\frac{Mg\tan\theta}{LB}$ to the right

C. $\frac{Mg\tan\theta}{LB}$ to the left

D. $\frac{3Mg\tan\theta}{2LB}$ to the left

Answer: c

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67. In a moving coil galvanometer is based on the

A. heating effect of current

B. magnetic effect of current

C. chemical effect of current

D. Peltier effect of current

Answer: b

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68. In a moving coil galvanometer, we use a radial magnetic field so that the galvanometer scale is

A. logarithmic

B. expontial

C. linear

D. None of these

Answer: c

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69. The current that must flow through the coil of a galvanometre so as to produce a deflection of one division on its scale is called

A. Charge senstivity of the galvanometer

B. current senstivity of the galvanometer

C. micro-volt senstivity

D. None of these

Answer: b

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70. In a moving coil galvanometer, the deflection of the coil θ is related to the electrical current I by the relation

A. $i \propto \tan\theta$

B. $i \propto \theta$

C. $i \propto (\theta)^2$

D. $i \propto \left(\sqrt{\theta}\right)$

Answer: b

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Exercises Multiple Correct

1. Which of the following statements is correct?

A. If the moving charged particle enters into a region of magnetic field form outside, it does not complete a circular path.

B. If a moving charged particle traces a helical path in a uniform magnetic field, the axis of the helix is parallel to the magnetic field.

C. The power associated with the force exerted by a magnetic field on a moving charged particle moving charged particle is always equal to zero.

D. If in a region a uniform magnetic field and a uniform electric field both exist, a charged particle moving in this region cannot trace a circular path.

Answer: (a,b,c,d)

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2. 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. $B = \frac{B_0}{2}, v = 2v_0$

Answer: (a,b)

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3. If a charged particle is moving in a plane perpendicular to a uniform magnetic field with a time period T Then

A. never move parallel to the x-axis

B. move parallel to the x-axis once during every rotation for all velues of θ

C. move parallel to the x-axis at least once during every rotation if $\theta = 45^\circ$

D. never move perpendicular to the x-direction

Answer: (a,d)

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4. In the previous question, if the pitch of the helical path is equal to the maximum distance of the particle from the x-axis

A. $\cos\theta = \frac{1}{\pi}$

B. $\sin\theta = \frac{1}{\pi}$

C. $\tan\theta = \frac{1}{\pi}$

D. $\tan\theta = \pi$

Answer: (a,b,c)

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5. A particle having a mass of 0.5g carries a charge of $2.5 \times 10^{-8} C$. The particle is given an initial horizontal velocity of $6 \times 10^4 ms^{-1}$. To keep the particle moving in a horizontal direction

A. The magnetic field may be perpendicular to the direction of the velocity

B. the magnetic field should be along the direction of the velocity

C. magnetic field should have a minimum value of 3.27T

D. no magnetic field is required

Answer: (a,c)

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6. 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 $\vec{F} = q\left(\vec{v} \times \vec{B}\right)$. Which pairs of vectors are at right angles to each other?

A. $\overrightarrow{F}$ and $\overrightarrow{v}$

B. $\overrightarrow{F}$ and $\overrightarrow{B}$

C. $\overrightarrow{B}$ and $\overrightarrow{v}$

D. $\overrightarrow{F}$ and $\left(\overrightarrow{v} \times \overrightarrow{B}\right)$

Answer: (a,b)

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7. A charged particle moves in a uniform magnetic field. The velocity of the particle at some instant makes an acute angle with the magnetic field. The path of the particle will be

A. a circle

B. a helix with uniform pitch

C. a helix with non-uniform pitch

D. a helix with uniform radius

Answer: (b,d)

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8. An electron is moving along the positive x-axis. You want to apply a magnetic field for a short time so that the electron may reverse its direction and move parallel to the nagative x-axis. This can be done by applying the magnetic field along

A. y-axis

B. z-axis

C. y-axis only

D. z-axis only

Answer: (a,b)

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9. If a charged particle goes unaccelerated in a region containing electric and magnetic fields,

A. $\overrightarrow{E}$ must be perpendicular to $\overrightarrow{B}$

B. $\overrightarrow{v}$ must be perpendicular to $\overrightarrow{E}$

C. $\overrightarrow{v}$ must be perpendicular to $\overrightarrow{B}$

D. E must be equal to vB

Answer: (a,b)

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10. A proton is fired from origin with velocity $V = v_0\widehat{J} + v_0\widehat{K}$ in a uniform magnetic field B=B_(0)hatJ, in the susbsequent motion of the proton

A. its z-coordinate can never be negative

B. its x-coordinate can never be negative

C. its x-and z-coordinates cannot be zero at the same time

D. its y-coordinate will be proportional to its time of flight

Answer: (b,d)

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11. Velocity and acceleration vector of a charged particle moving in a magnetic field at some instant are $V = 3\hat{i} + 4\hat{j}$ and $a = 2\hat{i} + x\hat{j}$. Select the correct alternative(s).

A. $x = -1.5$

B. $x = 3$

C. Magnetic field is along z-direction

D. Kinetic energy of the particle is constant

Answer: (a,b,c)

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12. A charged particle goes undeflected in a region containing electric and magnetic field. It is possible that

A. $\vec{E} \| \vec{B}, \vec{v} \| \vec{E}$

B. $\vec{E}$ is not parallel to $\vec{B}$

C. $\vec{v} \mid \mid \vec{B}\, but \vec{E}$ is not parallel to $\vec{B}$

D. $\vec{E} \mid \mid \vec{B}\, but\, \vec{v}$ is not parallel to $\vec{E}$

Answer: (a,b)

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13. A charge partilce with velocity $V = x\hat{i} + y\hat{j}$ moves in a magnetic field $B = y\hat{i} + x\hat{j}$. The magnitude of magnetic force acting on the particle is F. Which one of the following statement(s) is/are correct ?

A. No force will act on charged particle if x=y

B. If $x > y$,f $\mu(x^2 - y^2)$

C. If $x > y$, the force will act along z-axis

D. If $y > x$, the force will act along y-axis.

Answer: (a,b,c)

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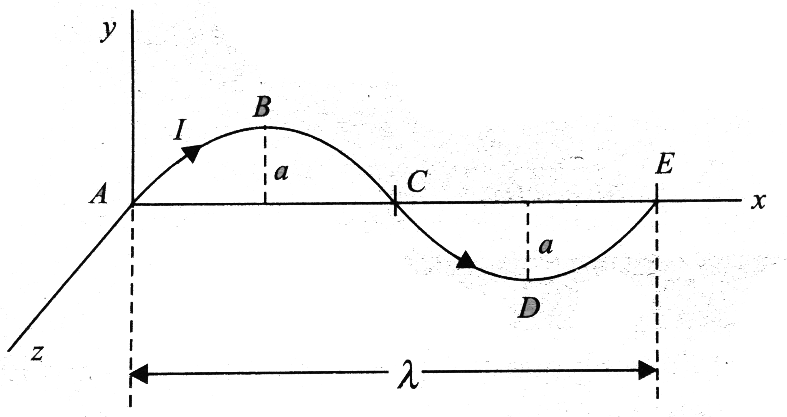
14. A conductor ABCDE, shaped as shown, carries current I. It is placed in the x-y plane with the end A and E on the x-axis. A uniform magnetic field of magnitude B exists in the region. The force acting on it will be



A. zero, if B is in the x-direction

B. λBI in the z-direction, if B is in the y-direction

C. λBI in the negative y-direction,if B is in the z-direction

D. λaBI, if B is in the x-direction

Answer: (a,b,c)

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15. A regular polygon of n sides is formed by bending a wire of total length $2\pi r$ which carries a current i. (a) Find the magnetic field B at the centre of the polygon. (b) By letting $n \rightarrow \infty$, deduce the expression for the magnetic field at the centre of a circular current.

A. $B = \dfrac{\mu_0 I}{2\sqrt{2}\pi}$

B. $B = \dfrac{\mu_0 I}{2\sqrt{3}\pi}$

C. B is parallel to the z-axis

D. B makes an angle of 45° with the x-y plane

Answer: (a,d)

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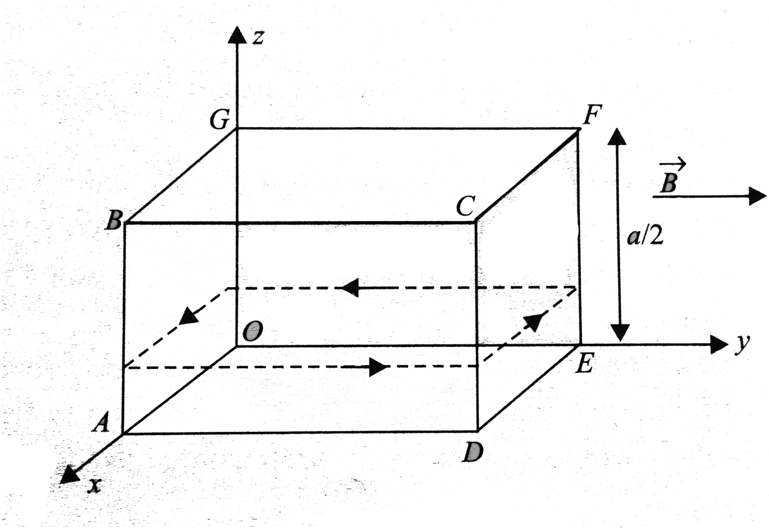
16. A wooden cubical block ABCDEFG of mass m and side a is wrapped by a square wire loop of perimeter 4a, carying current I. The whole system is placed at frictionless horizontal surface in a uniform magnetic field $\vec{B} = B_0 \hat{j}$ as shown in fig. In this situation, normal force between horizontal surface and block passes through a point at a distance x from centre. Choose correct statement (s).



A. The block must not topple if $I < \frac{mg}{aB_0}$

B. The block must not topple if $I < \frac{mg}{2aB_0}$

C. $x = \frac{a}{4}$ if $I = \frac{mg}{2aB_0}$

D. $x = \frac{a}{4}$ if $I = \frac{mg}{4aB_0}$

Answer: (b,d)

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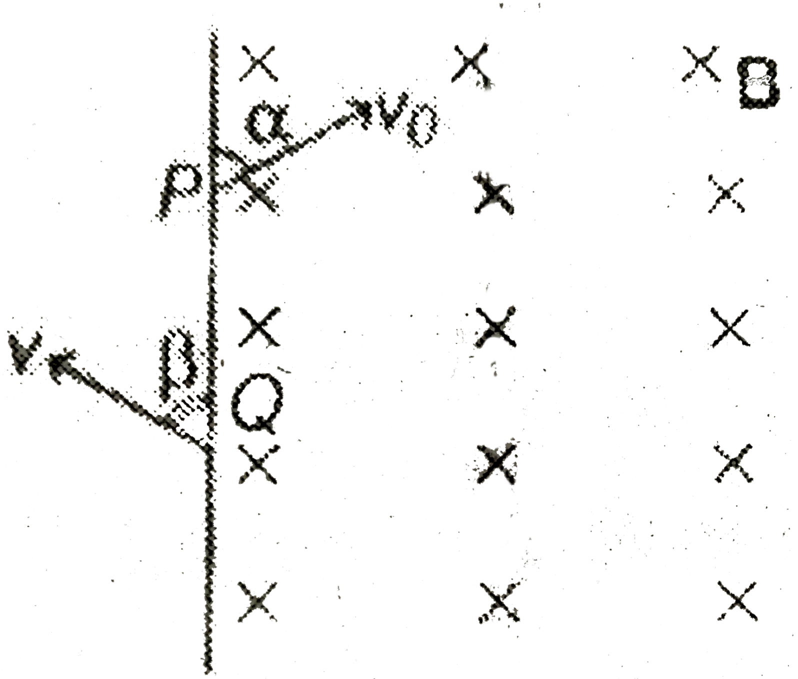
17. A particle of charge -q and mass m enters a uniform magnetic field B (perpendicular to paper inwards) P with a velocity v_0 at an angle α and leaves the free at Q with velocity v at angle β as shown in figure. The



A. α=β

B. $v = v_0$

C. $PQ = \dfrac{2mv_0 \sin\alpha}{Bq}$

D. The particle remains in field for time $t = \dfrac{2m(\pi - \alpha)}{Bq}$

Answer: (a,b,c,d)

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18. Let $\overrightarrow{E}$ and $\overrightarrow{B}$ denote the electric and magnetic field in a certain region of space. A proton moving with a velocity along a straight line enters the region and is found to pass through it undeflected. Indicate which of the following statement are consistent with the observation.

A. $\overrightarrow{E} = 0$ and $\overrightarrow{B} = 0$

B. $\overrightarrow{E} \neq 0$ and $\overrightarrow{B} = 0$

C. $\overrightarrow{E} \neq 0$ and $\overrightarrow{B} \neq 0$ and both $\overrightarrow{E}$ and $\overrightarrow{B}$ are parallel to $\overrightarrow{v}$

D. $\overrightarrow{E}$ is parallel to $\overrightarrow{v}\, but \overrightarrow{B}$ is perpendicular to $\overrightarrow{v}$

Answer: (a,b,c)

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19. A charged particle of unit mass and unit charge moves with velocity of $v = \left(8\hat{i} + 6\hat{j}\right)m/s$ in a magnetis field of `B=2hatKT. Then

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

B. The path of the particle may be $x^2 + y^2 = 25$

C. The path of the particle may be $y^2 + z^2 = 25$

D. The time period of the particle will be 3.14s

Answer: (a,b,d)

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20. A particle moves in a gravity free space where an electric field of strength E and a magnetic field of induction B exit. Which of the following statement is are correct?

A. If $E \neq 0 \text{ and } B \neq 0$, velocity of the particle may remains constant

B. If E=0, the particle cannot trace a circular path

C. If E=0, the kinetic energy of the particle remains constant

D. None of these

Answer: (a,c)

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21. A charged particle of specific charge α moves with velocity $v = v_0 \hat{i}$ in a magnetic field $B = \frac{B_0}{\sqrt{2}}\left(\hat{J} + 1\right)$ Then (specific charge=charge per unit mass)

A. path of the particle is a helix

B. path of the particle is circle

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

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

Answer: (b,c)

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22. When a current carrying coil is placed in a uniform magnetic field with its magnetic moment anti-parallel to the field.

A. torque on it is maximum

B. torque on it is zero

C. potential energy is maximum

D. dipole is in unstable equilibrium

Answer: (b,c,d)

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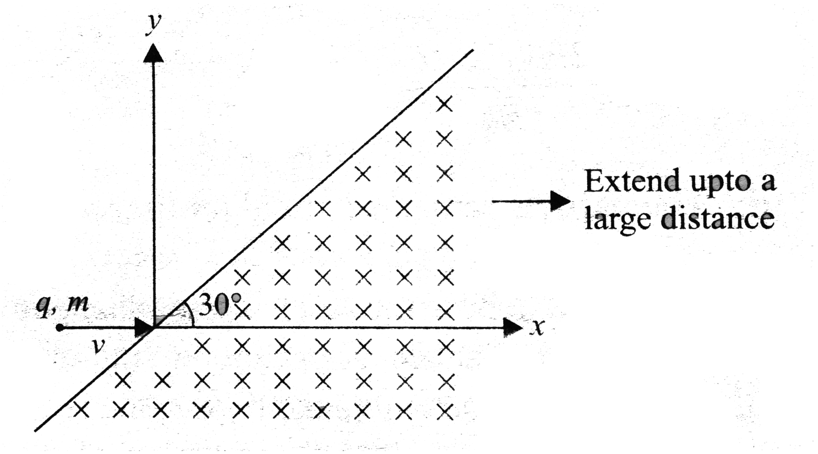
23. A charge particle of charge q and mass m is moving with velocity v as shown in fig In a uniform magnetic field B along -ve z-direction.Select the correct alternative (s).



A. Velocity of the particle when it comes out form the magnetic field is

$\overrightarrow{v} - v\cos 60^\circ \hat{i} + v\sin 60^\circ \hat{j}$

B. Time for which the particle was in magnetic field is $\frac{\pi m}{3qB}$

C. Distance travelled in magnetic field is $\frac{\pi m v}{3qB}$

D. None of these

Answer: (a,b,c)

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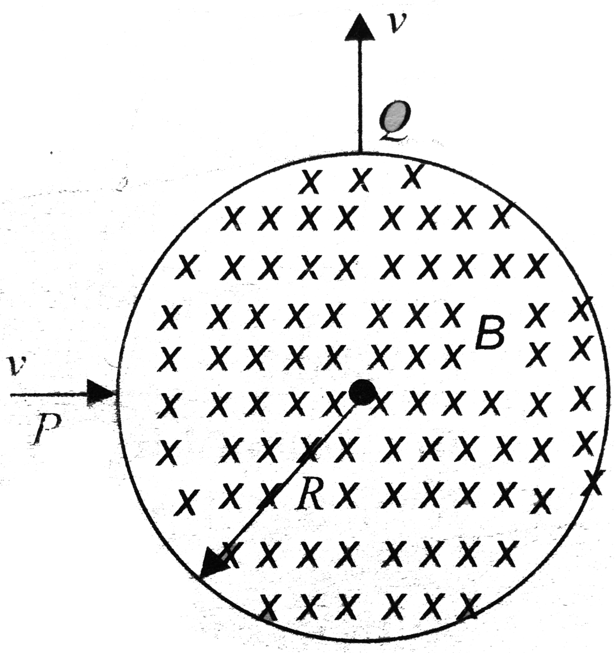
24. A particle of charge q and mass m enters normally (at point P) in a region of magnetic field with speed v. It comes out noramally from Q after time T as shown in Fig. The magnetic field B is present only in the region of radius R and is uniform. Initial and final velocities are along radial direction and they are perpendicular to each other. For this to happen, which of the following expression (s) is are correct?



A. $B = \frac{mv}{qR}$

B. $T = \frac{\pi R}{2v}$

C. $T = \frac{\pi m}{2qB}$

D. None of these

Answer: (a,b,c)

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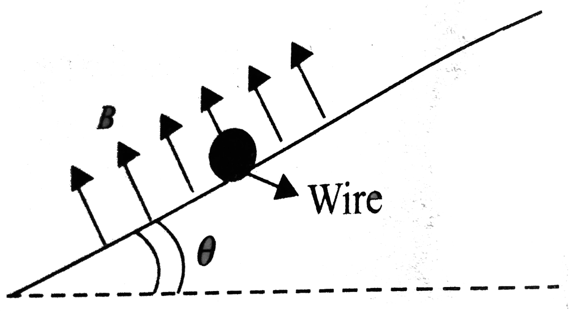
25. A wire of mass m and length l is placed on a smooth incline making an angle θ with the horizontal, whose fornt view is shown in Fig. When a finite amount of charge is passed through it in an infinitesimal time, the wire immediately acquires some velocity and then ascends the incline by a distance s. For this small duration, we can neglect the gravitational force because the current can be considered very large due to small time duration. The amount of charge passed through the wire is



A. $\dfrac{m\sqrt{2gs\sin\theta}}{Bl}$

B. $\dfrac{mv}{Bl}$

C. $\dfrac{m\sqrt{2gs\sin\theta}}{Bl\cos\theta}$

D. information insufficient

Answer: (a,b)

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Exercises Assertion -reasoning

1. Statement 1: Cyclotron is a device which is used to accelerate the positive ions.

Statement 2: Cyclotorn frequency depends upon the evelocity.

A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: c

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2. Statement 1: The net force on a closed circular current carrying loop placed in a uniform magnetic field is zero.

Statement 2: The torque produced in a conducting circular ring is zero when it is placed in a uniform magnetic field such that the magnetic field is perpendicular to the plane of loop.

A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: c

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3. Statement 1: A rectangular current loop is in an arbitray oreintation in an external uniform magnetic field. No work is required to rotate the loop abour an axis perpendicular to its plane.

Statement 2: All positions represents the same level of energy.

A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: a

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4. 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 particle and inversely proprotional to the charge of particle.

A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: a

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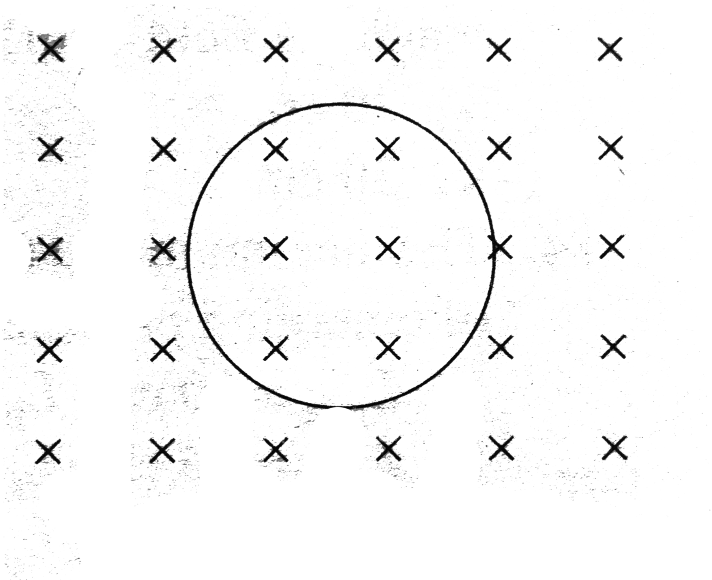
5. Statement 1: A charged particle is moving in a circular path under the action of a uniform magnetic field as shown in Fig. During motion kinetic energy of charged particle is costant.

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



A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: a

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6. Statement 1: When radius of a circular loop carrying current is doubled, its magnetic moment becomes four times.

Statement 2: Magnetic moment depends on the area of the loop.

A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: a

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7. 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 no work on the charged particle.

A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: c

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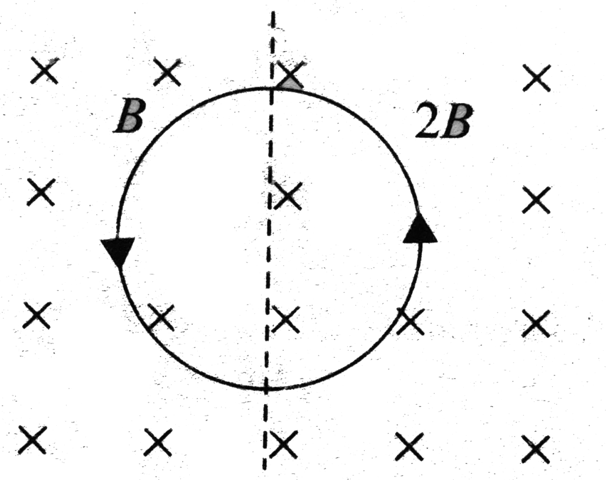
8. Statement 1: The magnetic field as magnetic field does no work on the charged particle.

Statement 2: force (magnetic) on the wire is $\int dF = \int i d\overrightarrow{l} \times \overrightarrow{B}$



A. If both statement 1 and statement 2 are ture, statement 2 is the correct explanation of statement 1.

B. If both statement 1 and statement 2 are ture, statement 2 is not the correct explanation of statement 1.

C. If statement 1 is true, statement 2 is false.

D. If statement 1 is false, statement 2 is true.

Answer: d

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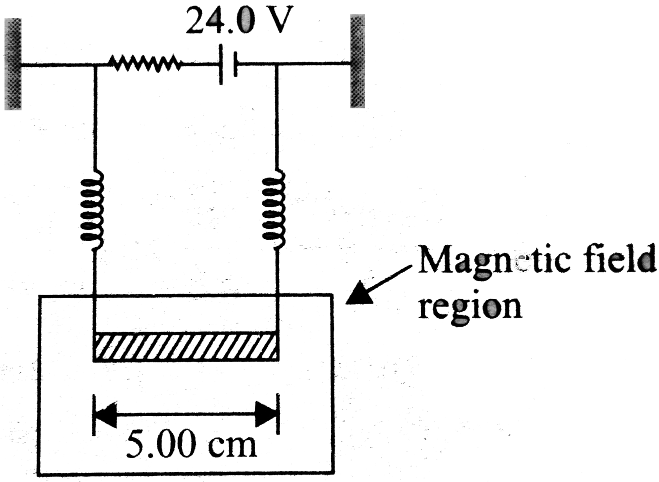
Exercises Linked Comprehension

1. The circuit in fig. consists of wires at the top and bottom and identical metal springs at the left and right sides.The wire at the bottom has a mass of 10.0g and is 5.00cm long. The wire is hanging as shown in the figure. The springes stretch 0.500 cm under the weight of the wire, and the circuit has a total resistance of 12.0Ω. When a magnetic field is turned on the springes stretch an additional 0.300 cm.



From the above statements we can conclude that

A. the magnetic field is directed into the plane of page

B. the magnetic field is directed out of the page

C. The magnetic field is toward left in the plane of page

D. The magnetic field is toward right in the plane of page

Answer: b

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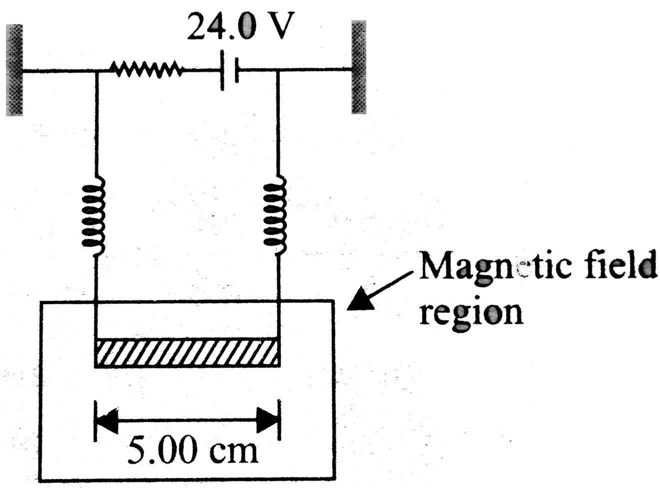
2. The circuit in fig. consists of wires at the top and bottom and identical metal springs at the left and right sides.The wire at the bottom has a mass of 10.0g and is 5.00cm long. The wire is hanging as shown in the figure. The springes stretch 0.500 cm under the weight of the wire, and the circuit has a total resistance of 12.0Ω. When a magnetic field is turned on the springes stretch an additional 0.300 cm.



The magnitude of magnetic field is

A. $1.2T$

B. $6T$

C. $0.6T$

D. $12T$

Answer: c

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3. A particle of mass m and charge q is accelerated by a potential difference V volt and made to enter a magnetic field region at an angle θ with the field. At the same moment, another particle of same mass and charge is projected in the direction of the field from the same point. Magnetic field induction is B. What would be the speed of second particle so that both particles meet again and again after regular interval of time. Also, find the time interval after which they meet and the distance travelled by the second particle during that interval.

A. $\sqrt{\frac{qV}{m}}\cos\theta$

B. $\sqrt{\frac{2qV}{m}}\cos\theta$

C. $\sqrt{\frac{qV}{m}}\sin\theta$

D. $\sqrt{\frac{qV}{2m}}\cos\theta$

Answer: b

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4. A particle of mass m and charge q is accelerated by a potential difference V volt and made to enter a magnetic field region at an angle θ with the field. At the same moment, another particle of same mass and charge is projected in the direction of the field from the same point. Magnetic field induction is B. What would be the speed of second particle so that both particles meet again and again after regular interval of time. Also, find the time interval after which they meet and the distance travelled by the second particle during that interval.

A. $\frac{2\pi m}{qB}$

B. $\frac{\pi m}{2qB}$

C. $\frac{\pi m}{qB}$

D. $\frac{3\pi m}{2qB}$

Answer: a

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5. A particle of mass m and charge q is accelerated by a potential difference V volt and made to enter a magnetic field region at an angle θ with the field. At the same moment , another particle of same mass and charge is projected in the direction of the field from the same point. Magnetic field of induction is B.

What would be the speed of second particle so that both particles meet again and again after a regular interval of time, which should be minimum?

A. $\sqrt{\frac{Vm}{q}\frac{2\pi}{B}\cos\theta}$

B. $\sqrt{\frac{2Vm}{3q}\frac{2\pi}{B}\cos\theta}$

C. $\sqrt{\frac{2Vm}{q}\frac{2\pi}{B}\cos\theta}$

D. $\frac{2}{3}\sqrt{\frac{Vm}{q}\frac{\pi}{m}\cos\theta}$

Answer: c

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6. A charged particle carrying charge $q = 10\mu C$ moves with velocity $v_1 = 10^6, s^{-1}$ at angle 45° with x-axis in the xy plane and experience 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.

Find the magnetic field $\overrightarrow{B}$.

A. $(10^{-3}T)\left(\hat{i} + \hat{j}\right)$

B. $(2 \times 10^{-3}T)\hat{i}$

C. $(10^{-3}T)\hat{i}$

D. $(2 \times 10^{-3}T)\left(\hat{i} + \hat{j}\right)$

Answer: c

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7. A charged particle carrying charge $q = 10\mu C$ moves with velocity $v_1 = 10^6 ms^{-1}$ at angle 45° with x-axis in the xy plane and experience 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.

Find the magnitude of the force F_2.

A. $10^{-2}N$

B. $10^{-3}N$

C. $10^{-4}N$

D. $10^{-5}N$

Answer: a

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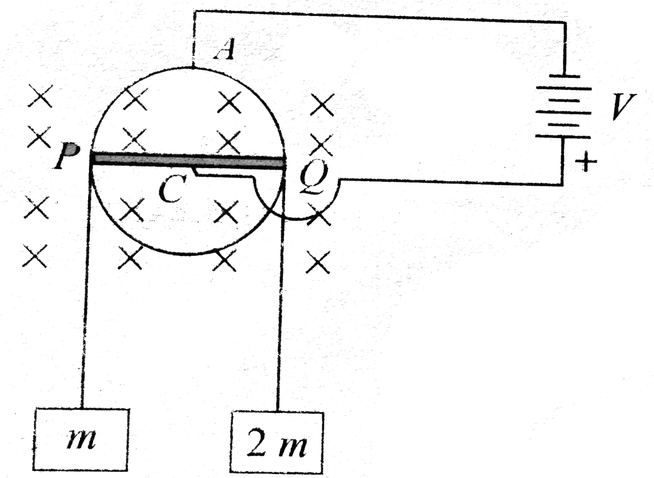
8. A conducting ring of mass m and radius r has a weightless conducting rod PQ of length 2r and resistance 2R attached to it along its diametre. It is pivoted at its centre C with its plane vertical, and two blocks of mass m and 2m are suspended by means of a light inextensible string passing over it as shown in Fig. The ring is free to rotate about C and the system is placed in magnetic field B (into the plane of the ring). A circuit is now complete by connecting the ring at A and C to a battery of emf V. It is found that for certain value of V , the system remains static.



In static condition, find the current through rod PC.

A. V / R

B. $V / 2R$

C. $4V/R$

D. $2V/R$

Answer: a

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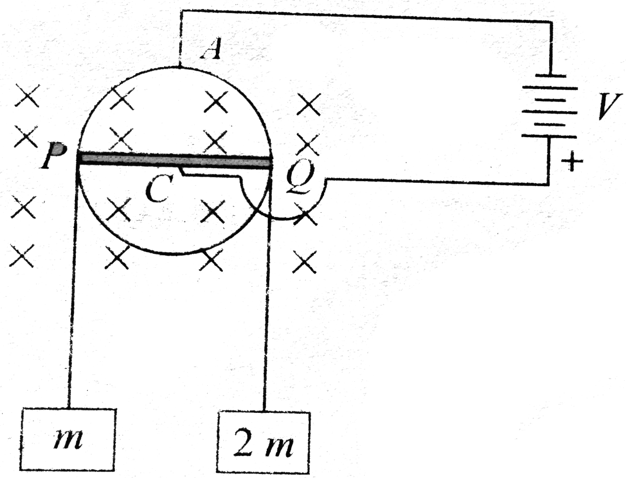
9. A conducting ring of mass m and radius r has a weightless conducting rod PQ of length 2r and resistance 2R attached to it along its diametre. It is pivoted at its centre C with its plane vertical, and two blocks of mass m and 2m are suspended by means of a light inextensible string passing over it as shown in Fig. The ring is free to rotate about C and the system is placed in magnetic field B (into the plane of the ring). A circuit is now complete by connecting the ring at A and C to a battery of emf V. It is found that for certain value of V , the system remains static.



Net torque applied by the tension in strings can be related as

A. $\frac{3BVr^2}{R}$

B. $\frac{BVr^2}{R}$

C. $\frac{BVr^2}{3R}$

D. $\frac{BVr^2}{2R}$

Answer: b

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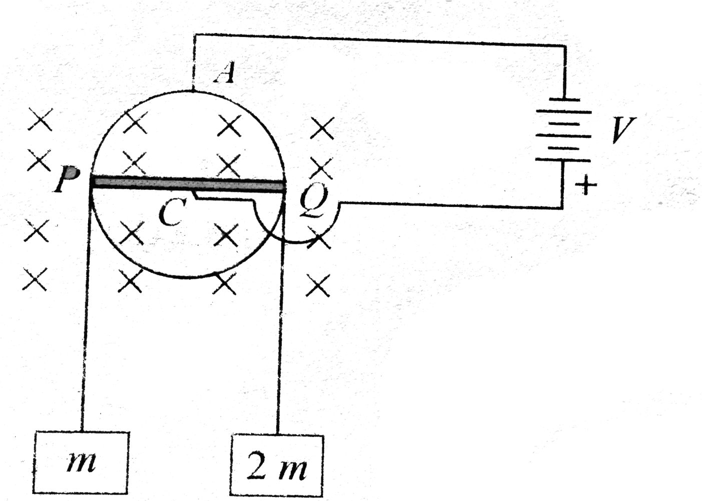
10. A conducting ring of mass m and radius r has a weightless conducting rod PQ of length 2r and resistance 2R attached to it along its diametre. It is pivoted at its centre C with its plane vertical, and two blocks of mass m and 2m are suspended by means of a light inextensible string passing over it as shown in Fig. The ring is free to rotate about C and the system is placed in magnetic field B (into the plane of the ring). A circuit is now complete by connecting the ring at A and C to a battery of emf V. It is found that for certain value of V , the system remains static.



The value of V can be related with m, B and r as

A. $2mgR / Br$

B. mgR / Br

C. $mgR/2Br$

D. $3mgR/Br$

Answer: b

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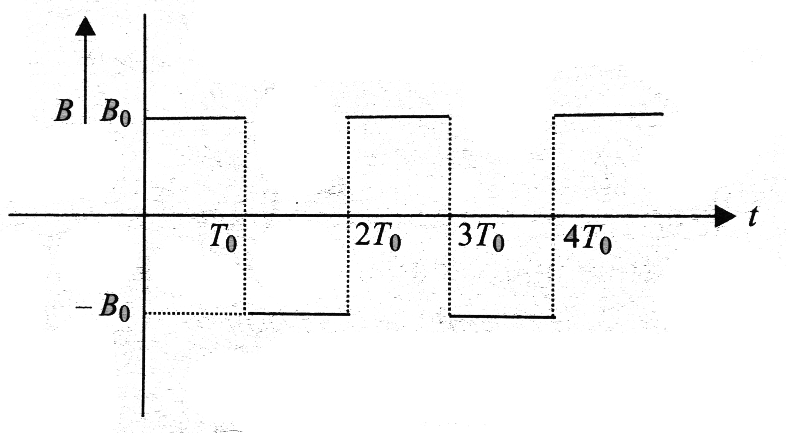
11. In a region, magnetic field along x-axis changes according to the graph given in fig.



If time period, pitch and radius of helix path are T_0, P_0 and R_0, respectively, and if the particle is projected at an angle θ_0 with the positive x-axis towards positive y-axis in x-y plane, then

select the correct statement

A. At $t = \frac{T_0}{2}$, coordinates of charge are $\left(\frac{P_0}{2}, 0, -2R_0\right)$

B. At $t = \frac{3T_0}{2}$, coordinates of charge are $\left(\frac{3P_0}{2}, 0, 2R_0\right)$

C. At $t = \frac{T_0}{2}$, coordinates of charge are $(P_0, 0, -2R_0)$

D. At $t = \frac{3T_0}{2}$, coordinates of charge are $(3P_0, 0, 2R_0)$

Answer: (a,b)

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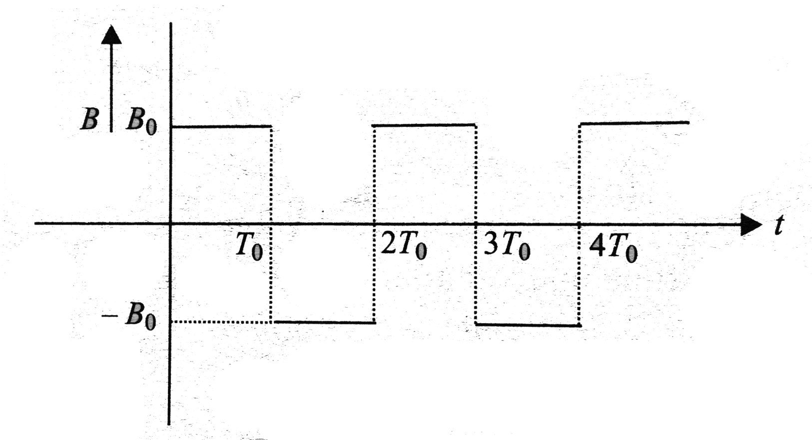
12. In a region, magnetic field along x-axis changes according to the graph given in fig.



If time period, pitch and radius of helix path are T_0, P_0 and R_0, respectively, and if the particle is projected at an angle θ_0 with the positive x-axis towards positive y-axis in x-y plane, then select the correct statement:

A. Two extremes (positions of charge particle during the motion) form x-axis are at distance $2R_0$ form each other

B. Two extreams form x-axis are at a distance $4R_0$ from each other

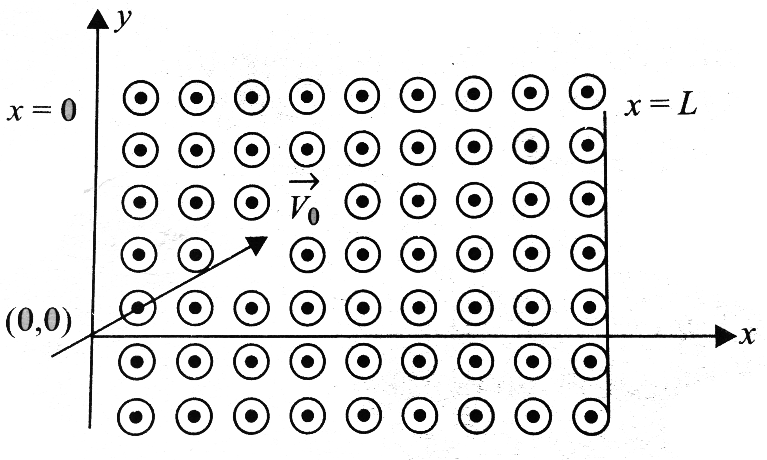
C. Two extreams (positions of charge particle during the motion) from x-axis are at a distance R_0 form each other

D. Two extreams form x-axis are at a distance $3R_0$ from each other

Answer: b

Watch Video Solution

13. The region between x=0 and x=L is filled with uniform constant magnetic field 25(T)$\hat{k}$. A particle of mass m=50g having positive charge q=1C and velocity $\overrightarrow{V}_0 = 50\sqrt{3}\hat{i} + 50\hat{j}ms^{-1}$ enters the region of the magnetic field. Neglect gravity throughout the question.



The value of L if the particle emerges from the region of magnetic field with its velocity $100(ms^{-1})\hat{i}$ is

A. $20cm$

B. $10cm$

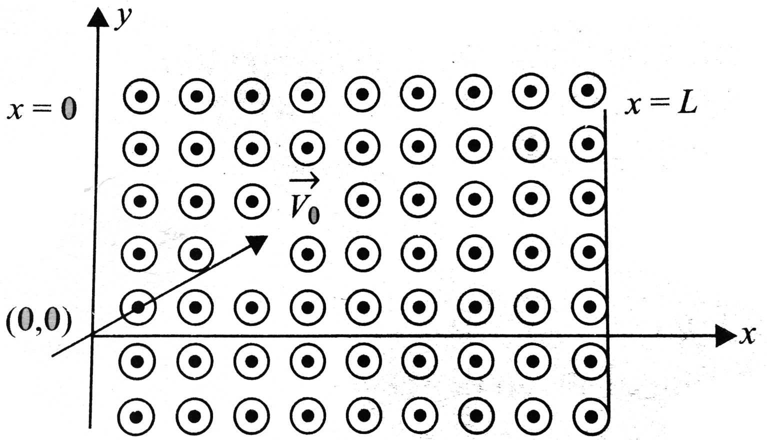
C. $30cm$

D. None of these

Answer: b

Watch Video Solution

14. The region between x=0 and x=L is filled with uniform constant magnetic field 25(T)$\hat{k}$. A particle of mass m=50g having positive charge q=1C and velocity $\vec{V}_0 = 50\sqrt{3}\hat{\imath} + 50\hat{\jmath} ms^{-1}$ enters the region of the magnetic field. Neglect gravity throughout the question.



The maximum and minimum values of L such that velocity of emerging particle makes angle $\pi / 3$ with the y-axis are

A. $L_{\min} = 10cm, L_{\max} = \infty$

B. $L_{\min} = 20cm, L_{\max} = 40cm$

C. $L_{\min} = 10cm, L_{\max} = 20cm$

D. $L_{\min} = 20cm, L_{\max} = \infty$

Answer: d

Watch Video Solution

15. In a certain region of space, there exists a uniform and constant electric field of magnitude E along the positive y-axis of a coordinate system. A charged particle of mass m and charge -q (qgt0) is projected form the origin with speed 2v at an angle of 60° with the positive x-axis in x-y plane. When the x-coordinate of particle becomes $\sqrt{3}mv^2 / qE$ a uniform and constant magnetic field of strength B is also switched on along positive y-axis.

Velocity of the particle just before the magnetic field is switched on is

A. $v\hat{i}$

B. $v\hat{i} + \frac{\sqrt{3}v}{2}\hat{j}$

C. $v\hat{i} - \frac{\sqrt{3}v}{2}\hat{j}$

D. $2v\hat{i} - \frac{\sqrt{3}v}{2}\hat{j}$

Answer: a

Watch Video Solution

16. In a certain region of space, there exists a uniform and constant electric field of magnitude E along the positive y-axis of a coordinate system. A charged particle of mass m and charge -q (qgt0) is projected form the origin with speed 2v at an angle of 60° with the positive x-axis in x-y plane. When the x-coordinate of particle becomes $\sqrt{3}mv^2/qE$ a uniform and constant magnetic. field of strength B is also switched on along positive y-axis.

x-coordinate of the particle as a function of time after the magnetic field is switched on is

A. $\dfrac{\sqrt{3}mv^2}{qE} - \dfrac{mv}{qB}\sin\left(\dfrac{qB}{m}t\right)$

B. $\dfrac{\sqrt{3}mv^2}{qE} + \dfrac{mv}{qB}\sin\left(\dfrac{qB}{m}t\right)$

C. $\dfrac{\sqrt{3}mv^2}{qE} - \dfrac{mv}{qB}\cos\left(\dfrac{qB}{m}t\right)$

D. $\dfrac{\sqrt{3}mv^2}{qE} + \dfrac{mv}{qB}\cos\left(\dfrac{qB}{m}t\right)$

Answer: b

Watch Video Solution

17. In a certain region of space, there exists a uniform and constant electric field of magnitude E along the positive y-axis of a coordinate system. A charged particle of mass m and charge -q (qgt0) is projected form the origin with speed 2v at an angle of 60° with the positive x-axis in x-y plane. When the x-coordinate of particle becomes $\sqrt{3}mv^2 / qE$ a uniform and constant magnetic. field of strength B is also switched on along positive y-axis.

x-coordinate of the particle as a function of time after the magnetic field is switched on is

A. $\frac{mv}{qB}\left[1-\cos\left(\frac{qB}{m}t\right)\right]$

B. $-\frac{mv}{qB}\left[1+\cos\left(\frac{qB}{m}t\right)\right]$

C. $-\frac{mv}{qB}\left[1-\cos\left(\frac{qB}{m}t\right)\right]$

D. $\frac{mv}{qB}\left[1+\cos\left(\frac{qB}{m}t\right)\right]$

Answer: c

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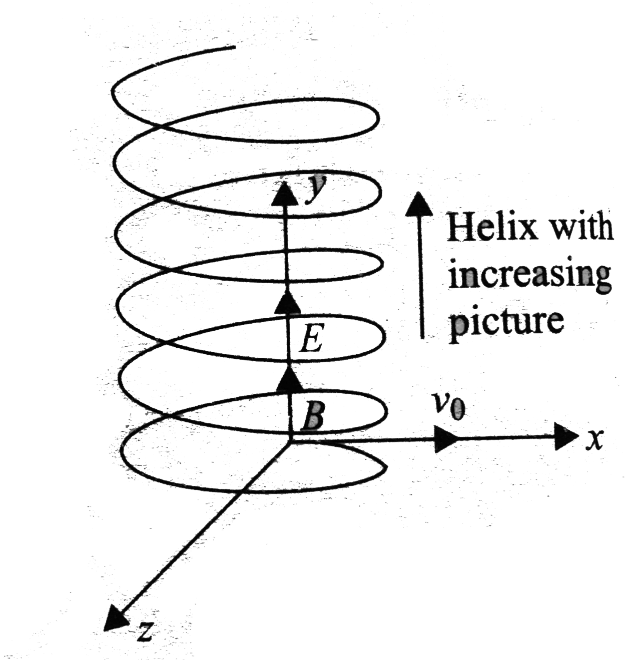
18. Uniform electric and magnetic fields with strength E and induction B, respectively, are along y-axis as shown in Fig. A particle with specific charge q/m leaves the origin O in the direcction of x-axis with an initial non-relativistic velocity v_0



The coordinate y_n of the particle when it crosses the y-axis for the n^{th} time is

A. $\dfrac{2\pi^2 mn^2 E}{qB^2}$

B. $\dfrac{\pi^2 mn^2 E}{qB^2}$

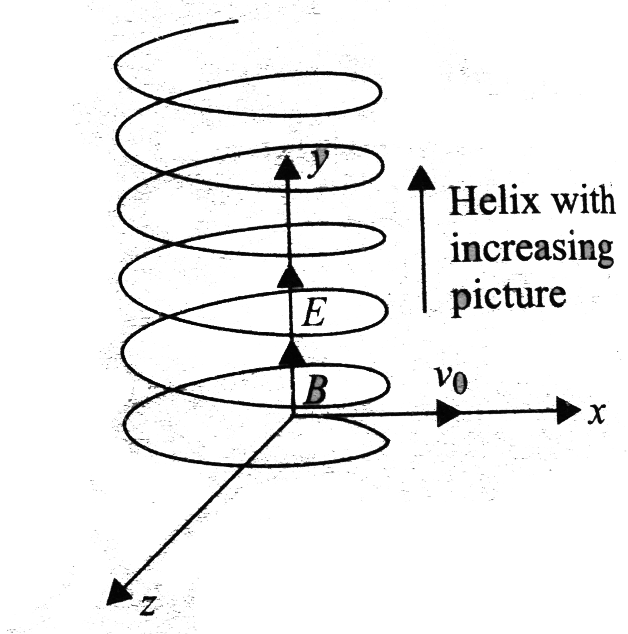
C. $\dfrac{2\pi^2 mn^2 E}{3qB^2}$

D. $\dfrac{\sqrt{3}\pi^2 mn^2 E}{qB^2}$

Answer: a

Watch Video Solution

19. Uniform electric and magnetic fields with strength E and induction B, respectively, are along y-axis as shown in Fig. A particle with specific charge q/m leaves the origin O in the direcction of x-axis with an initial non-relativistic velocity v_0



The angle α between the particle's velocity vector and y-axis at and moment is

A. $\tan^{-1}\left(\frac{3v_0B}{2\pi nE}\right)$

B. $\tan^{-1}\left(\frac{v_0B}{\pi nE}\right)$

C. $\tan^{-1}\left(\frac{v_0B}{\sqrt{2}\pi nE}\right)$

D. $\tan^{-1}\left(\frac{v_0B}{2\pi nE}\right)$

Answer: d

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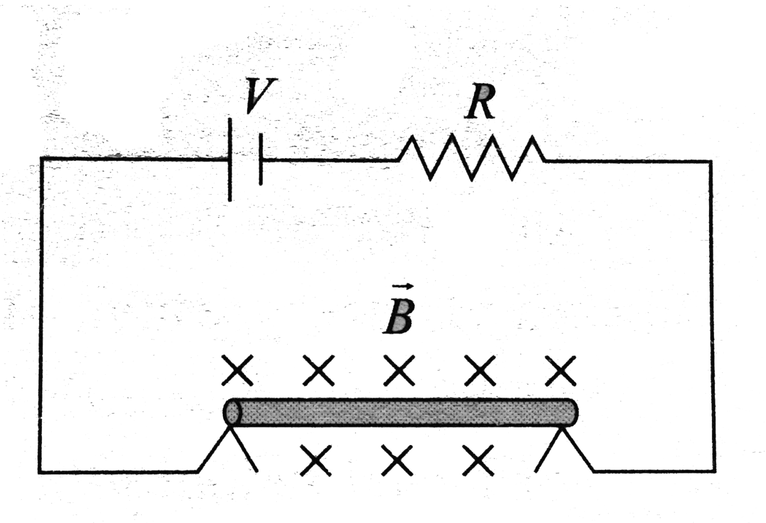
20. A thin, 50 cm long metal bar with mass 750 g rests on, but is not attracted to, two metallic supports in a uniform 0.450T magnetic field, as shown in fig. A battery and a 25Ω resistor in series are connected to the supports.



What is the largest voltage the battery can have without breaking the circuit at the supports?

A. $817V$

B. $412V$

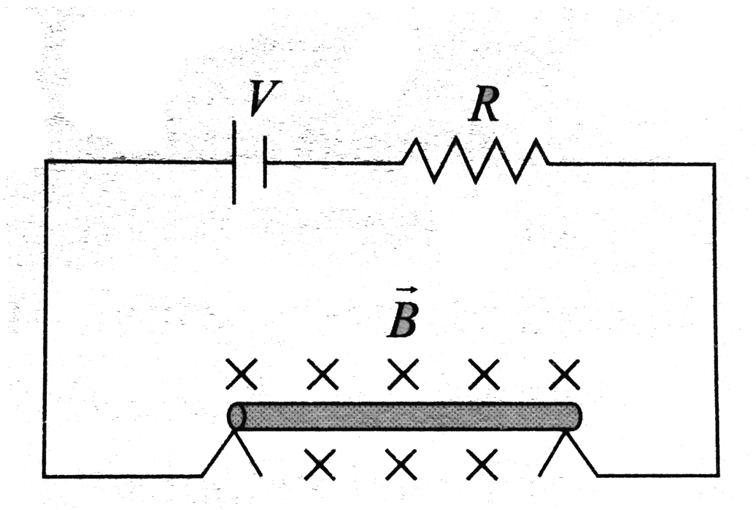
C. $325V$

D. $160V$

Answer: a

Watch Video Solution

21. A thin, 50 cm long metal bar with mass 750 g rests on, but is not attracted to, two metallic supports in a uniform 0.450T magnetic field, as shown in fig. A battery and a 25Ω resistor in series are connected to the supports.



The battery voltage has the maximum value calculated in above question.

If the resistor suddenly gets partially short-circuited, decreasing its resistance to 2Ω, find the initial accleration of the bat.

A. $113ms^{-2}$

B. $55ms^{-2}$

C. $180ms^{-2}$

D. $12.4ms^{-2}$

Answer: a

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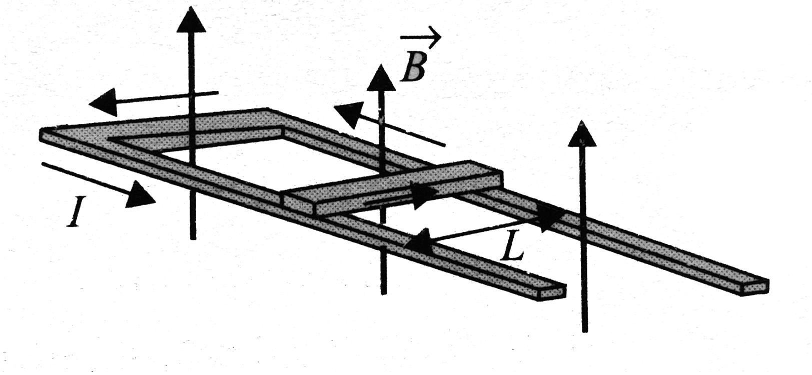
22. A conductor bar with mass m and length L slides over horizontal rails that are connected to a voltage source. The voltage source maintains a constant current I in the rails and bar, and constant, uniform, vertical magnetic field $\vec{B}$ fills the region between the rails (as shown in Fig.)



Find the magnitude and direction of the net force on the conducting bar.

Ignore friction, air resistance and electrical resistance.

A. ILB, to the right.

B. ILB, to the left.

C. 2ILB, to the right.

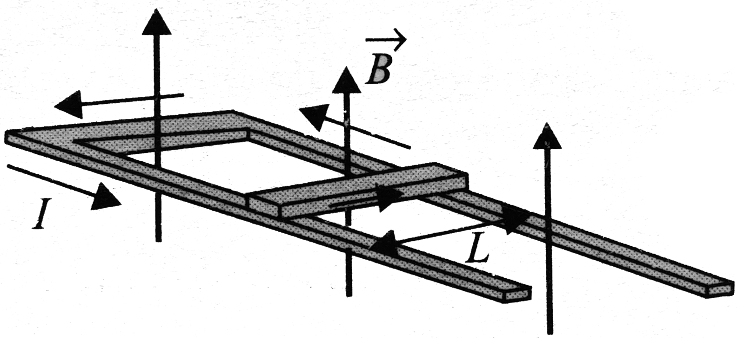
D. 2ILB, to the left.

Answer: a

Watch Video Solution

23. A conductor bar with mass m and length L slides over horizontal rails that are connected to a voltage source. The voltage source maintains a constant current I in the rails and bar, and constant, uniform, vertical magnetic field $\vec{B}$ fills the region between the rails (as shown in Fig.)

If the bar has mass m, find the distance d that the bar must move along the rails from rest to attain speed v.



A. $\frac{3v^2m}{2ILB}$

B. $\frac{5v^2m}{2ILB}$

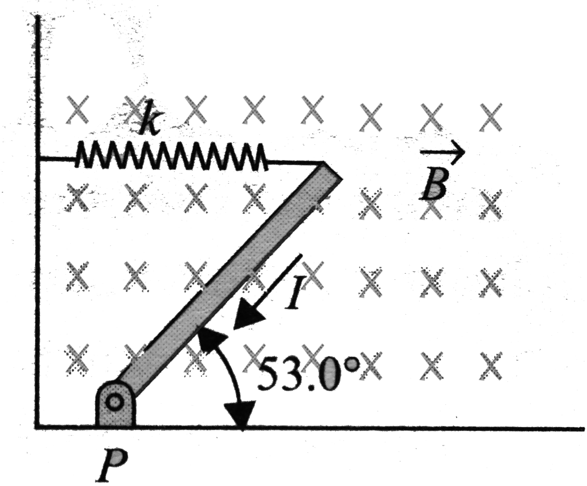
C. $\frac{v^2m}{ILB}$

D. $\frac{v^2m}{2ILB}$

Answer: d

Watch Video Solution

24. A thin, uniform rod with negligible mass and length 0.200m is attached to the floor by a frictionless hinge at point P (as shown in fig) A horizontal spring with force constant $k = 4.80Nm^{-1}$ connects the other end of the rod to a vertical wall. The rod to a vertical wall. The rod is in a uniform magnetic field B=0.340T directed into the plane of the figure. There is current I=6.50 A in the rod, in the direction shown.



Calculate the torque due to the magnetic force on the rod, for an axis at P.

A. $0.0442Nm^{-1}$, clockwise

B. $0.0442Nm^{-1}$, anticlockwise

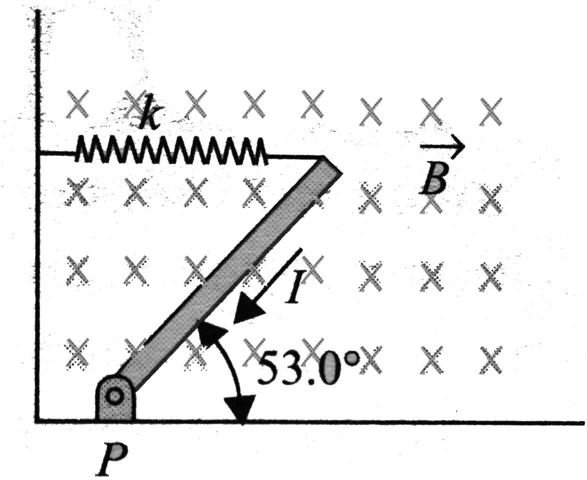
C. $0.022Nm^{-1}$, clockwise

D. $0.022Nm^{-1}$, anticlockwise

Answer: a

Watch Video Solution

25. A thin, uniform rod with negligible mass and length 0.200m is attached to the floor by a frictionless hinge at point P (as shown in fig) A horizontal spring with force constant $k = 4.80Nm^{-1}$ connects the other end of the rod to a vertical wall. The rod to a vertical wall. The rod is in a uniform magnetic field B=0.340T directed into the plane of the figure. There is current I=6.50 A in the rod, in the direction shown.



When the rod is in equilibrium and makes an angle of 53.0° with the floor, is the spring stretched or compressed?

A. 0.05765m,stretched

B. 0.05765m,compresed

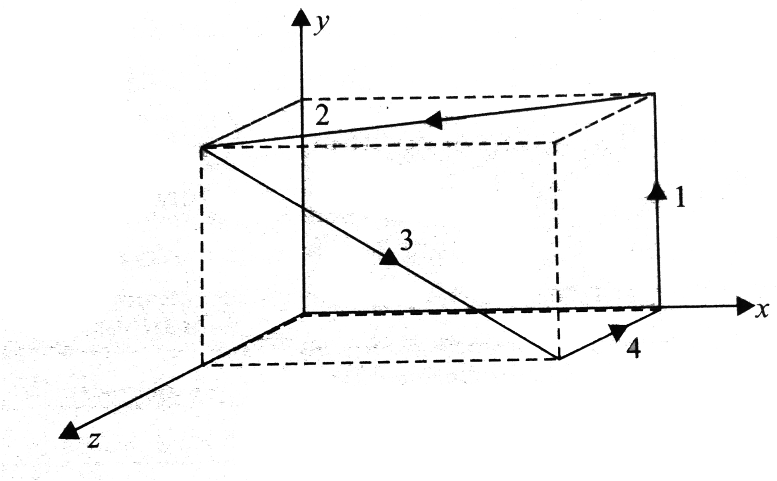
C. 0.0242m,stretched

D. 0.0242m,compresed

Answer: a

Watch Video Solution

26. A wire carrying a 10A current is bent to pass through various sides of a cube of side 10 cm as shown in fig. A magnetic field $\overrightarrow{B} = \left(2\hat{i} - 3\hat{j}_{\square}\right)T$ is present in the region.



Find the net force on the loop shown.

A. $\overrightarrow{E}_{net} = 0$

B. $\overrightarrow{E}_{net} = \left(0.1\hat{i} - 0.2\hat{k}\right)N$

C. $\overrightarrow{E}_{net} = \left(0.3\hat{i} + 0.4\hat{k}\right)N$

D. $\overrightarrow{E}_{net} = \left(0.36\hat{k}\right)N$

Answer: a

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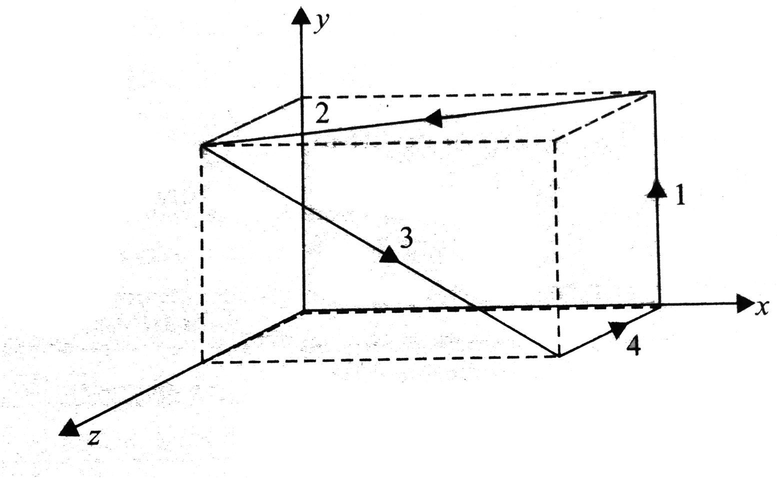
27. A wire carrying a 10A current is bent to pass through various sides of a cube of side 10 cm as shown in fig. A magnetic field $\overrightarrow{B} = \left(2\hat{i} - 3\hat{j} - \hat{k}\right)T$ is present in the region.



Find the magnetic moment vector of the loop.

A. $\left(0.1\hat{i} + 0.05\hat{j} - 0.05\hat{k}\right)Am^2$

B. $\left(0.1\hat{i} + 0.05\hat{j} + 0.05\hat{k}\right)Am^2$

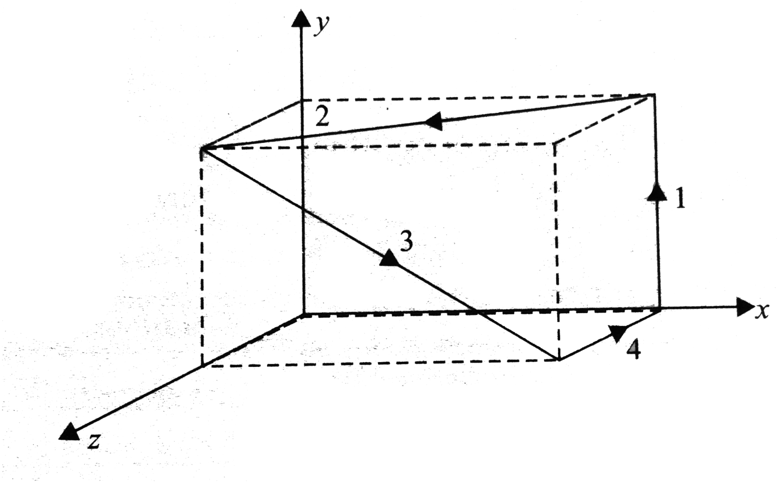
C. $\left(0.1\hat{i} - 0.05\hat{j} + 0.05\hat{k}\right)Am^2$

D. $\left(0.1\hat{i} - 0.05\hat{j} - 0.05\hat{k}\right)Am^2$

Answer: b

Watch Video Solution

28. A wire carrying a 10A current is bent to pass through various sides of a cube of side 10 cm as shown in fig. A magnetic field $\overrightarrow{B} = \left(2\hat{i} - 3\hat{j} + \hat{k}\right)T$ is present in the region.



Find the net torque on the loop.

A. $-0.1\hat{i} + 0.4\hat{k}Nm$

B. $-0.1\hat{i} - 0.4\hat{k}Nm$

C. $0.2\hat{i} - 0.4\hat{k}Nm$

D. $0.1\hat{i} - 0.4\hat{k}Nm$

Answer: c

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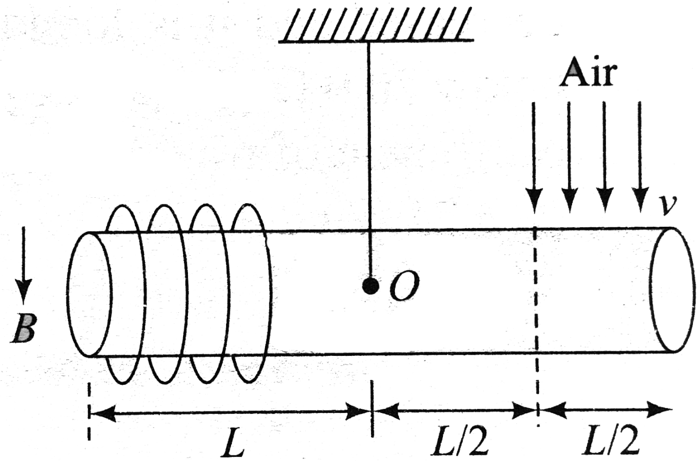
Exercises Integer

1. A non-conducting rod having circular cross section of radius R is suspended from a rigid support as shown in fig. A light and small coil of 300turns is wrapped tightly at the left end where uniform magnetic filed B exists in vertically downward direction. Air of density ρ hits the half of the right part of the rod with velocity V as shown in the fig. What should be current in clockwise direction (as seen from O) in the coil so that rod remains horizontal? Give answer in mA. Given $\frac{2}{Lv}\sqrt{\frac{\pi RB}{\rho}} = \frac{1}{\sqrt{5}} A^{-1/2}$.



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2. A current I flows in a rectangularly 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 $D(x_0 + d,$ respectively. Assume that a,b,d << x_0. Find the magnitude of magnetic dipole moment vector of the rectangular wire frame in J/T. (Given, b=10 m,I=0.01A, d=4m,a=3m).

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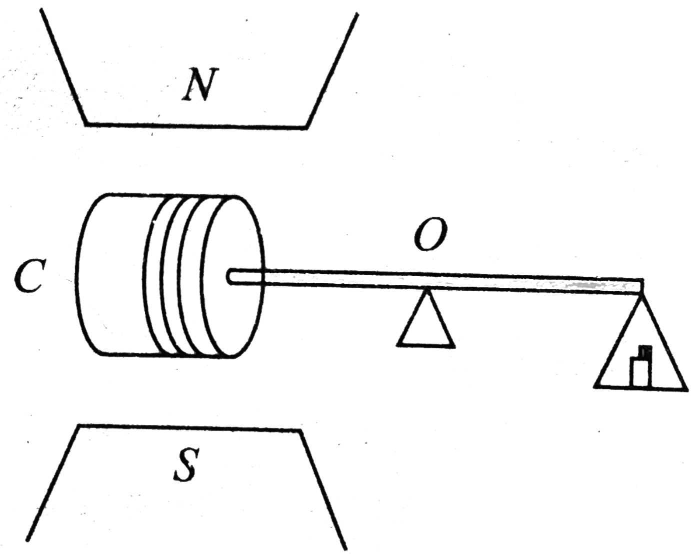
3. A small coil C with N=200 turns is mounted on one end of a balance beam and introduced between the poles of an electromagnetic as shown in Fig. The area of the coils is $S = 1cm^2$, the length of the right arm of the balance beam is l=30cm. When there is no current in the coil the balance is in equilibrium. On passing is a currentI=22mA through the coil, equilibrium is restored by putting an additional weight of mass m=60mg on the balance pan. Find the magnetic induction field (in terms of x $10^{-1}T$) between the poles of the electromagnetic assuming it to be uniform.



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4. A current I = 10 A flows in a ring of radius $r_0 = 15cm$ 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 the magnetic field at which the ring is broken

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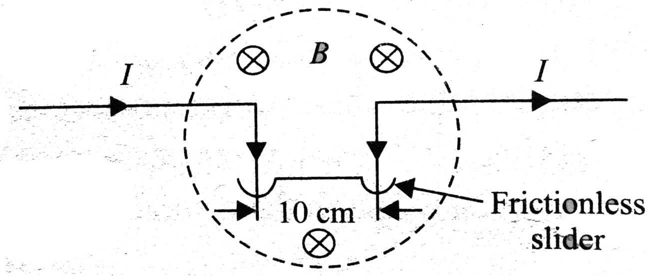
5. A 10 cm length of wire with a mass of 20g is attached frictionlessly to the vetical segments of a wire in which a current I flows. The surrounding has horizontal field $B = 10^4 G$ and the vertical direction is shown in fig. What must be the current I (in A) to maintain the 10cm wire in an equilibrium position?



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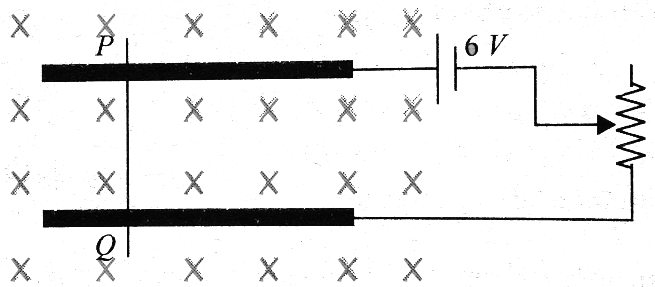
6. A metal wire PQ of mass 10g lies at rest on two horizontal metal rails separated by 5cm as shown in Fig. A vertically downward magnetic field of magnitude 0.80T exist in the space. The resistance of the circuit is slowly decreased and it is found that when the resistance goes below 20.0Ω the wire PQ starts sliding on the rails. The coefficient of friction between wires and rails is found. The coefficient of friction between wires and rails is found to be $n/25$. find n



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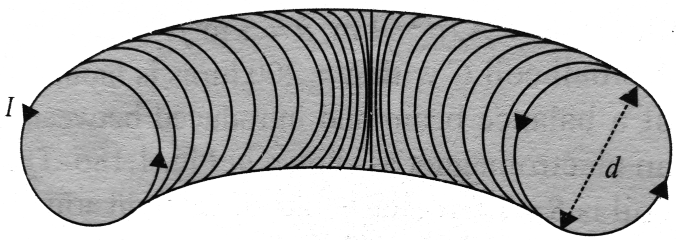
7. Calculating the magnetic moment (in Am^2) of a thin wire with a current I=0.8A, wound tightlly on a half a tore (see figure). The diameter of the cross section of the tore is equal to d=5cm, and the number of turns is N=500.



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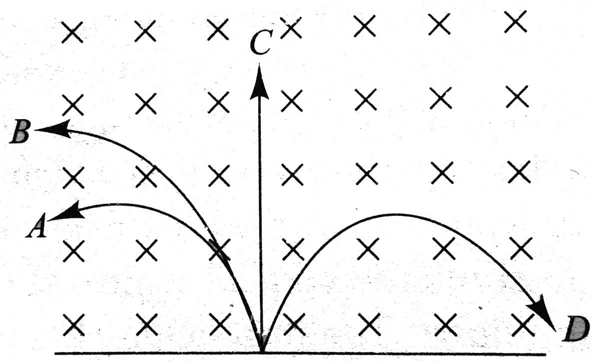
Archives Fill In The Blank

1. A neutron, a proton, an electron and an alpha particle enter a region of constant magnetic field with equal velocities. The magnetic field is along the inward normal to the plane of the paper. The tracks of the particles are lebelled in Fig. The electron follow track......... and the alpha particle follow track..........



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2. A wire of length l meter carrying current i ampere is bent in form of circle. Magnetic moment is

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3. An electron revolving in an orbit of radius 0.5Å in a hydrogen atom executes per secon. The magnetic momentum of electron due to its orbital motion will be

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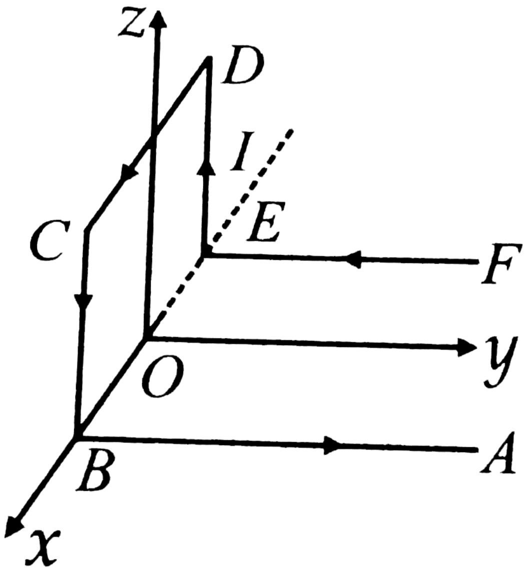
4. A wire ABCDEF (with each side of length L) bent as shown in figure. The wire carrying a current I is placed in a uniform magnetic induction B parallel to the positive y-direction. The force experienced by the wire in the z-direction is



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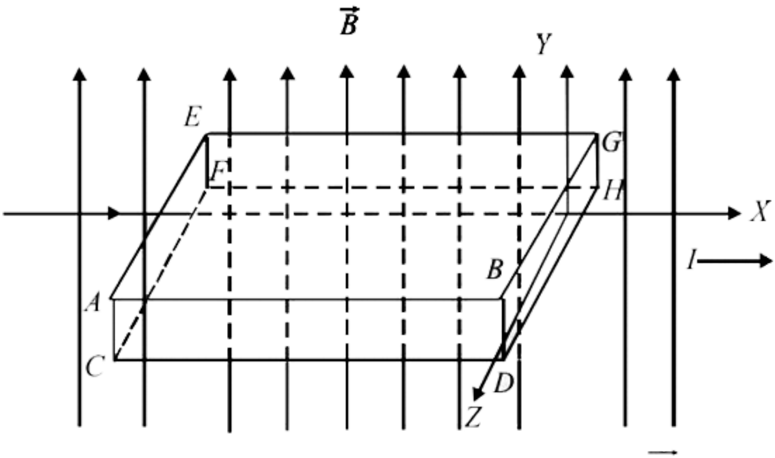
5. A metallic block carrying current I is subjected to a uniform magnetic induction $\overrightarrow{B}$ as shown in Figure . The moving charges experience a force $\overrightarrow{F}$ given by ..... Which results in the lowering of the potential of the face

.... Assume the speed of the carries to be v .



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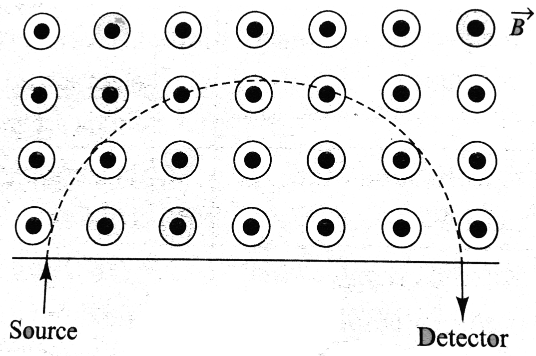
6. A uniform magnetic field with a slit system as shown in Fig. is to be used as a momentum filter for highenergy charged particles. With a field B tesla, it is found than the filter transmits α each of energy 5.3MeV. The magnetic field is increased to 2.3 times and deuterons are passed into the filter. The energy of each deutrons are passed into the filter. The energy of each deutrons transmitted by the filter is .... MeV.



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Archives True /false

1. No net force acts on a rectangular coil carrying a steady current when suspended freely in a uniform magnetic field.

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2. There is no change in the energy of a charged particle moving in a magnetic field although a magnetic force is acting on it . True/False.

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3. A charged particle enters a region of uniform magnetic field at an angle of 85° to the magnetic line of force. The path of the particle is a circle. Is this statement true or false?

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4. An electron and a proton are moving with the same kinetic energy along the same direction, When they pass through a uniform magnetic field perpendicular to the direction of their motion, they describe circular path of the same radius. Is this statement true or false?

Watch Video Solution

Archives Single Correct

1. A magnetic needls is kept in a non-unifrom magnetic field . It experinces

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

Answer: a

Watch Video Solution

2. A circular loop of radius R carrying a current I is placed in a uniform magnetic field B perpendicular to the loop. The force on the loop is

A. irB_0

B. $2\pi irB_0$

C. zero

D. πirB_0

Answer: c

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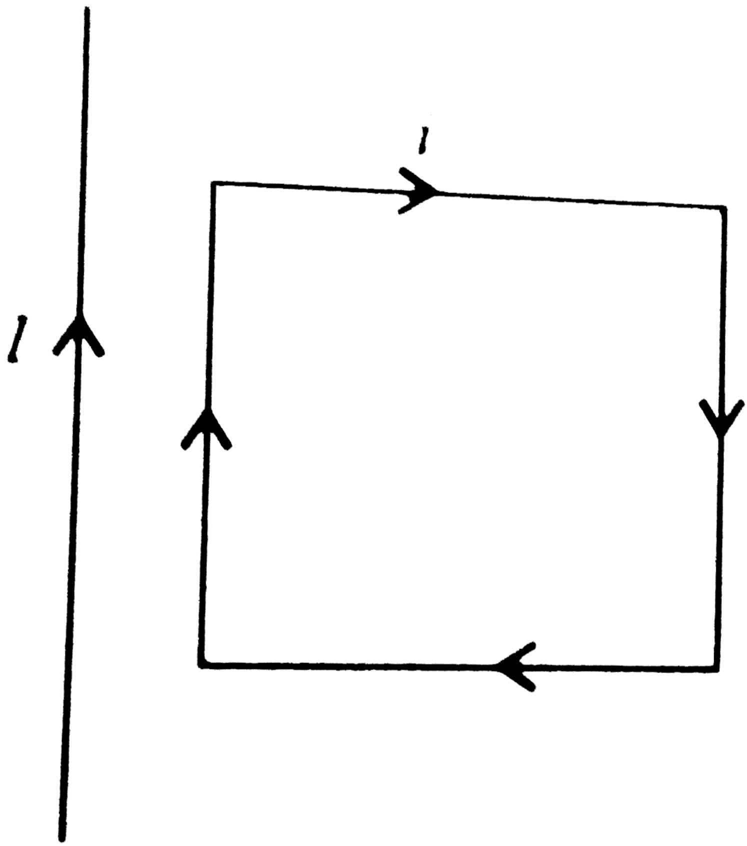
3. A rectanguar doop carrying a current I is situated near a long straight wire such that the wire is parallel to one of the sides of the loop. If a steady current I is established in the wire, as shown in figure, the loop will



A. rotate about an axis parallel to the wire

B. move away form the wire

C. move toward the wire

D. remain stationary

Answer: c

Watch Video Solution

4. Twio thin long parallel wires seprated byb a distance b are carrying a current i ampere each . The magnitude of the force per unit length excrted 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. $\frac{\mu_0 i}{2\pi b^2}$

Answer: b

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5. Two particle X and Y having equal charge, 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. $(R_1 / R_2)^{1/2}$

B. R_2 / R_1

C. $(R_1 / R_2)^2$

D. R_1 / R_2

Answer: c

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6. A proton a deuteron and an α - particle having the same kinetic energy are moving in circular trajectories in a constant magnetic of the trajectories of these particle, then

A. $r_{\alpha} = r_p < r_d$

B. $r_{\alpha} > r_d > r_p$

C. $r_{\alpha} = r_d < r_p$

D. $r_p = r_d = r_{\alpha}$

Answer: a

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7. 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. $q/2m$

B. q/m

C. $2q/m$

D. $q/\pi m$

Answer: a

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8. 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 remove in a

A. straight line

B. circle

C. helix

D. cycloid

Answer: a

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9. 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. $\omega \text{ and } q$

B. $\omega, q \text{ and } m$

C. $q \text{ and } m$

D. $\omega \text{ and } m$

Answer: c

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10. An ionised gas contains both positive and negative ions initially at rest. 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

Answer: c

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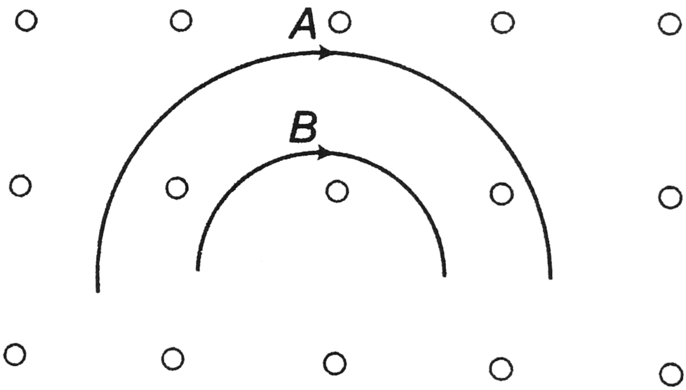
11. Two particles A and B of masses m_A and m_B respectively and having the same charge are moving ina plane. A uniform magnetic field exists perependicular to this plane. The speeds of the particles are v_A and v_B respectively and the trajectories are as shown in the figure. Then,



A. $m_A v_A < m_B v_B$

B. $m_A v_A > m_B v_B$

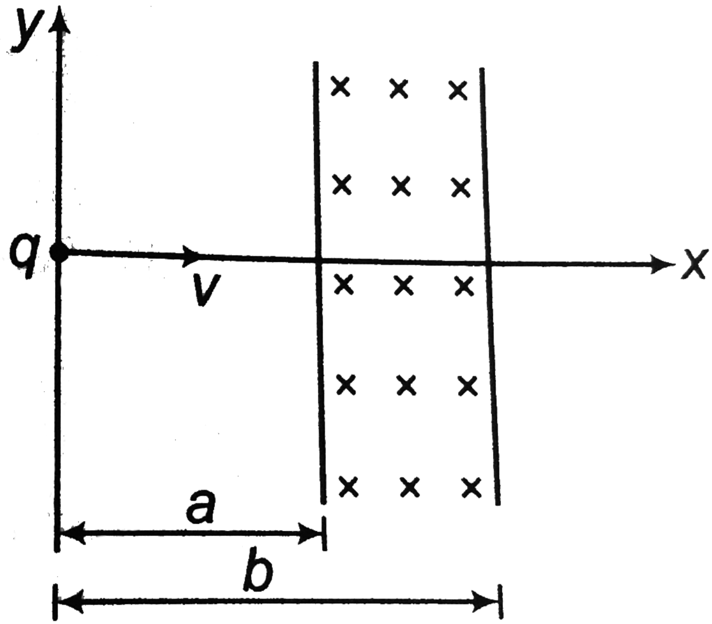
C. $m_A < m_B$ and $v_A < v_B$

D. $m_A = m_B$ and $v_A = v_B$

Answer: b

Watch Video Solution

12. In the figure shown a charge q moving with a velocity v along the x-axis enter into a region of uniform magnetic field. The minimum value v so that the charge q is able to enter the region $x > b$



A. $\frac{qbB}{m}$

B. $\frac{q(b-a)B}{m}$

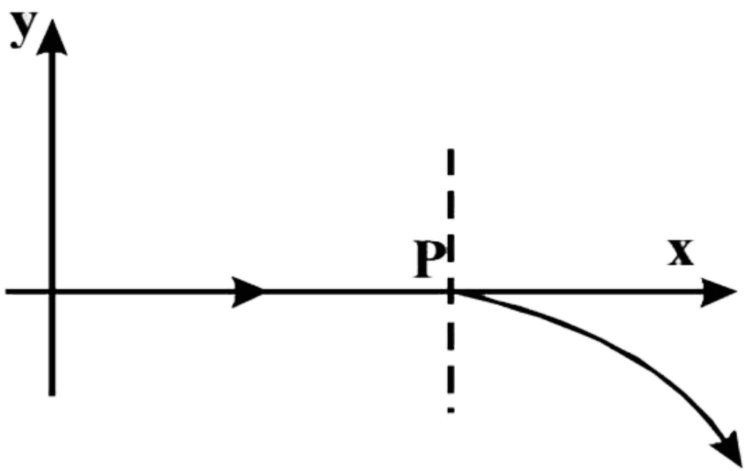
C. $\frac{qaB}{m}$

D. $\frac{q(b+a)B}{2m}$

Answer: b

Watch Video Solution

13. 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. $\overrightarrow{E} = 0, \overrightarrow{B} = b\hat{i} + c\hat{k}$

B. $\overrightarrow{E} = a\hat{i}, \overrightarrow{B} = c\hat{k} + a\hat{i}$

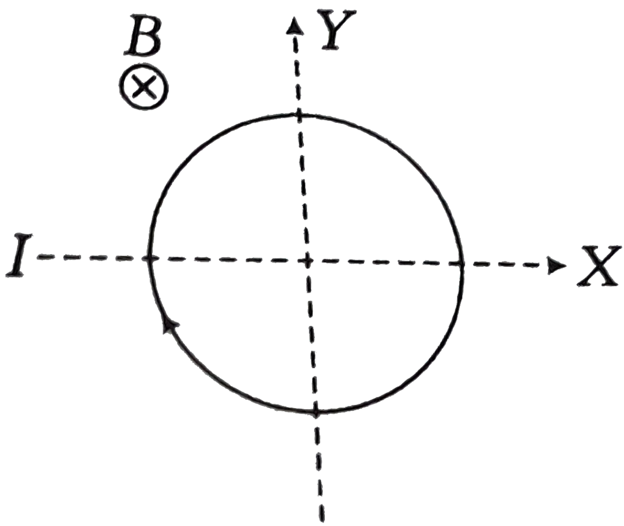
C. $\overrightarrow{E} = 0, \overrightarrow{B} = c\hat{j} + b\hat{k}$

D. $\overrightarrow{E} = a\hat{i}, \overrightarrow{B} = c\hat{k} + b\hat{j}$

Answer: b

Watch Video Solution

14. 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

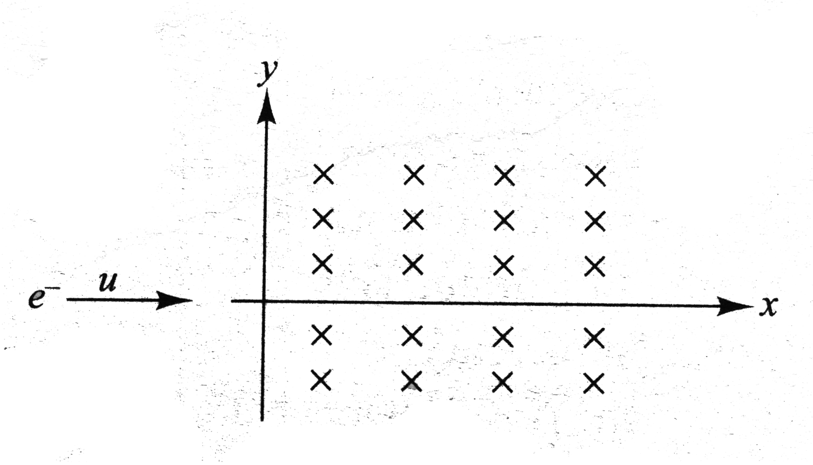
C. move toward +ve x-axis

D. move toward -ve x-axis

Answer: b

Watch Video Solution

15. An electron moving with a speed u along the positive x-axis at $y = 0$ enters a region of uniform magnetic field which exists to the right of y-axis. The electron exits from the region after some time with the speed v at coordinate y, then



A. $v = uaty > 0$

B. $v = uaty < 0$

C. $v > uaty > 0$

D. $v > uaty < 0$

Answer: b

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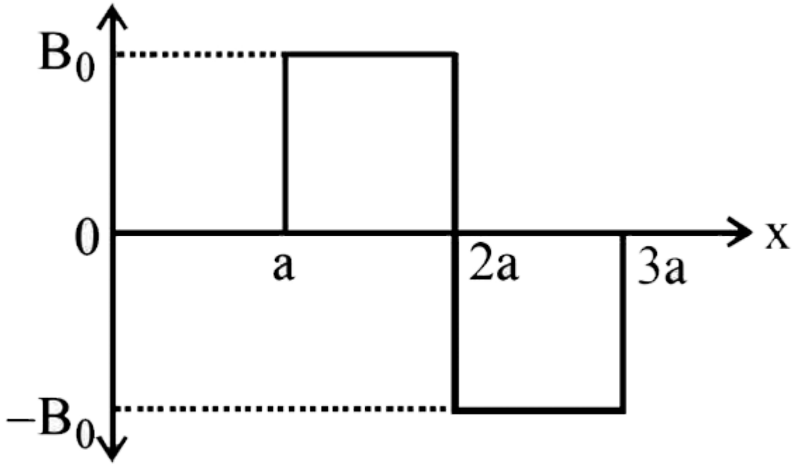
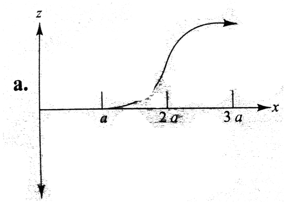
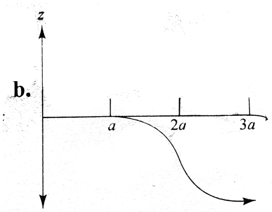
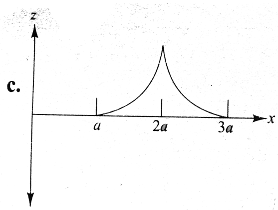
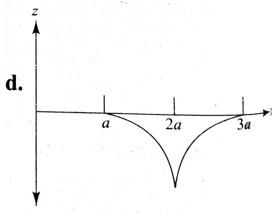
16. A magnetic field $\overrightarrow{B} = B_0\hat{j}$, exists in the region $a < x < 2a$, and $\overrightarrow{B} = -B_0\hat{j}$, in the region $2a < x < 3a$, where B_0 is a positive constant . A positive point charge moving with a velocity $\vec{v} = v_0 \hat{i}$, where v_0 is a positive constant , enters the magnetic field at $x = a$. The trajectory of the charge in this region can be like



A. 

B. 

C. 

D. 

Answer: a

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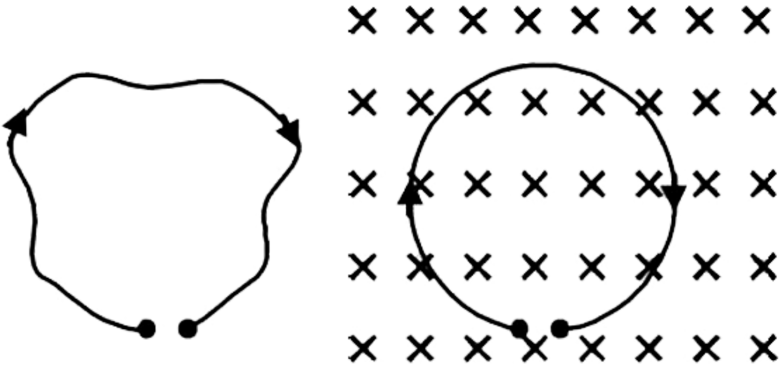
17. A thin wire of length L is connected to two adjacent fixed points and carries a current I in the clockwise direction , as shown in the figure. When the system is put in a uniform magnetic field of strength B going into the plane of the paper , the wire takes the shape of a circle . The tension in the wire is



A. (IBL)

B. $\frac{IBL}{p}$

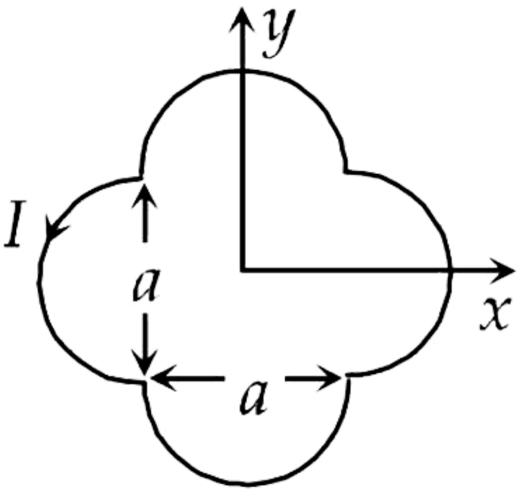
C. $\frac{IBL}{2\pi}$

D. $\frac{IBL}{4\pi}$

Answer: c

Watch Video Solution

18. A loop carrying current I lies in the $x - y$ plane as shown in the figure . The unit vector $\hat{k}$ is coming out of the plane of the paper . The magnetic moment of the current loop is



A. $a^2 I\hat{k}$

B. $\left(\frac{\pi}{2}+1\right)a^2 I\hat{k}$

C. $-\left(\frac{\pi}{2}+1\right)a^2 I\hat{k}$

D. $(2\pi+1)a^2 I\hat{k}$

Answer: b

Watch Video Solution

1. A proton moving with a constant velocity passes through a region of space without any changing its velocity. If E and B represent the electric and magnetic fields, respectively. Then, this region of space may have

A. $E = 0, B = 0$

B. $E = 0, B \neq 0$

C. $E \neq 0, B = 0$

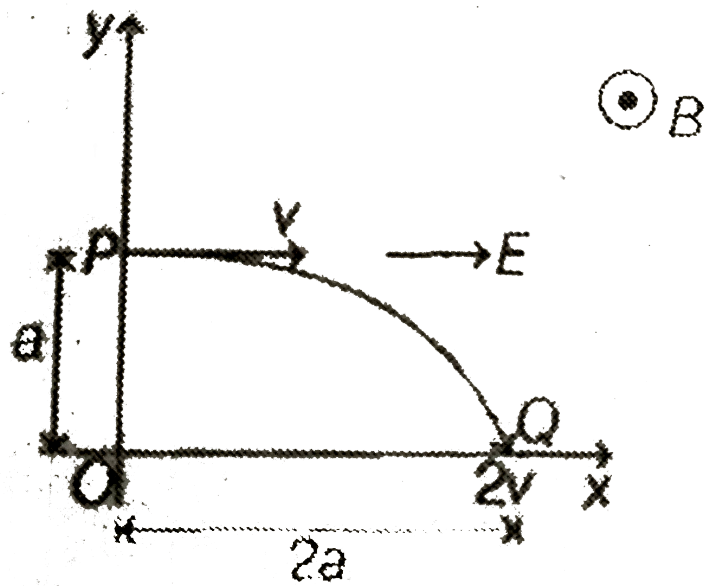
D. $E \neq 0, B \neq 0$

Answer: (a,b,d)

Watch Video Solution

2. A particle of charge +q and mass m moving under the influence of uniform electric field $E\hat{i}$ and uniform magnetic field $B\widehat{K}$ follows a trajectory from P to Q as as shown in figure. The velocities at P and Q are

$v\hat{i}$ and $-2v\hat{j}$ of the following statements is/are correct ?



A. $E = \frac{3}{4}\left[\frac{mv^2}{qa}\right]$

B. Rate of work done by the electric field at P is $E = \frac{3}{4}\left[\frac{mv^3}{a}\right]$

C. Rate of work done by the electric field at P is zero

D. Rate of work done by both the feilds at Q is zero.

Answer: (a,b,d)

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3. H^+, He^+ and O^{2+} ions having same kinetic energy pass through a region of space filled with uniform magnetic field B directed perpendicular to the velocity of ions. The masses of the ions H^+, He^+ and O^{2+} are respectively, in the ratio $1:4:16$. As a result

A. H^+ will be deflected most

B. O^{2+} will be deflected most.

C. He^+, and O^{2+} will be deflected equally

D. All will be deflected equally

Answer: (a,c)

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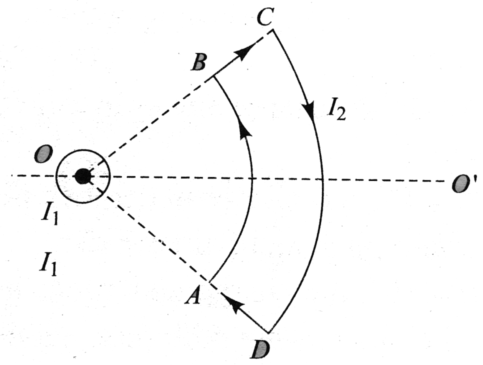
4. A long current carrying wire, carrying current such that it is flowing out from the plane of paper, is placed at O. A steady state current is flowing in the loop ABCD. Then,



A. the net force is zero

B. the net torque is zero

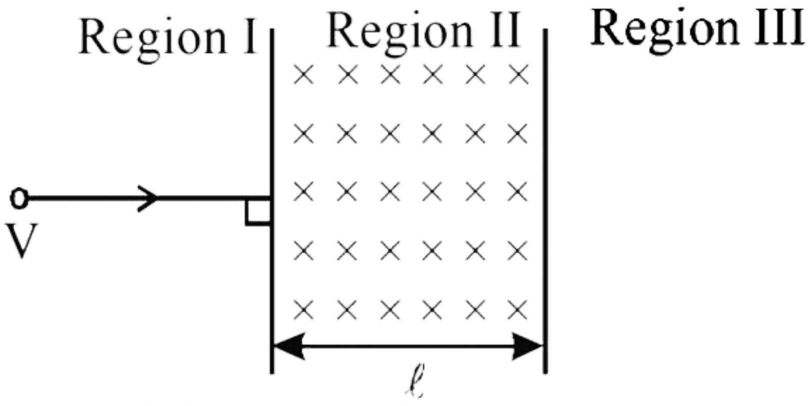
C. as seen from O, the loop will rotate in clockwise direction along axis OO'

D. as seen from O, the loop will rotate in anticlockwise direction along axis OO'

Answer: (a,c)

Watch Video Solution

5. 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 $V > \frac{qlB}{m}$

B. The particle enters Region III only if its velocity $V < \frac{qlB}{m}$

C. Path length of the particle in Region II is maximum when velocity $V = \frac{qlB}{m}$

D. Time spent in Region II is same for any velocity V as long as the particle returns to Regions I

Answer: (a,c,d)

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6. 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 never come out travelling along parallel paths.

C. They will never come out at the same time.

D. They will never come out at different times.

Answer: (b,d)

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7. Consider the motion of a positive point charge in a region where there are simultaneous uniform eletric and magnetic field $E = E_0\hat{j}$ and $B = B_0\hat{j}$. At time $t = 0$, this charge has velocity 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 $\theta = 0^0$ the charge moves in a circular path in the xy-plane.

$b. If\theta = 0^0$ the charge undergoes helical motion with constant pitch along the y-axis.

c. If $\theta = 10^0$ the charge undergoes helicalmotion 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.

A. If $\theta = 0^\circ$, the charge moves in a circular path in the x-z plane

B. If $\theta = 0^\circ$, 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

Answer: (c,d)

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8. A particle of mass M and positive charge Q, moving with a constant velocity $\overrightarrow{u_1} = 4\hat{i}ms^{-1}$, 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 $10 milli \sec onds$ with a velocity $\overrightarrow{u_2} = 2\left(\sqrt{3\hat{i} + \hat{j}}\right)ms^{-1}$. 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 direction of the magnetic field is $\dfrac{50\pi M}{3Q}$ unit.

D. The direction of the magnetic field is $\dfrac{100\pi M}{3Q}$ units.

Answer: (a,c)

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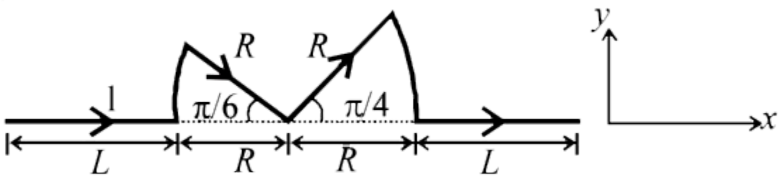
9. A conductor (shown in the figure) carrying constant current I is kept in the $x-y$ plane in a uniform magnetic field $\overrightarrow{B}$. If $\overrightarrow{F}$ is the magnitude of the total magnetic force acting on the conductor, then the correct statement(s) is (are)



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

B. If $\overrightarrow{B}$ is along $\widehat{x}$, $F = 0$

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

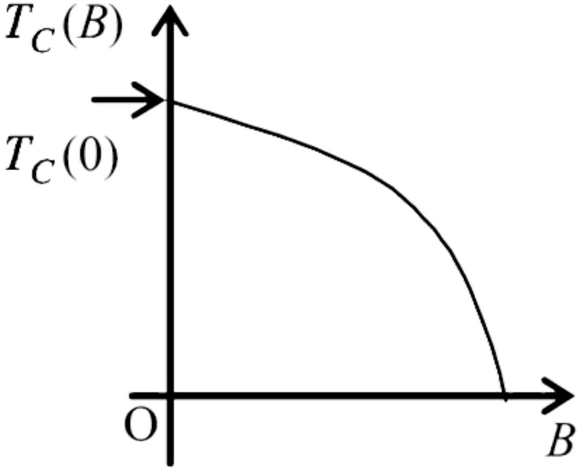
D. If $\overrightarrow{B}$ is along $\hat{z}$, $F = 0$

Answer: (a,b,c)

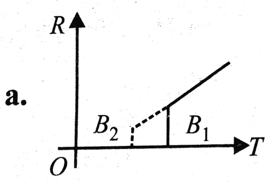
Watch Video Solution

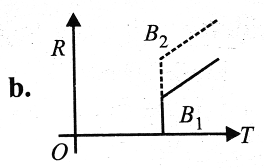
Archives Comprehension

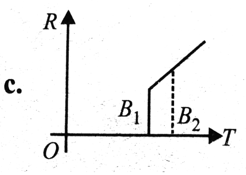
1. Electrical resistance of certain materials, known as superconductors, changes abruptly from a nonzero value of zero as their temperature is lowered below a critical temperature $T_C(0)$. An interesting property of super conductors is that their critical temperature becomes smaller than $T_C(0)$ if 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 the figure.

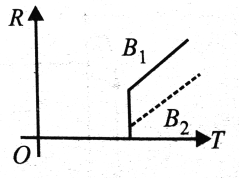


In the graphs below, the resistance R of a superconductor is shown as a function of its temperature T for two different magnetic fields B_1(solid line) and B_2 (dashed line). If B_2 is larget than B_1 which of the following graphs shows the correct variation of R with T in these fields?

A. 

B. 

C. 

d. 

D.

Answer: a

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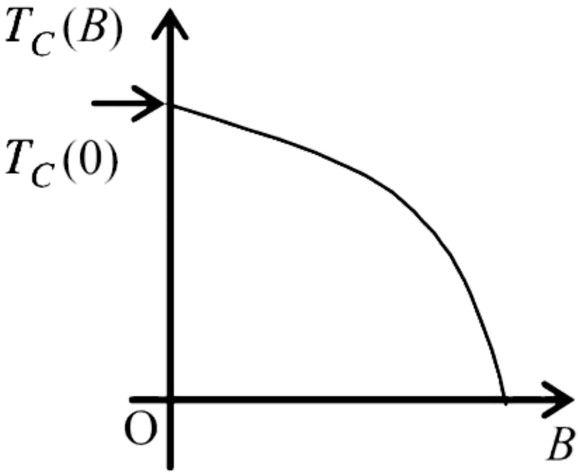
2. Electrical resistance of certain materials, known as superconductors, changes abruptly from a nonzero value of zero as their temperature is lowered below a critical temperature $T_C(0)$. An interesting property of super conductors is that their critical temperature becomes smaller than $T_C(0)$ if 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 the figure.



A superconductor has $T_C(0) = 100K$. When a magnetic field of 7.5 Tesla is applied , its T_C decreases to 75 K. For this material one can difinitely say that when

A. $B = 5T, T_C(B) = 80K$

B. $B = 5T, 75K < T_C(B) < 100K$

C. $B = 10T, 75K < T_C(B) < 100K$

D. $B = 10T, T_C(B) = 70K$

Answer: b

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Archives Integer

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

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Archives Assertion-reasion

1. Statement -1 : The sensitvity 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.

A. Statement 1 is true, Statement 2 is true, Statement 2 is a correct explanation for Statement 1.

B. Statement 1 is true, Statement 2 is true, Statement 2 is NOT a correct explanation for Statement 1.

C. Statement 1 is true, Statement 2 is false.

D. Statement 1 is false, Statement 2 is true.

Answer: c

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Single Correct Answer Type

1. A uniform electric field and a uniform magnetic field are acting along the sa,e direction in a certion region. If a electron is projected in the region such that its velocity is pointing along the direction of fields, then the electron

A. The electron will turn to its right

B. The electron will turn to its left

C. The electron velocity will increase in magnitude

D. The eletron velocity wil decrease in magnitude

Answer: D

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2. An electron is moving with speed $2 \times 10^5 m/s$ along the positive x-direction in the presence of magnetic induction $\vec{B} = \left(\hat{i} + 4\hat{j} - 3\hat{k}\right)T$. The magnitude of the force experienced by the electron in $N\left(e = 1.6 \times 10^{-19} C\right)\left(\vec{F} = q\left(\vec{v} \times \vec{B}\right)\right)$

A. 1.18×10^{-13}

B. 1.28×10^{-13}

C. 1.6×10^{-13}

D. 1.72×10^{-13}

Answer: C

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3. A proton (mass m and charge $+e$) and an α-particle (mass 4 m and charge $+2e$) are projected with the same kinetic energy at right angles to the uniform magnetic field. Which one of the following statements will be true?

A. The α-particle will be bent in a circular path with a small radius that for the proton

B. The radius of the path of the α-particle will be greater than that of the proton

C. The α-particle and the proton will be bent in a circular path with the same radiuys

D. The α-particle and the proton will go through the field in a straight line

Answer: C

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4. A proton is moving along Z-axis in a magnetic field. The magnetic field is along X-axis. The proton will experience a force along

A. X-axis

B. Y-axis

C. Z-axis

D. Negative Z-axis

Answer: B

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5. A proton carrying $1MeV$ kinetic energy is moving in a circular path of radius R in uniform magnetic field. What should be the energy of an $\alpha -$

particle to describe a circle of the same radius in the same field?

A. 1 MeV

B. 4 MeV

C. 2 MeV

D. 0.5 MeV

Answer: A

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6. A deutron kinetic energy 50 keV is describing a circular orbit of radius 0.5 m in a plane perpendicular to magnetic field B. The kinetic energy of the proton that describes a circular orbit of radius 0.5 m in the same plane with the same magnetic field B is

A. 25 keV

B. 50 keV

C. 200 keV

D. 100 keV

Answer: D

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7. An electron and a proton enter region of uniform magnetic field in a direction at right angles to the field with the same kinetic energy. They describe circular paths of radius r_e and r_p ?respectively. Then what will be the relation between r_e and r_p?

A. $r_e = r_p$

B. $r_e < r_p$

C. $r_e > r_p$

D. r_e may be less than or greater than r_p depending on the direction of the magnetic field

Answer: B

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8. The charge on a particle Y is double the charge on particle X.These two particles X and Y 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. $\left(\frac{2R_1}{R_2}\right)^2$

B. $\left(\frac{R_1}{2R_2}\right)^2$

C. $\frac{R_1^2}{2R_2^2}$

D. $\frac{R_1}{R_2}$

Answer: C

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9. A particle of charge q and mass m moving with a velocity v along the x-axis enters the region $x > 0$ with uniform magnetic field B along the $\hat{k}$ direction. The particle will penetrate in this region in the x-direction upto a distance d equal to

A. Zero

B. $\dfrac{mv}{qB}$

C. $\dfrac{2mv}{qB}$

D. Infinity

Answer: B

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10. An electron is moving along positive x-axis. To get it moving on an anticlockwise circular path in x-y plane, a magnetic field is applied

A. Along positive y-axis

B. Along positive z-axis

C. Along negative y-axis

D. Along negative z-axis

Answer: B

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11. A particle of mass $0.6g$ and having charge of $25n_C$ is moving horizontally with a uniform velocity $1.2 \times 10^4 ms^{-1}$ in a uniform magnetic field, then the value of the magnetic induction is $(g = 10ms^{-2})$

A. Zero

B. 10 T

C. 20 T

D. 200 T

Answer: C

Watch Video Solution

12. An electron is travelling along the x-direction. It encounters a magnetic field in the y-direction. Its subsequent motion will be

A. Straight line along the x-direction

B. A circle in the xz-plane

C. A circle in the yz-plane

D. A circle in the xy-plane

Answer: B

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13. An electron, a proton, a deuteron and an alpha particle, each having the same speed are in a region of constant magnetic field perpendicular to the direction of the velocities of the particles. The radius of the circular orbits of these particles are respectively R_e, R_p, R_d and R_α It follows that

A. $R_e = R_p$

B. $R_p = R_d$

C. $R_d = R_\alpha$

D. $R_p = R_\alpha$

Answer: C

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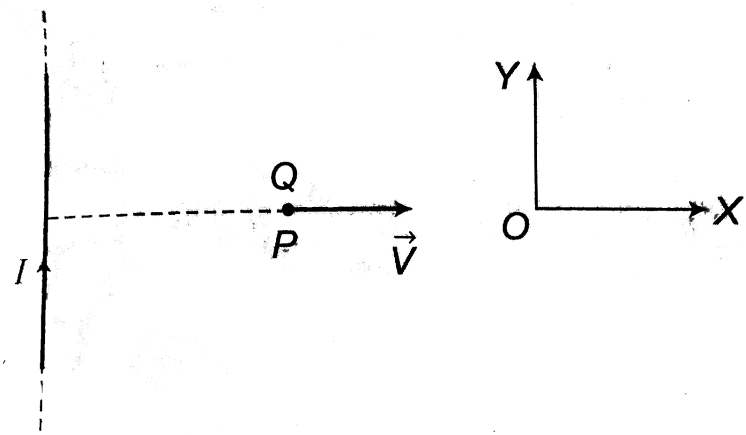
14. A very long straight wire carries a current I. At the instant when a charge $+Q$ at point P has velocity $\overrightarrow{V}$, as shown, the force on the charge is



A. Opposite to OX

B. Along OX

C. Opposite to OY

D. Along OY

Answer: D

Watch Video Solution

15. An electron (mass $= 9.1 \times 10^{-31} kg$, charge $= 1.6 \times 10^{-19} C$) experiences no deflection if subjected to an electric field of $3.2x10^5 \frac{V}{m}$, and a magnetic fields of $2.0 \times 10^{-3} W\frac{b}{m^2}$. Both the fields are normal to the path of electron and to each other. If the electric field is removed, then the electron will revolve in an orbit of radius

A. 45 m

B. 4.5 m

C. 0.45 m

D. 0.045 m

Answer: C

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16. A charge q moves in a region where electric field as well as magnetic field exist, then force on it is

A.

B.

C.

D.

Answer: B

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17. Bainbridge's mass spectrometer separates ion having the same velocity. The ions, after enteering through slits, S_1 and S_2, pass through a velocity selector composed of an electric field pproduced by the charged plates P and P' abd a magnetic field $\vec{B}$ perpendicular to electric field and the ion path.Thew ions that then passs undeviated through the crossed $\vec{E}$ 1 and $\vec{B}$ fields enter into a region where a second magnetic field $\vec{B}$ exists, where they are made to follow circular path. A photographic plate (or a modern detector) registors their arrival. If r is the radius of the circular orbit , then specific charge $\frac{q}{m}$ of ion is

A. $\frac{E}{rBB'}$

B. $\frac{2E}{rBB'}$

C. $\frac{3E}{2rBB'}$

D. $\frac{2E}{3rBB'}$

Answer: A

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18. An electron moves through a uniform magnetic fields given by $\overrightarrow{B} = B_x\hat{i} + (3.0B_x)\hat{j}$. At aparticular instant, the electron has velocity $\overrightarrow{v} = \left(2.0\hat{i} + + 4.0\hat{j}\right)m/s$ and the magnetic force acting on it is $\left(6.4 \times 10^{-19}N\right)\hat{k}$. The value of B_x (in T) will

A. -3.0

B. 3

C. 2

D. -2.0

Answer: D

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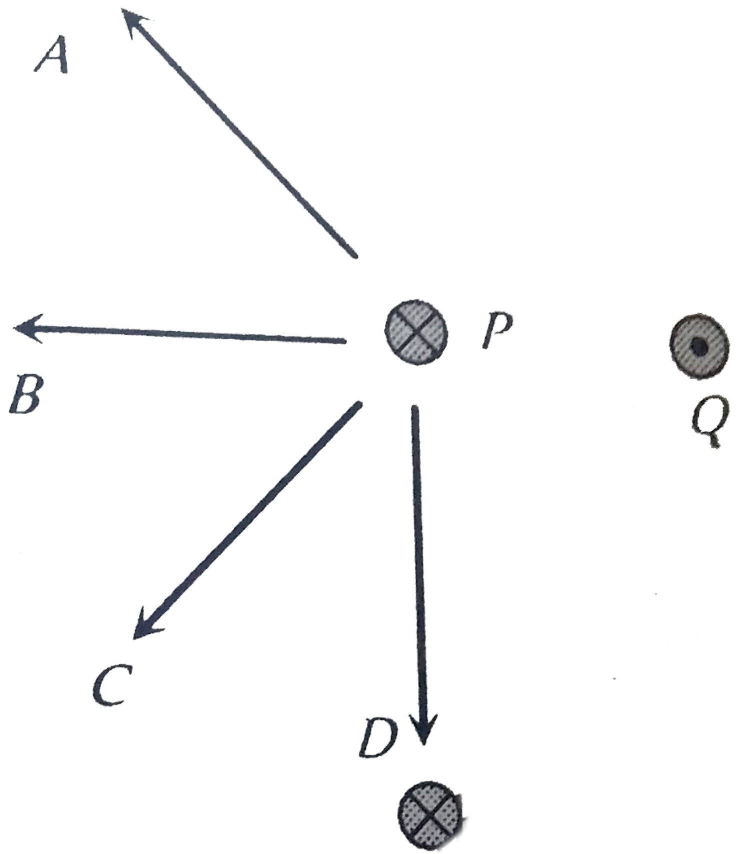
19. In figure shows three long straight wires P, Q and R carrying currents normal to the plane of the paper. All three currents have the same magnitude. Which arrow best shows the direction of the resultant force on the wire P



A. A

B. B

C. C

D. D

Answer: N//A

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20. A conductor in the form of a right angle ABC with $AB = 3cm$ and $BC = 4cm$ carries a current of $10A$.There is a uniform magnetic field of $5T$ perpendicular to the palne of the conductor. The force on the conductor will be

A. 1.5 N

B. 2.0 N

C. 2.5 N

D. 3.5 N

Answer: C

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21. Two long wires are hanging freely. They are joined first in parallel and then in series and then are connected with a battery. In both cases, which type of force acts between the two wires

A. Attraction force when in parallel and repulsion force when in series

B. Repulsion force when in parallel and attraction force when in series

C. Repulsion force in both cases

D. Attraction force in both cases

Answer: A

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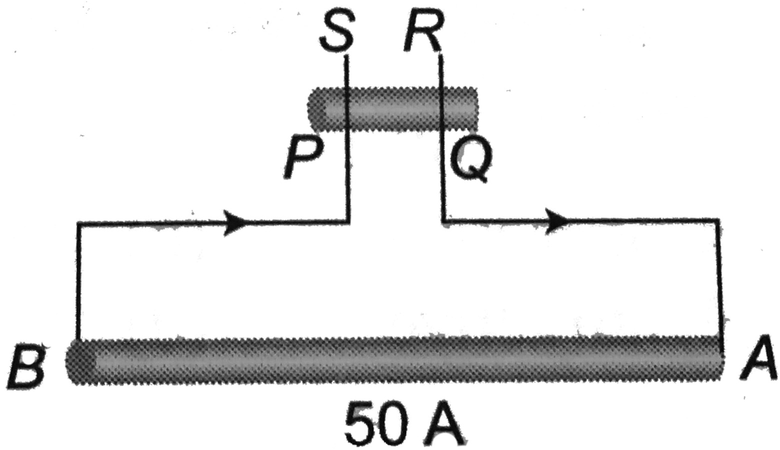
22. A long wire AB is placed on a table. Another wire PQ of mass $1.0g$ and length $50cm$ is set to slide on two rails PS and QR. A current of $50A$ is passed through the wires. At what distance above AB, will the wire PQ be in equilibrium?



A. 25 mm

B. 50 mm

C. 75 mm

D. 100 mm

Answer: A

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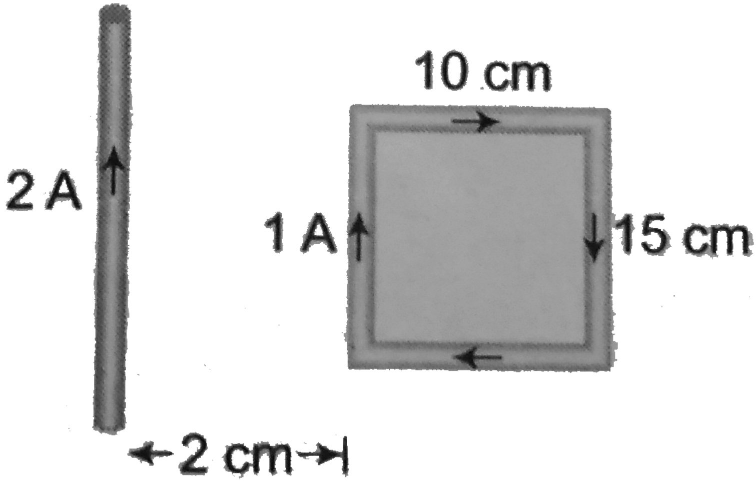
23. What is the net force on the square coil?



A. 25×10^{-7} N moving towards wire

B. 25×10^{-7} N moving away from wire

C. 35×10^{-7} N moving towards wire

D. 35×10^{-7} N moving away from wire

Answer: A

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24. A and B are two conductors carrying a currwnt i in same direction x and y are two electron beams moving in the same direction .there will be

A. There will be repulsion between A and B attraction between x and y

B. There will be attraction between A and B, repulsion between x and y

C. There will be repulsion between A and B and also x and y

D. There will be attraction between A and B and also x and y

Answer: B

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25. A horizontal rod of mass $10g$ and length $10cm$ is placed on a smooth plane inclined at an angle of 60° with the horizontal with the length of the rod parallel to the edge of the inclined plane. A uniform magnetic field induction B is applied vertically downwards. If the current through the rod is $1 \cdot 73ampere$, the value of B for which the rod remains stationary on the inclined plane is

A. 1.73 T

B. $\frac{1}{1.73}$ T

C. 1.T

D. None of the above

Answer: C

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26. A fixed horizontal wire carries a current of 200 A. Another wire having a mass per unit length 10^{-2} kg/m is placed below the first wire at a distance of 2 cm and parallel to is. How much current must be passed through the second wire if it floats in air without any support? What should be the direction of current in it?

A. 25 A (direction of current is same to first wire)

B. 25 A (direction of current is opposite to first wire)

C. 49 A (direction of current is same to first wire)

D. 49 A (direction of current is opposite to first wire)

Answer: C

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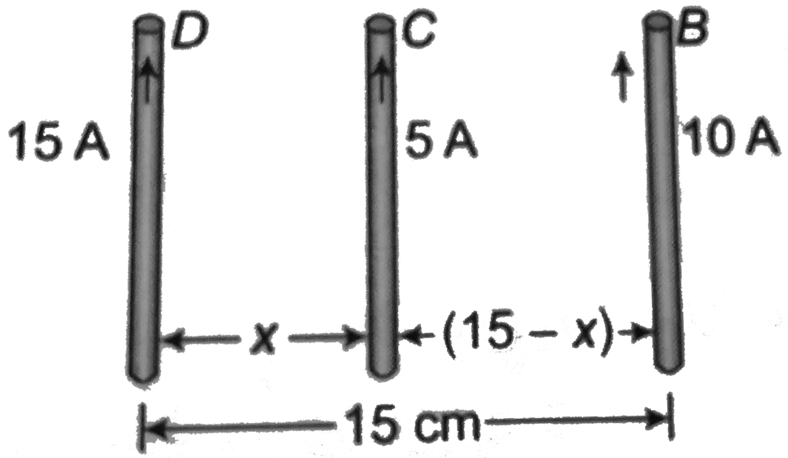
27. Three long straight and parallel wires carrying currents are arranged as shown in the figure. The wire C which carreis a current of $5.0 amp$ is so placed that it experiences no force. The distance of wire C from D is then



A. 9 cm

B. 7 cm

C. 5 cm

D. 3 cm

Answer: A

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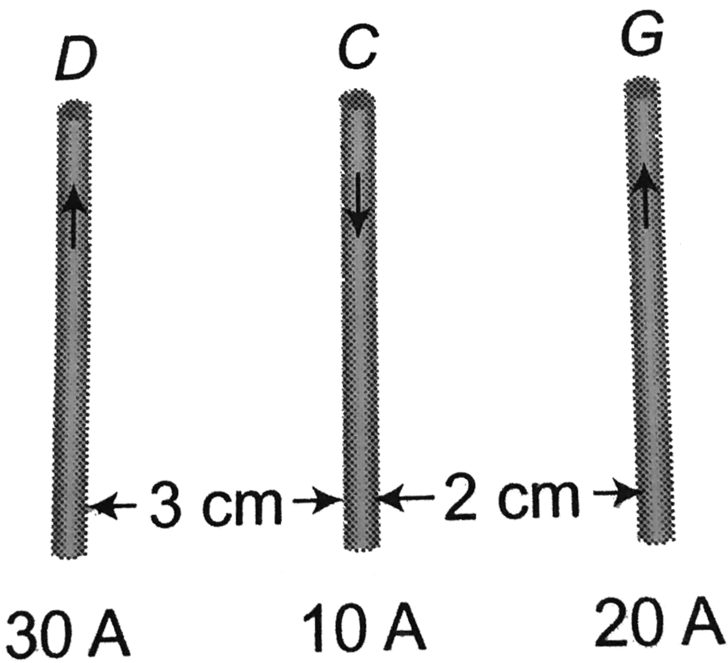
28. Three long, straight parallel wires carrying current, are arranged as shown in figure. The force experienced by a $25cm$ length of wire C is



A. 10^{-3}

B. 2.5×10^{-3} N

C. Zero

D. 1.5×10^{-3} N

Answer: C

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29. Same current i=2 A is flowing in a wire frame as shown in the figure. The frame is a combination of two equilateral triangles ACD and CDE of side 1 m. It is placed in uniform magnetic field B=4 Tacting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is

A. 24 N

B. Zero

C. 16 N

D. 8 N

Answer: A

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30. A parabolic wire as shown in the figure is located in x-y plane and carries a current I=10 amp. A unifrom magnetic field of intensity $2\sqrt{2T}$, making an angle of 45° with x-axis exists throughout the plane. If the coordinates of end point 'P' of wire are $(2m, 1.5m)$ then the total force acting on the wire is:

A. $40N\widehat{M}$

B. $10N\widehat{M}$

C. $-10N\widehat{M}$

D. $-40N\widehat{M}$

Answer: B

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31. Four wires each of length 2.0 metres are bent into four loops P,Q,R and S and then suspended into uniform magnetic field. Same current is passed in each loop. Which statement is correct?

A. Couple on loop P will be the highest

B. Couple on loop Q will be the highest

C. Couple on loop R will be the highest

D. Couple on loop S will be the highest

Answer: D

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32. Two wires of the same length are shaped into a square and a circle. If they carry same current, ratio of the magnetic moment is

A. $2 : \pi$

B. $\pi : 2$

C. $\pi : 4$

D. $4 : \pi$

Answer: C

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33. A wire of length l meter carrying current i ampere is bent in form of circle. Magnetic moment is

A. $\frac{IL}{4\pi}$

B. $\frac{IL^2}{4\pi}$

C. $\frac{I^2L^2}{4\pi}$

D. $\frac{I^2 L}{4\pi}$

Answer: B

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34. A thin circular wire carrying a current I has a magnetic moment M. The shape of the wire is changed to a square and it carries the same current. It will have a magnetic moment

A. M

B. $\frac{4}{\pi^2}M$

C. $\frac{4}{\pi}M$

D. $\frac{\pi}{4}M$

Answer: D

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35. A current carrying circular loop is freely suspended by a long thread. The plane of the loop will point in the direction

A. wherever left free

B. North-south

C. East-south

D. At 45° with the east-west direction

Answer: C

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36. A triangular loop of side l carries a current I. It is placed in a magnetic field B such that the plane of the loop is in the direction of B. The torque on the loop is

A. Zero

B. IBl

C. $\frac{\sqrt{3}}{2} I l^2 B^2$

D. $\frac{\sqrt{3}}{4} I B l^2$

Answer: D

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37. A current carrying loop is free to turn in a uniform magnetic field. The loop will then come into equilibrium vhen its plane is inclined at

A. 0° to the direction of the field

B. 45° to the direction of the field

C. 90° to the direction of the field

D. 135° to the direction of the field

Answer: C

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38. A current I flows in a circular coil of radius r. If the coil is placed in a uniform magnetic field B with its plane parallel to the field, magnitude of the torque that acts on the coil is

A. Zero

B. $2\pi r i B$

C. $\pi r^2 i B$

D. $2\pi r^2 i B$

Answer: C

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39. The $(\tau - \theta)$ graph for a coil is

A.

B.

C.

D.

Answer: A

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40. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field B. The work done to rotate the loop by 30° about an axis perpendicular to its plane is

A. MB

B. $\sqrt{3}\frac{MB}{2}$

C. $\frac{MB}{2}$

D. Zero

Answer: A

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41. A circular coil of radius 4 cm has 50 turns. In this coil a current of 2 A is flowing. It is placed in a magnetic field of $0.1 weber/m^2$. The amount of work done in rotating it through 180° from its equilibrium position will be

A. $0.1J$

B. $0.2J$

C. $0.4J$

D. $0.8J$

Answer: A

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42. A ring of radius 5 m is lying in the x-y plane and is carrying current of 1 A in anticlockwise sense. If a uniform magnetic field $\bar{B} = 3\hat{i} + 4\hat{j}$ is switched on, then the coordinates of point about which the loop will lift up is:

A. (3,4)

B. (4,3)

C. (3,0)

D. (0,3)

Answer: A

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Comprehension type

1. A cyclotron is device for accelerating ions and charged particles. It was developed by Lawerence in 1932.

The heart of the appritus consists of a split metal pillbox. Figure sHOws top and front views of the halves called dees. A rapidly oscilating potential difference is applied between the Dees. This produces an oscilating electric field in the gap between the dees, the region inside each dee being essentially free of electric field. The Dees are enclosed in an evaccutaed container, and the entire unit is placed in a uniform magnetic field B whose direction is normal to the plane Of Dees, A charged particle of mass 'm' and charge 'q' in the gap between the dees, it moves with constant speed in a semi-circle.

The period of uniform circular motion is $T = \frac{2\pi m}{qB}$ and is independant of speed. If the time-period of the oscilating elctric field is equal to this time, then the charged particle will be accelerated again and again

Answer the following questions (consider the mass of particles remains constant during motion):

A cyclotron is accelerating deutrons having mass=$2 \times 1.6 \times 10^{-27}$ kg and charge +e. If B=2T, then the required angular frequency of oscilating electric field is :

A. 10^8 radian / sec

B. 10^7 radian / sec

C. 10^{10} radian / sec

D. 10^9 radian / sec

Answer: A

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2. A double slit is illuminated by the light of wavelength 12000A .The slits are 0.1 cm apart and the screen is placed one metre away.calculate the angular posiyion of 10 maximum in radians ?

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3. Light is incident on a glass plate of refractive index 3.0 such that angle of refraction is 60° .Dark band is observed corresponding to the wavelength of 6000 A .If the thickness of glass plate is 1.2x10^{-3} mm. Calculate the order of the interference band for reflected system.

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4. A cyclotron is device for accelerating ions and charged particles. It was developed by Lawerence in 1932.

The heart of the appritus consists of a split metal pillbox. Figure sHOws top and front views of the halves called dees. A rapidly oscilating potential difference is applied between the Dees. This produces an oscilating electric field in the gap between the dees, the region inside each dee being essentially free of electric field. The Dees are enclosed in an evaccutaed container, and the entire unit is placed in a uniform magnetic field B whose direction is normal to the plane Of Dees, A charged particle of mass 'm' and charge 'q' in the gap between the dees, it moves with constant speed in a semi-circle.

The period of uniform circular motion is $T = \frac{2\pi m}{qB}$ and is independant of speed. If the time-period of the oscilating elctric field is equal to this time, then the charged particle will be accelerated again and again

Answer the following questions (consider the mass of particles remains constant during motion):

A cyclotron has been adjusted to accelereted deutrons. It is now to be adjusted to accelerate other particles , for this following changes may be made:

(a) In order to keep the frequency of oscillating electric field same, the magnetic field is halved for proton

(b) If the magnetic field remain unchanged, the oscillation frequency of electric field should be halved for α particle

(c) If the magnetic field remain unchanged, the oscillation frequency of electric field should be double for proton

(d) If the frequency of oscillating electric field is kept same, the magnetic field should be kept same for α particle

A. a,b and c

B. a,b and d

C. a,c and d

D. b,c and d

Answer: C

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5. A cyclotron is device for accelerating ions and charged particles. It was developed by Lawerence in 1932.

The heart of the appritus consists of a split metal pillbox. Figure sHOws top and front views of the halves called dees. A rapidly oscilating potential difference is applied between the Dees. This produces an oscilating electric field in the gap between the dees, the region inside each dee being essentially free of electric field. The Dees are enclosed in an evaccutaed container, and the entire unit is placed in a uniform magnetic field B whose direction is normal to the plane Of Dees, A charged particle of mass 'm' and charge 'q' in the gap between the dees, it moves with constant speed in a semi-circle.

The period of uniform circular motion is $T = \frac{2\pi m}{qB}$ and is independant of speed. If the time-period of the oscilating elctric field is equal to this time, then the charged particle will be accelerated again and again

In a cyclotron resonance experiment, if we assume that maximum radius attained by any chared particles is equal to radius of dees, then minimum kinetics energy gained by the particles will be

A. alpha particle

B. proton

C. deutron

D. same for all

Answer: C

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6. A current I amperes flows through a loop abcdefgha along the edge of a cube of width l metres as shown in figure. One corner 'a' of the loop lies at origin.

Thish current path (abcdefgha) can be treated as a superposition of three square loops carrying current I. Choose the correct option?

A. fghaf,fabef,ebcde

B. fghaf,fabef,fgdef

C. fghag,abcha,ebcde

D. fgdef,fabef,ebcde

Answer: A

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7. A current I amperes flows through a loop abcdefgha along the edge of a cube of width l metres as shown in figure. One corner 'a' of the loop lies at origin.

The unit vector in the direction of magnetic field at the centre of cube abcdefgh of width λ is given by

A. $\hat{i}$

B. $-\hat{j}$

C. $\frac{2\hat{i}-\hat{j}}{\sqrt{5}}$

D. $\hat{k}$

Answer: B

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8. A current I amperes flows through a loop abcdefgha along the edge of a cube of width l metres as shown in figure. One corner 'a' of the loop lies at origin.

Now if a uniform external magnetic field is $\bar{B} = B_0\hat{j}$ is switched on, then the unit vector in the direction of torque due to external magnetic field $-B$ acting on the current carrying loop (abcdefgha) is

A. $\hat{k}$

B. $-\hat{i}$

C. $\dfrac{2\hat{i} - \hat{j}}{\sqrt{5}}$

D. none of these

Answer: D

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Subjective

1. A proton of charge +e and mass m enters a uniform magnetic Field $\overrightarrow{B} = \widehat{B}$ with an intial velocity $\overrightarrow{v} = v_{0x}\hat{i} + v_{0y}\hat{j}$. Find an expression in unit-vector notation for its velocity at any later time t.

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2. An electron with kinetic energy 2.5 keV moving along the positive direction of an x axis enters a region in which a uniform electric field of magnitude 10 kV/m is in the negative direction of the y-axis. A uniform magnetic field $\overrightarrow{B}$ is to be set up to keep the electron moving along the x-axis , and the direction $\overrightarrow{B}$ of is to be chosen to minimize the required magnitude of $\overrightarrow{B}$. In unit-vector notation, what $\overrightarrow{B}$ should be set up?

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3. A beam of electrons whose kinetic energy is K emerges from a thin-foil "window" at end of an accelerator tube. A metal plate at distance d from this window is perpendicular to the direction of the emerging beam. (a) Show that we can prevent the beam from hitting the plate if we apply a uniform magnetic field such that

$$B \geq \sqrt{\frac{2mK}{e^2 d^2}}$$

in which m and e are the electrons mass and charge

(b) How should $\overrightarrow{B}$ be oriented?

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4. A particle with charge 2.0 C movess through a uniform magnetic field. At one instant the velocity of the particle is $\left(2.0\hat{i} + 4.0\hat{j} + 6.0\hat{k}\right)$ m/s and the magnetic force on the particle is $\left(4.0\hat{i} - 20\hat{j} + 12\hat{k}\right)$ N. The x and y components of the magnetic fields are equal. What is $\overrightarrow{B}$?

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5. A particle of mass 6.0 g moves at 4.0 km/s in an xy plane, in a region with a uniform magnetic field given by 5.0 mT. At one instatnt, when the particles velocity is directed 37° counterclockwise from the positive direction of the x-axis, the magnetic force on the particle is $0.45\hat{k}$ N. What is the particle's charge?

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6. The bent wire shown in figure lies in a uniform magnetic field. Each straight section is 2.0 m long and makes an angle $\theta = 60^\circ$ with the x-axis , and the wire carries a current of 2.0A . What is the net magnetic force on the wire in unit -vector rotation if the magnetic field is given by (a) $4.0\hat{k}T$ and (b) $4.0\hat{i}T$?

A.

B.

C.

D.

Answer: N//A

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7. In a metal wire of mass m=24.1 mg can slide with negligible friction on two horizontal parallel rails separated by distance d=2.56 cm . The track lies in a vertical uniform magnetic field of magnitude 56.3 m. At time t=0 , device G is connected to the rails . producing a constant current i=9.13 mA in the wire and rails (even as the wire moves). At t=61.1 ms , what are the wire's (a) speed and (b) direction of motion (left or right)?

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8. Figure shows a rectangular 20-trun coil of wire of dimensions 10 cm by 5.0 cm. It carries a current of 0.10 A and is hinged along one long side. It is mounted in the xy. Plane, at angle $\theta = 30^\circ$ to the direction of a uniform magnetic field of magnitude 0.50 T. In unit-vector notation, what is the torque acting on the coil about the hinge line?

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9. A current loop, carrying a current of 5.0 A, is in the shape of a right triangle with sides 30,40, and 50 cm. The loop is in a uniform magnetic field of magnitude 80 mT whose direction is parallel to the current in the 50 cm side of the loop. Find the magnitude of (a) the magnetic dipole moment of the loop and (b) the torque on the loop.

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10. The coil in figure carries current i=2.00 A in the direction indicated is parallel to an xz plane, has 3.00 turns and an area of $4.00 \times 10^{-3} m^2$, and lies in a uniform magnetic field $\bar{B} = \left(2.00\hat{i} - 3.00\hat{j} - 4.00\hat{k}\right) mT$. What are (a) the orientation energy of the coil in the magnetic field and

(b) the torque (in unit-vector notation) on the coil due to the magnetic field?

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11. A conducting shell of radius R carries charge–Q. A point charge +Q is placed at the centre of shell. The electric field E varies with distance r (from the centre of the shell) as :

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Multiple

1. A charged particle would continue to move with a constant velocity in a region wherein,

A. E=0,$B \neq 0$

B. $E \neq 0, B \neq 0$

C. $E \neq 0, B = 0$

D. $E = 0, B = 0$

Answer: A::B::D

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2. A proton, a deutron and α-particle, whose kinetic energies are same, enter perpendicularly a uniform magnetic field. Compare the radii of their circualr paths.

A. the radius r_d of the deutron path to the radius r_p of the proton path is $\sqrt{2}$

B. the radius r_α of the alpha particle path to r_p is 1

C. the radius r_d of the deutron path to the radius r_p of the proton path is 2

D. the radius r_α of the alpha particle path to r_p is $\sqrt{2}$

Answer: A::B

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Comphension Based

1. A charged particle with charge to mass ratio $\left(\frac{q}{m}\right) = \frac{(10)^3}{19} Ckg^{-1}$ enters a uniform magnetic field $\vec{B} = 20\hat{i} + 30\hat{j} + 50\hat{k}T$ at time t = 0 with velocity $\vec{V} = \left(20\hat{i} + 50\hat{j} + 30\hat{k}\right)m/s$. Assume that magnetic field exists in large space.

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. increase

C. decrease

D. may increse or decrease

Answer: A

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2. A charged particle with charge to mass ratio $\left(\frac{q}{m}\right) = \frac{(10)^3}{19} Ckg^{-1}$ enters a uniform magnetic field $\overrightarrow{B} = 20\hat{i} + 30\hat{j} + 50\hat{k}T$ at time t = 0 with velocity $\overrightarrow{V} = \left(20\hat{i} + 50\hat{j} + 30\hat{k}\right) m/s$. Assume that magnetic field exists in large space.

The frequency (in Hz) of the revolution of the particle in cycles per second will be

A. $\dfrac{10^3}{\pi\sqrt{19}}$

B. $\dfrac{10^4}{\pi\sqrt{38}}$

C. $\dfrac{10^4}{\pi\sqrt{19}}$

D. $\dfrac{10^4}{2\pi\sqrt{19}}$

Answer: B

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Subjective type

1. Figure shows a wire ring of radius a that is perpendicular to the general direction of a radially sysmmetric, diverging magnetic field. The magnetic field at the ring is everywhere of the same magnitude B, and its direction at the ring everywhere makes an angle θ with a normal to the plane of the ring. thge twisted lead wires have no effect on the problem. Find the magnitude of the force the field exerts on the ring if the ring carries a current i.

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2. A copper rod of mass m rests on two horizontal rails distance L apart and carries a current of I from one rail to the other. The coefficient of static friction between rod and rails is μ_s What are the (a) magnitude and

(b) angle (relative to the vertical) of the smallest magnetic field that puts the rod on the verge of sliding?

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3. A straight conductor of length l carrying a current I is placed perpendicular to a long straight conductor which carries a current i_o as shown in the figure. Find the force of interaction between them.

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Multiple Correct Answer type

1. Which of the following statements is correct in the given figure?

Infinitely long wire at E kept perpendicular to paper carrying current inwards:

A. Net force on loop is zero

B. Net torque on 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

Answer: A::C

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2. A current carrying conductor is in the form of a sine curve as shown, which carries current I. If the equation of this curve is $Y = 2\sin\left(\frac{\pi x}{L}\right)$ and a uniform magnetic field B exists in space.

A. Force on wire is BIL if field is along Z axis

B. Force on wire is 2BIL if field is along Y axis

C. Force on wire is zero if field is along X axis

D. Force on wire is BIL if field is in the XY plane making an anlge 30° with X-axis

Answer: B::C::D

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