PHYSICS

BOOKS - GK PUBLICATIONS PHYSICS (HINGLISH)

MAGNETIC EFFECTS OF CURRENT AND MAGNETISM

Illustrative Example

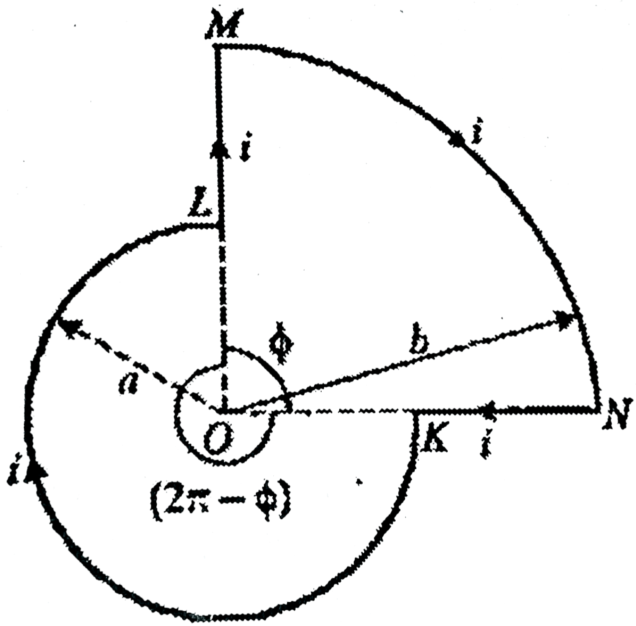
1. A current $I = 1.00$ A circulates in a round thin-wire loop of radius $R = 100mm$. Find the magentic induction

(a) at the centre of the loop,

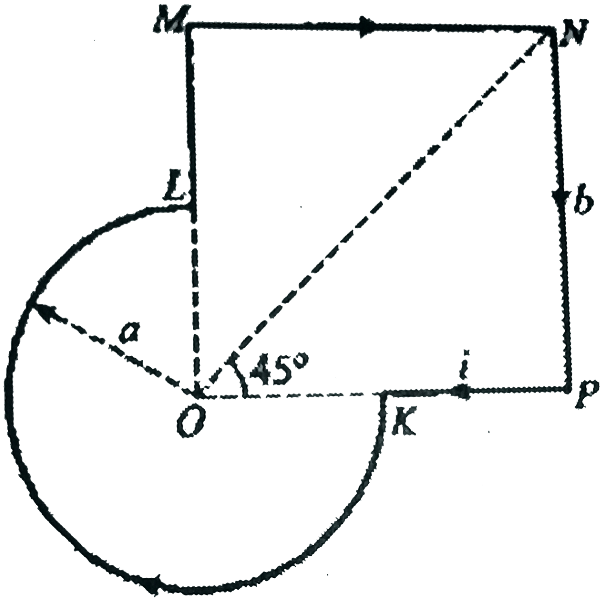
(b) at the point lying on the axis of the loop at a disatnace $x = 100mm$ from its centre.

2. Find the magnetic induction at the point O due to the loop current I in the two cases given below. The shape of the loop are illustrated as

(a) In figure-4.17 (a), the radii A and b, as well as the angle ϕ are known.



(b) In figure 4.17 (b), the radius a and the side b are known.



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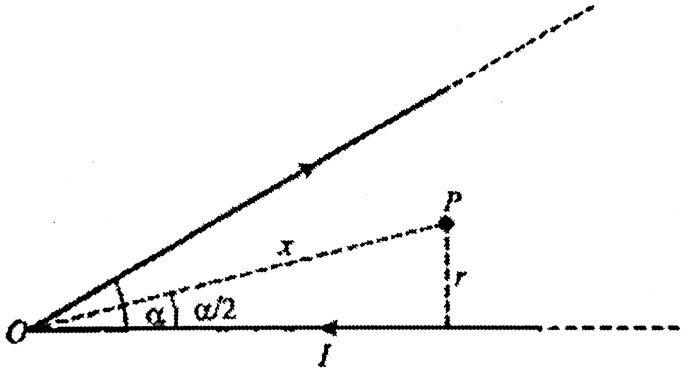
3. Figure4.18 shows a current carrent carrying wire bent at an angle α.

Find magentic induction at a point P located on the angle bisector at a distance x from the point O at the bend.



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4. A current I flows through a thin wire shaped as regular polygon of n sides which can be inscribed in a circle of radius R. The magnetic fiedl induction at the center of polygon due to one side of the polygon is

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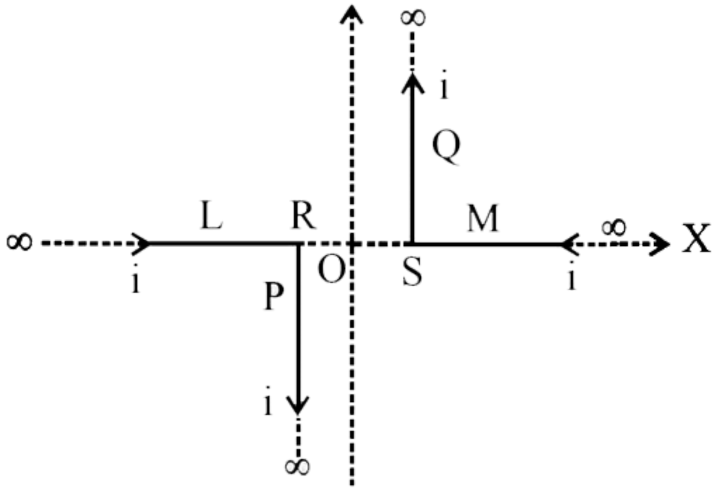
5. A pair of stationary and infintely long bent wires are placed in the XY planes as shown in fig. The wires carry currents of $I = 10amperes$ each as shown . The segments P and Q are parallel to the $Y-a\xi s$ such that

$OS = OR = 0.02m$. Find the magnitude and direction of the magnetic induction at the origin O.



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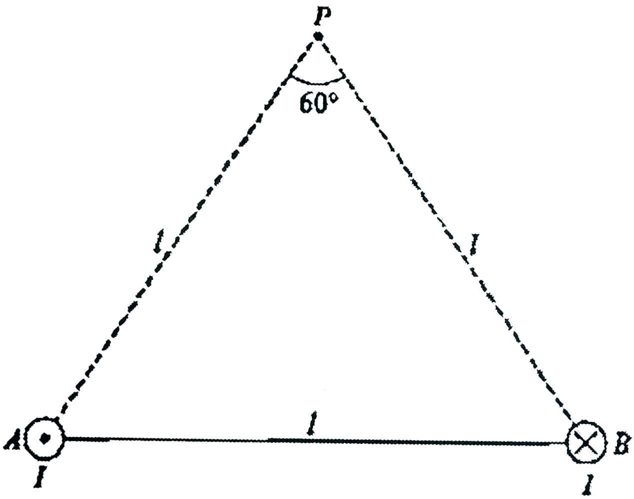
6. figure 4.22 shows two long wires A and B, each carrying a current I, separated by a distance l and oriented in a plane perpendicular to the plane of paper. The directions of currents are shown in figure. Find the magnetic induction at a point P located at a distance l from both wires as shown in figure4.22



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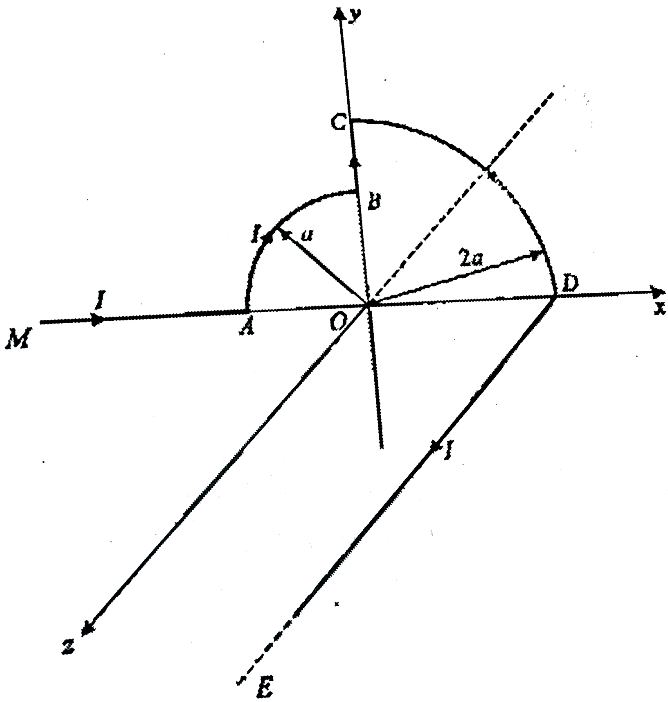
7. In figure-4.24 a current carrying wire configuration is shown with current l Find the vector of magnetic induction at origin of co-ordinate

system O.



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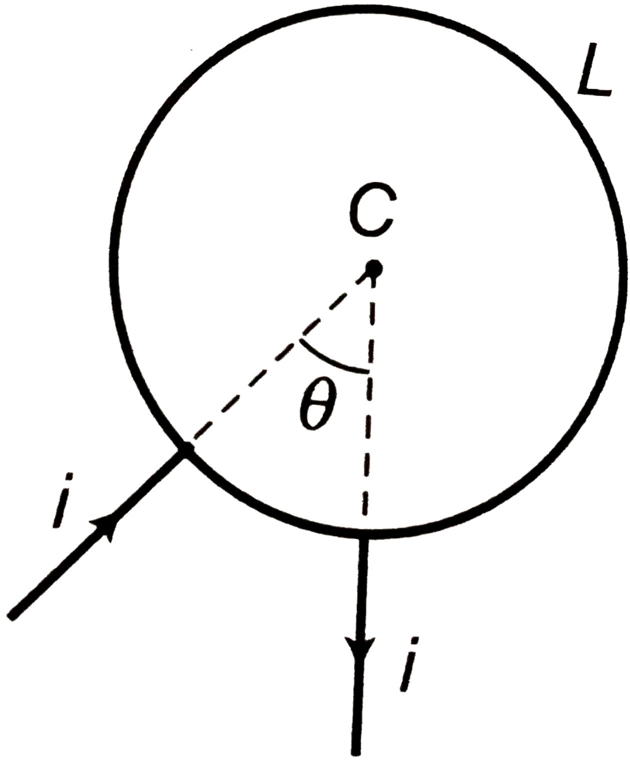
8. L is a circular ring made of a uniform wire, currents enters and leaves the ring through straight conductors which, if produces, would have passed through the centre C of ring. The magnetic field at C



(i) due to the straight conductors is zero

(ii) due to the loop is zero

(iii) due to the loop is proportional to θ

(iv) due to loop is proportional to $(\pi - \theta)$

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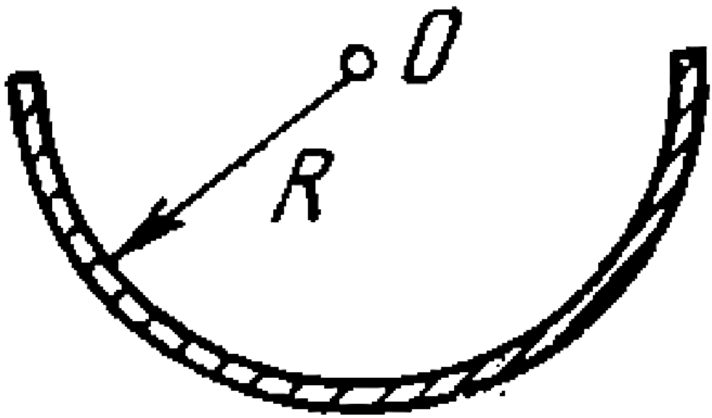
9. A current I flows in a long straight wire with cross-section haviing the form of a thin half-ring of radius R (Fig). Find the induction of the magnitude field at the point O.



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10. A very long straight solenoid has a cross section radis R and n turns per unit lenghth. A direct current Iflows throguh the solenoid. Suppose that x is the distance from the end of the the solenoid, measured along its axis. Find:

(a) the magnetic induction B on the axis as a funciton of x, draw an approximate plot of B vs ratio x/R,

(b) the distance x_0 to the point on the axis at which the value of B differs by $\eta = 1\%$ from that in the middle section of the solnoid.

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11. A straight long solenoid produces magnetic induction Bat its centre. If it is cut into two equal parts and same number of turns wound on one part in double layer. Calculate magnetic field produced by new solenoid at its centre.

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12. A very long straight solenoid carries a current i. The cross-sectional area of the solenoid is equal to S, the number of turns per unit length is equal to n. Find the flux of the vector B through the end plane of the solenoid.

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13. A non-conducting sphere of radius $R = 50mm$ charged uniformly with surface density $\sigma = 10.0\mu C / m^2$ rotates with an angular velocity $\omega = 70$ rad/s about the asxis passign thorugh its centre. Find the magnetic induction at the centre of the sphere.

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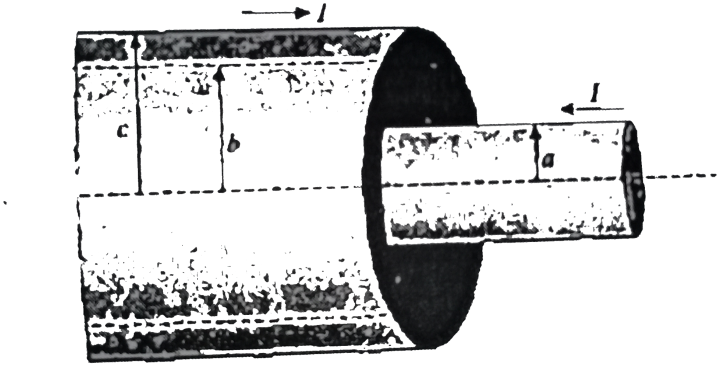
14. A coaxial cable carries the a current i in the inside conductor of radius a as shown in figure-4.80 and the outer conductor of inner radius b and outer radius c carries a current i' in opposite direction. Find the magnetic induction due to the coaxial cable at distance r from the central axis of the cable for (a) $r > a$, (b) $a < r < b$ and (c) $b > r > c$



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15. Inside a long straight uniform wire of round cross-section, there is a long round cylindrical cavity whose axis is parallel to the axis of the wire and displaced from the latter by a distance l. A direct current of density j flows along the wire. Find the magnetic induction inside the cavity. Consider, in particular, the case $l = 0$.

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16. In a long cylindrical wire of radius R, magnetic induction varies with the distance from axis as $B = cr^{\alpha}$. Find the function of current density in wire with the distance from axis of wire.

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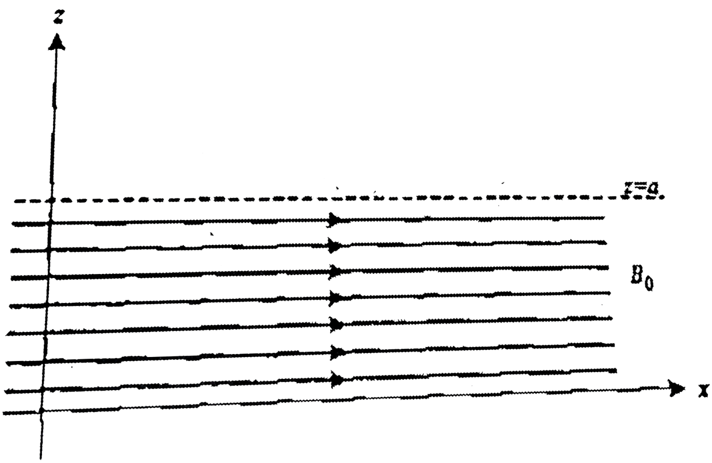
17. Figure-4.76 shows a region of space in which a uniform magnetic induction B_0 is is present between the planes $z = 0$ and $z = a$. Using Ampere's law prove that such a field cannot exist between two planes as described here.



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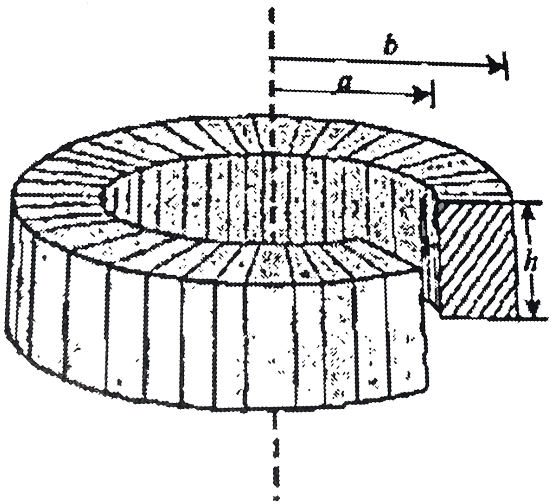
18. Figure-4.78 shows a toroidal solenoid whose cross-section is rectangular in shape. Find the magnetic flux through this cross-section if the current through the toroidal winding is I, total number of turns in winding is N, the inside and outside radii of the toroid are a and b respectively and the height of toroid is equal to h.



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19. A charge $4\mu C$ enters in a region of uniform magnetic field with a velocity $\left(4\hat{i} - 7\hat{j}\right)$ m/s experiences a force $\left(5\hat{i} - C\hat{j}\right)N$. Find the value of C.

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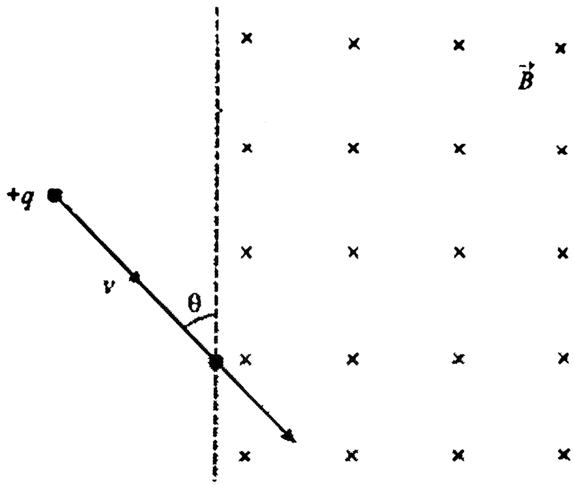
20. A charge particle of mass m and charge q is accelerated by a potential difference V volt. It enters in a region of uniform magnetic field Bas shown in figure-4.93. Find the time after which it will come out from the magnetic field.



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21. 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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22. 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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23. 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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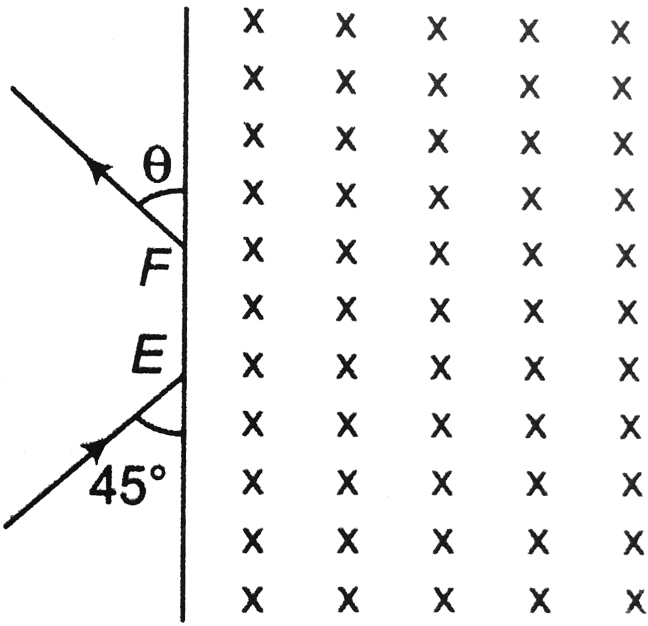
24. A particle of mass $m = 1.6 \times 10^{-27}$ kg and charge $q = 1.6 \times 10^{-19} C$ enters a region of uniform magnetic field of stregth $1T$ along the direction shown in figure. The speed of the particle is $10^7 m/s$



a. The magnetic field is directed along the inward normal to the plane of the paper. The particle leaves the region of the fiedl at the point F. Find the distasnce EF and the angle theta.

b. If the direction of the field is along the outward normal to the plane of the paper find the time spent by the particle in the regin of the magnetic field after entering it at E.

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25. In a right handed coordinate system XY plane is horizontal and Z-axis is vertically npward. A uniform magnetic field exist in space in vertically npward direction with magnetic induction B. A particle with mass m and charge q is projected from the origin of the coordinate system at $t = 0$ with a velocity vector given as

$$\vec{v} = v_1 \hat{i} + v_2 \hat{k}$$

Find the velocity vector of the particle after time t.

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26. Two parallel horizontal conductors are suspended by two light vertical threads each 75 cm long. Each conductor has a mass of $40gm$, and when there is no current they are 0.5 cm apart. Equal current in the two wires result in a separation of 1.5 cm. Find the values and directions of currents. Take $g = 9.8ms^{-2}$.

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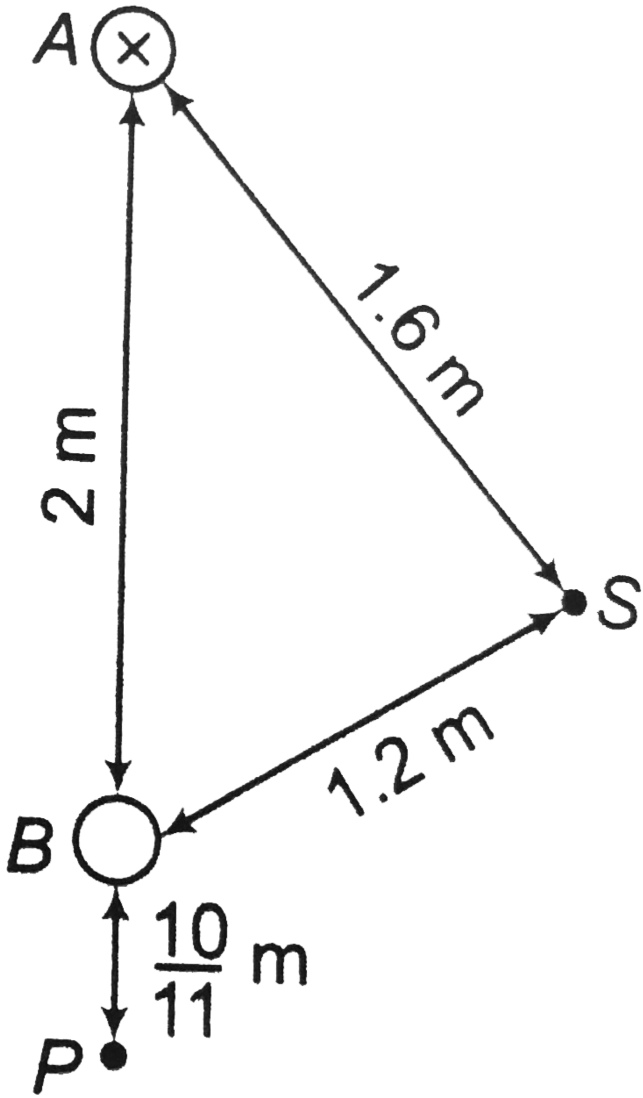
27. Two long straight parallel wieres are $2m$ apart, perpendicular to the plane of the paper. The wire A carries a current of $9.6A$, directed into the plane of the paper. The wire B carries a current such that the magnetic field of induction at the point P, at a distance of $\frac{10}{11}$ m from the wire B, is zero. find

a. the magnitude and directiion of the current in B.

b. the magnitude of the magnetic field of induction of the pont S.

c. the force per unit length on the wire B.



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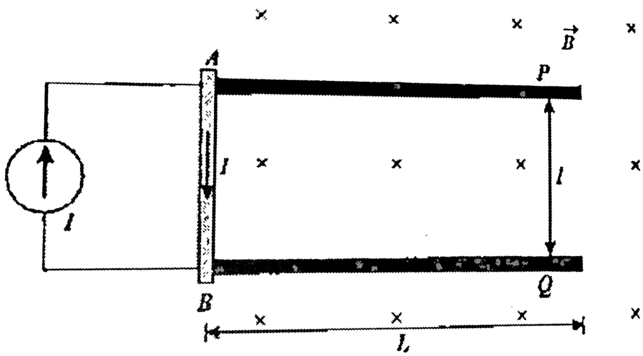
28. A rod AB of mass m and length l is placed on two smooth rails P and Q in a uniform magnetic induction B as shown in figure-4.110. The rails are connected to a current source supplying a constant current J. Find the speed attained by rod AB when it leaves off the other end ofrails oflength L.



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29. Two long parallel wires of negligible resistance are connected at one end to a resistance R and at the other end to a constant voltage source of voltage V. The distance between·the axes of the wires is η times greater than the cross-sectional radiµs of each wire. At what value of resistance R, does the resultant force of interaction between the wires will become zero?

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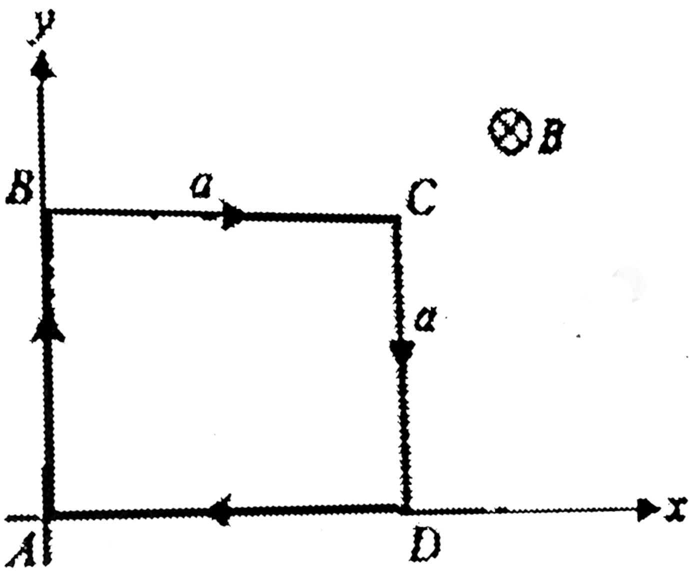
30. A rectangular loop of wire ABCD is oriented with the left corner at the origin, one edge along X-axis and the other edge along Y-axis as shown in the figure-4.113. A magnetic · field exist in space in direction perpendicular to the XYplane as shown and has a magnitude that is given as $B = \alpha y$ where α is a constant. Find the total magnetic force on the loop if it carries current i.



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31. An infinte wire place along z-axis has current I_1 in positive z-direction A conducting rod placed in xy plane parallel to y-axis has current I_2 in positive y-direction The ends of the rod subtend $+30^\circ$ and -60° at the origin with positive x direction The rod is at a distance a from the origin. Find net force on the rod .

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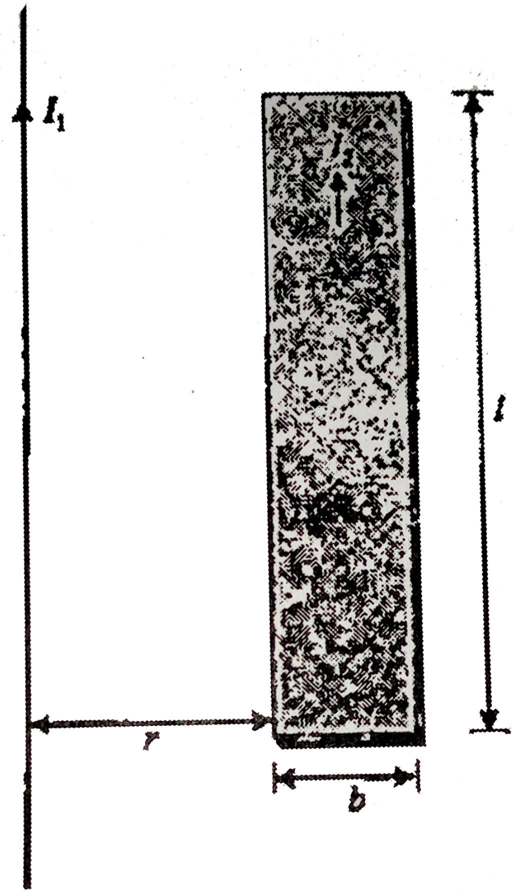
32. Figure shows a long straight current carrying wire with a current I_1 and a thin strip of width b and length l placed parallel to it with a current I_2 as shown in figure. Find the magnitude force of interaction between current I_1 and I_2



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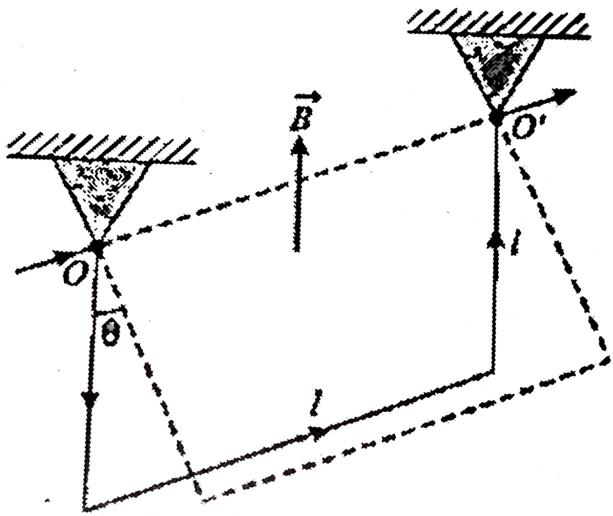
33. A copper wire with density ρ with cross-sectional area S bent to make three sides of a squae frame which can turn about a horizontal axis OO' as shown in figure. The wire is located in uniform vertical magnetic field. Find the magnetic induction if on passing a current I through the wire the frame deflects by an angle θ in its equilibrium position.



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34. A proton beam passes without deviation through a region of space where there are uniform transverse mutually perpendicular electric and magnetic field with E and B Then the beam strikes a grounded target. Find the force imparted by the beam on the target if the beam current is equal to I .

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35. 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 $B_x = B_z = 0, B_y = 8X10^{-2}$. 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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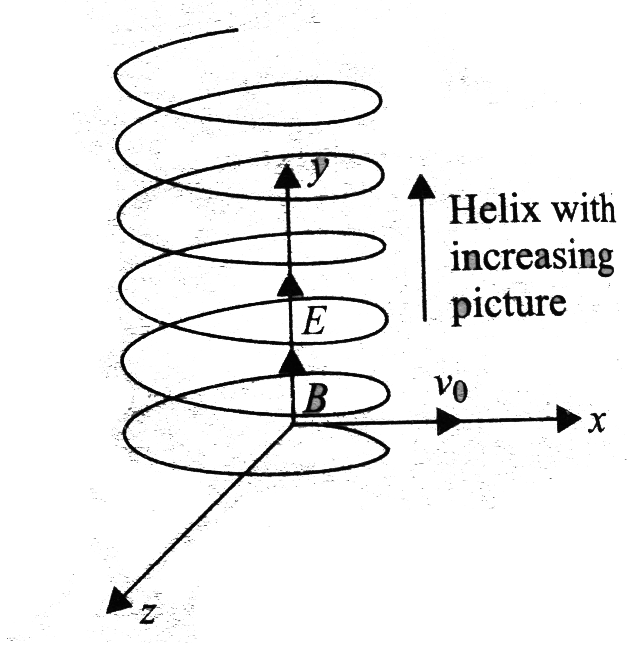
36. Uniform electric and magnetic fields with strength E and induction B, respectively, are along y-axis as shown in Fig. A particle with specific charge q/m leaves the origin O in the direcction of x-axis with an initial non-relativistic velocity v_0



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n^(th)` time is

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37. an electron beam passes through a magnetic field of magnetic induction $2 \times 10^{-3} T$ and an electric field of strength $3.4 \times 10^4 V/m$ both acting simultaneously in mutually perpendicular directions. If the path of electrons remains undeviated, calculate the speed of the electrons. If the electric field is removed, what will be the radius of curvature of the trajectory of the electron path after 2s?

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38. There is a constant homogeneous electric field of $100 V m^{-1}$ within the region $x = 0$ and $x = 0.167 m$ pointing in x-direction. There is a constant homogeneous mangetic field B within the region $x = 0.167 m$ and $x = 0.334 m$ 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 $x = 0, y = 0.167 m$. (mass of proton $= 1.67 \times 10^{-27} kg)$

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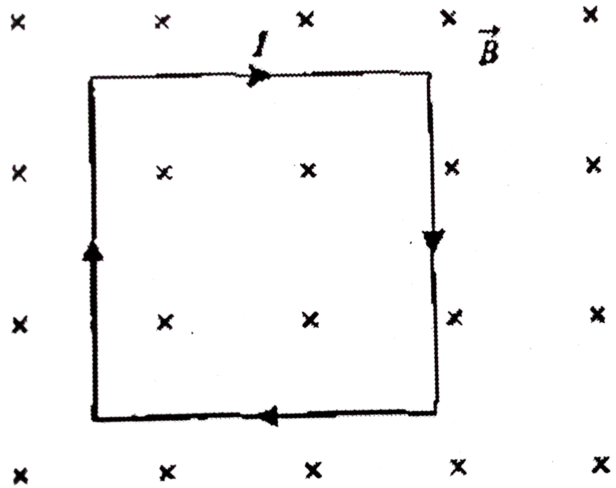
39. Figure shows a coil of area A and N turns with a current I is placed in a uniform magnetic induction B. Find the work required to pull this coil out from magnetic field.



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40. 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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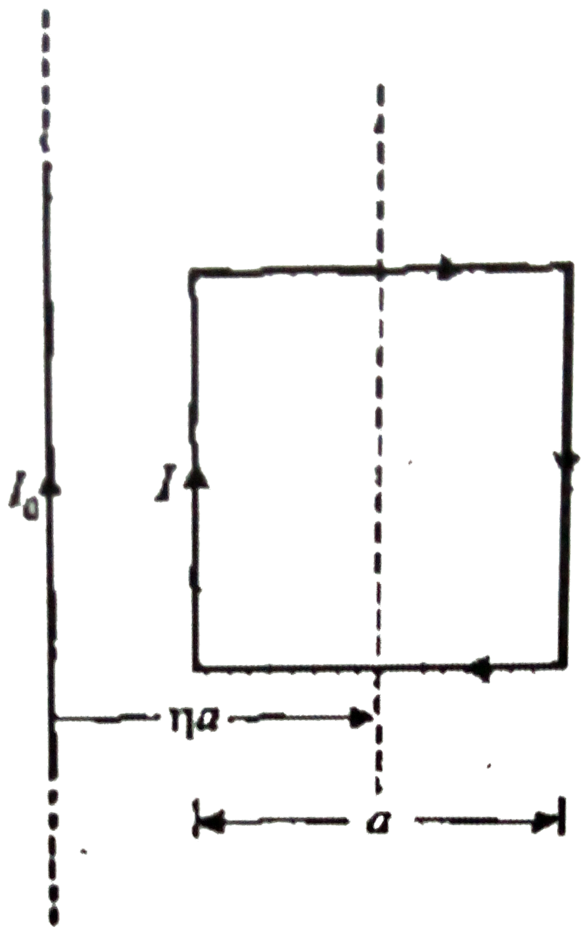
41. A square frame carrying a current I is located in the same plane as a long straight wire carrying a current I_0 The frame side has a length a. The axis of the frame passing through the midpoints of the opposite sides is parallel to the wire and is separated from it by the distance which is η times greater than the side of the frame. Find



(a) Force acting on the frame

(b) The mechanical work to be performed in order to turn the frame through 180° about its axis, with the currents maintained constant.

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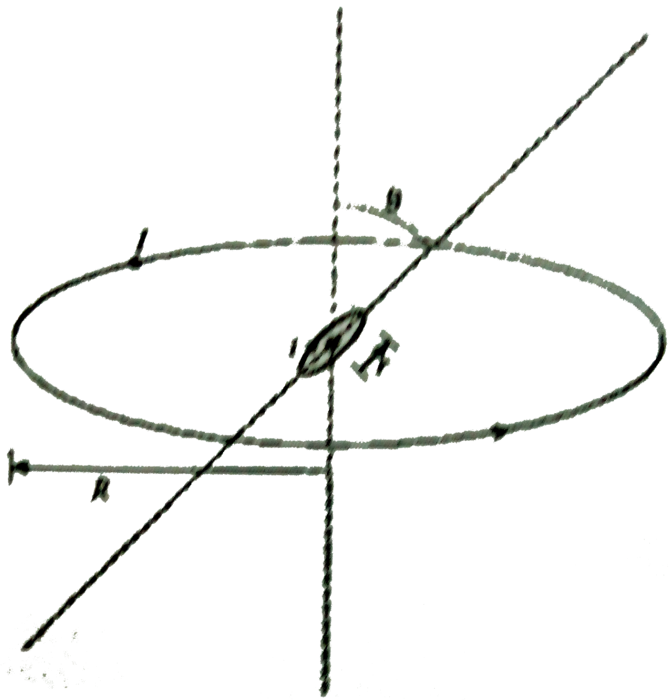
42. Figure shows a larger horizontal coil of radius R carrying a current I. Another small coil of radius $r(r << R)$ carrying a current i & N turns is placed at the centre with its plane at an angle θ from the axis. Find the torque experienced by the smaller coil in this situation.



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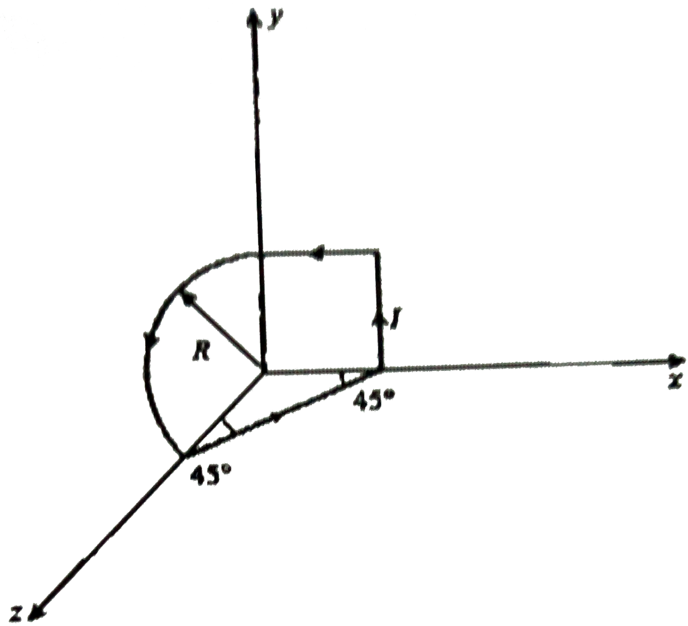
43. Find the magnetic moment of the current carrying loop shown in figure.



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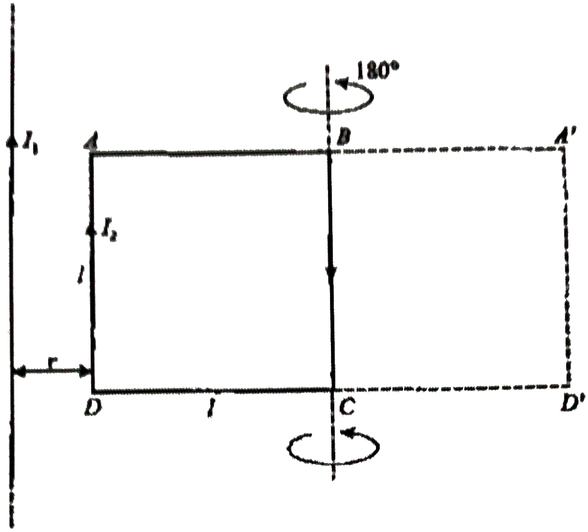
44. A square coil of edge l carrying a current I_2 is placed near to a long straight wire carrying current I_1 as shown in figure. Find work required to rotate the coil ABCD about the axis along edge BC by 180° to the dotted position A 'BCD' as shown.



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45. 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 magnetic field of $9 \times 10^{-3} T$. What is the torsional constant of the spring connected to the coil if a current of 0.20mA produces an angular deflection of 180° ?

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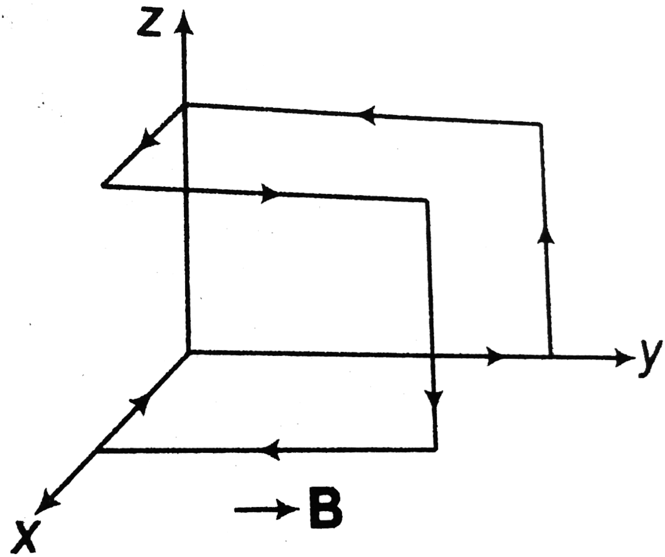
46. Given figure shows a coil bent with all edges of length $1m$ and carrying a current of $1A$. There exists in space a uniform magnetic field of $2T$ in positive y-direction. Find the torque on the loop.



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47. A flat disc of radius R charged uniformly on its surface at a surface charge density σ. About its central axis of rotation it rotates at an angular speed ω. Find the magnetic moment of disc due to rotation of charges.

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48. A flat dielectric disc of radius R carries an excess charge on its surface. The surface charge density σ. The disc rotastes about an axis perpendicular to its lane passing thrugh the centre with angulasr velocity ω. Find the toruque on the disc if it is placed in a uniform magnetic field B directed perpendicular to the rotation axis.

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49. A sphere of radius R, uniformly charged with the surface charge density σ rotates around the axis passing through its centre at an angular velocity. (a) Find the magnetic induction at the centre of the rotating sphere. (b) Also, find its magnetic moment.

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50. What pressure does the lateral surface of a long straight solenoid with n turns per unit length experience when a current I flows through it.

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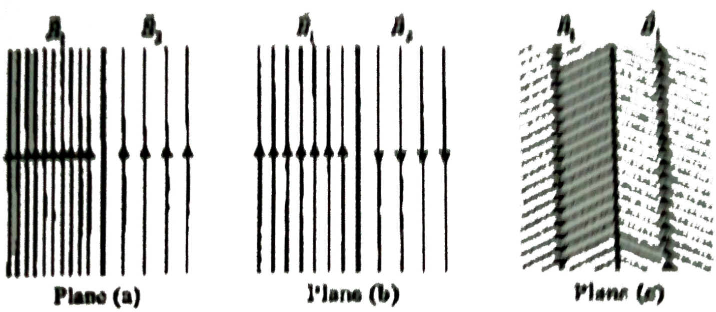
51. A conducting current-carrying plane is placed in an external uniform magnetic field. As a result, the magnetic induction becomes equal to B_1 on one side of the plane and equal to B_2 on the other side. Find the magnetic force acting per unit area of the plane in the cases illustrated in the figure.



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52. A bar magnet is 0.1 m long and its pole strength is 12 Am. Find the magnetic induction at a point on its axis at a distance of 0.2 m from its centre.

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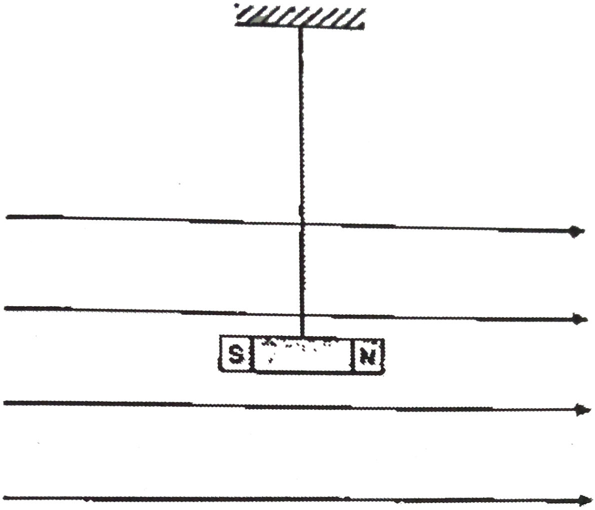
53. A magnetic dipole of magnetic moment M is suspended by a string in a uniform horizontal magnetic field as showo in figure. If in horizontal plane this dipole is slightly tilted and released, show that it will execute simple harmonic motion and find its oscillation period. Consider the dipole as a uniform rod of mass m and length l.



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54. A small magnet of magnetic moment $\pi \times 10^{-3} Am^2$ is placed on the Y-axis at a distance of 0.1 from the origin with its axis parallel to the X-axix. A coil have 169 turns and radius 0.05 m is placed on the X-axis at a distance of 0.12 m from the origin with the axis of the coil coinciding with the X-axis. Find the magnitude and direction of the current in the coil for a compass needle placed at the origin, to point in the north-south direction.

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55. Centers of two similar coils P and Q having same number of turns are located at the coordinates (0.4,0) and (0,0.3) such that the plane of coils are perpendicular to X-and Y-axis respectively. The areas of cross section of coils P and Q are in the ration $4:3$ Coil P has 16 A current in clockwise direction and coil Q has $9\sqrt{3}A$ current in anticlockwise direction as seen from the origin. A small compass needle is placed at the origin. Find the deflection in the needle, assuming the earth's magnetic field negligible and the radii of the coils very small compared to their distances from the origin.

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56. A magnetic dipole with a dipole moment of magnitude $0.020\frac{J}{T}$ is released from rest in a uniform form magnetic field of magnitude $52mT$. The rotation of the dipole due to the magnetic force on it is unimpeded. When the dipole rotates through the orientations where its dipole moment is aligned with the magnetic field, its kinetic energy is $0.80 mJ$.

(a) What is the initial angle between the dipole moment and the magnetic field?

(b) What is the angle when the dipole is next (momentarily) at rest?

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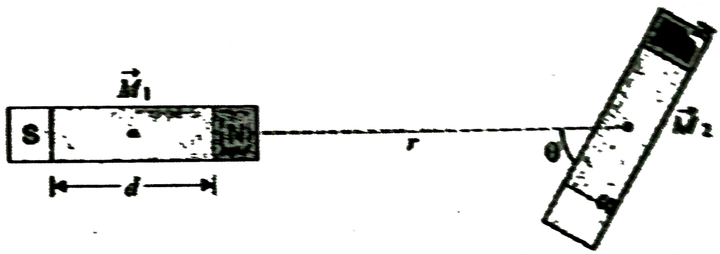
57. Figure shows two small bar magnets having dipole moments M_1 and M_2 placed at separation r. Find the magnetic interaction energy of this system of dipoles for $d < < r$.



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58. At a point on earth surface horizontal component of earth's magnetic field is $40 \mu T$ and dip angle is 30°. Find the total magnetic field of earth at this point.

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59. The radius of tangent galvanometer coil is 16 cm. Find the number of turn in its coil if a current of 40 mA is required to produce a deflection of 30° in it from magnetic meridian. Horizontal component of earth's magnetic field is $36 \times 10^{-6}T$.

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60. In the magnetic meridian of a certain place at the center of the coil ofa tangent galvanometer, the horizontal component of earth's magnetic field is 0.26G and the dip angle is 60°. Find:

(a) Vertical component of earth's magnetic field

(b) The net magnetic field at this place.

(c) If a current is passed in tangent galvanometer, its coil produces a magnetic induction $3.47 \times 10^{-3}T$. Calculate the defleciton in compass needle of tangent galvanometer.

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Practice Exercise

1. Find the magentic inducrtion at the centre of a recentagular wire frame whose diagonal is equal to $\varphi = 30^\circ$, the current flowing in the frame equlas $I = 5.0A$.

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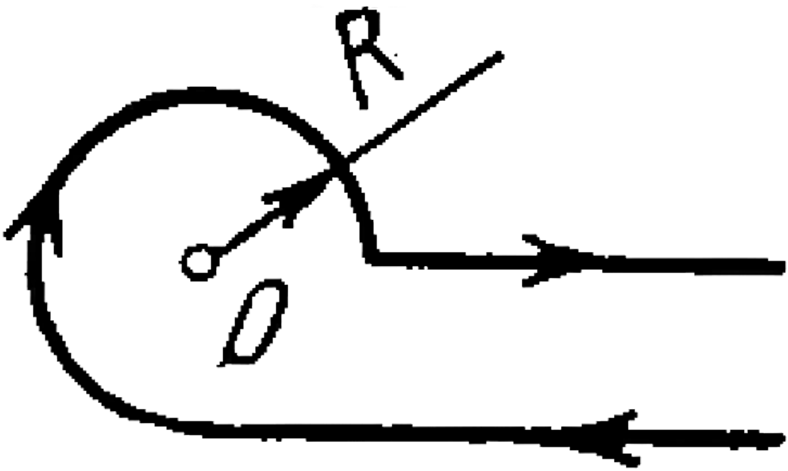
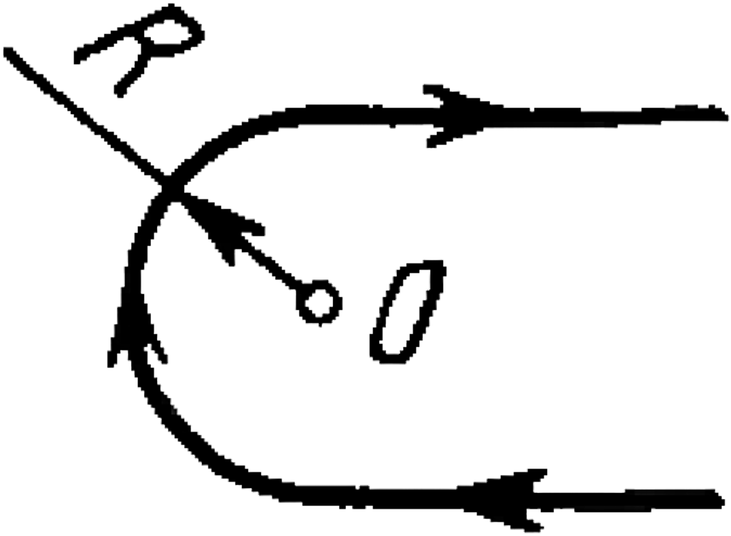
2. Find the magentic induction of the field at the pont O if a current-carrying wire has the shape shown in Figa,b,c The raidius of the curved part of the of the weir is R the linear parts are assumed to be very long.

(a)





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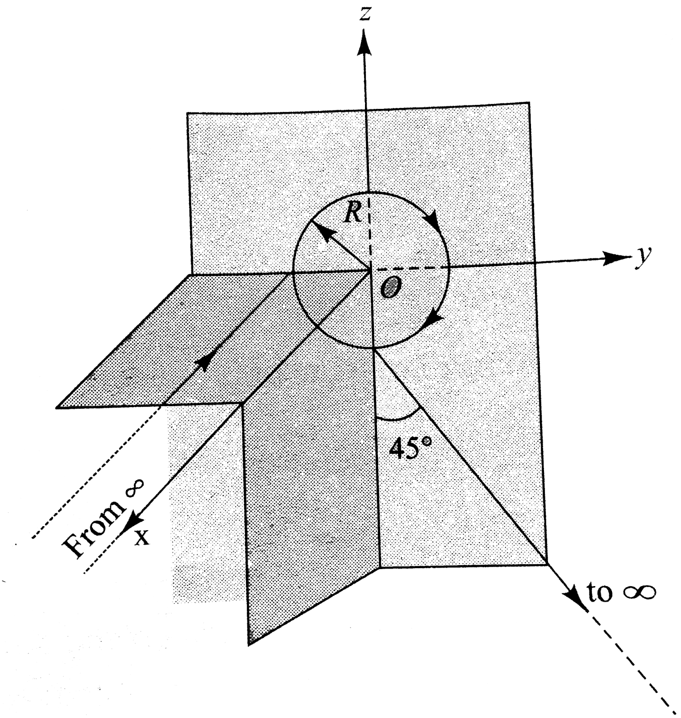
3. Calculate magnetic induction at point O if the wire carrying

a current I has the shape shown in Fig.



(The radius of the curved part of the wire is equal to R and linear parts of the wire are very long.)

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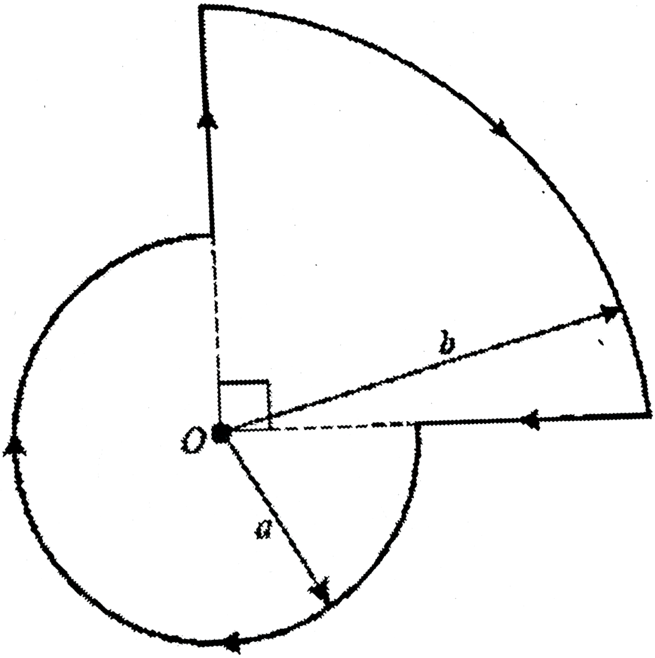
4. In the figure-4.30 shown two circular arcs are joined to make a closed loop carrying current l. Frnd the magnetic induction at the common centre O.



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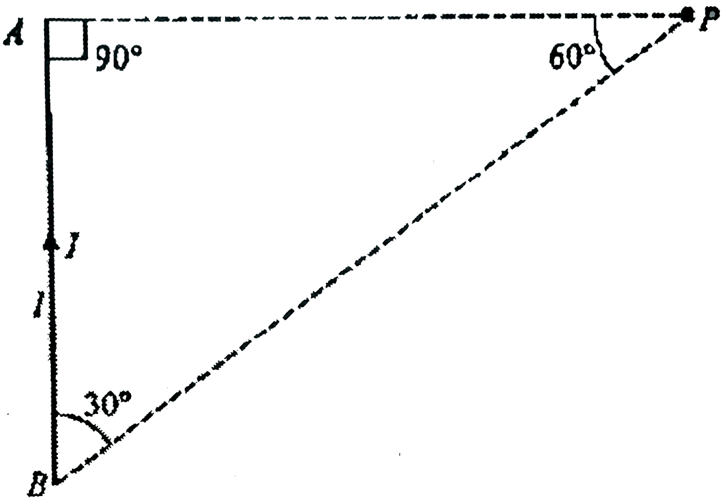
5. Find the magnetic induction at point P due to a current carrying wire AB as shown in figure-4.31



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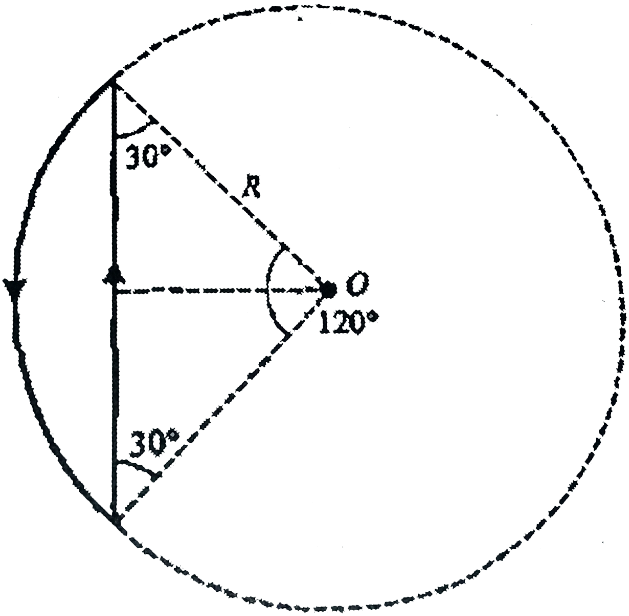
6. Find magnetic induction at point O in the figure-4.32 shown due to the current carrying loop with current/ as shown .



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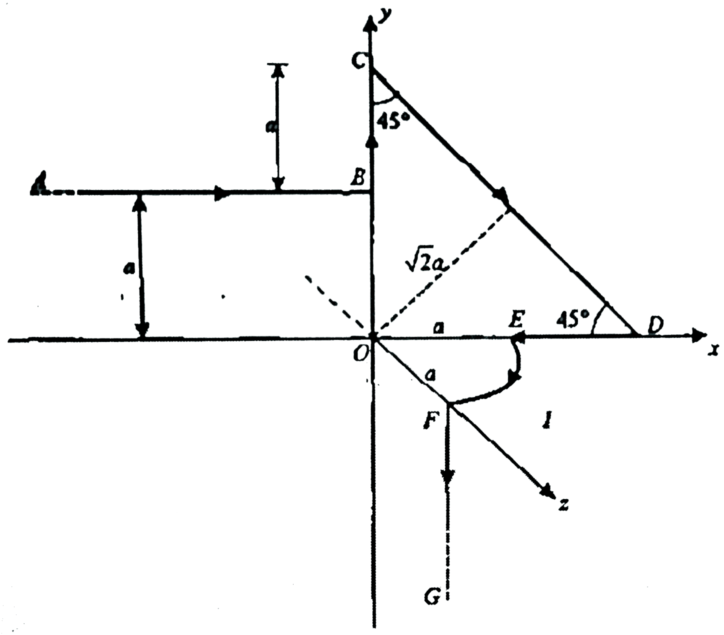
7. Find the magnetic induction vector at origin O due to the current carrying wire configuration as shown in figure-4.33.



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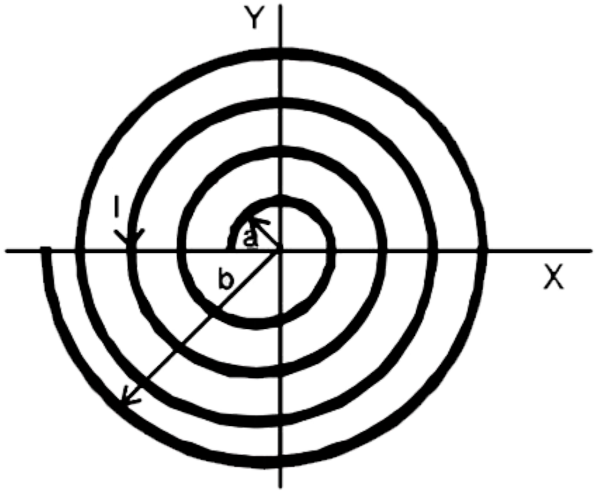
8. A long insulated copper wire is closely wouind as a spiral of 'N' turns . Thw spiral has inner radius 'a' and outer radius 'b' . The spiral lies in the XY plane and a steady current ' I' flows through the wire . The Z -

component of the magnetic field at the centre of the spiral is



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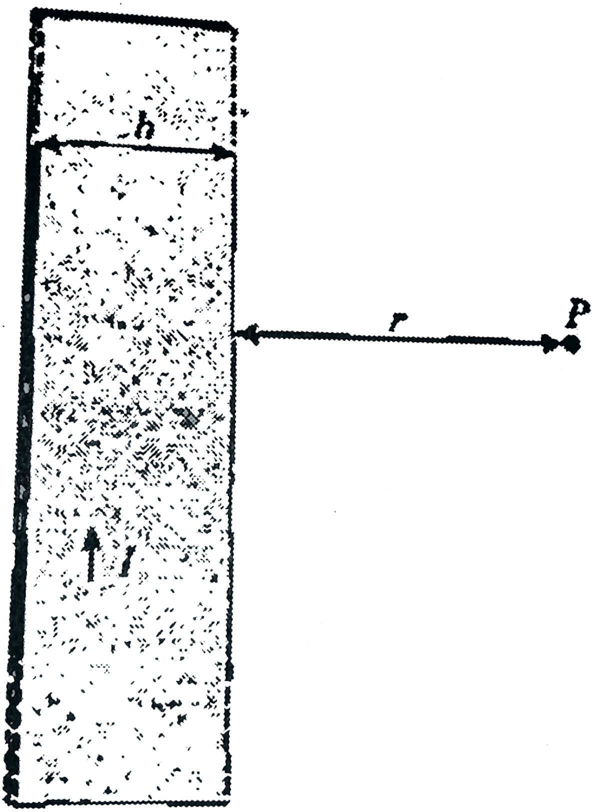
9. Figure shows a long and thin strip of width b which carries a current I.

Find magnetic induction due to the current in strip at point P located at a distance r from the strip in the plane of strip as shown in figure-4.35.



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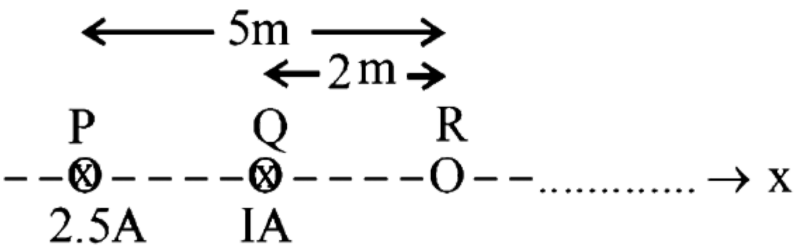
10. Two long parallel wires carrying current $2.5 amperes$ and $I ampere$ in the same direction (directed into the plane of the paper) are held at P and Q respectively such that they are perpendicular to the plane of paper. The points P and Q are located at a distance of $5 metres$ and $2 metres$ respectively from a collinear point R (see figure)

(i) An electron moving with a velocity of $4 \times 10^5 m/s$ along the positive $x - direction$ experiences a force of magnitude $3.2 \times 10^{-20} N$ at the point R. Find the value of I.

(ii) Find all the positions at which a third long parallel wire carrying a current of magnitude $2.5 amperes$ may be placed so that the magnetic induction at R is zero.



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11. A tightly- wound, long solenoid is kept with its axis parallel to a large metal sheet carrying a surface current. The surgace current through a width dl of the sheet is Kdl and the number of turns per unit length of the solenoid is n. The magnetic field near the centre of the solenoid is found to be zero. (a) find the current in the solenoid. (b) If the solenoid is rotated to make its axis perpendicular to the metal sheet, what would be the magnitude of the magnetic field near its centre?

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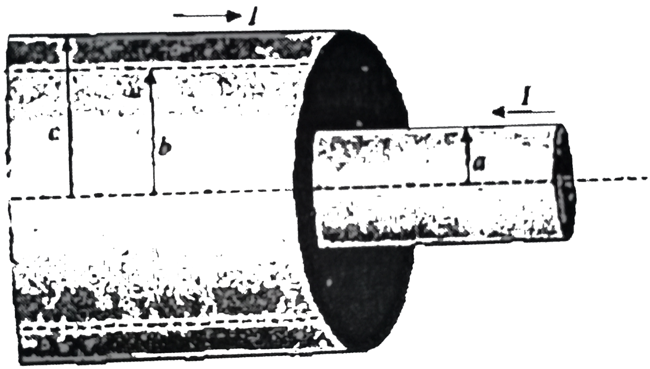
12. A coaxial cable carries the a current i in the inside conductor of radius a as shown in figure-4.80 and the outer conductor of inner radius b and outer radius c carries a current i' in opposite direction. Find the magnetic induction due to the coaxial cable at distance r from the central axis of the cable for (a) $r > a$, (b) $a < r < b$ and (c) $b > r > c$



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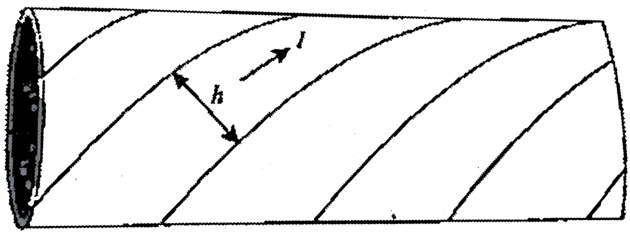
13. A thin conducting strip of width his tightly wound in the shape of a very long cylindrical coil with cross-sectional radius R to make a single layer straight solenoid as shown in figure-4.81. A direct current I flows through the strip. Find the magnetic induction inside and outside the solenoid as a function of the distance r from its axis.



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14. A long cylinder of uniform cross section and radius R is carrying a current i along its length and current density is uniform cross section and radius r in the cylinder parallel to its length. The axis of the cylinderical cavity is separated by a distance d from the axis of the cylinder. Find the magnetic field at the axis of cylinder.

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15. Two straight infinitely long and thin parallel wires are spaced 0.1m apart and carry a current of 10A each. Find the magnetic field at a point distance 0.1m from both wires in the two cases when the currents are in the (a) same and (b) opposite directions.

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16. A capacitor of capacitance C is connected to a battery of EMF E for a long time and then disconnected. The charged capacitor is then connected across a long solenoid having n turns per meter in its closely packed winding on its core. After connections it is found that the voltage across the capacitor drops to E/η in a time Δt. In this period estimate the average magnetic induction at the centre of solenoid.

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17. A current I flows radius along a lengthy thin-walled tube of radisu R with longiitual slit of width h. Find the induction of the magnietic field inside the tube under the condition $h < < R$

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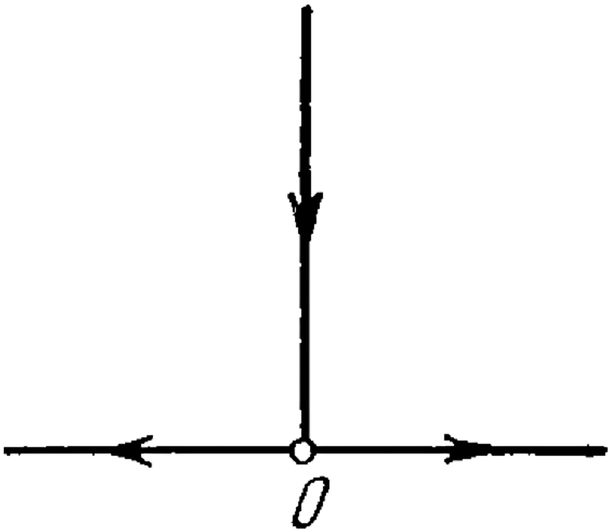
18. A direct current I flows along a lengthly straight wire. From the point O (fig) the current sperads radially all over an infinite conducting plane paerpendicular to the wire. Find the magnitude induction at all points of space.



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19. A toroid of total 1000 turns is made by using a tore of average radius 25cm. What is the magnetic induction inside the tore if a current of2A is passed through it and the relative magnetic permeability of the tore material is $\mu = 100$

A. $[16 \times 10^{-2} T]$

B. $[16 \times 10^{2} T]$

C. $[1.6 \times 10^{-2} T]$

D. $[0.16 \times 10^{-2} T]$

Answer: A

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20. 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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21. An electron moving with a velocity $10^8 m/s$ enters a magnetic field at an angle of 20° to the direction of the field. Calculate

(a) The value of magnetic induction so that the helical path radius will be 2m.

(b) The time required to execute one revolution of the helical path.

(c) The pitch o fhelical path followed by the electron.

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22. 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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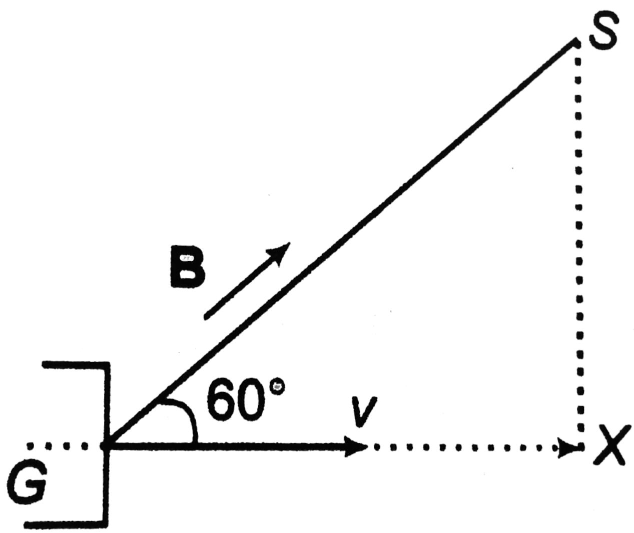
23. An electron gun G emits electons of energy $2keV$ travelling in the positive x-direction. The electons are required to hit the spot S where $GS = 0.1m$, and the line GS makes an angle of 60° with the x-axis as shown in figure. A uniform magnetic field B parallel to GS exists in the region outside the electron gun.



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

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24. A $15000V$ electron is describing a circle in a uniform field of magnetic indnction 250G acting at right angle to it. Calculate tbe radius oftbe circle.

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25. 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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26. A direct current flowing through tbe winding of a long cylindrical solenoid ofradius R produces a uniform magnetic induction B in it. An electron travelling at velocity v enters into tbe solenoid along the radial direction between its turn at right angles to the solenoid axis. After a certain time tbe electron deflected by magnetic field leaves the solenoid.

Calculate the time which the electron spends inside the solenoid.

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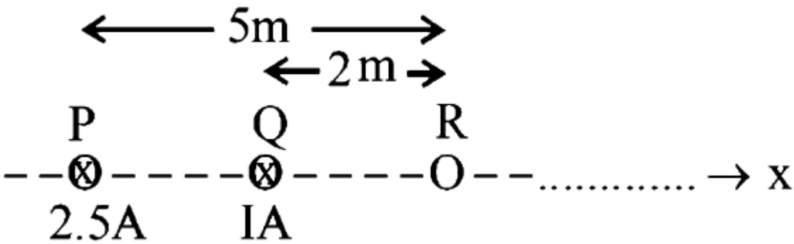
27. Two long parallel wires carrying current $2.5 amperes$ and $I ampere$ in the same direction (directed into the plane of the paper) are held at P and Q respectively such that they are perpendicular to the plane of paper. The points P and Q are located at a distance of $5 metres$ and $2 metres$ respectively from a collinear point R (see figure)

(i) An electron moving with a velocity of $4 \times 10^5 m/s$ along the positive $x - direction$ experiences a force of magnitude $3.2 \times 10^{-20} N$ at the point R. Find the value of I.

(ii) Find all the positions at which a third long parallel wire carrying a current of magnitude $2.5 amperes$ may be placed so that the magnetic induction at R is zero.



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28. In a right handed coordinate system XY plane is horizontal and Z-axis is vertically npward. A uniform magnetic field exist in space in vertically npward direction with magnetic induction B. A particle with mass m and charge q is projected from the origin of the coordinate system at $t = 0$ with a velocity vector given as

$\overrightarrow{v} = v_1 \hat{i} + v_2 \hat{k}$

Find the velocity vector of the particle after time t.

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29. Inside a cylindrical capacitor of inner radius a and outer radius b, an electron is projected from the surface of inner cylindrical shell perpendicular to it with an initial velocity. In the annular region between the two cylindrical shells a uniform magnetic induction B exist in direction parallel to the axis of capacitor. Find tbe maximum initial velocity with which tbe electron is to be projected so that it will not hit the outer shell.

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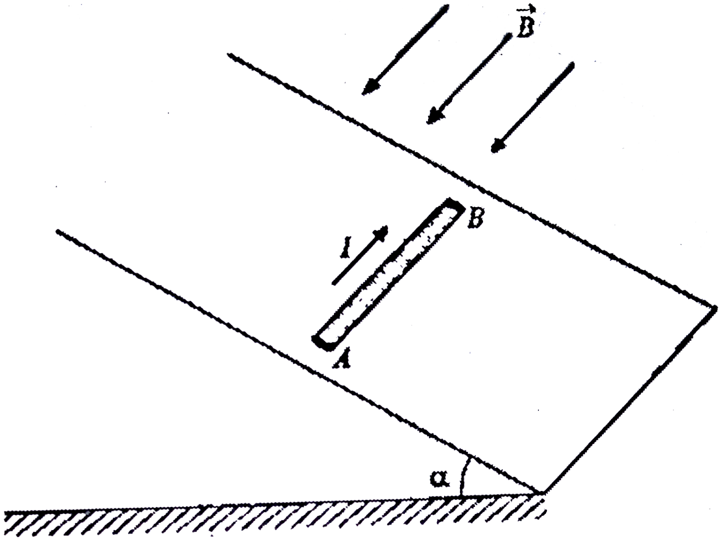
30. Figure shows a wire AB of mass m placed on a rough inclined plane of inclination α and static friction coefficient μ. The wire carries a current I. Find the minimum magnitude of magnetic induction required to slide the wire up the inclined plane if direction of magnetic induction is normal to plane as shown in figure.



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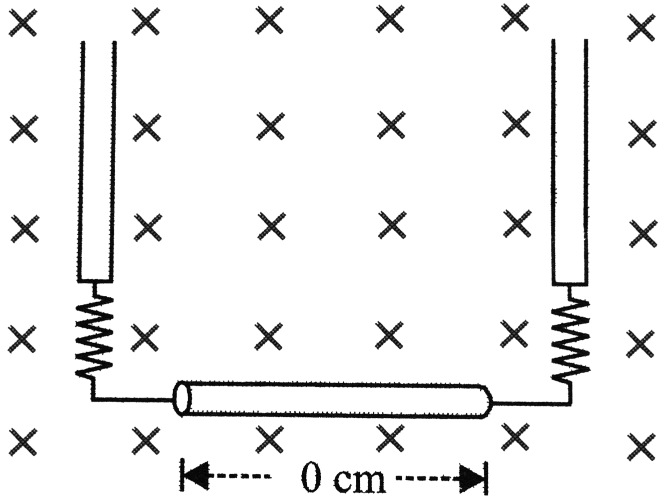
31. A wire of 60 cm length and mass 16 gm is suspended by a pair of flexible leads in a magnetic field of induction 0.40 T. What are the magnitude and direction of the current required to remove the tension in the supporting leads?



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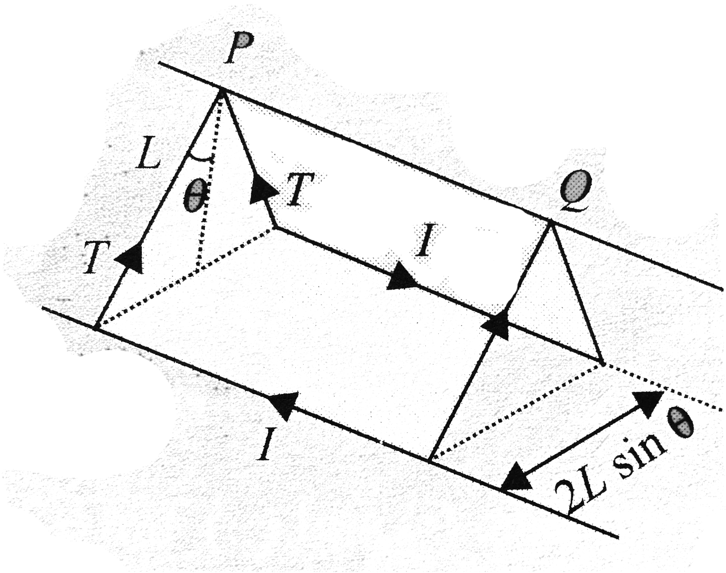
32. Two long parallel wires carry currents of equal magnitude but in opposite directions. These wires are suspended from rod PQ by four chords of same length L as shown in Fig The mass per unit length of the wires is λ. Determine the value of θ assuming it to be small.



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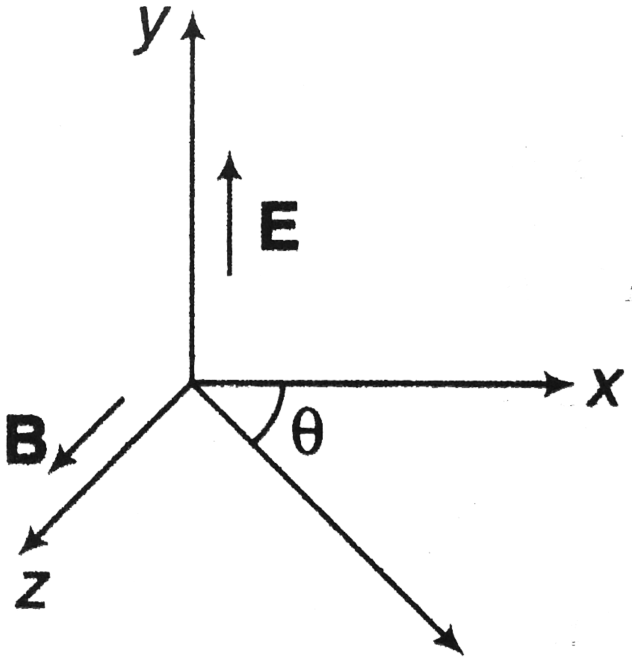
33. Protons move rectilinearly in the region of space where there are uniform mutually perpendicular electric and magnetic fields E and B. The trajectory of protons lies in the plane xz as shown in the figure and forms an angle 9 with x-axis. Find the pitch of the helical trajectory along which the protons will move after the electric field is switched off.



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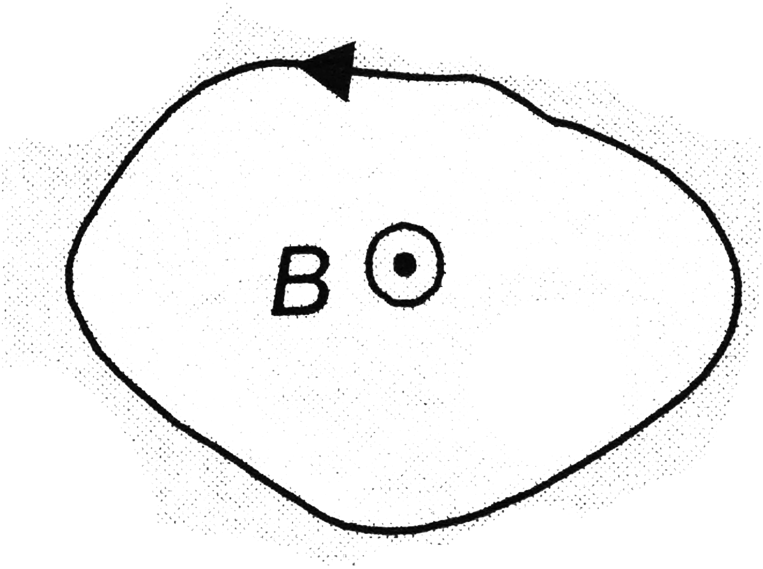
34. A loop of flexible conducting wire of length 0.5 m lies in a magnetic field of 1.0 T perpendicular to the plane of the loop. Show that when a current as shown in Fig. 1.112 is passed through the loop, it opens into a circle. Also calculate the tension developed in the wire if the current is

1.57 A.



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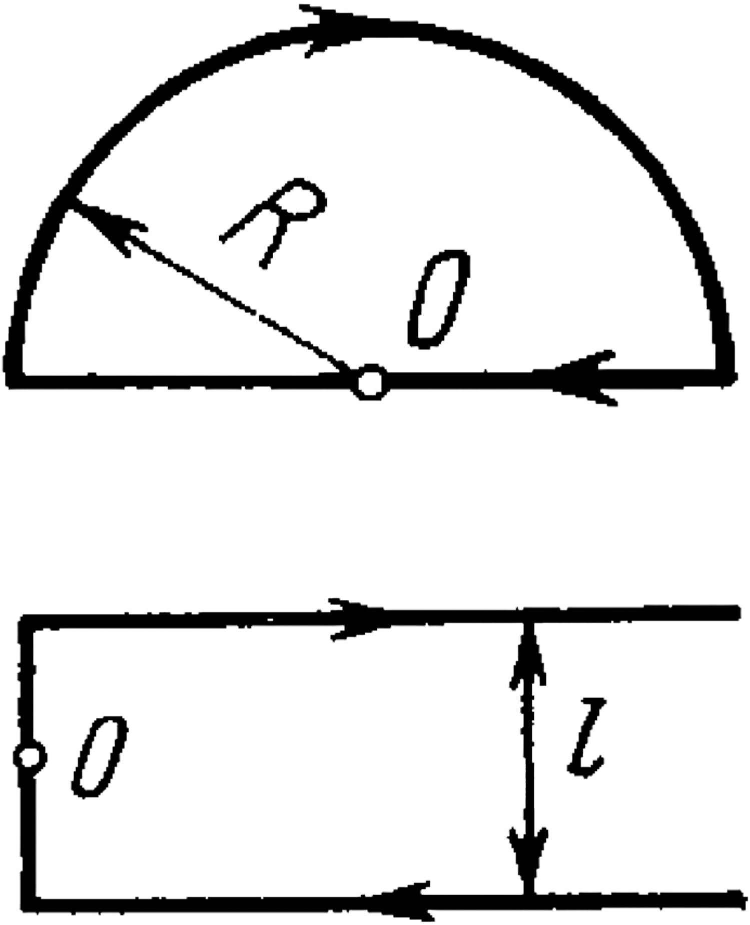
35. Find the magtiude and direction of a force vector acting on a unit length of a thin wire, carrying a current $I = 8.0A$, at a point O. If the wire is hent as shown in (a) Fig with curvature radius $R = 10cm$

(b) Fig the distance between the long parallel segments of the wire being equal to $l = 20cm$.



(b)

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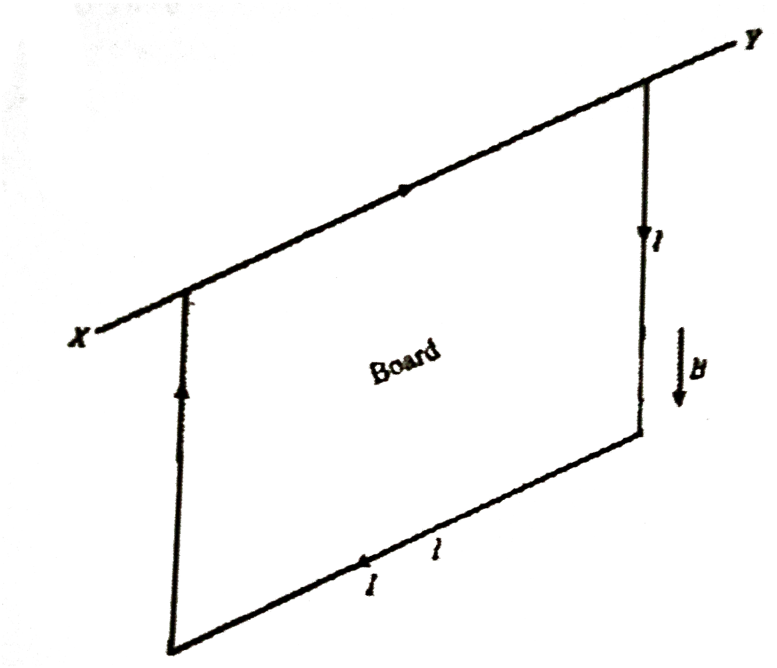
36. A square cardboard of side l and mass m is suspended from a horizontal axis XY as shown in figure. A single wire is wound along the periphery of board and carrying a clockwise current I. At t = 0, a vertical downward magnetic field of induction B is switched on. Find the minimum magnitude of B so that the board will be able to rotate up to horizontal level.



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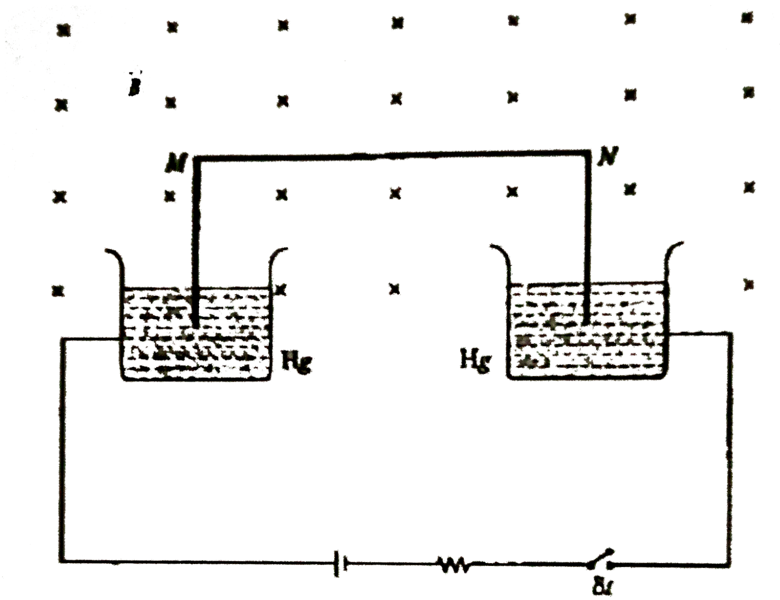
37. Figure shows a horizontal wire MN of length l and mass mis placed in a magnetic field B. The ends of wire are bent and dipped in two bowls containing Hg which are connected to an external circuit as shown. If key is pressed for a short time δt.due to which a charge q suddenly flows in the circuit. Find the maximum height above initial level the wire MN, it will jump.



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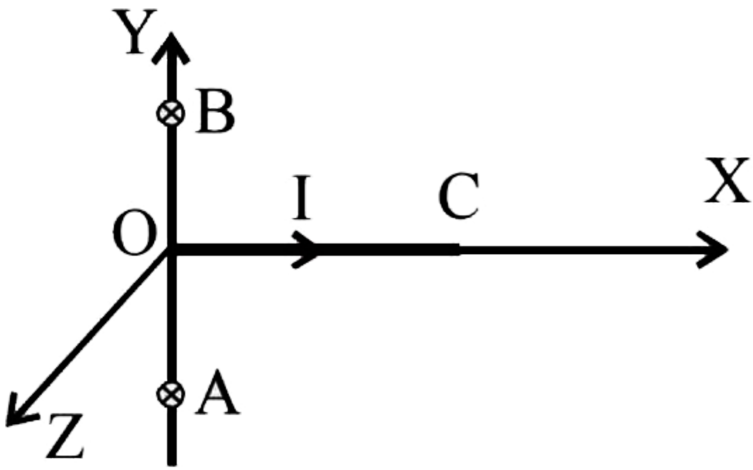
38. A straight segment OC(of length L meter) of a circuit carrying a current $Iamp$ is placed along the $x - a\xi s$ (fig.). Two infinetely long straight wires A and B , each extending from $z = -\infty \to +\infty$, are fixed at $y = -ameter$ and $y = +ameter$ respectively, as shown in the figure.

If the wires A and B each carry a current $Iamp$ into the plane of the paper, obtain the expression for the force acting on the segment OC. What will be the force on OC if the current in the wire B is reversed?



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39. A positively charged particle having charge $q_1 = 1C$ and mass $m_1 = 40gm$ is revolving along a circle of radius $R = 40cm$ with velocity $v_1 = 5ms^{-1}$ in a uniform magnetic field with center of circle at origin O of a three-dimensional system. At $t = 0$, the particle was at (0, 0.4m, 0) and velocity was directed along positive x direction. Another particle having charge $q_2 = 1C$ and mass $m_2 = 10g$ moving uniformly parallel to positive z-direction with velocity $v_2 = 40/\pi ms^{-1}$ collides with revolving particle at $t = 0$ and gets stuck to it. Neglecting gravitational force and coulomb force, calculate x-, y- and z-coordinates of the combined particle at $t = \pi/40s$.

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40. From the surface of a round wire of radius a carrying a direct current i, a positive charge q escapes with a velocity v_0 perpendicular to the surface. Find what the maximum distance of the electron will be from the axis of the wire before it turns back due to the action of the magnetic field generated by the current.

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41. In the Bohr model of the hydrogen atom, the electron circuulates around the nucleus in a path of radius $5 \times 10^{-11} m$ at a frequency of $6.8 \times 10^{15} Hz$.

a. What value of magnetic field is set up at the centre of the orbit?

b. What is the equivalent magnetic dipole moment?

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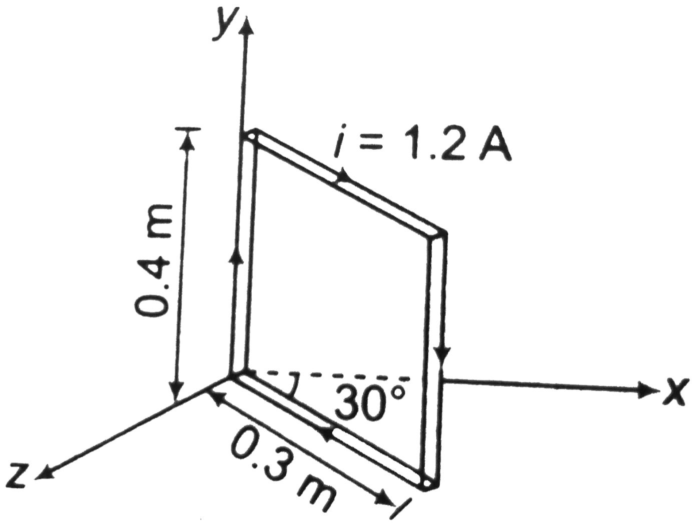
42. A rectangular loop consists of $N = 100$ closed wrapped turns and has dimensions $(0.4m \times 0.3m)$. The loop is hinged along the y-axis and its plane makes an angle $\theta = 30^\circ$ with the x-axis. What is the magnitude of the torque exerted on the loop by a uniform magnetic field $B = 0.8T$ directed along the x-axis when current is $i = 1.2A$ in the direction shown. What is the expected direction of rotation of the loop?



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43. 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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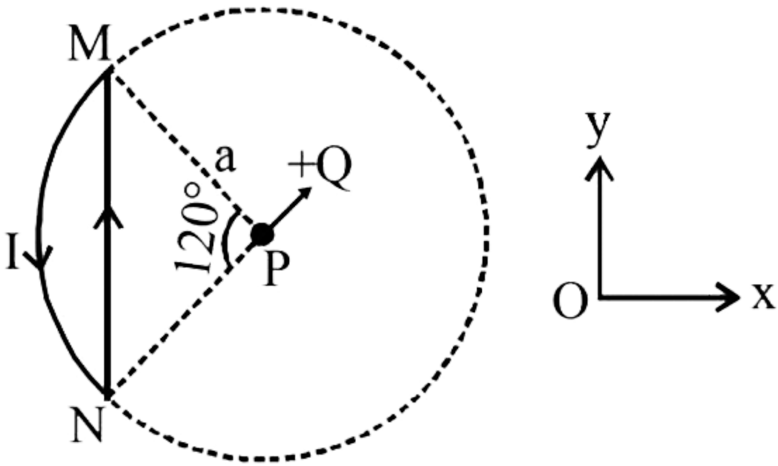
44. A wire loop carrying I is placed in the $x-y$plane as shown in fig.

(a) If a particle with charge $+Q$ and mass m is placed at the centre P and given a velocity $\vec{v}$ along NP(see figure), find its instantaneous acceleration.

(b) If an external uniform magnetic induction field $\vec{B}=B\hat{i}$ is applied , find the force and the torque acting on the loop due to this field.



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45. A coil of radius R carries current i_1. Another concentric coil of radius $r(r < < R)$ carries current i_2. Planes of two coils are mutually perpendicular and both the coil are free to rotate about common diametre. Find maximum kinetic energy of smaller coil when both the coils are released, masses of coils are M and m, respectively.

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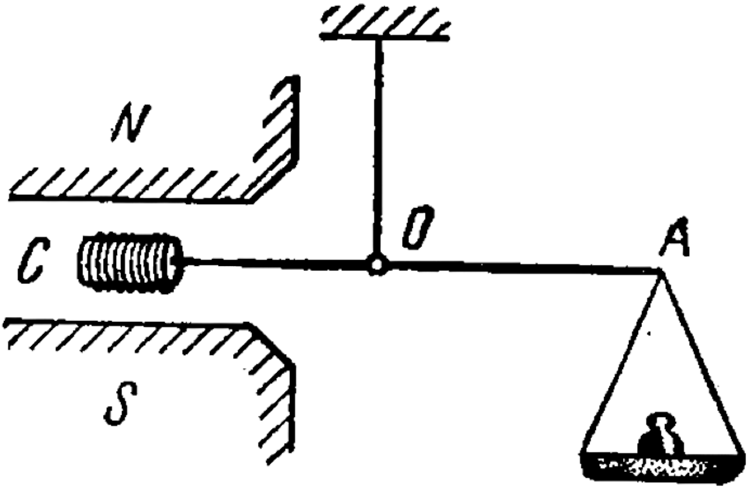
46. A small coil C with N = 200 turns is mounted on one end of a balance beam and introduced between the poles of an electromagnet as shown in Fig. The cross sectinal area of the coil is $S = 1.0 cm^2$, the length of the arm OA of the balance beam is $l = 30 cm$. When there is no current in the coil the balance is irl equilibrium. On passing a current $I = 22 mA$ through the coil the equiibrium is restroed by putting the additional counterweight of mass $\Delta m = 60 mg$ ont he balnace pan. Find the magnetic induction at the spot where the coil is located.



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47. 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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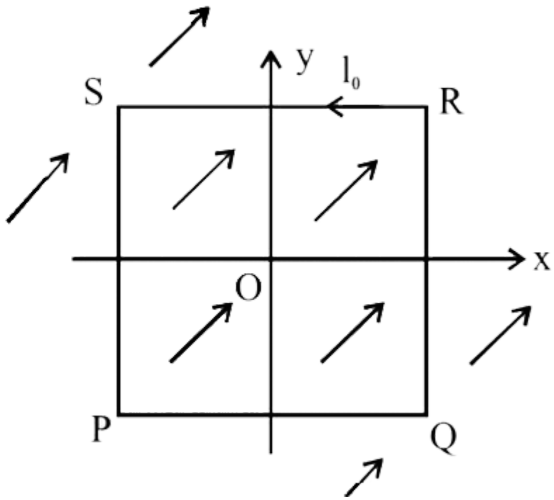
(4)/(3) ML^(2)`.



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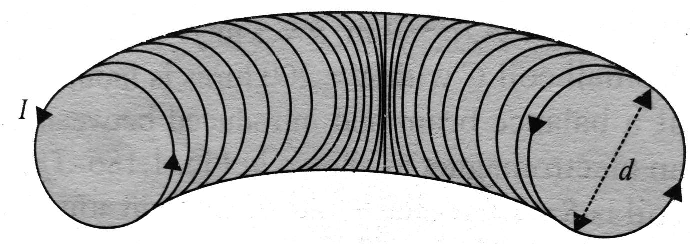
48. Calculating the magnetic moment (in Am^2) of a thin wire with a current I=8A, wound tightlly on a half a tore (see figure). The diameter of the cross section of the tore is equal to d=5cm, and the number of turns is N=500.



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49. A flat circular coil with 10 turns of wire on it has a diameter 20mm and carries a current 0.5A. It is mounted inside a long solenoid that has 200 turns and the length of the solenoid is 0.25m. The current passing through the solenoid is 2.4A. Calculate the torque needed to hold the coil with its axis perpendicular to that of solenoid.

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50. A coil al a moving Coil galvanometer twists through 90° when a current of one microampere is passed through it. If the area of the coil is

$10^{-4}m^2$ and it has 100 turns, calculate the magnetic field of the magnet of the galvanometer. Given, $k = 10^{-8}N - \frac{m}{d}egree.$

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51. A short bar magnet is placed in magnetic meridian with its north pole pointing toward south: Its magnetic moment is $2Am^2$. Neutral point is obtained 10cm from centre of magnet toward north. Calculate horizontal component of earth's magnetic field.

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52. A magnetic dipole of magnetic moment $6Am^2$ is lying in a horizontal plane with its north pole pointing toward 60° East of North. Find the net horizontal magnetic field at a point· on the axis of the magnet 0.2m away from it. Horizontal Component of earth field at this place is $30\mu T$.

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53. A coil of 50 turns and 10cm diameter is made out of a wire of resistivity $2 \times 10^{-6} \Omega cm$ and cross sectional radius 0.1mm. The coil is connected to a source of EMF $10V$ and of negligible internal resistance.

(a) Find the current through the coil

(b) What must be potential difference across the coil so as to nullify the horizontal component of earth's magnetic field, $0.314 \times 10^{-4} T$ at the centre of the coil. How should the coil be placed to achieve. this result?

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54. Two circular coils C_1 and C_2 each of 100 turns are held in such a way that C_1 lies in vertical plane and the other C_2 in the horizontal plane, with their centres coinciding. The radii of the coils are $r_1 = 20cm$ and $r_2 = 30cm$. The directions of currents I_1 and I_2 passed through the two coils are such that earth's magnetic field at the common centre is neutralised completely. If $H = 27 \cdot 8Am^{-1}$ and angle of dip is 30°. Calculate the values of I_1 and I_2.

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55. A magnetic needle suspended in a vertical plane at 30° from the magnetic meridian makes an angle of 45° with the horizontal. Find the true angle of dip.

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56. Two small magnets of magnetic moments $0.108Am^2$ and $0.192Am^2$ are placed at some separation that their axes are mutually perpendicular. If the distance of the point of intersection of axes of magnets be respectively 30 cm and 40 cm from these magnets, then find the resultant magnetic induction at the point of intersection. The magnetic moments of both the magnets are pointing toward the point of intersection of their axes.

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57. A short magnet porduces a deflection of 30° when placed at certain distance in tanA position of magnetometer. If another short magnet of double the length and thrice the pole strength is placed at the same distance in tan B position of the magnetometer, the deflection produced will be-

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58. A magnetic needle performs 20 oscillations per minute in a horizontal plane. If the angle of dip be 30°, then how many oscillation per minute will this needle perform in vertical, north south plane and in vertical east - west plane?

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Discussion Question

1. A magnet is kept fixed with its length parallel to the magnetic meridian. An identical magnet is parallel to this such that its center lies on perpendicular bisector of both. If the second magnet is free to move, it will have

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2. Does Ampere's law on a closed loop in a region is valid if no current is enclosed by the loop and there are some currents which exist outside the loop.

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3. The electric current in a straight wire is constant and wire is kept along east-west line at a point in a horizontal plane. A point P is located to the north side of wire at some distance. What is the direction of magnetic induction at point P. If the wire is rotated in horizontal plane hy an angle 30° then what will be the direction at point P.

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4. Can a charged particle be accelerated by a magnetic field? Can its speed be increased?

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5. Torques τ_1 and τ_2 are required for a magnetic needle to remain perpendicular to the magnetic fields at two different places. The magnetic field at those places are B1 and B2 respectively, then $\frac{B_1}{B_2}$ is

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6. If a wire carries a time varying current then in its surrounding will Ampere's law be valid for a closed loop.

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7. 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.

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8. Assertion: If a compass needle be kept at magnetic north pole of the earth, the compass needle may stay in way direction.

Reason: Dip needle will stay vertical at the north pole of earth.

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9. A current carrying wire is placed along the axis of a uniformly charged circular ring. If the ring starts rotating about its central axis what will be force on the current carrying wire due to the moving charges of ring.

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10. An isolated metal wire not carrying any current is placed in magnetic field. Does free electrons of this metal wire experience magnetic force due to thermal motion. If yes what is the effect of it.

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11. At a particular place, horizontal and vertical components of earth's magnetic field are equal. The angle of dip at that place is............... .

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12. In different electrical circuit generally connecting lead wires are twisted together in electrical appliances. Why this is done?

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13. For a three dimensional current carrying loop is it possible that in a magnetic field net torque on it is zero for some orientation? Explain the situation.

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14. What is the maximum value of angle of dip?

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15. An iron needles is attracted to the ends of a bar magnet but not to the middle region of the magnet. Is the material making up the ends of a bar magnet different from that of the middle region?

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16. Two wires carrying equal currents i each, are placed perpendicular to each other, just avoiding a contact. If one wire is held fixed and the other is free to move under magnetic forces, what kind of motion wil results?

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17. Cosmic rays are charged particles that strike out atmosphere from some external source. We find that more low-energy cosmic rays reach the earth at the north and south magnetic poles than at the (magnetic) equator. Why it is so?

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18. Can you calculate magnetic induction due to a semi-infinite current carrying straight wire. Ifnot then explain why?

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19. Two bar magnets are placed close to each other with their opposite poles facing each other. In absence of other forces, the magnets are pulled towards each other and their kinetc energy increases. Does it contradict our earlier knowledge that magnetic forces cannot do any work and hence cannot increase kinetic energy of a system?

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20. Is there any point on earth surface where dip angle is 90°? If yes how many such points are there.

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21. Two proton beams going in the same direction repel each other whereas two wires carrying currents in the same direction attract each other. Explain.

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22. Suppose a charged particle moves with a velocity v near a wire carrying an electric current. A magenetic force, therefore, acts on it. If the same particle is seen form a frame moving with velocity v in the same direction the charge will be found at rest. Will the magnetic force become zero in this frame? Will the magnetic field become zero in this frame?

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23. The neutron, which has no charge, has a magnetic dipole moment. Is this possible?

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Conceptual MCQ

1. A uniform magnetic field acts right angles to the direction of motion of electrons. As a result, the electron moves in a circular path of radius 2 cm.

If the speed of electrons is doubled, then the radius of the circular path will be

A. 0.5 cm

B. 2.5 cm

C. 5.0 cm

D. 7.5 cm

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2. A current is passed through a straight wire bent at a point. The magnetic field established around it has its lines offorces :

A. Circular and endless

B. Oval in shape and endless

C. Straight

D. All are true

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3. A charged particle moves in a circular path in a uniform magnetic field. If its speed is reduced, then its tiem period will

A. Increase

B. Decrease

C. Remain same

D. None of these

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4. An electron of mass m_e initially at rest moves through a certain distance in a uniform electric field in time t_1. A proton of mass m_p also initially at rest takes time t_2 to move through an equal distance in this uniform electric field.Neglecting the effect of gravity, the ratio of t_2 / t_1 is nearly equal to

A. 1

B. $(m_p / m_e)^{1/2}$

C. $(m_e / m_p)^{1/2}$

D. 1836

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5. A proton, a deuteron and an α- particle having the same kinetic energy are moving in circular trajectors in a constant magnetic field. If r_p, r_d and r_α denote respectively the radii of the trajectories of these particles then

A. $r_\alpha = r_p < r_d$

B. $r_\alpha > r_d > r_p$

C. $r_\alpha = r_d > r_p$

D. $r_p = r_d = r_\alpha$

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6. Identify the correct sttement related to the direction of magnetic moment of a planar loop.

A. It is always perpendicular to the plane of the loop

B. It depends on the direction of current

C. It can be obtained by right hand screw rule

D. All of the above

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7. Two free paralell wires carrying currents in opposite direction

A. Attract each other

B. Repel each other

C. Do not affect each other

D. Get rotated to be perpendicular to each other

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8. A non planar closed loop of arbitrary shape carryign a current I is placed in uniform magnetic field. The force acting on the loop

A. Is zero only for one orientation ofloop in magnetic field

B. Is zero for two symmetrically located positions ofloop in magnetic field

C. Is zero for all orientations

D. Is never zero

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9. A vertical straight conductor carries a current vertically upwards. A point P lies to the east of it at a small distance and another point Q lies to the west at the same distance. The magnetic field at P is

A. Greater than at Q

B. Same as at Q

C. Less than at Q

D. Greater or less than at Q depending upon the strength of the current

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10. A wire is placed parallel to the lines of force in a magnetic field and a current flows in the wire. Then :

A. The wire will experience a force in the direction of the magnetic field

B. The wire will not. experience any force at all

C. The wire will experience a force in a direction opposite to the field

D. It experiences a force in a direction perpendicular to lines of force

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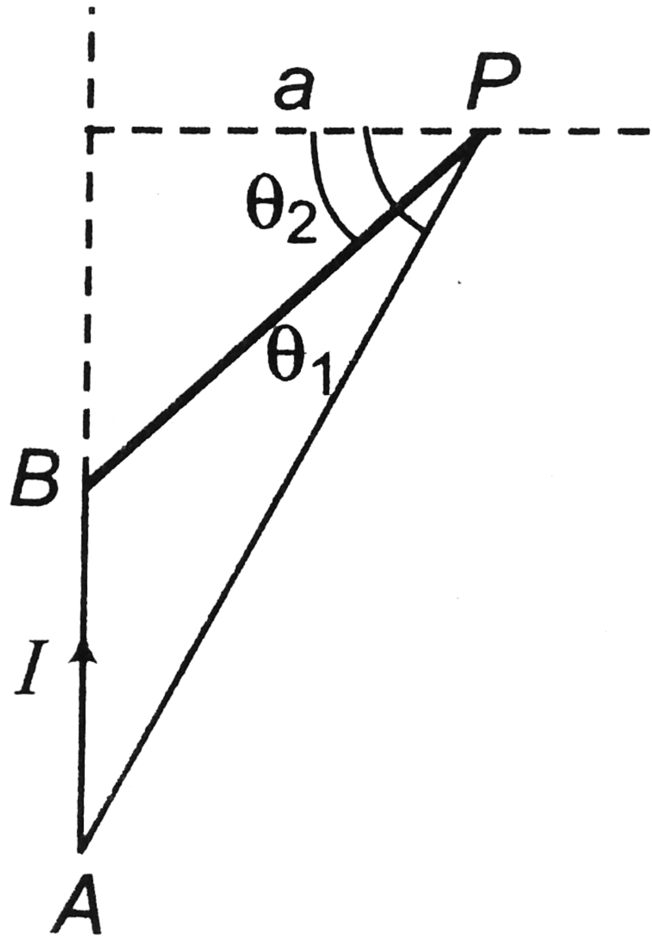
11. The straight wire AB carries a current I. The ends of the wire subtend angles θ_1 and θ_2 at the point P as shown in figure. The magnetic field at the point P is



A. $\frac{\mu_0 I}{4\pi a}(\sin\theta_1 - \sin\theta_2)$

B. $\frac{\mu_0 I}{4\pi a}(\sin\theta_1 + \sin\theta_2)$

C. $\frac{\mu_0 I}{4\pi a}(\cos\theta_1 - \cos\theta_2)$

D. $\frac{\mu_0 I}{4\pi a}(\cos\theta_1 + \cos\theta_2)$

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12. Before using tangent galvanometer for the measurement of current, why is the plane of coil of tangent galvanometer set in the magnetic meridian?

A. To avoid the magnetic effect of the earth field

B. To produce intense magnetic field at the centre of the coil

C. To produce a field at right angle to the earth's field

D. To avoid error due to parallax

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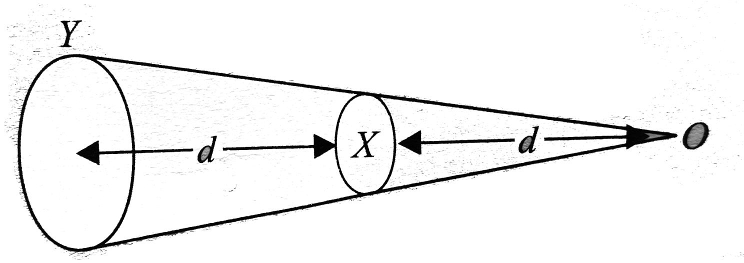
13. Two circular coils X and Y, having equal number of turns and carrying currents in the same sense, subtend same solid angle at point O. If the smaller coil X is midway between O and Y and if we represent the magnetic induction due to bigger coil Y at O as B_y and the due to smaller coil X at O as B_x,then find the ratio B_x / B_y.



A. $\frac{B_y}{B_x} = 0.25$

B. $\frac{B_y}{B_x} = 0.5$

C. $\frac{B_y}{B_x} = 1$

D. $\frac{B_y}{B_x} = 2$

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14. Two parallel wires carrying current in the same direction attract each other while two beams of electrons travelling in the same direction repel each other. Why?

A. Potential difference between them

B. Mutual inductance between them

C. Electric forces between them

D. Magnetic forces between them

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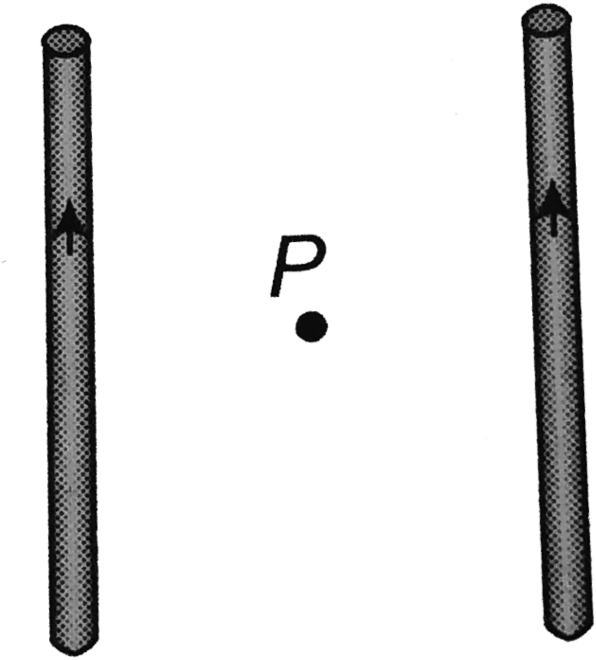
15. Two long straight wires are set parallel to each other. Each carriers a current i in the same direction and the separation between them is $2r$.

The intensity of the magnetic field midway between them is



A. i / r

B. $2i / r$

C. $4i / r$

D. Zero

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16. The magnetic field ofa U-magnet is parallel to the surface of this paper with the N-pole on the left side. A conductor is placed in the field so that it is perpendicular to this page. When a current flows through the conductor out of the paper, it will tend to move :

A. Downward

B. Upward

C. To the right

D. First downward and then upward

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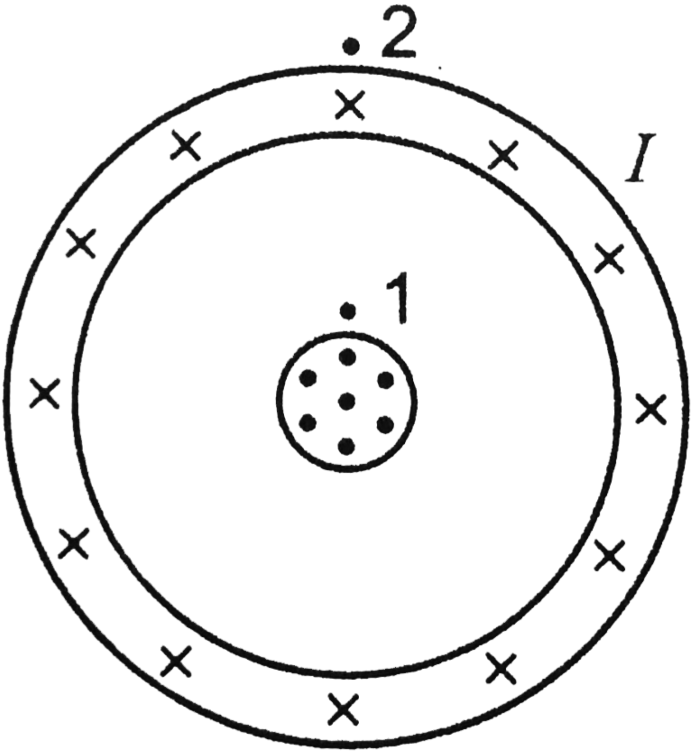
17. The figure shows the cross section of two long coaxial tubes carrying equal current I in opposites directions. If B_1 and B_2 are magnetic fields at point 1 and 2 as shown in figure then



A. $B_1 \neq 0, B_2 = 0$

B. $B_1 = 0, B_2 = 0$

C. $B_1 \neq 0, B_2 \neq 0$

D. $B_1 = 0, B_2 \neq 0$

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18. 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. $\frac{\pi q f l^2}{12}$

B. $\frac{\pi q f l^2}{2}$

C. $\frac{\pi q f l^2}{6}$

D. $\frac{\pi q f l^2}{3}$

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19. The strength of the magnetic field around a long straight current carrying conductor :

A. Is same everywhere around the conductor

B. Obeys inverse square law

C. Is directlyproportional to the square of the distance from the cnductor

D. None of the above

Answer: D

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20. The plane of dip circle is set in the geographic meridian and the apparent dip is θ_1. It is then set in a vertical plane perpendicular to the geographic meridian. Now, the apparent dip is θ_2. The angle of declination θ at that place is

A. $\tan\alpha = \sqrt{(\tan\theta_1 \tan\theta_2)}$

B. $\tan\alpha = \tan\theta_1 / \tan\theta_2$

C. $\tan\alpha = (\tan^2\theta_1 + \tan^2\theta_2)$

D. $\tan\alpha = \tan\theta_2 / \tan\theta_1$

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21. A moving coil type of galvanometer is based upon the principle that

A. Wire carrying a current experiences a force in magnetic field

B. Wire carrying current produces a force in magnetic field

C. A current carrying loop in magnetic field experiences a torque

D. All are true

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22. A charge moving with velocity v in X-direction is subjected to a field of magnetic induction in the negative X-direction. As a result, the charge will

A. Remain uneffected

B. Start moving in a circular path Y-Z plane

C. Retard along X-axis

D. Moving along a helical path around X-axis

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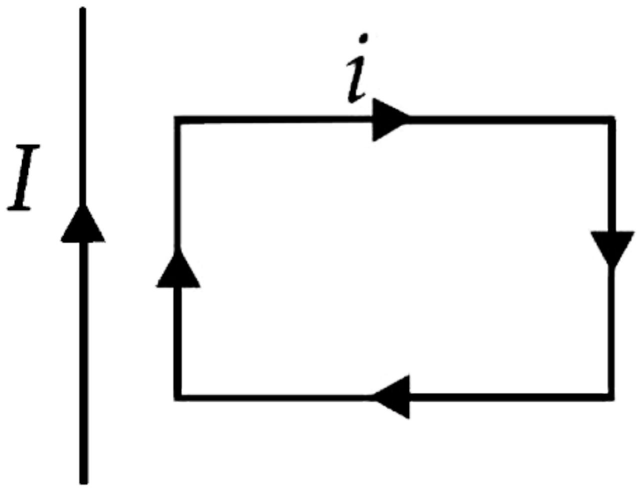
23. A rectangular loop carrying a current i is situated near a long straight wire such that the wire is parallel to one of the sides of the loop and is in the plane of the loop . If steady current I is established in the wire as shown in the figure ,



A. Rotate about an axis parallel to the wire

B. Move away from the wire

C. Move towards the wire

D. Remain stationary

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24. An electron enters a region where magnetic field (B) and electric field (E) are mutually perpendicular, then

A. it will always move in the direction of B

B. it will always move in the direction of E

C. It always possess circular motion

D. It can go undeflected

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25. A length of wire carries a steady current. It is first bent to form a circular coil of one turn. The same length is now bent more sharply to give a loop of two turns of smaller radius. The magentic field at the centre caused by the same current now will be

A. Quarter ofits first value

B. Unaltered

C. Four times ofits first value

D. A halfofits first value

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26. A protn and an alpha particle enter into a uniform magnetic field with the same velocity. The period of rotation of the alpha particle will be

A. Four times that of the proton

B. Two times that of the proton

C. Three times that of the proton

D. Same as that of the proton

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27. 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

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28. A charged particle moves through a magnetic field perpendicular to its direction. Then

A. Both momentum and energy of the particle change

B. The momentum changes but the energy is constant

C. Both momentum and energy are constant

D. The momentum remains constant and energy is changed

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29. A uniform electric field and a uniform magneitc field exist in a region in the same direction An electron is projected with velocity pointed in the same direction the electron will

A. The electron will tum to its right

B. The electron will turn to its left

C. Toe electron velocity will increase in magnitude

D. The electron velocitywill decrease in magnitude

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30. Two circular coils P and Q are made from similar wire but radius of Q is twice that of P. Relation between the values of potential difference across them so that the magnetic induction at their centers may be the same is

A. $V_q = 2V_p$

B. $V_q = 3V_P$

C. $V_q = 4V_P$

D. $V_q = 1/4V_P$

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31. 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 alpha-particle will be bent in a circular path with a smaller radius that of the proton

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

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

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

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32. A circular coil has one tum and carries a current i. The same wire is wound into a smaller coil of 4 turns and the same current is passed through it. The field at the centre :

A. Decreases to 1/4 of the value

B. Is the same

C. Increases to 14 times the value

D. Increases to 16 times the value

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33. Two electrons move parallel to each other with equal speed $'V'$ the ratio of magnetic $\&$ electric force between them is

A. v/c

B. c/v

C. v^2 / c^2

D. c^2 / v^2

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34. An electron moving with a uniform velocity along the positive x-direction enters a magnetic field directed along the positive y-direction. The force on the electron is directed along

A. Positive direction of Y-axis

B. Negative direction of Y-axis

C. Positive direction of Z-axis.

D. Negative direction of Z-axis

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35. A charged particle moving in a uniform magnetic field penetrates a layer of lead and thereby loses one half of its kinetic energy. How does the time period of revolution of particle change.

A. Twice the original radius

B. $\sqrt{2}$ times the original radius

C. Half the original radius

D. $(1/\sqrt{2})$ times the original radius

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36. Protons are shot in a region perpendicular to a uniform magnetic field in a region :

A. Magnetic field will have no influence on the motion of protons

B. Protons will continue to move in the same direction but will gain momentum

C. Protons will continue to move in the opposite directions but will gain momentum

D. They will bend in an arc ofcircle

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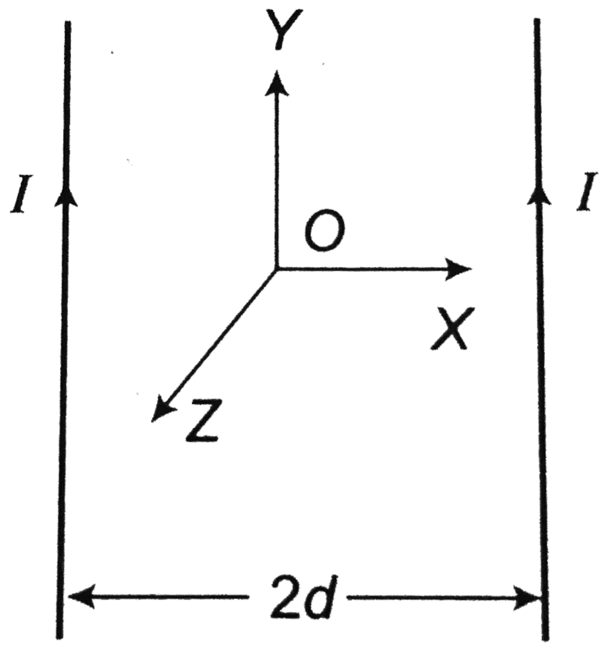
37. In fig. two long parallel wires carry equal currents in opposite directions. Point O is situated midway between the wires and $X-Y$ plane contains the two wires and the position Z-axis comes normally out of the plane of paper. The magnetic field B at O is non-zero along



A. X, Y and Z axes

B. X-axis

C. Y-axis

D. Z-axis

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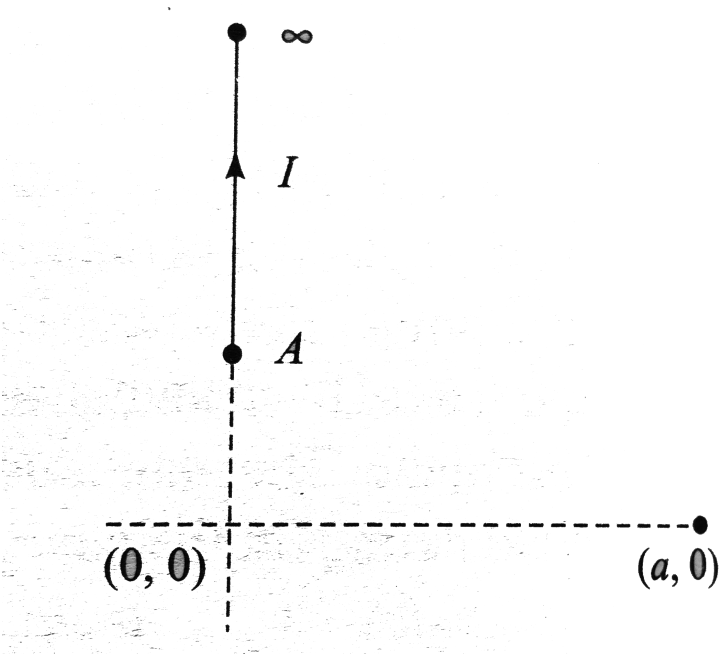
Numerical MCQ

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



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

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

C. $\frac{\mu_0 l}{4\pi a}\left(\frac{b}{\sqrt{a^2+b^2}}\right)$

D. None of these

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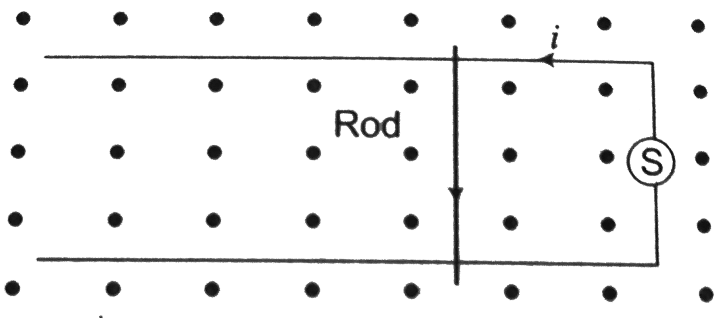
2. A conducting rod of mass $50gm$ and length $10cm$ can slide without friction on two long, horizontal rails. A uniform magnetic field of magnitude $5mT$ exists in the region as shown. A source S is used to maintain a constant current $2A$ through the rod. If motion of the rod starts from the rest, its speed after $10s$ from the start of the motion will be



A. 2cm/s

B. 8cm/s

C. 12cm/s

D. 20cm/s

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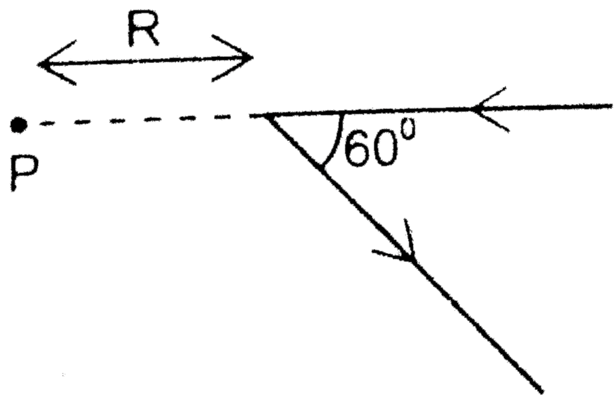

3.

A long stragith wire, carrying a current I is bent at its mid point to form an angle 60^0. AT a point P, distance R from the point of bending the magnetic field is

A. $\dfrac{\left(\sqrt{2}-12\right)\mu_0 l}{4\pi R}$

B. $\dfrac{\left(\sqrt{2}+1\right)\mu_0 l}{4\pi R}$

C. $\dfrac{\left(\sqrt{2}+1\right)\mu_0 l}{4\sqrt{2}\pi R}$

D. $\dfrac{\left(\sqrt{2}-1\right)\mu_0 l}{2\sqrt{2\pi R}}$

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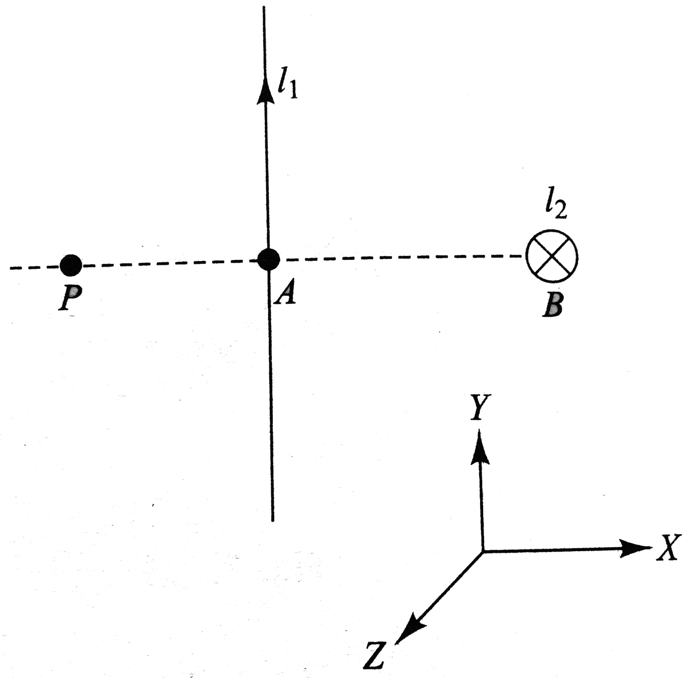
4. Two infinitely long linear conductors are arranged perpendicular to each other and are in mutually perpendicular planes as shown in Fig. If $I_1 = 2A$ along the y-axis, $I_2 = 3A$, along -ve z-axis and AP=AB=1cm, the value of magnetic field strength $\overrightarrow{B}$ at P is



A. $(3 \times 10^{-5} T)\hat{j} + (-4 \times 10^{-5} T)\hat{k}$

B. $(3 \times 10^{-5} T)\hat{j} + (4 \times 10^{-5} T)\hat{k}$

C. $(4 \times 10^{-5} T)\hat{j} + (3 \times 10^{-5} T)\hat{k}$

D. $(-3 \times 10^{-5} T)\hat{j} + (4 \times 10^{-5} T)\hat{k}$

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

A. $5\hat{k}-10\hat{j}$ units

B. $-6\hat{j}k-9\hat{j}$ units

C. $-6\hat{k}+8\hat{j}$ units

D. $6\hat{k}+8\hat{j}$ units

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6. If the magnetic induction at a point on the axis of current coil is half of that at the centre of the coil, then the distance of that point from the centre of the coil is :

A. $\frac{R}{2}$

B. R

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

D. 0.766R

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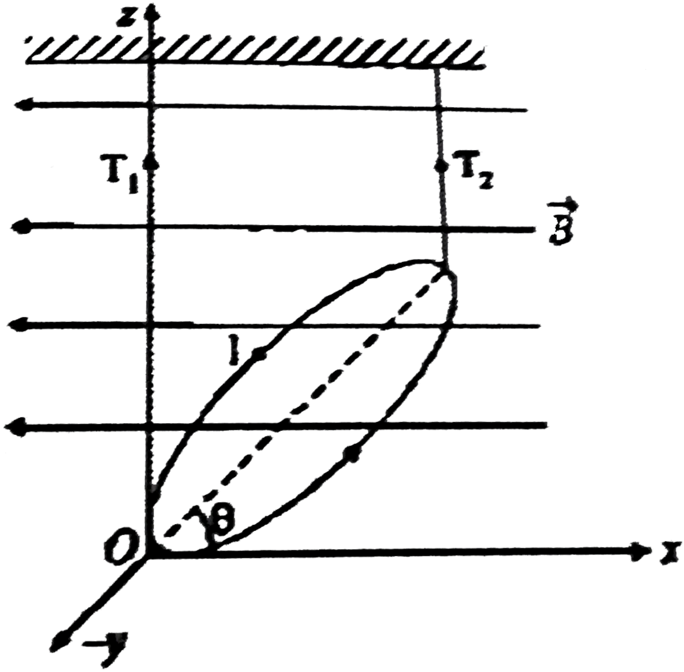
7. A current carrying circular coil of single tum of mass mis hanged by two ideal strings as shown in the figure-4.214. A constant magnetic field $\overrightarrow{V}$ is set up in the horizontal direction in the region. The ratio of tension (T_1/T_2) in the string will be: [Take $\pi BIR = \frac{mg}{4}$ and $\theta = 45^\circ$ in the figure shown]



A. $2:1$

B. $5:3$

C. $4:1$

D. $1:2$

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8. A helium nucleus is moving in a circular path of radius 0.8m. If it takes 2s to complete one revolution. Find out magnetic field produced at the centre of the circle:

A. $\mu_0 \times 10^{-19} T$

B. $\frac{10^{-19}}{\mu_0} T$

C. $2 \times 10^{-19} T$

D. $\frac{2 \times 10^{-19}}{\mu_0} T$

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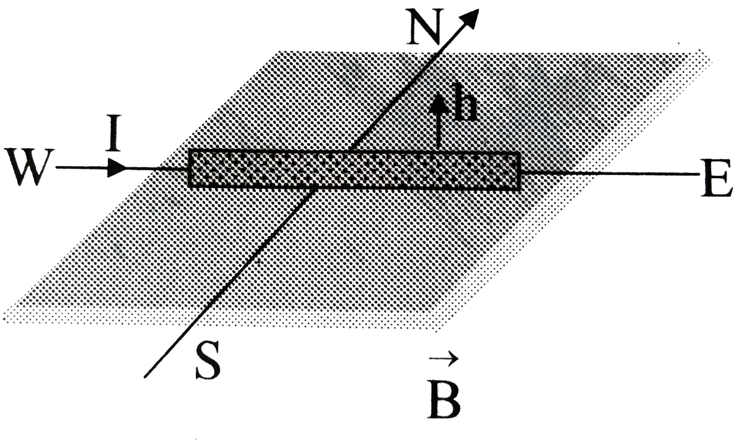
9. A conductor of length l is placed in E - W direction on a plane. Earth's horizontal magnetic field is B. The amount of charge passed through it when it is found to jump to a hight h is



A. $\dfrac{1}{Bmgh}$

B. $\dfrac{\sqrt{2gh}}{Blm}$

C. $\dfrac{gh}{Blm}$

D. $\dfrac{m\sqrt{2gh}}{Bl}$

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10. An α is moving along a circle of radius R with a constant angular velocity ω. Point A lies in the same plane at a distance 2R from the centre.

Point A records magnetic field produced by the α-particle. If the minimum time interval between two successive time at which A records zero magnetic field is t, the angular speed ω, in terms of t, is

A. $\frac{\pi}{t}$

B. $\frac{2\pi}{3t}$

C. $\frac{\pi}{3t}$

D. $\frac{\pi}{t}$

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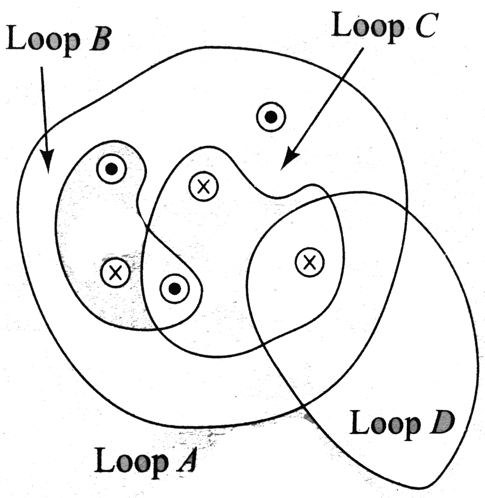
11. Consider six wires coming into or out of the page, all with the same current. Rank the line integral of the magnetic field (from most positive to most negative) taken counterclockwise around each loop shown



A. $B > C > D > A$

B. $B > C = D > A$

C. $B > A > C = D$

D. $C > B = D > A$

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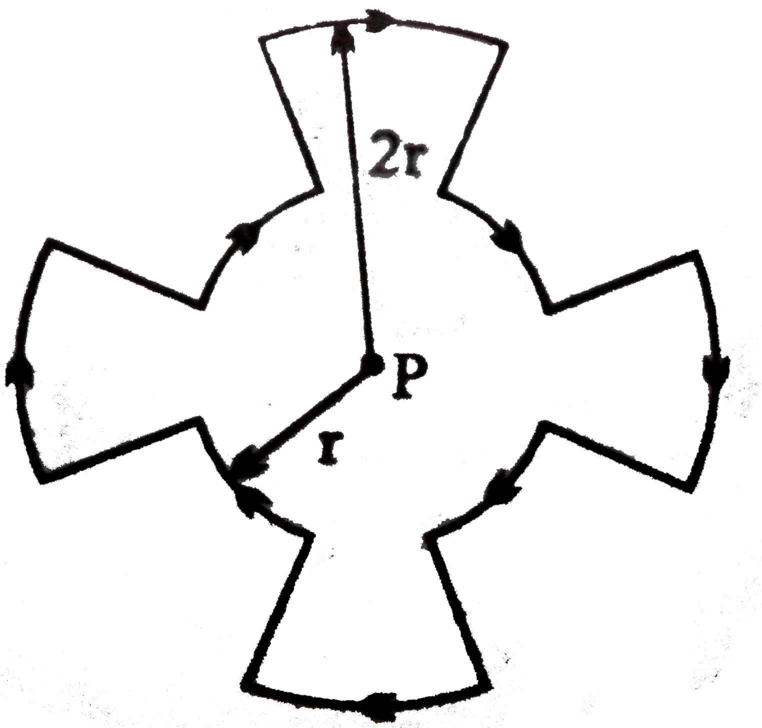
12. A current I flows around a closed path in the horizontal plane of circle as shown in the figure The path consists of eight arcs with alternating radii r and $2r$. Each segment of arc subtends equal angle at the common centre P The magnetic field produced by current path at point P is



A. $\frac{3}{8}\frac{\mu_0 I}{r}$: perpendicular to the plane of the paper and directed inward.

B. $\frac{1}{8}\frac{\mu_0 I}{r}$, perpendicular to the plane of the paper and directed outward.

C. $\frac{1}{8}\frac{\mu_0 I}{r}$: perpendicular to the plane of the paper and directed inward.

D. $\frac{3}{8}\frac{\mu_0 I}{r}$ perpendicular to the plane of the paper and directed outward

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13. A charged particle of specific charge (Charge/mass) α is released from origin at time t=0 with a velocity given as

$\overrightarrow{v} = v_0\left(\hat{i} + \hat{j}\right)$

The magnetic field in region is uniform with magnetic induction $\overrightarrow{B} = B_0\hat{i}$. Coordinates 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. $\left(\frac{V_0\pi}{B_0\alpha}, 0, \frac{-2V_0}{B_0\alpha}\right)$

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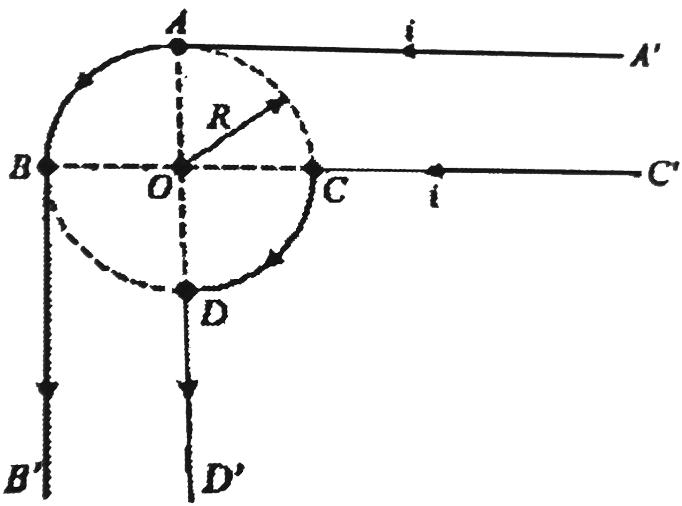
14. The configuration of some current carrying wires is shown in figure-4.217. All straight wires are very long. Both AB and CD are arcs of the same circle, both subtending right angles at the centre 0. The magnetic field at O is:



A. $\frac{\mu_0 l}{4\pi R}$

B. $\frac{\mu_0 i}{4\pi R}\sqrt{2}$

C. $\frac{\mu_0 i}{2\pi R}$

D. $\frac{\mu_0 i}{2\pi R}(\pi + 1)$

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15. A current i in a circular loop of radius b produces a magnetic field. At a fixed point fur from the loop on its axis the magnetic field is proportional to which of the following combinations of i and b ?

A. ib

B. ib^2

C. $i^2 b$

D. i / b^2

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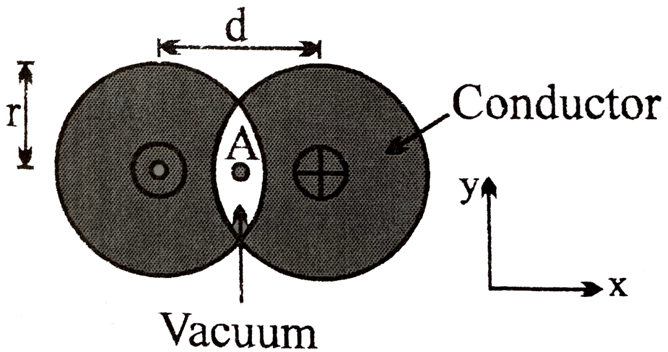
16. Two long conductors are arranged as shown above to form overlapping cylinders, each of raidus r, whose centers are separated by a distance d Current of density j flows into the plane of the page along the shaded part of one condutor and an equal current flows out of the plane of the page along the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



A. $\left(\frac{\mu_0}{2\pi}\right)\pi dj$, in the +y direction

B. $\left(\frac{\mu_0}{2\pi}\right)\frac{d^2}{r}$, in the +y direction

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

D. $\left(\frac{\mu_0}{2\pi}\right)\frac{Jr^2}{d}$, in the -Y-direction

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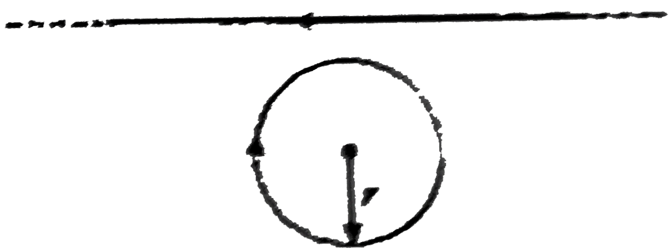
17. The radius of a coil of wire with N turns is 0.22m, and 3.5Acurrent flows clockwise in the coil as shown.Along straight wire carrying a current 54A toward the left is located 0.05 m from the edge of the coil. The magnetic field at the centre of the coil is zero tesla. The number of turns Nin the coil are:



A. 4

B. 6

C. 7

D. 8

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18. Two protons parallel to each other, keeping distane r between them, both moving with same velocity $\overrightarrow{V}$ Then the ratio of the electric is magnetic force of interaction between them is .

A. $\frac{C_0^z}{v^2}$

B. $\frac{V^2}{c_0^2}$

C. $\frac{c_0}{v}$

D. $\frac{v}{c_0}$

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19. A neutral atom of atomic mass number I 00 which is stationary at the origin in gravity free space emits an a-particle (A) in z-direction. The product ion is P. A uniform magnetic field exists in the x-direction. Disregard the electromagnetic interaction between A and P. If the angle ofrotation of A after which A and P will meet for the first time is $\frac{n\pi}{25}$ radians, what is the value of n?

A. 12

B. 24

C. 36

D. 48

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20. If the ratio of time periods of circular motion of two charged particles in magnetic field in $1/2$, then the ratio of their kinetic energies must be :

A. $1:\sqrt{2}$

B. $\sqrt{2}:1$

C. $2:1$

D. It can have any value

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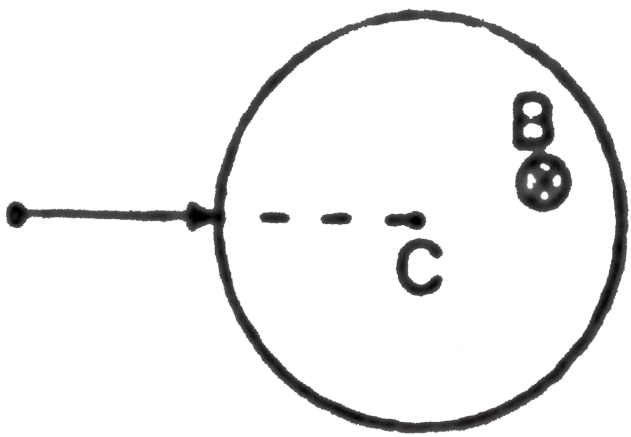
21. In the figure shown, a charged particle of mass 2 g and charge $5\mu C$ enters a circular region of radius $10cm$, in which there is a uniform magnetic field of strength 4 T and directed perpendicular to the plane of circular region in the figure. If the particle velocity vector rotates through 90° angle in passing through this region then its speed is :



A. 0.25 mm/s

B. 4mm/s

C. 1cm/s

D. 1mm/s

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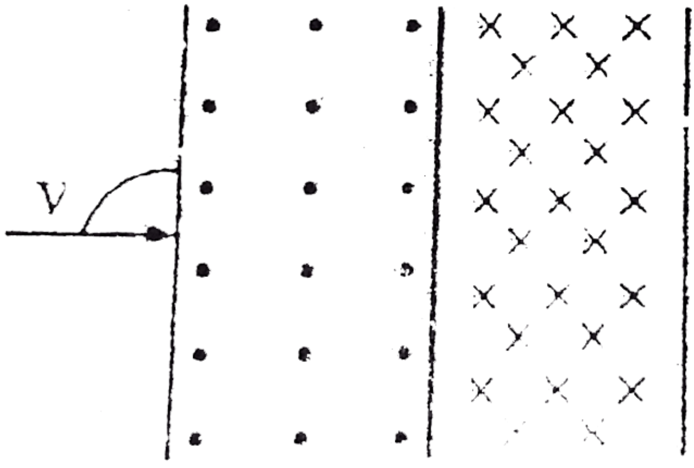
22. The magnetic field shown in the figure consists of two uniform regions. The width of the first part is 5cm and the magnetic induction here is 0.001 T. The width of the other part is also 5cm, with the direction of the induction being opposite in direction and 0.002 T in magnitude. What should be the minimum speed of the electron arriving from the direction indicated in the figure so that it can pass through the magnetic field? Mass of electron $= 9 \times 10^{-31}$kg



A. $\frac{8}{9} \times 10^7 m/s$

B. $\frac{4}{9} \times 10^7 m/s$

C. $\frac{16}{9} \times 10^7 m/s$

D. $\frac{4}{7} \times 10^7 m/s$

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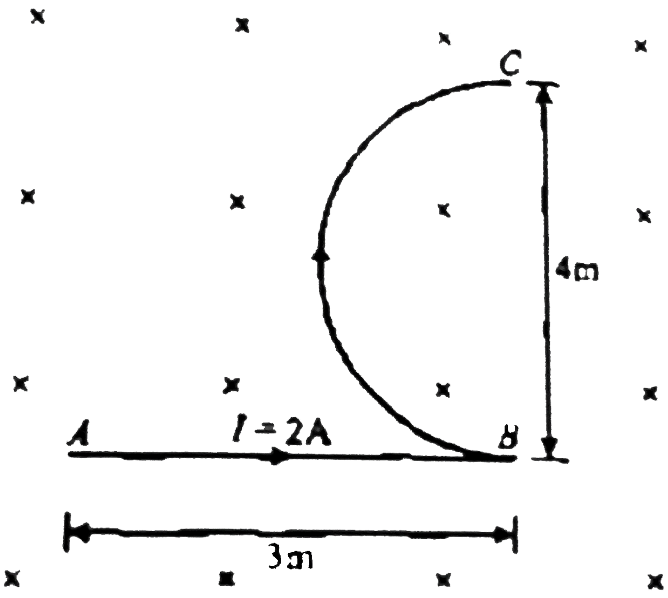
23. In the figure -4.222 the force on the wire ABC in the given uniform magnetic field of magnetic induction 2T is:



A. $4(3+2\pi)N$

B. 20N

C. 30N

D. 40N

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

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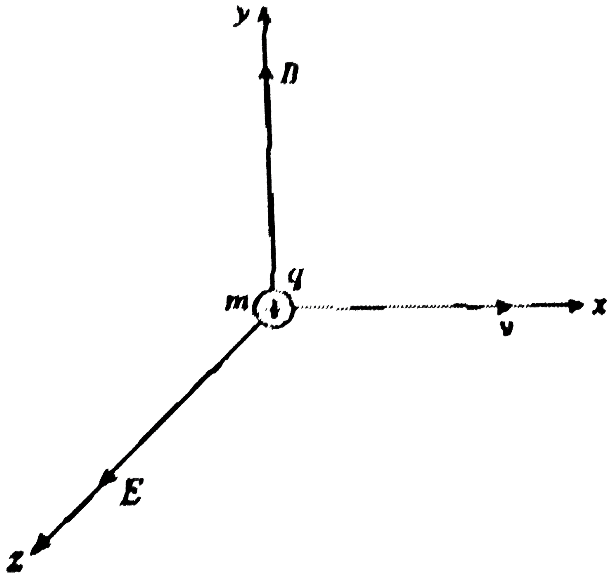
25. A charge particle of charge q, mass m is projected with a velocity $\overrightarrow{v} = v\hat{i}$ in a region of space where electric field strength $\overrightarrow{E} = E\hat{k}$ and magnetic induction $\overrightarrow{B} = B\hat{j}$ are present. The acceleration of the particle is:



A. $\frac{qvB}{m}\hat{k}$

B. $\frac{qE}{m}\hat{k}$

C. $\frac{q(E+vB)\hat{k}}{m}$

D. $\frac{q(E-vB)\hat{k}}{m}$

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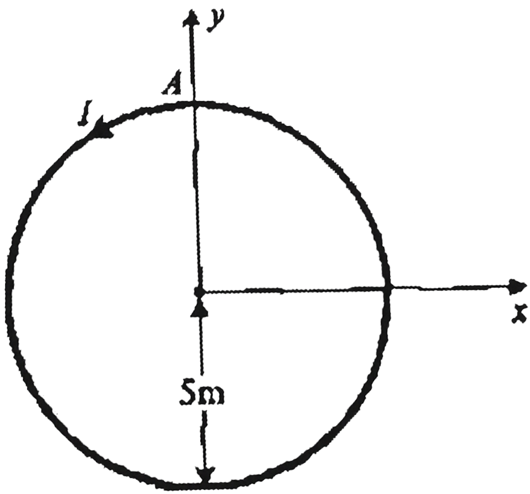
26. A ring of raidus 5m is lying in the x-y plane is carrying current of 1A in anti-clockwise sence. If uniform magnetic field of magnetic induction $\vec{B} = 3\hat{i} + 4\hat{j}$ is switched on in space, then the co-ordinates of point about which the loop will have a tendency to lift up is:



A. (3,4)

B. (4,3)

C. (3,0)

D. (0,3)

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27. An electron is shot into one end of a solenoid.As it enters the uniform magnetic field within the solenoid, its speed is $800 m/s$ and its velocity vector makes an angle of 30° with the central axis of the solenoid.The solenoid carries $4.0 A$ current and has 8000 turn along its length.Find number of revolutions made by the electron within the solenoid by the time it emerges from the solenoid's opposite end. (Use charge of mass ratio $\frac{e}{m}$ for electron $= \sqrt{3} \times 10^{11} C/kg$)Fill your answer in multiple of 10^3 (neglect end effect)

A. 1600

B. 1200

C. 800

D. 600

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28. Two identical wires each of length L are bent to form a circular loop and a square loop. If the same current i flows in the two wires, then the ratio of the magnetic inductions at the centre of the circular and square loops is :

A. $\pi^2 / 2\sqrt{2}$

B. $\pi^2 / 4\sqrt{2}$

C. $\pi^2 / 8\sqrt{2}$

D. 1

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29. In a gravity free space, a smooth insulating ring of radius R, with a bead having charge q is placed horizontally in a uniform magnetic field of induction B_0 and perpendiuclar to the plane of ring. Starting from t=0, the magnetic field is varying with time as B(l)=B_(0)+at, $where$alpha` is a positive constant. The contact force between the ring and bead as a function of time is:

A. $\frac{\alpha q^2 RT}{m}(2B_0 + at)$

B. $\frac{\alpha q^2 Rt}{4m}(2B_0 + at)$

C. $\frac{\alpha q^2 Rt}{4m}(B_0 + at)$

D. $\frac{4\alpha q^2 Rt}{m}(2B_0 + at)$

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30. A bar magnet is held perpendicular to a uniform magnetic field. If the couple acting on the magnet is to be halved by rotating it, then the angle by which it is to be rotated is

A. 45°

B. 30°

C. 15°

D. 0°

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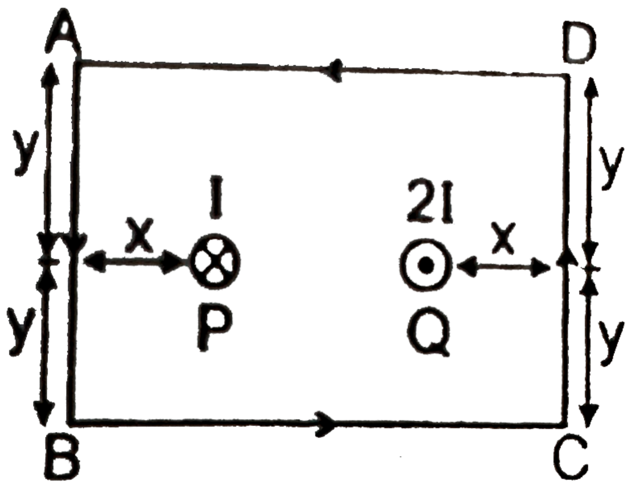
31. Let B_P and B_Q be the magnetic field produced by the wire P and Q which are placed symmetrically in a rectangular loop ABCD as shown in figure. Current in wire P is I directed inward and in Q is 2I directed outwards.



If $\int_A^B \vec{B}_Q . \vec{d} l = w\mu_0 \text{tesla meter}, \int_D^B \vec{B}_P . \vec{d} l = -2\mu_0$ tesla meter

$\& \int_A^B \overrightarrow{B}_P d \overrightarrow{l} = -\mu_0$ tesla meter

the value of 1 will be:

A. 6A

B. 8A

C. 10A

D. None of these

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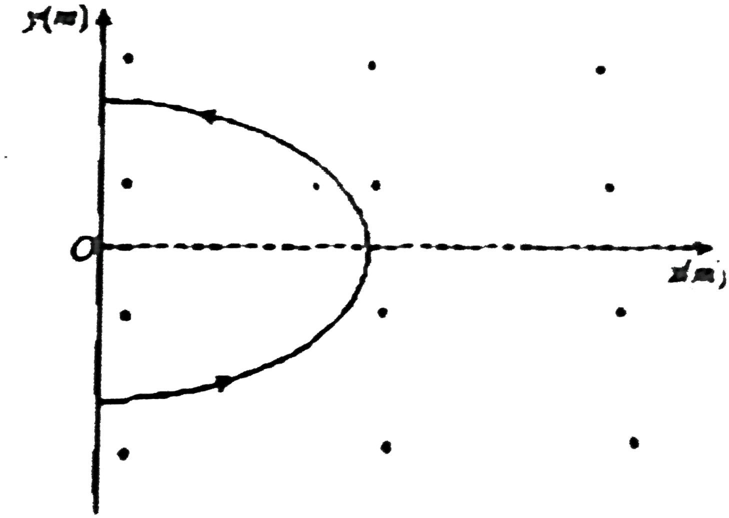
32. A wire carrying a current of 3A is bent in the form of a parabola $y^2 = 4 - x$ as shown in figure-4.226, where x and y are in metre. The wire is placed in a uniform magnetic field $\overrightarrow{B} = 5\hat{k}T$. The force acting on the wire is:



A. $60\hat{i}N$

B. $-60\hat{i}N$

C. $30\hat{i}N$

D. $-30\hat{i}N$

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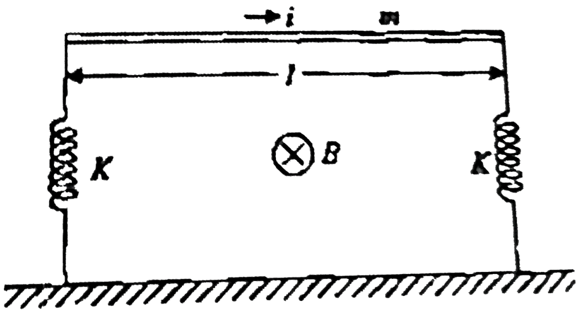
33. A horizontal metallic rod of mass m and length l is supported by two vertical identical springs of spring constant k each and natral length i_0 A current l is flowing in the rod in the direction shown if the rod is in equilibrium then the length of each spring in this state is:



A. $l_0 + \dfrac{ilB - mg}{K}$

B. $l_0 + \dfrac{ilB - mg}{2K}$

C. $l_0 + \dfrac{mg - ilB}{2K}$

D. $l_0 + \dfrac{mg - ilB}{k}$

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34. A dip circle is adjusted so that its needle moves freely in the magnetic meridian. In this position, the angle of dip ia 40°. Now the dip circle is rotated so that the plane in which the needle moves makes an angle of 30° with the magnetic meridian. In this position the needle will dip by an angle

A. 40°

B. 30°

C. More than 40°

D. Less than 40°

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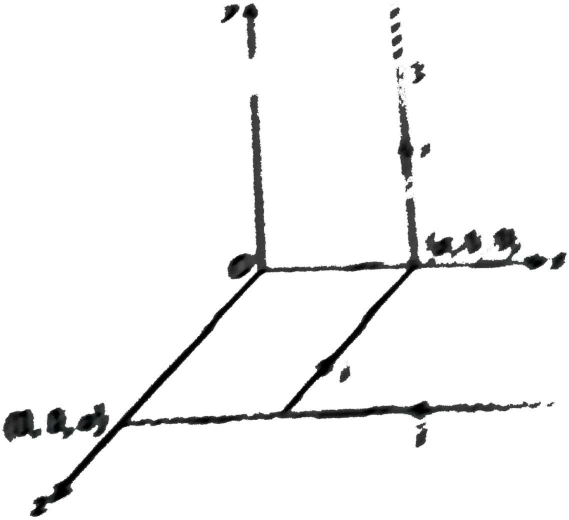
35. An infinite current carrying conductor is bent into three segments as shown in the figure-4.228. if it carries current i, the m agnetic field at the origin is found to be $\frac{\mu_o l}{r\pi a}\left(\sqrt{x-1}\hat{j}+\hat{k}\right)$. The value of x is:



A. 4

B. 3

C. 2

D. 1

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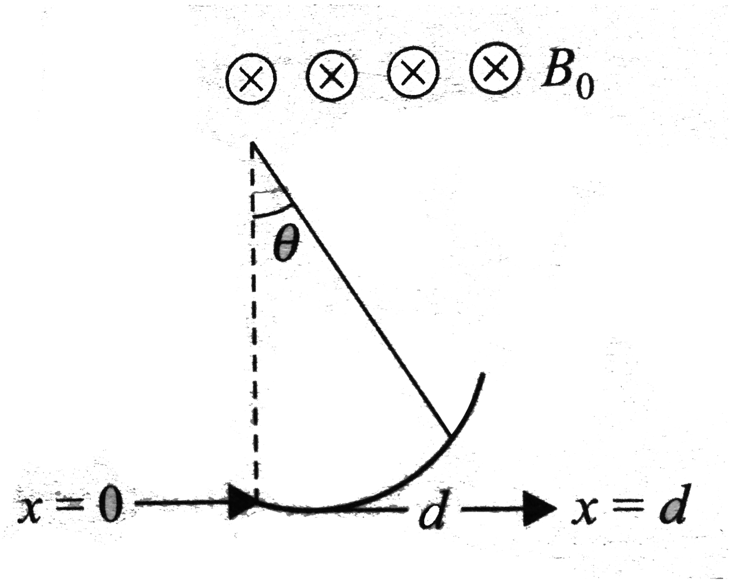
36. A charged particle moving along +ve x-direction with a velocity v enters a region where there is a uniform magnetic field $B_0\left(-\hat{k}\right)$, $omx = 0 \rightarrow x = d$. The particle gets deflected at an angle θ from its initial path. The specific charge of the particle is



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

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

C. $\dfrac{B\sin\theta}{vd}$

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

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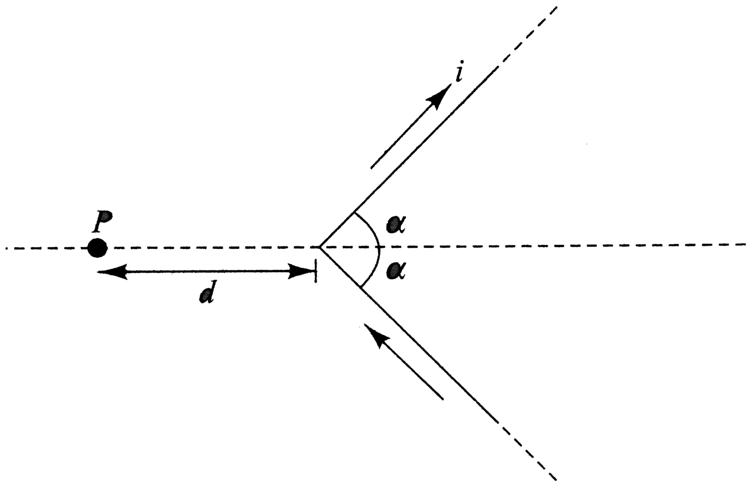
37. If the magnetic field at P can be written as $K\tan\left(\frac{\alpha}{2}\right)$,



A. $\frac{\mu_0 l}{4\pi d}$

B. $\frac{\mu_0 I}{2\pi d}$

C. $\frac{\mu_0 I}{\pi d}$

D. $\frac{2\mu_0 l}{nd}$

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38. The value of horizontal component of earth's magnetic field at a place is $-.35 \times 10^{-4} T$. If the angle of dip is 60°, the value of vertical component of earth's magnetic field is about:

A. $0.10 \times 10^{-4} T$

B. $0.2 \times 10^{-4} T$

C. $0.40 \times 10^{-4} T$

D. $0.6 \times 10^{-4} T$

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39. A wire of mass 100kg is carrying a current of 2A towards increasing x in the form of $y = x^2(-2m \leq x \leq +2m)$. This wire is placed in a magnetic field $\overrightarrow{B} = -0.02\hat{k} T$. The acceleration of the wire:

A. $-1.6\hat{j} m / s^2$

B. $-3.2\hat{\hat{j}} m / s^2$

C. $1.6\hat{j} m / s^2$

D. Zero

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

A. $\dfrac{\mu_0 l\left(y\hat{i} - x\hat{j}\right)}{2\pi(x^2 + y^2)}$

B. $\dfrac{\mu_0 l\left(x\hat{i} + y\hat{j}\right)}{2\pi(x^2 + y^2)}$

C. $\dfrac{\mu_0 l\left(x\hat{j} - y\hat{i}\right)}{2\pi(x^2 + y^2)}$

D. $\dfrac{\mu_0 l\left(x\hat{i} - y\hat{j}\right)}{2\pi(x^2 + y^2)}$

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41. A dip needle vibrates in the vertical plane perpendicular to the magnetic meridian. The time period of vibration is found to be 2 sec. The same needle is then allowed to vibrate in the horizontal plane and the time period is again found to be 2 seconds. Then the angle of dip is

A. 30°

B. 45°

C. 60°

D. None of the above

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42. A charged particle of mass m and charge q is accelerated through a potential differences of V volts. It enters of uniform magnetic field B which is directed perpendicular to the direction of motion of the particle. The particle will move on a circular path of radius

A. $\sqrt{\frac{Vm}{2qB^2}}$

B. $\frac{2vm}{qB^2}$

C. $\sqrt{\frac{2Vm}{q}}\left(\frac{1}{R}\right)$

D. $\sqrt{\frac{Vm}{q}}\left(\frac{1}{R}\right)$

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43. Two magnet of equal mass are joined at right angles to each other as shown the magnet 1 has a magnetic moment 3 times that of magnet 2. This arrangment is pivoted so that it is free to rotate in the horizontal plane. In equilibrium what angle will the magnet 1 subtend with the magnetic meridian?

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

B. $\tan^{-1}\left(\frac{1}{3}\right)$

C. $\tan^{-1}(A)$

D. 0°

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44. The magnetic moment of a short magnet is 8 Am^2. What is the magnetic induction at a point 20 cm away on its equatorial line form its mid point:

A. 10^{-4} Web/m^2

B. 10^{5} Wb/m^2

C. $10^{16} Wb/m^2$

D. $10^{-3} Wb/m^2$

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45. A particle of charge $-16 \times 10^{-18} co\underline{o}mb$ moving with velocity $10ms^{-1}$ along the $x - a\xi s$, and an electric field of magnitude $(10^4)/(m)$ is along the negative $z - ais$. If the charged particle continues moving along the x- axis , the magnitude of B is

A. $10^3 Wb/m^2$

B. $0.150 \times 10^{-4} Wb/m^2$

C. $0.175 \times 10^{-4} Wb/m^3$

D. $2.0 \times 10^{-4} Wb/m^2$

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46. The moment of a short magnet is $4Am^2$ the magnetic induction at a point on the axial. Line at a point 40 cm away from

A. $0.125 \times 10^{-4} Wb/m^2$

B. $0.150 \times 10^{-4} Wb/m^2$

C. $0.175 \times 10^{-4} Wb/m^2$

D. $2.0 \times 10^{-4} Wb/m^2$

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47. An electron is projected with velocity v_0 in a unifrom electric field E perpendicular to the field Again it is projectced with velocity v_0 perpendicular to a unifrom magnetic field B. if r_1 is initial radius of curvature just after entering in the electric field and r_2 is initial radius of curvature just after entering in magnetic field then the ratio r_1/r_2 is equal to .

A. $\frac{Bv_0^2}{E}$

B. $\frac{B}{E}$

C. $\frac{Ev_0}{B}$

D. $\frac{Bv_0}{E}$

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48. Magnetic field strength due to a short bar magnet on its axial line at a distance x is B. What is its value at the same distance on the equatorial line?

A. B/2

B. B

C. 2B

D. 4B

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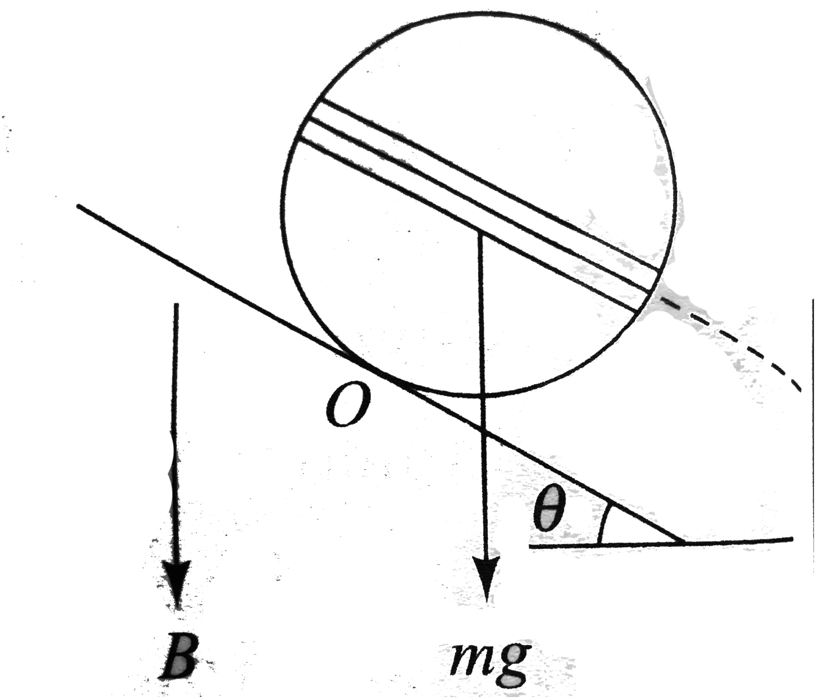
49. In Fig. a coil of single turn is wound on a sphere of radius r and mass m. The plane of the coil is parallel to the inclined plane and lies in the equatorial plane of the sphere. If the sphere is in rotational equilibrium, the value of B is [Current in the coil is i]



A. $\frac{mg\cos\theta}{\pi iR}$

B. $\frac{mg}{\pi iR}$

C. $\frac{mg\tan\theta}{\pi/R}$

D. $\frac{mg\sin\theta}{\pi iR}$

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50. If a magnet is suspended at an angle 30° to the magnetic meridian and in this plane the dip needle makes an angle of 60° with the horizontal. The true value of dip is:

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

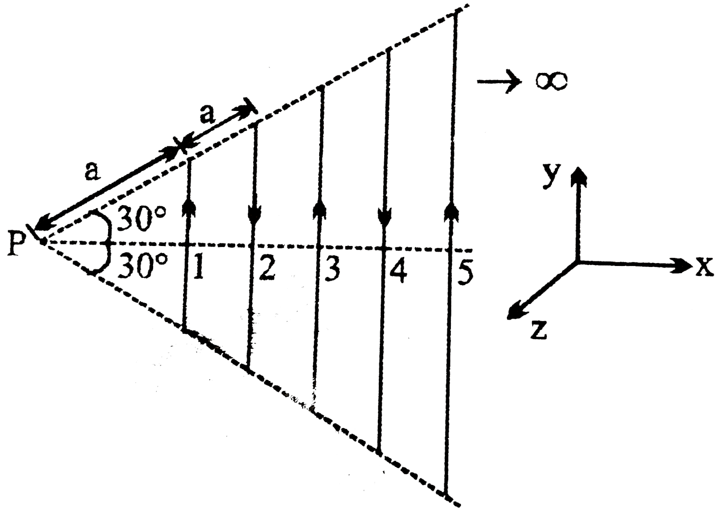
B. $\tan^{-1}\left(\frac{3}{2}\right)$

C. $\tan^{-1}(3)$

D. $\tan^{-1}(2)$

Watch Video Solution

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



A. $\dfrac{\mu_0 I}{4\pi}\dfrac{In2}{\sqrt{3}a}\hat{k}$

B. $\dfrac{\mu_0 I}{4\pi}\dfrac{In4}{\sqrt{3}a}\hat{k}$

C. $\dfrac{\mu_0 I}{4\pi}\dfrac{In4}{\sqrt{3}a}\left(-\hat{k}\right)$

D. Zero

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52. The magnetic field due to a current carrying circular loop of radius $3m$ at as point on the axis at a distance of $4m$ from the centre is $54\mu T$. What will be its value at the centre of the loop/

A. $250\mu T$

B. $150\mu T$

C. $125\mu T$

D. $75\mu T$

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53. 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. 45m

B. 4.5m

C. 0.45m

D. 0.045m

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54. An electron accelerated through a potential difference V passes through a uniform transverse magnetic field and experiences a force F. If the accelerating potential is increased to 2V, the electron in the same field will experience a force

A. F

B. F//2

C. $\sqrt{2}F$

D. 2F

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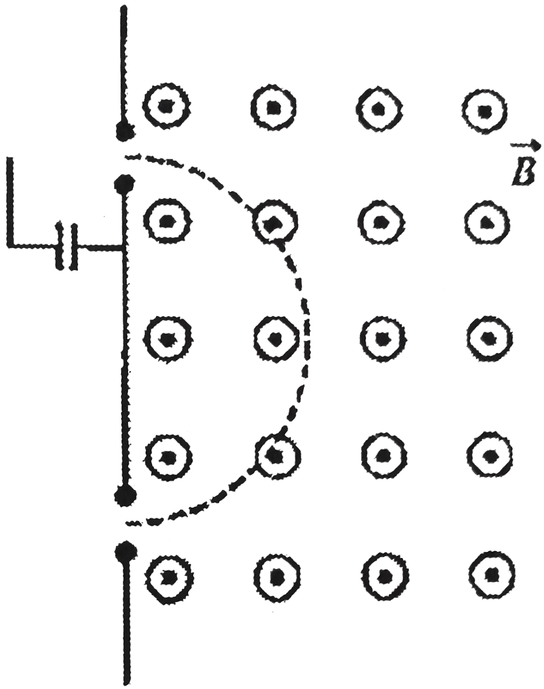
55. A mass spectrometer is a device which selelct particle of equal mass. An ion with an electric charge $q > 0$. Starts at rest from s ource S and is accelerated through a potential difference V. it passes thorugh a hole into a region of constant magnetic field $\overrightarrow{B}$ perpendicular to the plane of the paper as shown in the figure-4.233. The particle is deflected by the magnetic field and emerges thorugh the bottom hole at a distance d from the top hole. The mass of the particle is:



A. $\dfrac{qBd}{V}$

B. $\dfrac{qB^2d^2}{4V}$

C. $\dfrac{qB^2d^2}{8V}$

D. $\dfrac{qBd}{2V}$

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56. The field normal to the plane of a wire of n turns and radis r which carriers i is measured on the axis of the coil at a small distance h from the centre of the coil. This is smaller than the field at the centre by the fraction.

A. $\frac{2}{3}\frac{h^2}{r^2}$

B. $\frac{3}{2}\frac{r^2}{h^2}$

C. $\frac{3}{2}\frac{h^2}{r^2}$

D. $\frac{2}{3}\frac{h^3}{r^2}$

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57. A straight wire of diameter 0.5mm carrying a current 2A is replaced by another wire of diameter I mm carrying the saine current. The magnetic induction at a distance 2m away from the centre is :

A. Half of the previous value

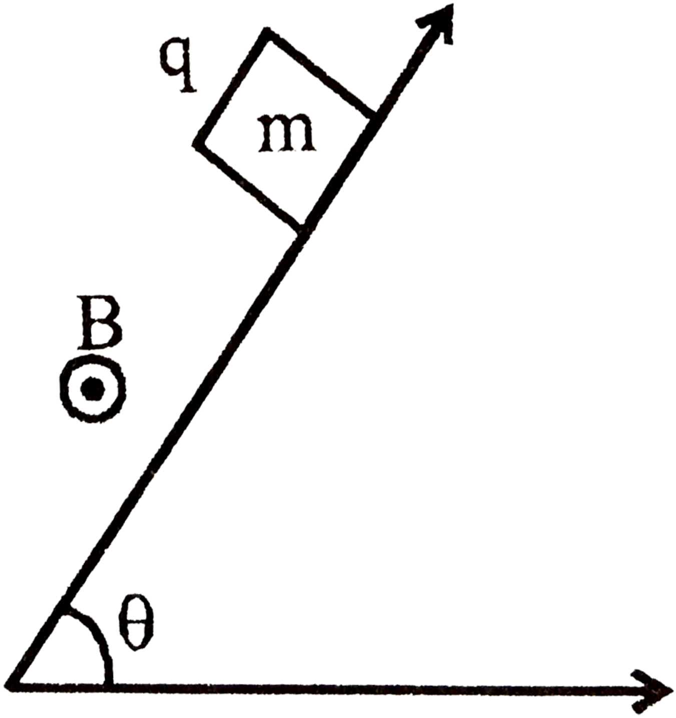
B. Twice of the previous value

C. Unchanged

D. Quarter of its previous value

Watch Video Solution

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



A. $\dfrac{m\cos\theta}{qB}$

B. $\dfrac{m\cos\theta}{qB}$

C. $\dfrac{m\cot\theta}{qB}$

D. None

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59. A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where the magnetic induction will be $\frac{1}{8}$ th to its value at the centre of the coil, is

A. $R\sqrt{3}$

B. $2R\sqrt{3}$

C. $R/\sqrt{3}$

D. $2R/\sqrt{3}$

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60. Two infinite length wires carries currents $8A$ and $6A$ respectively and placed along X and Y-axis. Magnetic field at a point $P(0, 0, d)m$ will be

A. $\frac{7\mu_0}{\pi d}$

B. $\frac{10\mu_0}{\pi d}$

C. $\dfrac{14\mu_0}{\pi d}$

D. $\dfrac{5\mu_0}{\pi d}$

Answer: D

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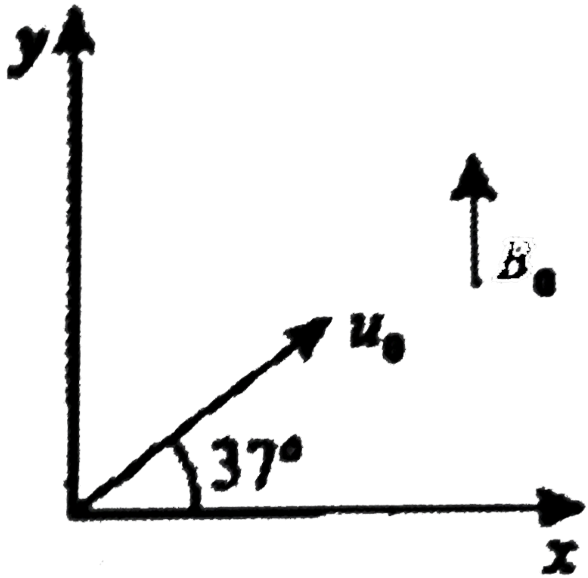
61. At t=0, a positively charged particle of mass m is projected from the origin with velocity u_0 at an angle 37° fromn the x-axis as sown in the figure-4.235. a constant $\overrightarrow{B}_0 = B_0\hat{j}$ is present in space. After a time internal t_0 velocity of particle may be:



A. $u_0\left[\frac{\sqrt{39}}{2}i+\frac{3}{5}\hat{j}-\frac{\hat{k}}{\sqrt{3}}\right]$

B. $u_0\left[\frac{\hat{i}}{\sqrt{3}}+\frac{\hat{j}}{\sqrt{2}}+\frac{\hat{k}}{\sqrt{6}}\right]$

C. $u_0\left[\frac{\sqrt{39}}{10}\hat{i}+\frac{3}{5}\hat{j}+\frac{1}{4}\hat{k}\right]$

D. $u_0\left[\frac{\sqrt{39}}{10}\hat{i}+\frac{3}{5}\hat{j}+\frac{1}{2}\hat{k}\right]$

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Advance MCQ

1. Consider two rings of copper wire. One ring is scaled up version of the other, twice large in all regards (radius, cross sectional radius). If current around the rings are driven by equal voltage source then choose the CORRECT alternative(s). Assume that cross-sectional radius is very small as compared to radius of rings :

A. Resistance of larger ring is half of the smaller ring

B. Current in the larger ring is two times that in the smaller ring

C. Magnetic field at their centres are same

D. Magnetic field at centre oflarger ring is twice as that at the centre of smaller ring

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

A. $8\pi \times 10^{-4} T$ if currents in the coils are in same sense

B. $4\pi \times 10^{-4} T$ if currents in the coils are in opposite sense

C. Zero if currents in the coils are in opposite sense

D. $8\pi \times 10^{-4} T$ if currents in the coils are in opposite sense

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3. A tangent galvanometer is connected to an ideal battery. In which of the following options the deflection of magnetic needle of the tangent galvanometer will remain same:

A. If battery voltage is doubled and number of turns in coil are also doubled

B. If battery voltage is kept constant and number of turns in coil are doubled

C. If number of turns and coil radius both are doubled

D. If number of turns are halved and coil radius is doubled

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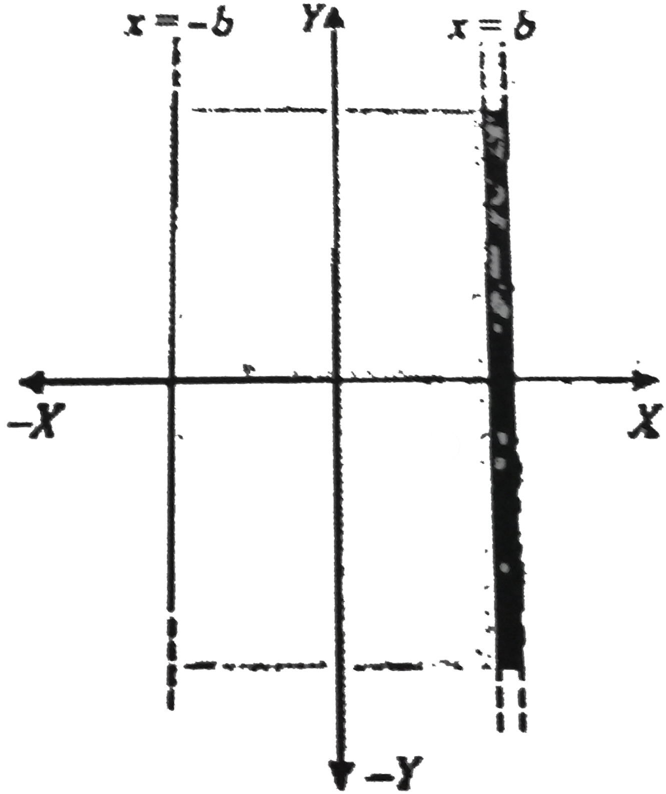
4. The figure-4.236 contains an infinite slab having current per unit area of $\vec{J}_1 = J\hat{k}$ between the infinite planes at $x = -b$ and $x = b$. Slightly to the right of $x = b$, an infinite thin sheet is lept. It carries a current per unit length $\overrightarrow{k}_2 = 2bJ\left(-\hat{k}\right)$. Choose the correct option(s):



A. The field due to sheet at any point is $\mu_0 Jb$

B. The field due to dheet at any point is $\frac{\mu_0 Jb}{2}$

C. The magnetic field due to slab at a point inside the slab must be independent of y co-ordinate and y component of field must be a fimction of x

D. Magnetic field at a point (x, y) inside slab, due to slab is $\mu_0 J x$

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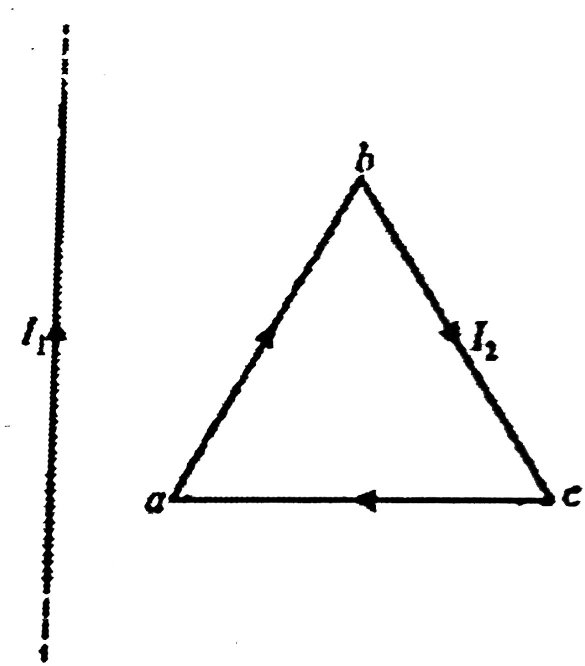
5. An infinitely long straight wire is carrying a current I_1. Adjacent to it there is another equilateral triangnlar wire having curent I_2. Choose the wrong options :



A. Net force on loop is leftwards

B. Net force on loop is rightwards

C. Net force on loop is upwards

D. Net force on loop is downwards

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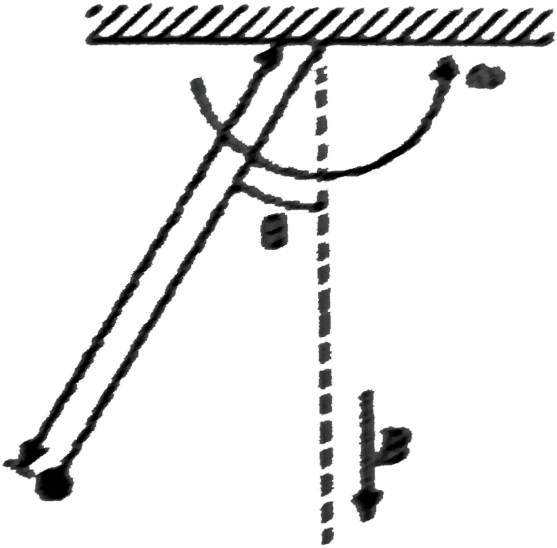
6. A charged particle having its charge to mass ratio as β goes in a conical pendulum oflength L making an angle θ with vertical and angular velocity ω. If a magnetic field B is directed vertically downwards (see figure-4.238):



A. $B=\frac{1}{\beta}\left[\omega-\frac{g}{\omega L\cos\theta}\right]$

B. Angular momentum of the particle about the point of suspension remains constant

C. If the direction of B were reversed maintaining same ω and L, then θ will remain unchanged

D. Rate ofchange of angular momentum of the particle about the point of suspension is not a constant vector.

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7. Two long and parallel wires at P and Q carry currents 0. 1A and 0.2A respectively in opposite directions as shown in figure-4.239. In which region(s) a neutral point may not exist, that is where the magnetic field is not zero?

A. Between Xand P

B. Between P and Q

C. Between Q and Y

D. In all the regions there exists no neutral point

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8. Which of the following statements given below is/are correct

A. Only electric charges can produce magnetic fields

B. Magnetic poles does not exist in nature these are only assumed for mathematical calculations

C. A long straight current carrying wire behaves like a bar magnet

D. For an observer facing a magnetic pole, a north pole acts like a clockwise current and a south pole acts like an anticlockwise current

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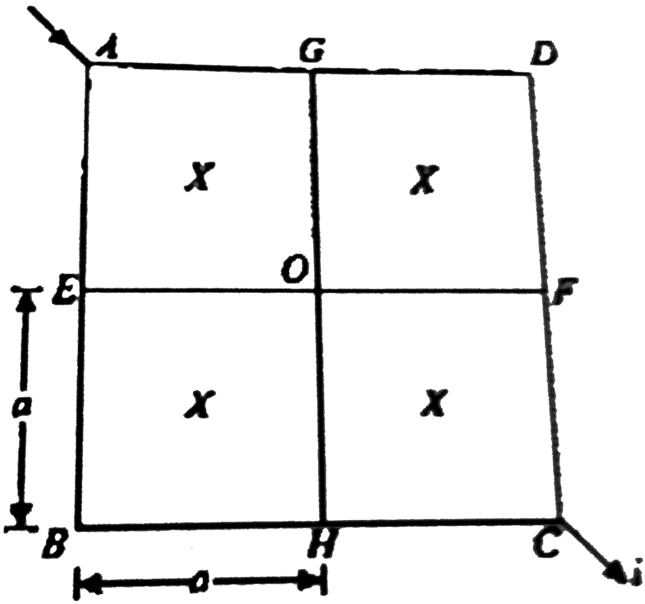
9. The figure-4.240 shows ·a square wire mesh made of conducting wires. Here, each small square has side a. The structure is kept in uniform magnetic field B perpendicular to the plane of paper:



A. The magnetic force on the structure is $2\sqrt{2}iBa$

B. The potential of point $B =$ potential of point D

C. Potential of point $O =$ potential of point B

D. The magnetic force on the structure is $\sqrt{2}iBa$

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10. A charged particle of unit mass and unit charge moves with velocity $\vec{v} = \left(8\hat{i} + 6\hat{j}\right)ms^{-1}$ in magnetic field of $\vec{B} = 2\hat{k}T$. Choose the correct alternative (s).

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

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

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

D. Time period of particle will be 3.14s

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11. Consider the following statements regarding a charged particle in a magnetic field. Which of the statements are true?

A. Starting with zero velocity, it accelerates in a direction perpendicular to the magnetic field

B. While deflection in magnetic field its energy gradually increases

C. Only the component of magnetic field perpendicular to the direction of motion of the charged particle is effective in deflecting it

D. Direction of deflecting force on the moving charged particle is perpendicular to its velocity

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12. A particle of specific charge $'\alpha'$ is projected from origin at $t=0$ with a velocity $\overrightarrow{V}=V_0\left(\hat{i}-\hat{k}\right)$ in a magnetic field $\overrightarrow{B}=-B_0\hat{k}$. Then : (Mass of particle =1 unit)

A. At $t=\dfrac{\pi}{\alpha B_0}$, velocity of the particle is $-V_0\left(\hat{i}-\hat{k}\right)$

B. At $t=\dfrac{\pi}{4\alpha B_0}$, speed of the particle is V_0

C. At $t=\dfrac{2\pi}{\alpha B_0}$, magnitude of displacement of the particle is more than $\dfrac{2V_0}{\alpha B_0}$

D. At $t = \frac{2\pi}{\alpha B_0}$, distance travelled by the particle is less than $\frac{2\sqrt{2}\pi V_0}{\alpha B_0}$

.

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13. For experimental measurement of the magnetic moment of a bar magnet which of the fellowing devices can be used

A. Deflection magnetometer if horizontal component of earth's magnetic field is given

B. Vibrational magnetometer if horizontal component of earth's magnetic field is given

C. Both Deflection and vibrational magnetometer ifhorizontal component of earth's magnetic field is not given

D. Tangent galvanometer if horizontal component of earth's magnetic field is not given

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14. Two identical charged particles enter a uniform magnetic field with same speed but at angles 30° and 60° with field Let a,b and c be the ratio of their time periods, radii and pitches of the helical paths than .

A. $abc = 1$

B. $abc > 1$

C. $abc < 1$

D. $a = bc$

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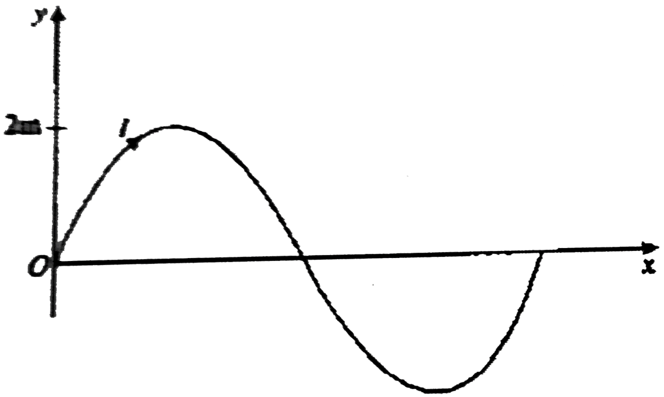
15. A current carrying conductor is in the form of a sine curve as shown in figure-4.241, which carries current I. If the equation of this curve is

$Y = 2\sin\left(\frac{\pi x}{L}\right)$ and a uniform magnetic field B exists in space:



A. Force on wire is BIL iffield is along Z-axis

B. Force on wire is 2BIL iffield is along Y-axis

C. Force on wire is zero iffield is along X-axis

D. Force on wire is BIL iffield is in theXY plane making an angle 30° with X-axis

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16. A straight conductor carries a current. Assume that all free electrons in the conductor move with the same drift velocity v. A and B are two observers on a striaght line XY parallel to the conductor. A is stationary B moves along XY with a velocity v in the direction of the free electrons.

A. A and B observe the same magnetic field

B. A observes a magnetic field, B does not

C. A and B observe magnetic fields of the same magnitude but opposite directions

D. A and B do not observe any electric field

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17. A dip circle is taken to geomagnetic equator. The needle is allowed to move in a vertical plane perpendicular to the magnetic meridian. The needle will stay

A. Horizontal

B. Vertical

C. At some angle to vertical

D. At any direction except vertical

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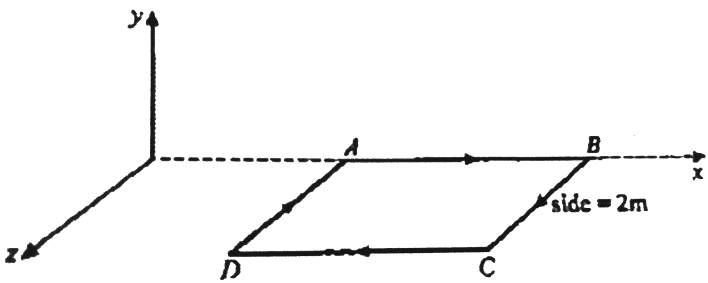
18. A square wire frame is hinged about one of it's sides AB. It carries a current of 0.5 A. Which of the following magnetic fields can hold it in equilibrium in horizontal position shown. It has a mass of 500 gm:



A. $3\hat{i} + \frac{5}{2}\hat{k}$

B. $\frac{5}{2}\hat{i} - 3\hat{j} + 2\hat{k}$

C. $2\hat{j} - \frac{5}{2}\hat{k}$

D. $\hat{i} + \frac{5}{2}\hat{j} + \frac{5}{2}\hat{k}$

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19. A compose needle which is allowed to move in a horizontal plane is taken to a geomagnetic pole. It

A. May stay in north-south direciton

B. May stay in east-west direction

C. May stay at 11° east of north

D. May oscillate

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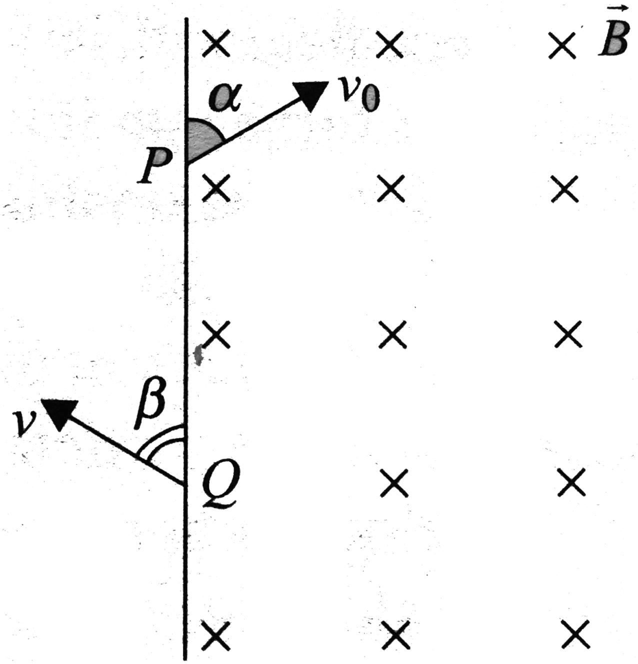
20. A particle of charge -q and mass m enters a uniform magnetic field $\overrightarrow{B}$ (perpendicular to paper inward) at P with a velocity v_0 at an angle α and leaves the field at Q with velocity v at angle β as shown in fig.



A. $\alpha = \beta$

B. $v = v_0$

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

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

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21. A charged particle with velocity $\overrightarrow{v} = x\hat{i} + y\hat{j}$ moves in a magnetic field $\overrightarrow{B} = y\hat{i} + x\hat{j}$. 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 particle if $x = y$

B. $F \propto (x^2 - y^2)$ if $x > y$

C. The force will act along z-axis if $x > y$

D. The force will act along y-axis if $y > x$

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22. A long thick conducting cylinder of radius 'R' carries a current uniformly distributed over its cross section :

A. The magnetic field strength is maximum on the surface

B. The magnetic field strength is zero on the surface

C. The strength of the magnetic field inside the cylinder will vary as inversely proportional to r, where r is the distance from the axis

D. The energy density of the magnetic field outside the conductor varies as inversely proportional to 1/r^2 , where 'r' is the distance from the axis.

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23. Two parallel conductors carrying current in the same direction attract each other, while two parallel beams of electrons moving in the same direction repel each other. Which of the following statement provide part of all of the reason for this ? (Choose the incorrect option)

A. The conductors are electrically neutral

B. The conductors produce magnetic fields on each other

C. The electron beams do not produce magnetic field on each other

D. The magnetic forces caused by the electron beams on each other are weaker than the electrostatic force between them

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24. A bar magnet is moved along the axis of a copper ring placed far away from the magnet. Looking from the side of the magnet, an anticlockwise current is found to be induced in the ring. Which of the following may be true?

A. Tiie south pole faces the ring and the magnet moves toward it

B. The north pole faces the ring and the magnet moves toward it

C. The south pole faces the ring and the magnet moves away from it

D. The north pole faces the ring and the magnet moves away from it

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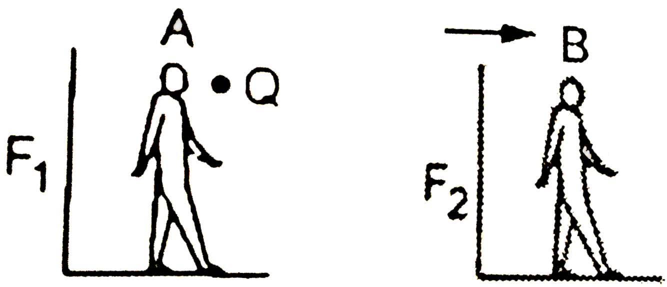
25.



An observer A and a charge Q are fixed in a stationary frame F_1. An observer B is fixed in a frame F_2 which is moving with respect to F_1

A. Both A and B will observe electric fields

B. Both A and B will observe magnetic fields.

C. Neither A nor B will observe magnetic fields.

D. B will observe a magnetic field, but A will not

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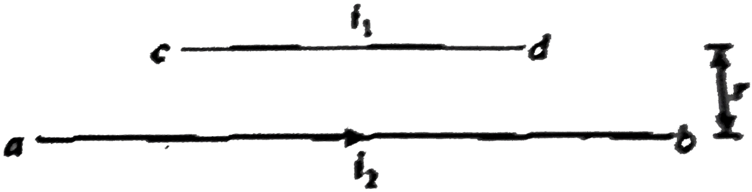
26. There are two wires ab and cd in a vertical plane as shown in figure-4.246. Direction of current in wire ab is rightwards. Choose the correct options :



A. If wire ab is fixed then wire cd can be kept in equilibrium by the current in cdin leftward direction

B. Equilibrium of wire cd will be stable equilibrium

C. If wire cd is fixed, then wire ab can be kept in equilibrium by flowing current in cd in rightward direction

D. Equilibrium of wire ab will be stable equilibrium

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27. An infinitely long, straight wire carrying current I_1 passes through the center of circular loop of wire carrying current I_2. The infinite wire is perpendicular to the plane ofthe loop. Which of the following statements is/are INCORRECT regarding the magnetic force on the loop due to the infinite wire:

A. Force on the loop due to infinite wire is upward, along the axis of the loop

B. Force on the loop due to infinite wire is downward, along the axis of the loop

C. Although net force on the loop due to infinite wire is zero, but due to magnetic interaction between infinite wire and loop, a tensile stress is developed in the loop

D. There is no magnetic force on the loop due to infinite wire.

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28. Which of the following statement is correct ?

A. A charge particle enters a region of uniform magnetic field at an angle 85° to magnetic lines of force. The path of the particle is a circle

B. An electron and a proton are moving with the same kinetic energy along the same direction. When they pass through uniform magnetic field perpendicular to their direction of motion, they describe circular path

C. There is no change in the energy of a charged particle moving in a magnetic field although magnetic force acts on it

D. Two electrons enter with the same speed but in opposite direction in a uniform transverse magnetic field. Then the two describe circle of the same radius and these move in the same direction

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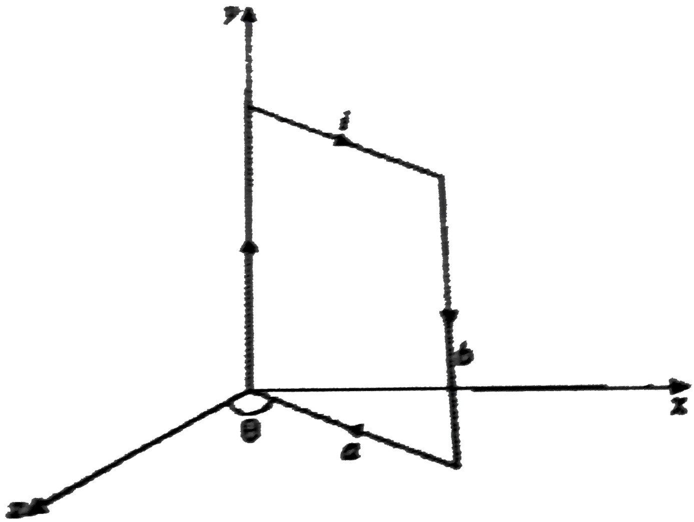
29. A rectangular loop of dimensions $(a \times b)$ carries a current i. A uniform magnetic field $\overrightarrow{B} = B_0\hat{i}$ exists in space. Then :



A. Torque on the loop is $iabB_0 \sin\theta$

B. Torque on the loop is in negative y-direction

C. If allowed to move the loop turn so as to increase θ

D. In allowed to move the loop turn so as to decrease θ

Answer: ABC

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U.N.P

1. 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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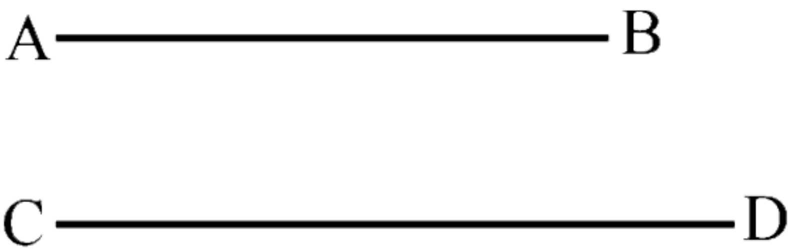
2. A long horizontal wire AB, which is free to move in a vertical plane and carries a steady current of $20A$, is in equilibrium at a height of $0.01m$ over another parallel long wire CD which is fixed in a horizontal plane and carries a steady current of $30A$, as shown in figure. Shown that when AB is slightly depressed, it executes simple harmonic motion. Find the period of oscillations.



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3. 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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4. A long straight cylindrical hollow pipe has inner and outer radii 1 cm and 2 cm respectively. It carries a current 100 A. Calculate the magnetic field at distance (a) 0.5 cm, (b) 1.5 cm and (c) 4 cm from the axis of pipe.

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5. 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.

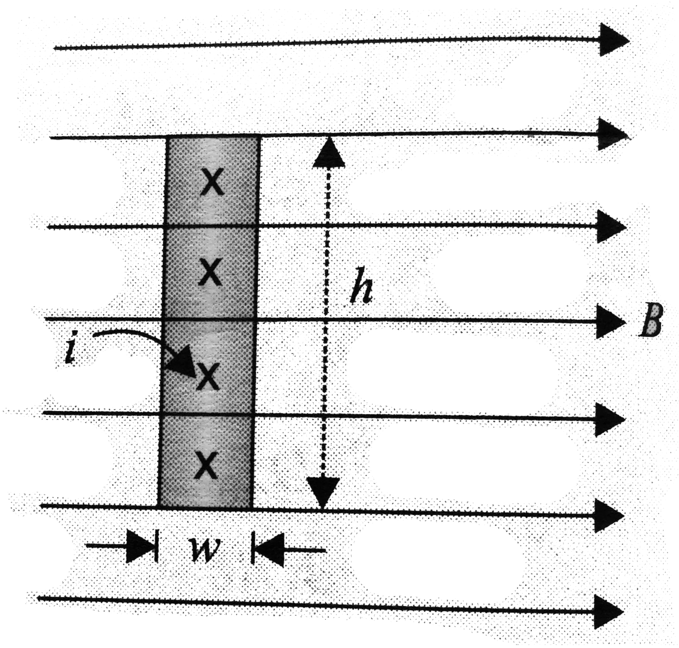
(b) What are the magnitude and direction of the magnetic force F acting on the electrons?

(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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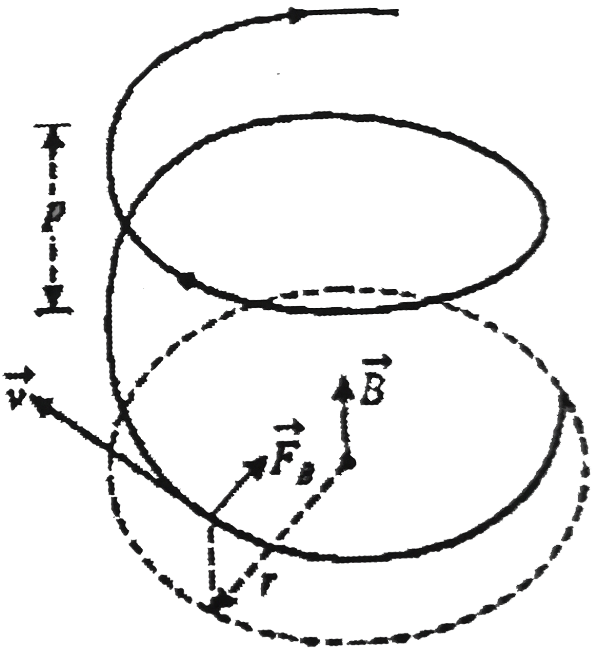
6. A 2 keV positron is projected into uniform field of induction B of $0.10T$ with its velocity vector making an angle of 89° with B. Convince your-self that the path will be a helix, its axis being the direction ofB. Find the period, the pitch p, and the radiusr of the helix, see figure-4.250.



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7. The distance between the two plates of a cathode-ray oscilloscope is 1 cm and the potential difference between them is 1200 V. If an electron of energy 2000 eV enters at right angles to the field, what will be its deflection if the plate be 1.5 cm long.

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8. A solenod of length 0.4m and diametre 0.6m consists of a single layer of 1000 turns of fine wire carrying a current of $5.0 \times 10^{-3} A$. Calculate the magnetic field intensity on the axis at the middle and at the ends of the solenoid.

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9. A charge of 1 coul. is placed at one end of a non-conducting rod of length 0.6m. the rod is rotated in a vertical plane about a horizontal axis passing through the other end of the rod with angular frequency $10^4 \pi \text{radian/sec}$. Find the magnetic field at a point on the axis ofrotation at a distance of 0.8 from the centre of the path. Now half of the charge is removed from one end and placed on the other end. The rod is rotated in a vertical plane about horizontal axis passing through the mid-point of the rod with the same angnlar frequency. Calculate the magnetic field at a point on the axis at a distance of 0.4m form the centre of the rod.

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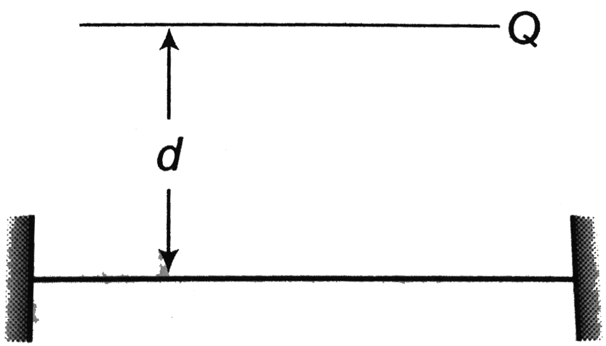
10. A long horizontal wire P carries of $50A$. It is rigidly fixed. Another fine wire Q is placed directly above and parallel to P. The wieght of wire Q is $0.075N/m$ and carries a current of $25A$. Find the position of wire Q from P so that the wire Q remains suspended due to magnetic repulsion.



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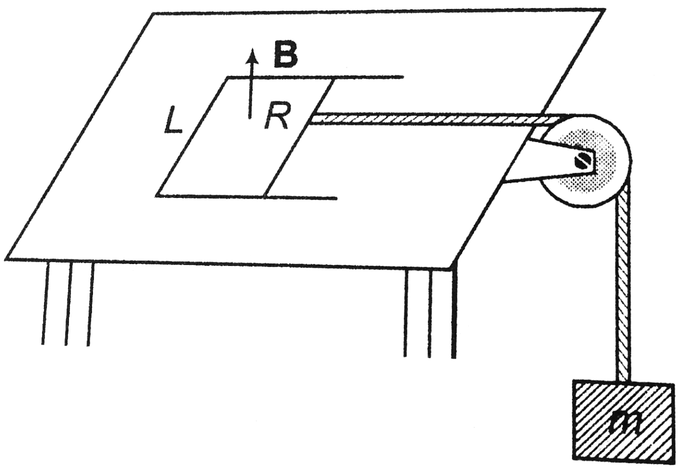
11. A pair of parallel horizontal conducting rails of negligible resistance shorted at one end is fixed on a table. The distance between the rails is L. A conducting massless rod of resistance R can slide on the rails frictionlessly. The rod is tied to a massless string which passes over a pulley fixed to the edge of the table. A mass m tied to the other end of the string hangs vertically. A constant magnetic field B exists perpendicular to the table. If the system is released from rest, calculate



a. the terminal velocity achieved by the rod and

b. The acceleration of the mass of the instant when the velocity of the rod is half the terminal velocity.

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12. Three infinitely long thin wires, each carrying current i in the same direction, are in the $x - y$ plane of a gravity free space . The central wire is along the $y - a\xi s$ while the other two are along $x = \pm d$.

(i) Find the locus of the points for which the magnetic field B is zero.

(ii) If the central wire is displaced along the $Z - direction$ by a small amount and released, show that it will excecute simple harmonic motion . If the linear density of the wires is λ, find the frequency of oscillation.

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13. The region between $x = o$ 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 $x - a\xi s$ and enters the region of the magnetic field. Neglect gravity throughout the question .

(a) Find the value of L if the particle emerges from the region of magnetic field with its final velocity at angle 30° to its initial velocity.

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

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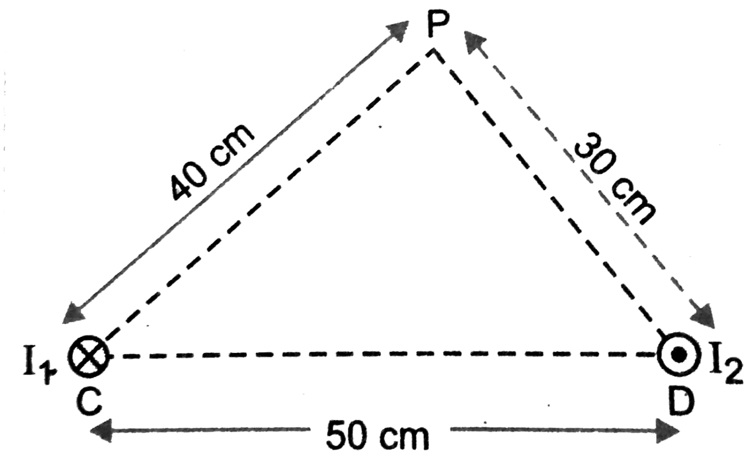
14. Two straight parallel conductors are $50cm$ apart and carry oppositively directed currents, held perpendicular to the plane of paper as shown in figure. The current in first conductor, $I_1 = 20A$ and in the second conductor is $I_2 = 24A$. A point P is separated from the first conductor by a distance of $40cm$ and the second conductor by $30cm$. Calculate the magnetic field at point P.



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15. In the Bohr model of the hydrogen atom, the electron circuulates around the nucleus in a path of radius $5 \times 10^{-11} m$ at a frequency of $6.8 \times 10^{15} Hz.$

a. What value of magnetic field is set up at the centre of the orbit?

b. What is the equivalent magnetic dipole moment?

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16. A coil carrying a current $10 mA$ is placed in a uniform magnetic field so that its axis coincides with the field direction. The single layer winding of the coil is made of copper wire with diameter $0 \cdot 1 mm$, radius of turns is equal to $30 mm$. At what value of the induction of the external magnetic field can the coil winding be ruptured? Breaking stress is $3 \cdot 1 \times 10^{8} Nm^{-2}$.

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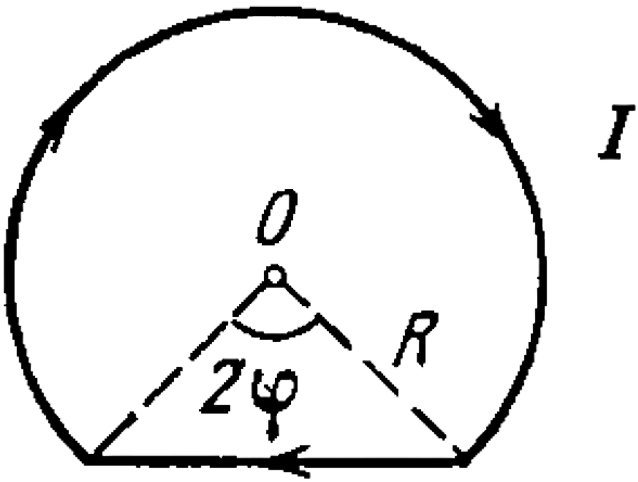
17. A current $I = 5.0A$ A flows along a thin wire shaped as shwon in Fig. The radius of a curved part of the wire is equal to $R = 120mm$, the angle $2\varphi = 90^\circ$. Find the magentic induction of the field at the point O.



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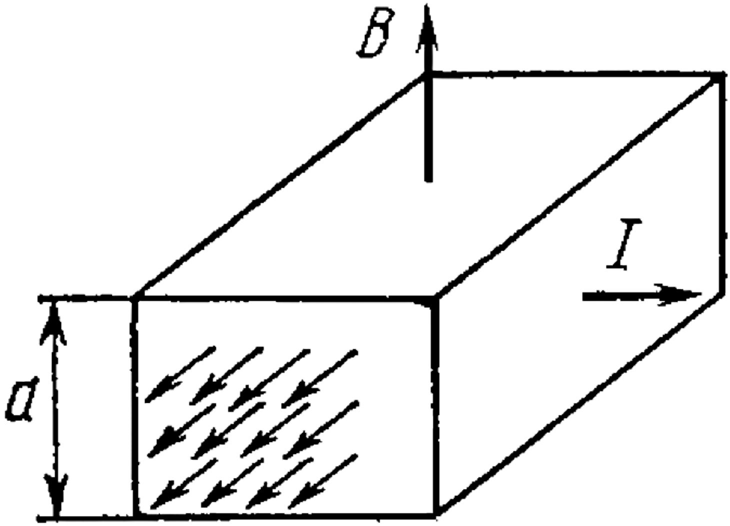
18. In an electromagnetic pump designed for transferring molten metals a pipe section with metal is located in unifrom magnetic field of induction B (Fig) A curent I is made to flow across this pipe section in the direaction perpendicular both to the vector B and to the axis of the pipe. FInd the gauge pressure produced by the pump if $B = 0.10T$, $l = 100A$, and $a = 2.0 cm,$



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19. A current I flows in a long thin walled cylinder of radius R. What pressure do the walls of the cylinder experience ?

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20. At the moment $t = 0$ on electron leaves one plate of a parallel-plate capacitor with a neglible velocity. An accelerting volatage, varrying as

$V = at$, where $a = 100V/s$ is applied between the plates is $l = 5.0cm$. What is the velocity of the of the electron at the moment it reaches the opposite plate?

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21. A non-relativistic proton beam passes without deviation through a region of space where there are uniform transverse mutually perpendicular electric and magnetic fields with $E = 120kVm^{-1}$ and $B = 50mT$. Then the beam strikes a grounded target. Find the force which the beam acts on the target if the beam current is equal to $i = 0.8mA$.

Mass of protons $= 1.67 \times 10^{-27}kg$.

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22. A proton accelarted by a potential differnce V gets into the unifrom electric field of a paralallel-plate capacitor whose plates extended over a length l in the motion direction. The field strenth varies with time as

$E = at$, where a is a constant. Assuming the proton to be non-relatistic, find the angle between the motion directions of the proton before and after its fight throgh the capacitor, the proton gets in the field at the moment $t = 0$. The edge effects are to be neglected.

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23. A charged particle moves along a circle of radius $r = 100mm$ in a unifrom magnetic field with induction $B = 10.0mT$. Find its velocity and perios of revolution if that particle is

(a) a non-relativistic proton,

(b) a relativistic electron.

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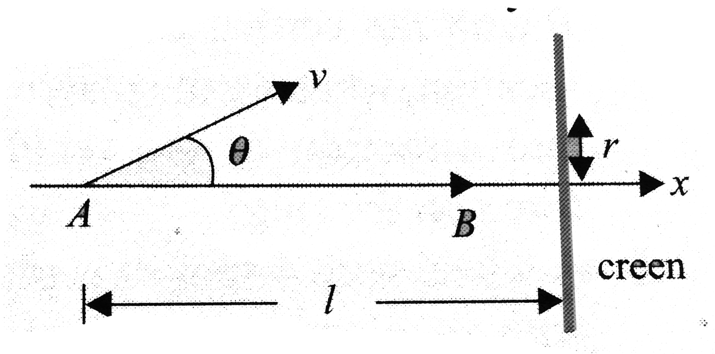
24. A non-relativistic charge q of mass m originates at a point A lying on x-axis and moves with velocity v at an angle to the x-axis. A screen is located at a distance l from A. Find the distance r from the x-axis to the point on the screen into which the charge strikes.



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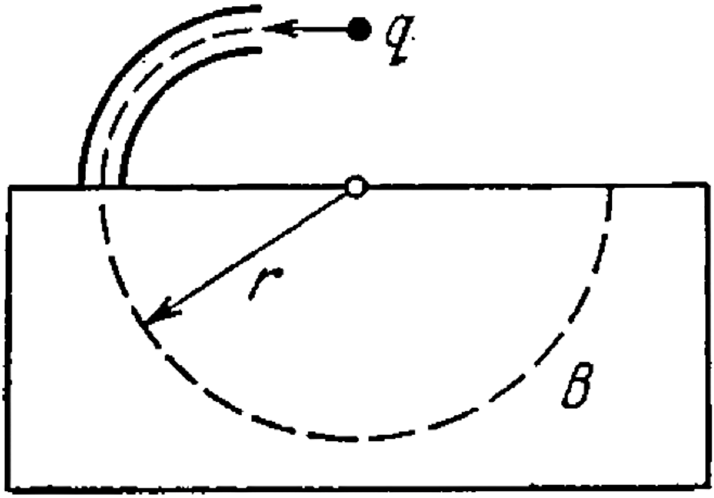
25. A non-relativistic charged particle files through the electric field of a cyclindrical capacitor and gets into a unifrom transverse magnetic field with induction B(fig). In the capacitor the particle moves along the are of a circle, in the magnetic field, along a semi-circle of radius r. The potential differnce applied to the capacitor is equal to V, the radii of the electrodes are equal to a and b, with $a < b$. Find the velocity of the particle and its specific charge q/m.



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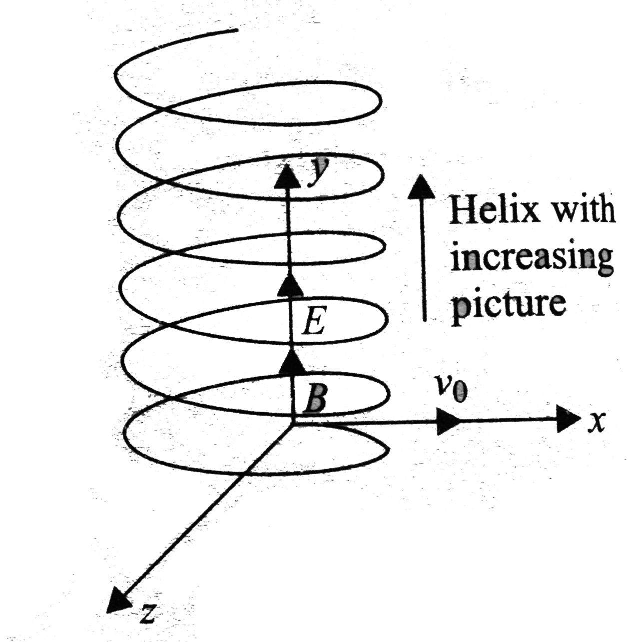
26. Uniform electric and magnetic fields with strength E and induction B, respectively, are along y-axis as shown in Fig. A particle with specific charge q/m leaves the origin O in the direcction of x-axis with an initial non-relativistic velocity v_0



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

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27. A narrow beam of identical ions with specific charge q/m, possessing different velocities, enters the region of space, where there are uniform parallel electric and magnetic fields with strengths E and B, at the point O. The beam direction coincides with the x-axis at the point O. A plane screen oriented at right angles to the x-axis is located at a distance I

from O. Find the equation of trace that the ion leaves on the screen. Demonostrate that at $z < < l$, it is the equation of a parabola.

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28. A beam of non-relativistic charged particles moves without deviation through the region of space A where there are transverse mutually perpendicular electric and magnetic fields with strength E and induction B. When the magnetic field is switched off, the trace of the beam on the screen S shifts by Δx. Knowing the distance a and b, find the specific charge q/m of the particles.

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29. An electron is accelerated through a PD of $100V$ and then enters a region where it is moving perpendicular to a magnetic field $B = 0.2T$. Find the radius of the circular path. Repeat this problem for a proton.

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30. 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.

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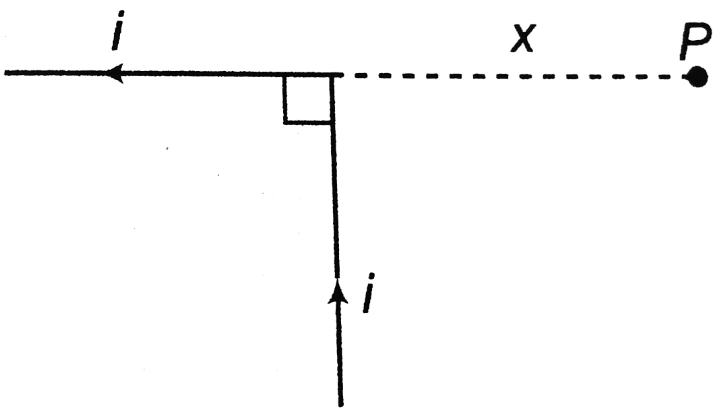
31. Determine the magnetic field at point P located a distance x from the corner of an infinitely long 2. Wire bent at right angle as shown in figure. The wire carries a steady current i.



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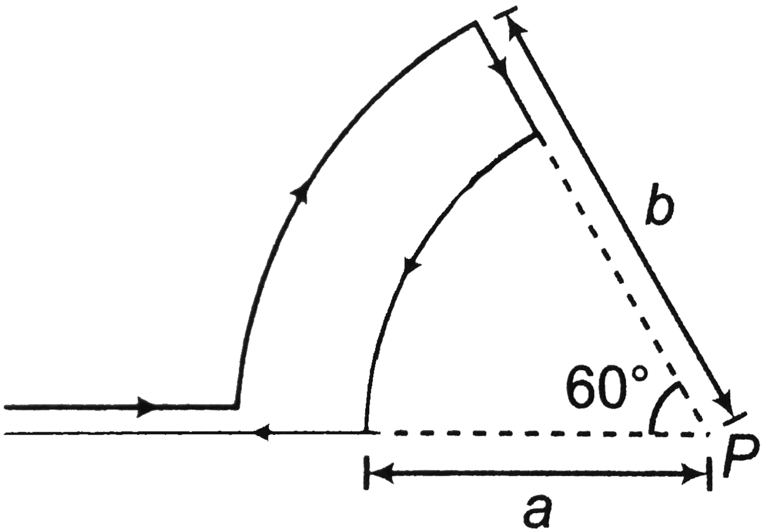
32. Consider the current carrying loop shown in figure formed of radial lines and segments of circles whose centres are at point P. Find the magnitude and direction of B at point P.



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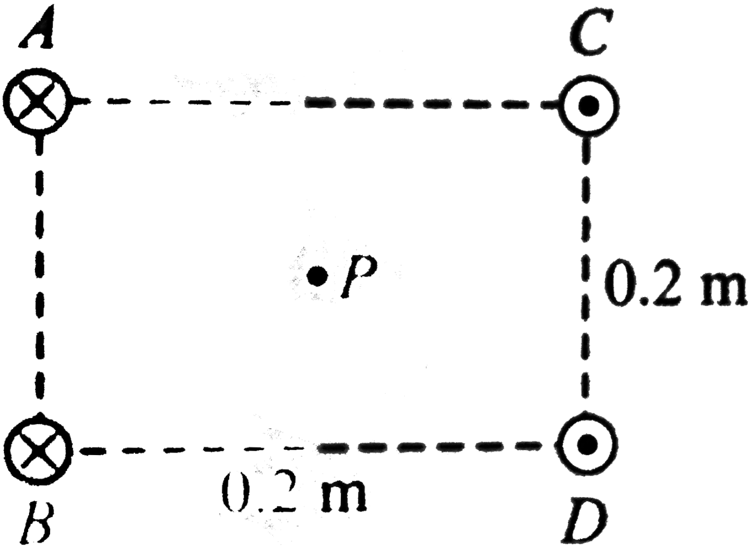
33. Four long, parallel conductors carry equal currents of 5.0A. The direction of the currents is into the page at point A and B and out of the page at C and D. Calculate the magnitude and direction of the magnetic field at point P, located at the centre of the square.



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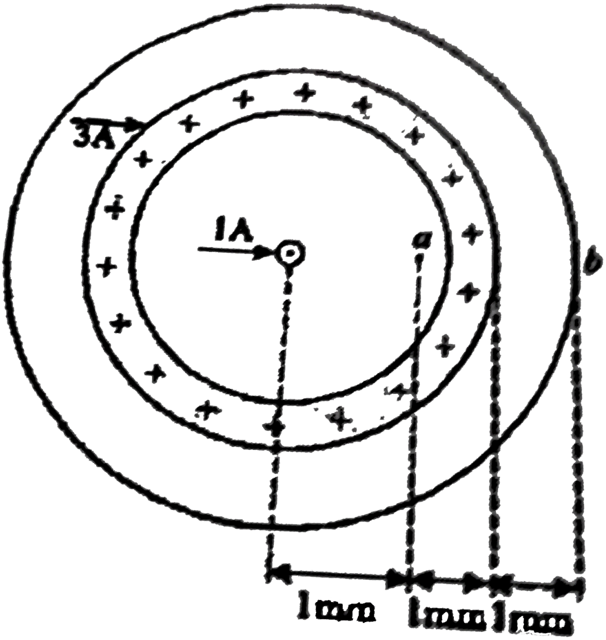
34. Figure given in the question is a cross-sectional view of a coaxial cable. The centre conductor is surrounded by a rubber layer, which is surrounded by an outer conductor, which is surrounded by another rubber layer. The current in the inner conductor is $1.0A$ out of the page, and the current in the outer conductor is 3.0A into the page. Determine the magnitude and direction of the magnetic field at points a and b.



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35. A galvanometer coil $5cm \times 2cm$ with 200 turns is suspended vertically in a field of $5 \times 10^{-2}T$. The suspension fibre needs a torque of $0.125x10^{-7}N-m$ to twist it through one radian. Calculate the strength of the current required to be maintained in the coil if we require a deflection of 6°.

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36. A charged particle carrying charge $q = 1\mu c$ moves in uniform magnetic with velocity $v_1 = 10^6 m/s$ at angle 45° with x-axis in the xy-plane and experiences a force $F_1 = 5\sqrt{2} mN$ along the negative z-axis. When te same particle moves with velocity $v_2 = 10^6 m/s$ along the z-axis it experiences a force F_2 in y-direction. Find

a. the magnitude and direction of the magnetic field

b. the magnitude of the force F_2.

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37. A wire shaped to a regular hexagon of side $2cm$ carries a current of $2A$. Find the magnetic field at the cetre of the hexagon.

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38. Three infinitely long thin wires, each carrying current i in the same direction, are in the $x - y$ plane of a gravity free space . The central wire is along the $y - a\xi s$ while the other two are along $x = \pm d$.

(i) Find the locus of the points for which the magnetic field B is zero.

(ii) If the central wire is displaced along the $Z - direction$ by a small amount and released, show that it will excecute simple harmonic motion . If the linear density of the wires is λ, find the frequency of oscillation.

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39. Uniform electrlc and magnetic fields with strength E and B are directed along of y-axis. A particle with specific charge $\frac{q}{m}$ leves the origin in the direction of x-axis with an initial velocity v_0. Find

a. the y-coordinate of the particle when it crosses the y-axis for nth time.

b. the angle α between the particle's velocity vector and the y-axis for nth time

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40. A particle of mass m and charge + q is projected from origin with velocity $\overrightarrow{V} = V_0\hat{i}$ in a magnetic field $\overrightarrow{B} = -(B_0x)\hat{k}$. Here V_0 and B_0 are positive constants of proper dimensions. Find the radius of curvature of the path of the particle when it reaches maximum positive x co-ordinate.

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41. A electron moves through a uniform magnetic field given by $\overrightarrow{B} = B_x\hat{i} + (3B_x)\hat{j}$. At a particular instant, the electron has the velocity $\overrightarrow{v} = \left(2.0\hat{i} + 4.0\hat{j}\right)m/s$ and magnetic force acting on it is $\left(6.4 \times 10^{-19}N\right)\hat{k}$. Find B_x.

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42. A neutral particle is at rest in a uniform magnetic field B. At time $t = 0$ it decays into two charged particles, each of mass m.

(a) If the charge of one of the particles is $+q$, what is the charge of the other?

(b) The two particles move off in separate paths, both of them lie in the plane perpendicular to B. At a later time, the particles collide. Express the time from decay until collision in terms of m, B and q.

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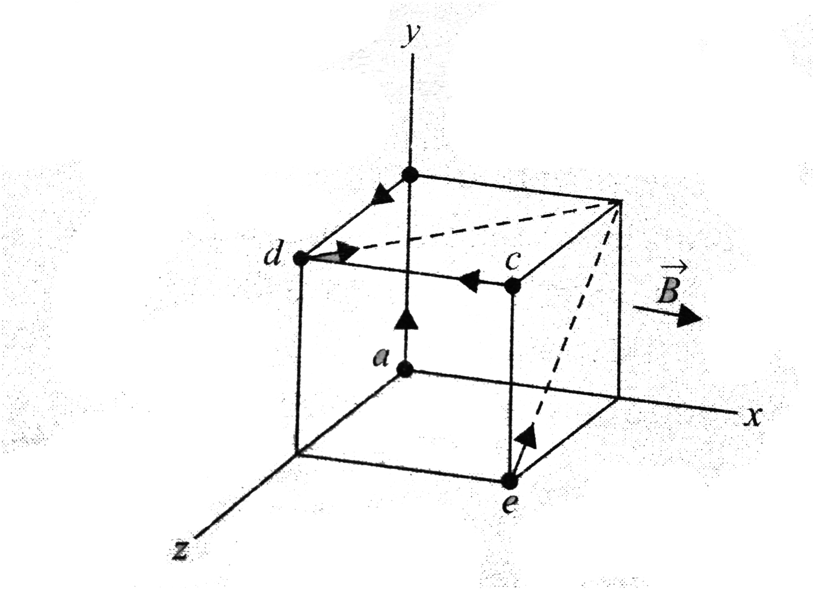
43. Each of the lettered points at the corners of the cube as shown in Fig. 1.60 represents a positive charge q moving with a velocity of magnitude v in the direction indicated. The region in the figure is in a uniform magnetic field $\vec{B}$, parallel to the x-axis and directed toward right. Copy the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



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44. A proton of charge e and mass m enters a uniform magnetic field $B = Bi$ with an initial velocity $v = v_x \hat{i} + v_y \hat{j}$. Find an expression in unit vector notation for its velocity at time t.

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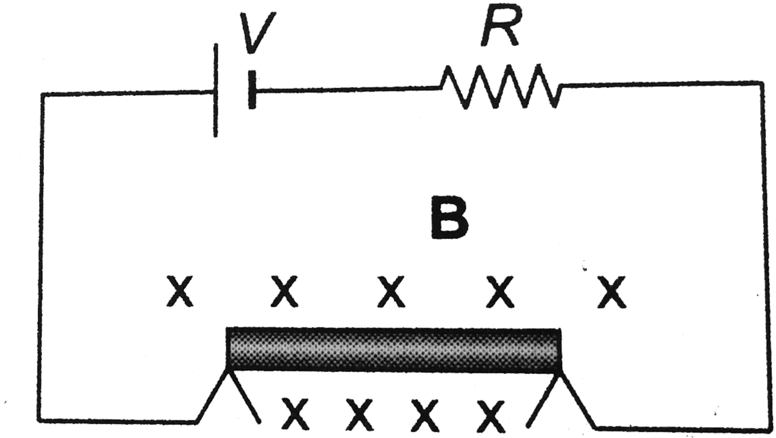
45. A thin, $50.0cm$ long metal bar with mass $750g$ rests on, but is not attached to, two metal supports in a $0.450T$ magnetic field as shown in figure. A battery and a resistance $R = 25.0\Omega$ in series are connected to the supports.



(a) What is the largest voltage the battery can have without breaking the circuit at the supper

(b) The battery voltage has this maximum value calculated. Decreasing the resistance to 2.0Ω the initial acceleration of the bar.

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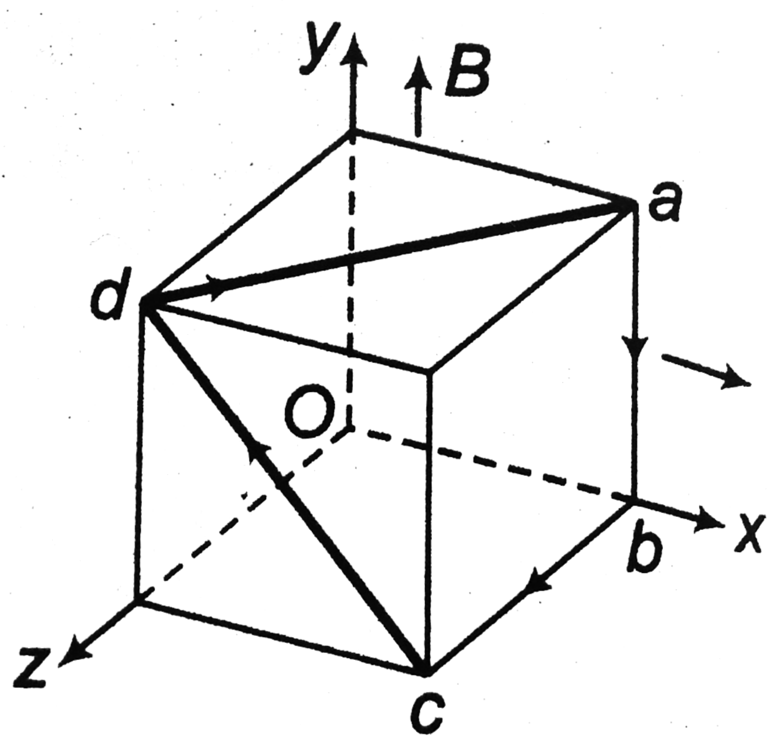
46. In figure, the cube is $40.0 cm$ on each edge. Four straight segments of wire ab, bc, cd and da form a closed loop that carries a current $I = 5.00 A$, in the direction shown. A uniform magnetic field B magnitude the positive y-direction. Determine the magnitude and $B = 0.020 T$ is in direction of the magnetic force on each segment.



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47. A length L of wire carries a current i. Show that if the wire is formed into a circular coil, then the maximum torque in a given magnetic field is developed when the coil has one turn only, and that maximum torque has the magnitude $\tau = L^2 i \frac{B}{4}\pi$

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48. A coil with magnetic moment $1.45A - m^2$ is oriented initially with its magnetic moment antiparallel to a uniform $0.835T$ magnetic field. What is the change in potential energy of the coil when it is rotated 180° so that its magnetic moment is parallel to the field?

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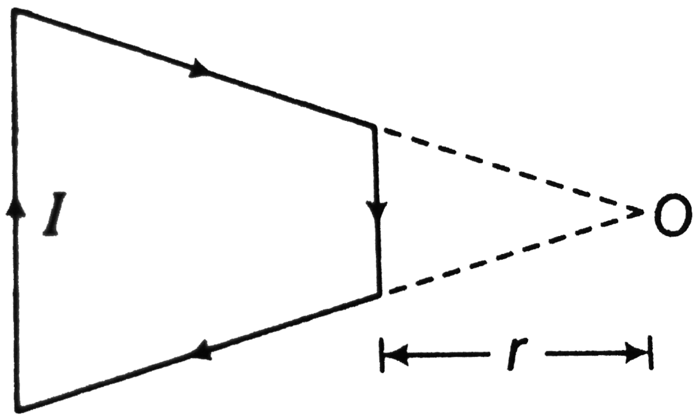
49. A current $I = \sqrt{2}$ A flows in a circuit having the shape of isosceles trapezium. The ratio of the bases of the trapezium is 2. Find the magnetic induction B at symmetric point O in the plane of the trapezium. The length of the smaller base of the trapezium is $100mm$ and the distance

$r = 50mm.$



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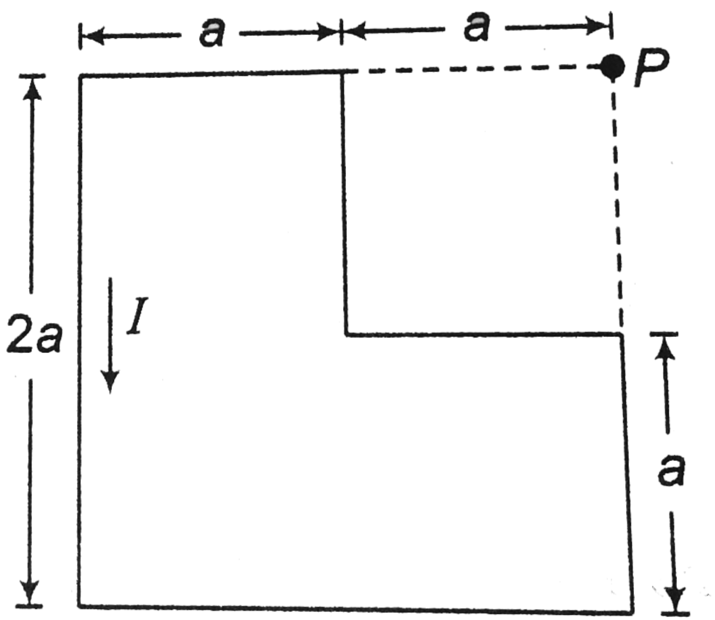
50. Find the magnetic field B at the point P in figure



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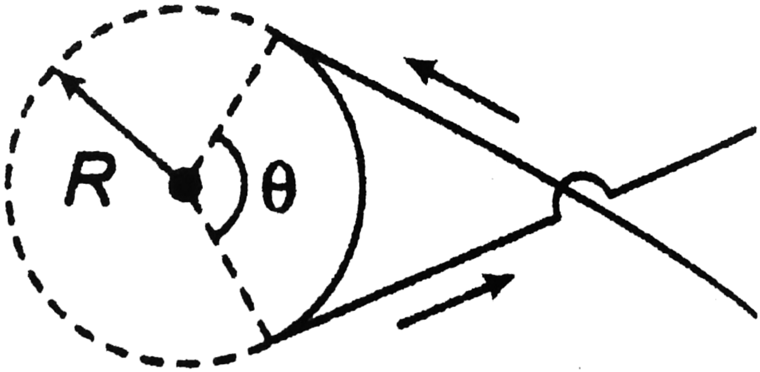
51. A wire carrying current i has the configuration as shown in figure. Two semi-infinite straight sections, both tangent to the same circle, are connected by a circular arc of central angle theta, along the circumference of the circle, with all sections lying in the same plane. What must be for B to be zero at the centre of the circle?



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52. A closely wound coil has a radius of 6.00 cm and carries a current of $2.50A$. How many turns must it have if, at a point on the coil axis $6.00cm$ from the centre of the coil, the magnetic field is $6.39 \times 10^{-4}T$?

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53. A closed cure encircles several conductors. The line integral $\int B.\,dI$ around this curve is $3.83 \times 10^{-7} T - m$

a. What is the net current in the conductors?

b. If you were to integrate aroundthe curve in the opposite direction, what would be the value of the line integral?

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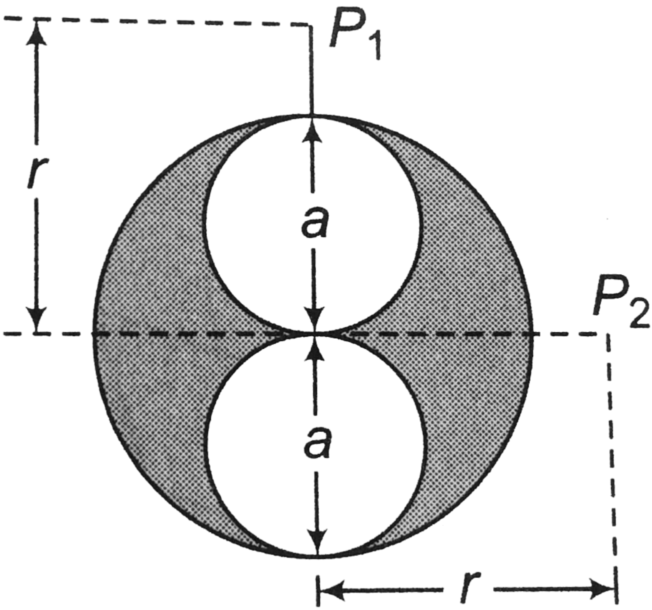
54. A long cylindrical conductor of radius a has two cylindrical cavities of diameter a through its entire length as shown in cross-section in figure. A current I is directed out of the page and is uniform throughout the cross-section of the conductor. Find the magnitude and direction of the magnetic field in terms of μ_0, I, r and a.



(a) at point P_1 and (b) at point P_2

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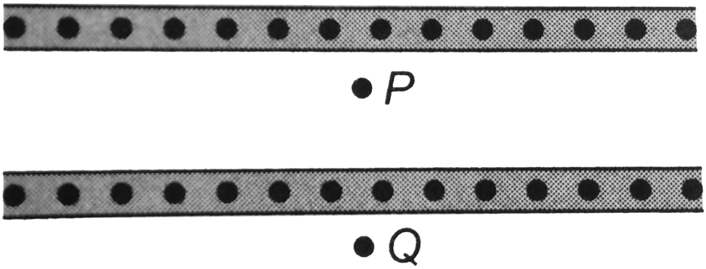
55. Two infinite plates shown in cross-section in figure carry λ amperes of current out of thepage per unit width of plate. Find the magnetic field at points P and Q.



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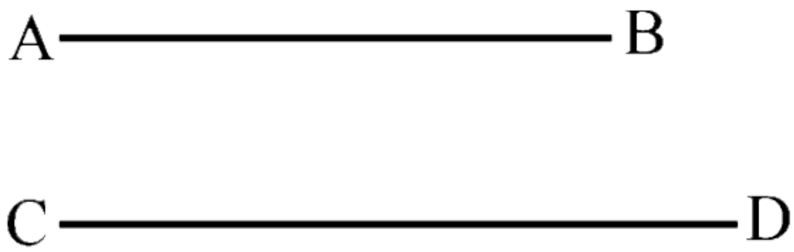
56. A long horizontal wire AB, which is free to move in a vertical plane and carries a steady current of $20A$, is in equilibrium at a height of $0.01m$ over another parallel long wire CD which is fixed in a horizontal plane and carries a steady current of $30A$, as shown in figure. Shown that when AB is slightly depressed, it executes simple harmonic motion. Find the period of oscillations.



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57. A magnet of length $0.1m$ and pole strength 10^{-4} A.m. is kept in a magnetic field of $30Wb/m^2$ at an angle 30°. The couple acting on it is $\ldots \times 10^{-4} Nm.$

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58. The force experienced by a pole of strength 100 Am at a distance of 0.2 m from a short magnet of length 5 cm and pole strength of 200 Am on its axial line will be

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59. A manetic needle is suspended at a distance of 1m from a short magnet on the eastern side on its axial line. The deflection produced is 30°. Calculate the horizontal component of earth's magnetic field if the magnetic moment of the magnet is $100Am^2$

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60. 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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61. A vibraiton magnetometer consits of two idential bar magnets placed one over the other such that they are mutually perpendicular and bisect each other. The time period of oscillations of combination in a horizontal magnetic field is $4s$. If one of the magnets is removed, then the period of oscillations of the other in teh same field is

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62. A small magnet of magnetic moment $\pi \times 10^{-3} Am^2$ is placed on the Y-axis at a distance of 0.1 from the origin with its axis parallel to the X-axix. A coil have 169 turns and radius 0.05 m is placed on the X-axis at a distance of 0.12 m from the origin with the axis of the coil coinciding with the X-axis. Find the magnitude and direction of the current in the coil for a compass needle placed at the origin, to point in the north-south direction.

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63. A circular of radius 0.157 m has turns. It is placed such that its axis is in magnetic meridian. A dip needle is supported at the centre of the coil with its axis of rotation horizontal, and in the plane of the coil. The angle of dip is 30° when a current flows through the coil. The angle of dip becomes 60° on reversing the current. Find the current in the coil assuming that the magnetic field due to the coil is smaller than the horizontal component of earth's magnetic field, $H = 3 \times 10^{-5} T$.

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64. A small magnet of magnetic moment M is placed at broad side on position of a magnet of magnetic M', length 2l' in such a way that the axis of former coincides with the perpendicular bisector of the latter. The separation between their centres is d. Calculate the nature of interaction (force or couple) among them. What is its limiting value, when d becomes very large ?

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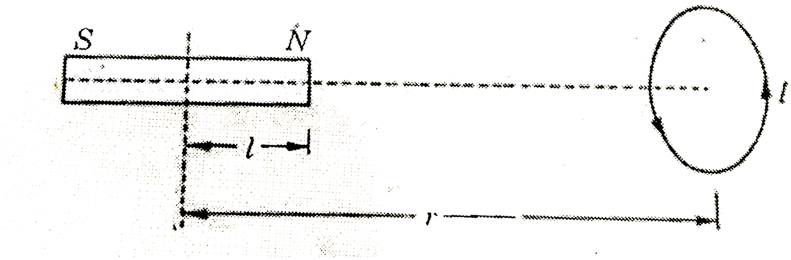
65. A small coil of radius 0.002 m is placed on the axis of a magnet of magnetic moment $10^5\ JT^{-1}$ and length 0.1 m at a distance of 0.15 m from the centre of the magnet. The plane of the coil is perpendicular to the axis of the magnet. Find the force on the when a current of 2.0 A is passed through it.



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

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67. A coil of 50 turns and 10cm diameter is made out of a wire of resistivity $2 \times 10^{-6} \Omega cm$ and cross sectional radius 0.1mm. The coil is connected to a source of EMF $10V$ and of negligible internal resistance.

(a) Find the current through the coil

(b) What must be potential difference across the coil so as to nullify the horizontal component of earth's magnetic field, $0.314 \times 10^{-4} T$ at the centre of the coil. How should the coil be placed to achieve. this result?

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68. A Rowland ring of mean radius 15 cm has 4500 turns of wire wound on a ferromagnetic core of relative permeability 800. Find the magnitnde of the magnetic field in the core for a magnetising current of 1.2 A.

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69. A magnet is suspended at an angle 60^0 in an external magnetic field of $5 \times 10^{-4} T$. What is the work done by the magnetic field in bringing it in its direction? $[\text{The magnetic moment} = 20 A - m^2]$

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70. The time period of a bar magnet oscillating in a uniform magnetic field is 3 seconds. if the magnet is cut into two equal parts along the equatorial line of the magnet and one part is made to vibrate in the same field, what is the time period ?

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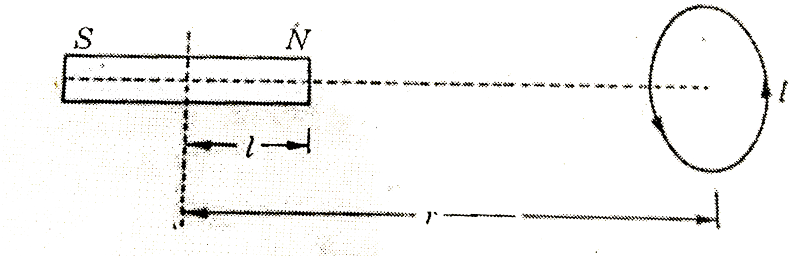
71. A small coil of radius 0.002 m is placed on the axis of a magnet of magnetic moment $10^5 \ JT^{-1}$ and length 0.1 m at a distance of 0.15 m from the centre of the magnet. The plane of the coil is perpendicular to the axis of the magnet. Find the force on the when a current of 2.0 A is passed through it.



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72. Find the interaction energy of two loops carrying currents I_1 and I_2 if both loops are shaped as circles of radii a and b, with $a < < b$. The loops centres are located at the same point and their planes from an angle θ between them.

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

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74. A particle accelerated by a potential difference V flies through a uniform transverse magnetic field with induction B. The field occupies a region of space din thickness. Prove that the angle a through which the particle deviates from the initial direction of its motion is given by.

$\alpha = \sin^{-1}\left(dB\sqrt{\frac{q}{2Vm}}\right)$

where m is the mass of the particle.

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75. A beam of electrons enters a uniform magnetic field of $0 \cdot 3T$ with a velocity of $4 \times 10^5 ms^{-1}$ at an angle of 60° to the field. Find the radius of the helical path taken by the beam. Also find the pitch of the helix (distance travelled by a proton parallel to the magnetic field during one period of rotation). Mass of proton is $1 \cdot 67 \times 10^{-27} kg$.

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

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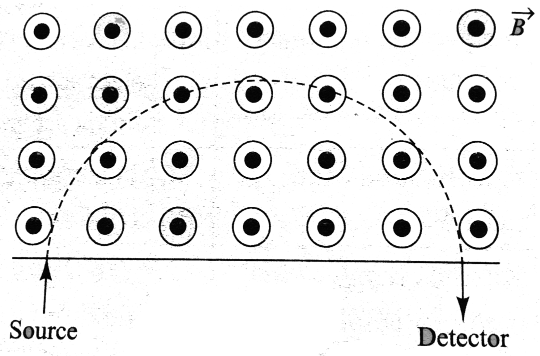
77. A uniform magnetic field with a slit system as shown in Fig. is to be used as a momentum filter for highenergy charged particles. With a field B tesla, it is found than the filter transmits α each of energy 5.3MeV. The magnetic field is increased to 2.3 tesla and deuterons are passed into the filter. 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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78. A deflection of 24 divisions ofa ballistic galvanometer is obtained either by charging a capacitor of $3\mu F$ capacitance to a potential difference of $2V$ and discharging through the galvanometer or by connecting the ballistic galvanometer in series with a flat circular coil of 80 turns, each of diameter 1cm, the combined resistance of coil and galvanometer being 4000 ohm and quickly thrusting the coil into a strong magnetic field so that the plane of the coil is perpendicular to the direction of the field. Calculate the sensitivity of the galvanometer and calculate the strength of the magnetic field. The strength of the earth's magnetic field may be neglected.

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79. Find the ratio of magnetic dipole moment and magnetic field at the centre of a disc. Radius of disc is R and it is rotating at constant angular speed o about its axis. The disc is insulating and uniformly charged

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