PHYSICS

BOOKS - MODERN PUBLISHERS PHYSICS (HINGLISH)

MOVING CHARGES AND MAGNETISM

SOLVED EXAMPLES

1. One charged particle with $+2e$ charge is projected from west to east with a speed of 2×10^6 m/s. A magnetic field of 2 T exists in the direction south to north. Find the magnetic force acting on the charged particle. In which direction the particle is going to get deviated? Neglect gravity and other forces.

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2. A particle with charge $+Q$ is moving on $X - Y$ plane.

Magnetic field existing in the region is given as $\overrightarrow{B} = B_o\hat{k}$.

At a certain instant of time net magnetic force acting on the particle is $\overrightarrow{F} = F_0\hat{i} + 2F_0\hat{j}$. Find the instantaneous velocity of particle.

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3. A charged particle is inside a magnetic field $\overrightarrow{B} = \left(10\hat{i} - 6\hat{j}\right) \times 10^{-4}T$. The acceleration of the charged particle is given by $\overrightarrow{a} = 3\hat{i} + x\hat{j}m/s^2$. What should be the value of x for this to be possible?

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4. A negative charge of magnitude 2 μC is moving with a speed of $3 \times 10^6 m/s$ along the positive Y-axis . A magnetic field $\vec{B} = \left(0.5\hat{i} - 0.4\hat{k}\right)$ T acts in the space.

What is the magnitude and direction of force on the given charge ?

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5. Suppose a magnetic field of 50 microtesla is applied along south to north direction. With what velocity should an electron be projected towards the west so that the upward magnetic force may balance its weight? In which direction and with what speed should a proton be projected so that magnetic force may balance its weight? Take $g = 10m/s^2$.

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6. A proton is moving horizontally with a velocity of 2×10^6 m/s. It suddenly enters a region of uniform magnetic field of 10^{-2} gouss acting vertically upwards as shown.

Trace the trajectory of prolon and calculate the taken by it to come out of the magnetic field region.

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7. A uniform magnetic field of 1 Tesla in space. The velocity of particle is V perpendicular to the magnetic field intensity. Find the radius of circular path followed by the particle. How much time will the particle take to complete one revolution? mass of particle is m and charge on particle is q

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8. A proton and an alpha particle, both are moving with same initial velocity, perpendicular to uniform magnetic field of 1 T. Find the ratio of radii of circles described by the alpha particle and the proton.

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9. A neutron and a proton both are fired with some speed of 3×10^6 m/s perpendicular to a uniform magnetic field of 1 T. What will be the individual acceleration of particles! Consider that only magnetic force is acting on the particles.

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10. An electron is moving in a circle of radius0.5 m inside a magnetic field of IT. Find the speed of electron. Are you getting a realistic value? What would be your answer if the particle was a proton instead of an electron?

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11. Two types of particles having same charge equal to $+2e$ but different masses are moving with a constant velocity of 6×10^4 m/s in the form of a beam. These particles suddenly encounter a perpendicular magnetic field in a rectangular region having intensity equal to 0.5 T. It is found that particles emerge from the field in the backward direction from two different points. These points are at a distance 3 cm and 3.5 cm from the incident beam. Find the ratio of their masses.

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12. An electron gun is firing electrons after accelerating them with a potential difference of V. These electrons are needed to get deviated by 90° with in a distance I after exit from gun. What transverse magnetic field intensity do you require for this?

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13. An alpha particle is travelling in a helical path after being projected into a magnetic field of 0.05 T. If the radius of helical path is 2 cm and pitch is 10 cm, find the components of the velocity of the alpha particle along and perpendicular to the magnetic field. Take the mass of alpha particle $= 6.64 \times 10^{-27}$ kg .

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14. A cyclotron has oscillatory frequency of 3×10^7 Hz and a dee radius of 60 cm. A deuteron is accelerated in the given cyclotron. Find the magnitude of magnetic field used to accelerate the deuteron. Also, calculate the energy possessed by the deutron after coming out from the cyclotron (in MeV).

Take, mass of deutron $= 3.34 \times 10^{-27}$ kg

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15. Protons are accelerated in a cyclotron using a magnetic field of 1.3 T. Calculate the frequency with which the electric field between the dees should be reversed.

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16. A copper wire of length 0.5 m and cross sectional area $10mm^2$, carries a current perpendicular to a magnetic field of strength 10gauss. As a result, the wire experiences a force of 0.06 N. What is the drift velocity of free electrons in the copper wire? Take the number density of electrons $= 8 \times 10^{28} m^{-3}$ and atomie weight of copper $= 63.5$.

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17. A magnetic field $\overrightarrow{B} = \left(\hat{i} + 0.5\hat{j} + 0.25\hat{k}\right)$ T exists in a space. A wire of length $\overrightarrow{l} = \left(0.25\hat{i} - 0.25\hat{j}\right)$ m carries a current of 1 A and is placed in the magnetic field region.

Find the magnitude of magnetic force on the wire.

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18. A magnetic field in a region of space is given by $\overrightarrow{B} = 2\hat{i} + 3\hat{j} - \hat{k}$ tesla. A straight wire of length Z carrying current I is placed along the Z-axis. Find the angle made by net magnetic force with the positive X-axis.

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19. A very long straight current carrying conductor is carrying current of 2 A from west to east in a horizontal plane. Suddenly, a magnetic field of 4×10^{-5} T is switched on in vertically downward direction. Find the magnitude and direction of force per unit length of the conductor. How will the force unit length changes if the current in the wire is reversed ?

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20. A cylindrical region of magnetic field is produced by an electromagnet as shown in the figure. A wint carrying a current of 0.5 A is placed perpendicularly to the axis of the cylindrical region. If the magnetic field produced by the electromagnets is 2.0 T in strength and the radius of cylindrical region is 5 cm, find the magnetic force acting on the wire due to the magnetic field in the region.

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21. A straight wire carrying current of 1 A is suspended in a magnetic field. If the length and mass of the wire are 50 cm and 500 g respectively, what should be the magnitude of the magnetic field, so that it stays in equilibrium? Take $g = 10m/s^2$.

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22. A magnetic field of 0.25 T is acting in a region from west to east. A wire PQ is bent and is placed in the magnetic field as shown in figure.

If a current of 5 A flows through the wire, then calculate the magnitude of magnetic force acting on the wire.

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23. The figure given below shows the arrangement of a uniform loop placed inside a magnetic field.

If the total resistance of all the four sides is 12Ω and the magnetic field strength is0.4 T. find the magnitude of magnetic force acting on the side AB.

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24. A uniform magnetic field Bexists along the Z-direction. A metal wire carrying current I, is placed along the curve $y = b \sin. \frac{2\pi}{\lambda} x.$ Calculate the magnetic force acting on a portion from $x = 0$ to $x = 5\lambda.$

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25. A rectangular coil is made of 100 turns and has dimension of $50cm \times 20cm$, carrying a current of 10A It is placed inside a magnetic field of 5 T making an angle of 30° with the field. What is the torque acting on the coil?

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26. A length L of a wire carries a current I. Prove that if the wise is formed into a circular loop, the maximum torque in a given magnetic field will be developed if the coil has one turn only. Find the value of the maximum torque acting on the circular coil.

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27. A coil of 500 turns and carrying 2A current is placed between the poles of an electromagnet of strength $0.1 \ \text{Wb/m}^2$ as shown in the figure. Find the magnitude and direction of luryue acting on the coil.

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28. A circular loop of area $1cm^2$, carrying a current of 10 A , is placed in a magnetic field of 0.1 T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is

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29. A circular current coil with 100 turns and area $20cm^2$ is placed in a uniform magnetic field in such a manner that magnetic field lines are parallel to the plane of the coil. Torque experienced by the coil is0.1 Nm when a current of 1 A is passed through the coil. What is the magnitude of magnetic field intensity?

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30. A circular coil of 100 turns and radius 2 cm is placed in a uniform magnetic field of strength0.1 T. Current flowing through the coil is 10 A. Coil is held in an orientation that it experiences maximum possible torque. By what angle should the plane of the coil be rotated that torque acting on it becomes half of this maximum value ?

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31. We have one rectangular coil of 50 turns and size of the coil is $20cm \times 10$ cm . A magnetic field of intensity0.1 T is applied in such a way that magnetic lines make an angle 30 degree with the plane of the coil. The current passing through the coil is 1 A. What would be the net force experienced by the coil and net torque ?

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32. Charge Q is uniformly distributed over a nonconducting ring of radius R and mass m. It is made to rotate about an axis passing through its centre and perpendicular to its plone with an angular velocity of rotation ω. Find its magnetic dipole moment and its ratio with angular momentum.

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33. uniformly charged disc of radius R and total charge Q is rotating about its axis passing through the centre of diae and perpendicular to the plane of dise, with an angular velocity ω. Calculate its magnetic dipole moment. Also find the ratio of angular momentum to that with the calculated magnetic moment of the system.

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34. A rectangular coil of N turns, with each turn of length 6 cm and breadth 8 cm is suspended freely in a magnetic field of strength 90

G. The field lines are in the plane of the coil. The torsional constant of the hair springs connected to the coil is 3×10^{-9} Nm/deg and a current of $5\mu A$ through the coil deflects it through on angle of 20° . What is the value of N?

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35. The coil of a moving coil galvanometer is suspended in a magnetic field of 100 G. If the torsional constant of the suspension wire is 1.5×10^{-8} Nm/rad, find the current sensitivity of galvanometer. The area of the coil is $0.05m^2$.

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36. When a current of $100\mu A$ is passed through the coil of a moving coil galvanometer, it is deflected through an angle of 15°.

Calculate the value of current required to cause a deflection of $\pi / 20$ radians. Also, calculate the sensitivity of the galvanometer.

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37. What is the voltage sensitivity of a galvanometer if it requirs 100 mV for a full - scale deflection of 60 divisions ? Also calculate the resistance of the galvanometer coil if its current sensitivity is 2 divisions / μA.

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38. A current element of length 0.1 cm is placed along northsouth direction and carries a current of 5 A from south to north. Find the magnetic field due to the current element at a point located at a distance of 150 cm from it towards east.

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39. A long straight wire , lying in horizontal plane is carrying 20 A of current from east to west. What is the magnetic field due to the wire at a point (i) 10 cm south from the wire and (ii) 20 cm upward in its vertical plane?

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40. Two long current carrying wires A and B separated by 20 cm are carrying currents of 10 A and 20 A respectively in the opposite directions. Find the magnitude and direction of magnitic field at a point 10 em from both the wires.

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41. The arrangement of two wires A and B carrying currents is shown below:

The current flowing in the wires A and B is 3 A and 2 A respectively. Find a point along the line AB where the resultant magnetic field due to both the wires is er in terms of distance between the wires.

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42. A straight metal wire of length L is carrying a current i. Calculate the magnetic field intensity due to this wire at a point which is at the same distance from both ends of the rod and equal to length of road.

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43. Find the magnetic field at the centroid of an equilateral triangle of side 0.03 m and a current 2 A flowing through the sides of it.

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44. A circular coil is lying in a horizontal plane. The coil has 20 turns with each turn of radius 10 cm. For an observer above the coil, the current of 5 A appears to flow in the anticlockwise direction. What is the magnitude and direction of magnetic field at the centre of the coil?

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45. Two identical current carrying coils of radius 10 cm each are placed coaxially 0.5 m apart. Find the magnetic fields at the centre of each coil if a current of 0.5 A is passed through each of them in opposite directions. Assume that each coil is made of a single turn.

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46. A current loop ABCD is shown below having two semicircular elements AD and BC joined by two straight wires BA and DC. Find the resultant magnetic field at the centre O.

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47. A thin metallic wire is bent into a shape as shown in figure.

O is the common centre of all the circular arcs. What is the magnetic field at O?

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48. Two long parallel straight wires, each carrying a current of 2 A are placed at distance of 3 cm. Calculate the force acting per unit length of each wire. Also, state the nature of force between the wires if the currents flow in the same direction in both the wires.

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49. A current carrying wire A is carrying current of 10 A from east to west and is fixed. Another wire B of maas 5 g, length 2 m and carrying a current 20 A is placed below the wire such that it remains suspended due to the magnetic force. Find the position of wire B and also indicate the direction of current in B. Take $g = 10m/s^2$.

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50. A long straight conductor is carrying a current of 20 A as shown in the figure. At a distance of 5 cm from it, a square loop PQRS of side 15 cm is placed with its side PQ nearest to the wire. If the square loop carries a current of 10 A as shown, what is the net force on the loop?

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51. Two infinitely long parallel straight conductors X and Y are placed 20 cm apart and are carrying currents of 20 A and 10 A as shown in the figure.

If a third conductor of 10 cm length and carrying 5 A current is now placed between X and Y, how much force it will experience. Consider that the direction of current in the third conductor is opposite to that in conductors X and Y.

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52. A solenoid made up of copper wire consists of 400 turns and carries a current of 5 A. If length of the solenoid is 0.5 m and has a radius of 2 cm, find the magnitude of the magnetic field inside the solenoid.

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53. A copper wire of resistance $0.02\Omega/m$ is used to construct a 1 m long solenoid of 500 turns and radius 1 cm. A battery of emf 1 V is connected across the solenoid. Find the magnetic field near the centre of the solenoid.

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54. A solenoid 60 cm long and of radius 4 cm has 3 layer of windings 300 turns each. A 2.3 cm long wire of mass 2.5g lies inside the solenoide near its centre normal to its axis, both the wire and the axis of the solenoid are in the horizontal plane. The wire is connected through two leads parallel to the axis of the solenoid to an external battery which supplies a current of 6A in the wire. What value of current (with appropriate sense of circulation) in the windings of the solenoid can support the weight of the wire?

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55. A coil made of 10 turns of a wire wound in a circular loop of radius0.02 m, carries a current of $0.5 \wedge$ and is placed inside a solenoid of 400 tums and length 0.5 m. If the solenoid carries a current of 0.2 A, what torque will be required to hold the coil in the centre of the solenoid when placed with its plane along the axis of solenoid.

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56. A toroid consists of a coil wrapped around with 4 layers of windings of 300 turns each. The inner and outer radius of toroid are 10 cm and 15 cm, respectively. Il the coil carries a current of 15 A, find the maximum and minimum values of the magnetic field within the toroid.

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PRACTICE PROBLEMS

1. In a region of magnetic field 0.05 T directed along positive direction of Y-axis, a beam of charged particles enters the region along X-axis with a velocity of $2.5 \times 10^4 ms^{-1}$. Calculate the radius of circular path described by the charge particles if their charge to mass ratio is $7.5 \times 10^6 Ckg^{-1}$.

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2. Three charged particle with charge in ratio,$1:1:2$ and mass in ratio $1:2:4$ enters in a region of uniform magnetic field. Calculate the ratio of radii of circular path described by three particles when inetic energy of all three particles is same.

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3. A long conducting wire is placed along Y-axis and a current of 5 A is flowing through it in positive Y-axis. A charged particle of charge $+3.2 \times 10^{-19}$ C is moving parallel to the conductor towards negative Y-axis with a speed of $5 \times 10^4 ms^{-1}$. Calculate the force exerted by the magnetic field of current on charged particle. The perpendicular distance between charged particle and wire is 25 cm.

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4. Can we calculate the force experienced by a charge moving in a magnetic field?

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5. A cyclotron's oscillator frequency is $10MHz$. What should be the operating magnetic field fro accelerating protons? If the radius of its dees is $60cm$, what is the kinetic energy (in MeV) of the proton beam produced by the acceleration?

$(e - 1.60 \times 10^{-19}C, m_p = 1.67 \times 10^{-27}kg, 1MeV = 1.6 \times 10^{-13}J)$

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6. A beam of charged particle enters in a region of magnetic field of 5×10^{-3} weber m and electric field of $2.5 \times 10^{4} V m^{1}$,acting perpendicularly. Calculate the speed of particles perpendicular to electric and ,magnetic field , if their path remains unchanged. The given charge on particles and mass are $3.2 \times 10^{-19} C$ and 12×10^{-31} kg , respectively.

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7. A beam of charged particle enters in a region of magnetic field of 5 × 10^(−3) weber m and electric field of 2.5 × 10 4 V m 1 ,acting perpendicularly. Calculate the speed of particles perpendicular to electric and ,magnetic field , if their path remains unchanged. The given charge on particles and mass are 3.2 × 10 − 19 C and 12 × 10 − 31 kg , respectively.calculate the radius of circular path traced by the charged particle if the electric field is removed .

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8. A proton is accelerated in cyclotron with dees of radius 40 cm has a operating frequency of 12 MHz. Calculate the magnitude of magnetic field. Given mass of proton, $m_P = 1.67 \times 10^{-27}$ kg and charge on proton $q_P = 1.6 \times 10^{-19} C$.

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9. An alpha particle is accelerated in a cyclotron with dees of radius 40 em and operating at frequency of 20 MHz. Calculate the kinetic energy of the alpha particle if magnetic field in cyclotron ia 1 tesla. Given, mass of alpha particle $m_\alpha = 6.65 \times 10^{-27}$kg and charge of α - particle $q_\alpha = 3.2 \times 10^{-19} C$.

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10. A wire of length 15 cm carrying current of 5 Ais balanced in air by a uniform magnetic field, B. The mass of wire is0.5 grams. Calculate the value of B.

Use g = $10ms^{-2}$.

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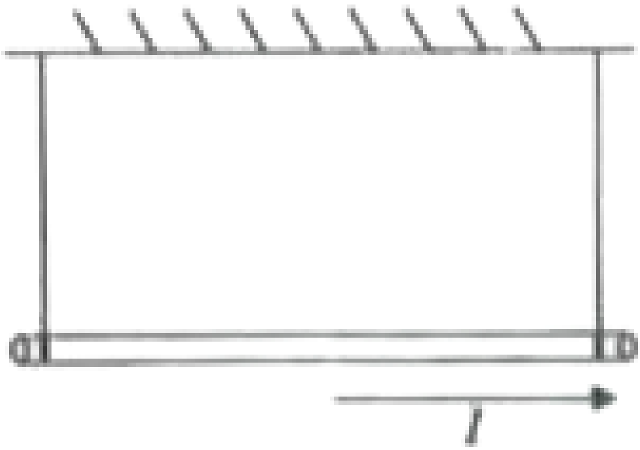
11. An iron rod of mass 50 g and length 50 cm is suspended by master wires as shown in the figure. Calculate the magnitude and direction of magnetic field to be set in the region such that the tension is the wires is zero. The current in the rod is 4 A.



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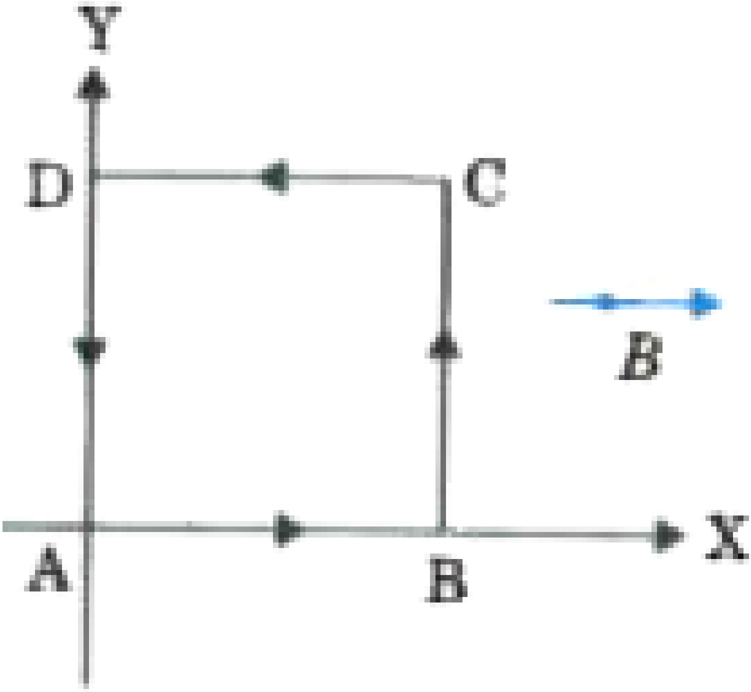
12. A square loop of conducting wire of side 10 cm carrying current of 1 A shown in adjoining figure is placed in a region of magnetic field of0.2 T directed towards positive X-axis calculate the force on each side of the square.



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13. चुम्बकीय क्षेत्र में गतिमान आवेश पर लगने वाले बल की दिशा ज्ञात होती हैं-

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14. Calculate the maximum torque experienced by a rectangular coil of length 10 em and breadth 8 cm carrying current of 100 mA and has 1,000 turns placed in a region of magnetic field of $0.2T$ such that magnetic field lie on the plane of coil.

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15. A coil bent in form of an equilateral triangle of side 10 cm is suspended with the help of a mass less string through one of its vertex. Calculate the torque experienced by the coil if the magnetic field in the region is0.2 T directed horizontally and current of 1 A is passing through the coil.

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16. A wire is bent to form a circular coil of radius 5 cm with 20 loops. The coil is placed in a magnetic field of 0.5 T and a current of 1 A flow through it. Calculate the maximum torque exerted by magnetic field.

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17. A rectangular coil of 10 em by 8 cm is suspended vertically in a region of horizontal magnetic field of 1.5T such that the field lines make an angle of 60° with the normal to the coil. Calculate the couple acting on the coil when a current of 5 A is passing through it.

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18. A circular coil of 30 turns and radius 15 cm carries a current of 5 A. Calculate the net torque on the coil when it is placed in a uniform magnetic field of0.2 T normal to the plane of coil. Also calculate the net force on the coil.

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19. A circular coil of 30 turns and radius 15 cm carries a current of 5 A. placed in a uniform magnetic field of 0.2 T normal to the plane of coil. , the coil has an aren of cross section $2 \times 10^{-6} m^2$ and electron density of $10^{27} m^{-3}$. Calculate the average force on each electron in the coil due to magnetic field.

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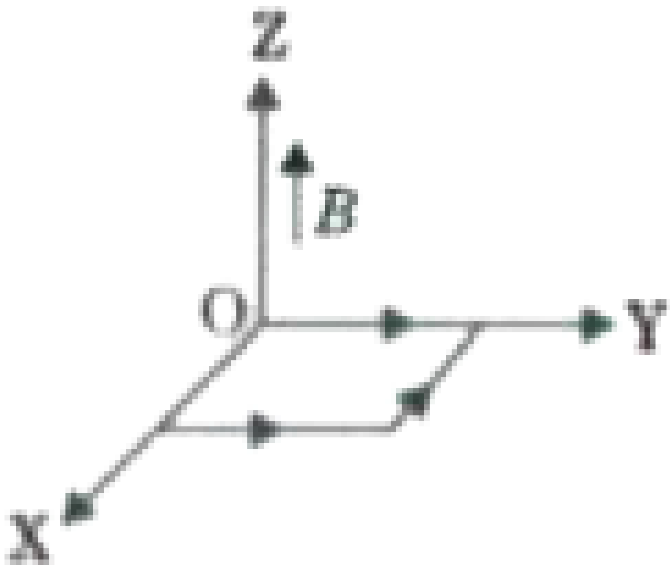
20. A rectangular loop of length 10 cm and 8 cm is carrying current of 10 A placed in X-Y plane as shown in adjoining figure. Calculate the torque on the loop if uniform magnetic field of 0.2 T is directed along positive Z-direction.



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21. A coil having 1,000 turns closely wound and an area of cross section $2 \times 10^{-5} m^2$ carries a current of 4A. The coil is kept in a region of uniform magnetic field of0.2 T. Calculate the net torque acting on the coil if it is free to move about vertical axis and its axis makes an angle of 30° with the magnetic field lines.

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22. The rectangular coil of a moving coil galvanometer has area of $8 \times 10^{-4} m^2$ and 100 turns. The coil is kept in a radial horizontal magnetic field of0.2 T.

Calculate the restoring torque constant of hair spring connected to coil when current of 4×10^{-5} A passes through it and deflects the scale by 20° .

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23. A moving coil galvanometer has a rectangular coil of area $10^{-3} m^2$ and 150 turns. The torsional constant of the hair springe connected to the coil is 5×10^{-7} Nm per degree. The maximum angular deflection is 30°.

Calculate the maximum current that can be measured by it if its rectangular coil is kept in a radial horizontal magnetic field of $2,000G$.

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24. In previous problem, if the minimum angular deflection that can be recorded is 0.2°, then calculate the minimum current that can be measured by the galvanometer.

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25. In a moving coil galvanometer, the current sensitivity increases by 30%.

When the coil resistance is doubled, calculate the percentage change in its voltage sensitivity.

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26. Two moving coil galvanometers A and B have rectangular coil of 100 turns each. The area of coil of galvanometers A and B are $2 \times 10^{-4} m^2$ and $6 \times 10^{-4} m^2$ respectively. Calculate the ratio of current sensitivity of A to B if coils in both salvanometers are kept in a radial horizontal magnetic field of 0.2 T and the torsional constant of hair springs are also same.

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27. In the previous problem calculate the ratio of voltage sensitivity if ratio of resistance of coil A to resistance of coil B is $1:3$.

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28. Calculate the magnetic field at a point P. 0.5m away from an infinitely long straight wire carrying current of 90 A.

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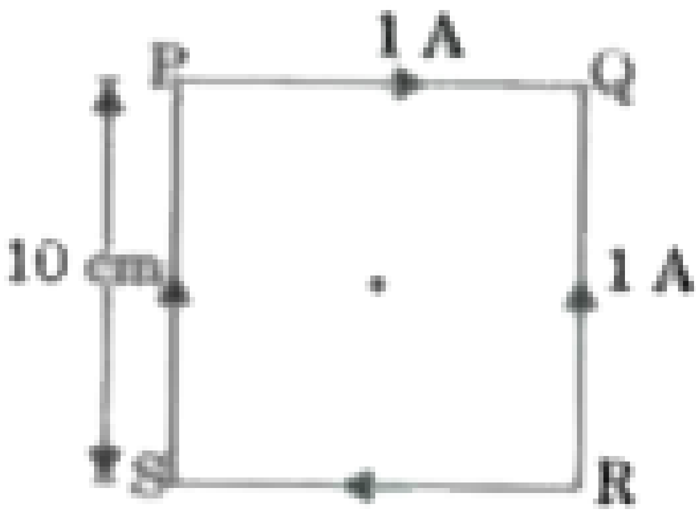
29. Calculate the magnetic field induction at the centre of a square shaped coil of side 10 cm, if it carries of current of 1A.



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30. A point charge $3.2 \times 10^{-19} C$ makes 7×10^{15} revolutions per second in a circular path of radius 1Å. Calculate the magnetic induction at the centre of the circular path.

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31. An electron moves with a uniform speed of $1.8 \times 10^{6} ms^{-1}$ in a circular orbit of radius 0.8Å. Calculate the magnetic induction at the centre of orbit.

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32. Consider a tightly wound 100 turn coil of radius 10 cm, carrying a current of 1 A. What is the magnitude of magnetic field at the centre of the coil?

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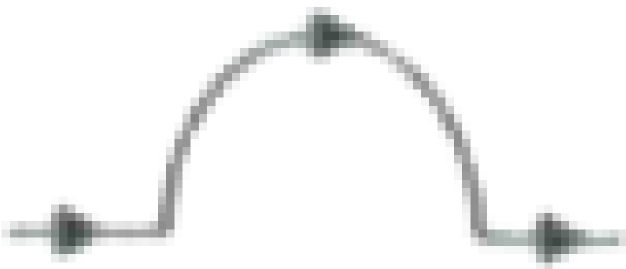
33. A straight wire carrying a current of 12 A is bent into a semi-circular are of radius of2.0 cm as shown in the adjoining figure (a). Consider the magnetic field B at the centre of the arc. Would your answer be different if the wire were bent into a semi-circular arc of the same radius but in the opposite way a shown in figure (b)?



(a)

(b)

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34. Magnetic field at the centre of a circular loop with n turns is 0.50 mt. Calculate the value of n if current of 5.3 A flows in the loop and radius of loop is 2 cm.

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35. A circular coil with 100 turns and radius 20 cm is kept in Y-Z plane with its centre at the origin. Find the magnetic field at point (20 cm, 0, 0) if coil carries a current of2.0 A.

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36. A0.5 m long conducting wire is bent in form of a circle, Calculate the magnetic field at the centre if wire carries a current of 5 A.

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37. Two circular loops of radius 6 cm and 8 cm are kept in Y-Z plane with their centres at (0, 0, 0) and (14 cm, 0, 0). Current in the first loop is 1 A and is in an anticlockwise direction, when seen from the second loop. Calculate the magnitude and direction of current in the second loop such that net magnetic field at point (8 cm, 0, 0) is zero.

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38. How are the magnitude and direction of magnetic field at a point denoted by the magnetic lines of force ?

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39. A circular metallic ring has a radius r. A battery of V volts is connected across the diameter of the ring as shown in the adjoining figure. Calculate the magnetic field at the centre of the coil.

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40. A straight conducting wire is bent as shown in the adjoining figure. Calculate the magnetic field at point O.

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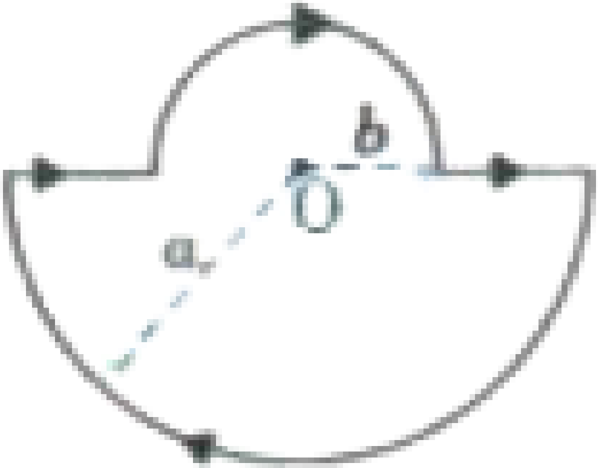
41. A wire is bent forming two semicircles as shown in the figure. Calculate the magnitude of magnetic intensity at the centre.



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42. . A small circular ring of radius R is placed in Y-Z plane with its centre at $(-a, 0, 0)$. Another small circular ring of same radius Ris placed in X-Z plane with its centre at$(0, -a, 0)$. Calculate the magnitude and direction of net magnetic field at the origin (0, 0, 0), if both the rings carry current I. The direction of current in the first loop and the second loop is clockwise and anticlockwise respectively, when seen from the origin.

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43. Calculate the change in magnetic field induction at the centre of a current carrying loop of radius R, if the radius of coil is reduced to half and current through it changes from I to 2I .

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44. Deduce the expression for the magnetic field induction at the centre of a circular electron orbit of radius r, and angular velocity of orbiting electron ω.

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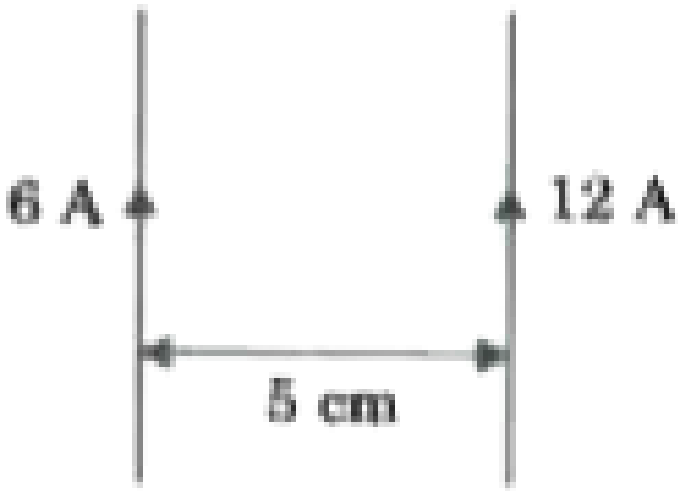
45. Two current carrying wire-1 and 2 infinitely long wires are kept parallel at a distance of 5 cm. Calculate the magnitude and direction of force per unit length on each wire if current of 6 A and

12 A flows in first and second wire respectively, in a similar direction.



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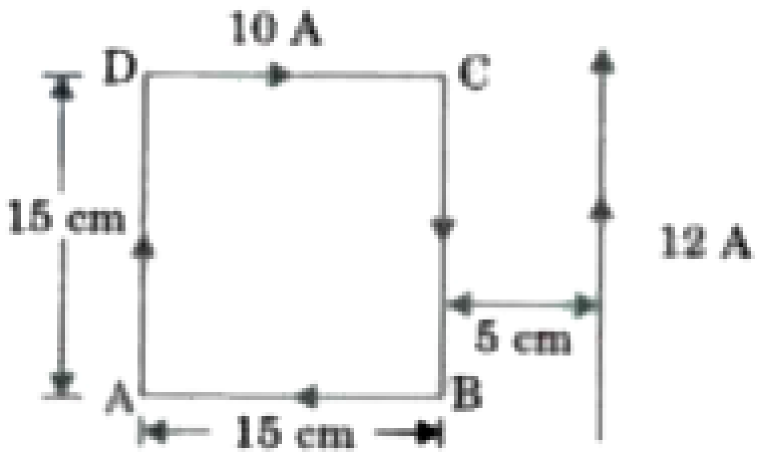
46. A square loop of side 15 cm carrying current of 10 A is kept at a distance of 5 cm from a long wire carrying 12 A current as shown in the adjoining figure. Calculate the net force acting on the loop.



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47. Two wires A and B of length 5 cm and infinite are kept 5 cm apart. Calculate the force experienced by wire B on A if wire A and B carry current of 10 A and 12 A respectively.

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48. A straight long wire carrying current 50 A is placed on a horizontal surface. Another wire of unit length carrying 22 A current is balanced in air above at a distance of 0.5 cm from the long wire. Calculate the mass of the wire.

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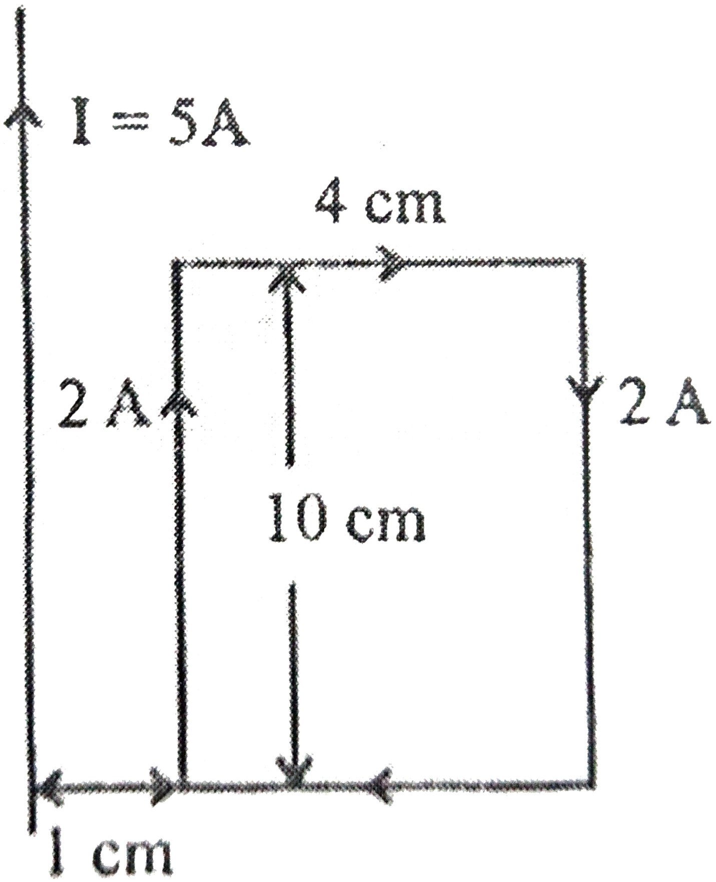
49. A rectangular loop of wire of size $4cm \times 10cm$ carries a steady current of 2A. A straight long wire carrying 5 A current is kept near the loop as shown. If the loop and the wire are coplanar, find

(i) the torque acting on the loop and

(ii) the magnitude and direction of the force on the loop due to the current carrying wire.



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50. A solid cylinder carries current of 1 A uniformly distributed over its cross sectional area. Calculate the magnetic field induction at point P, at a distance of 3 cm from the axis of cylinder, if its radius is 7 cm .

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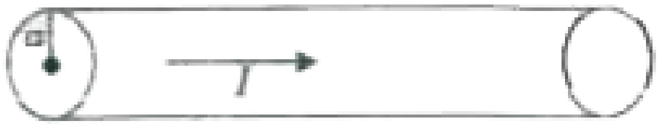
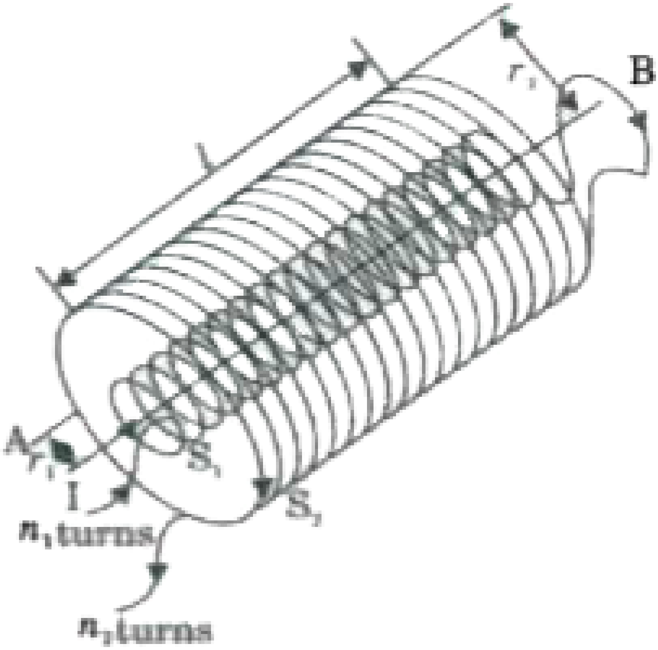
51. The adjoining figure shows a long straight wire of a circular cross section (radius a) carrying steady current I. The current I is uniformly distributed across its cross section. Calculate the magnetic field at a distance from its axis for $(i) r < a$, $(ii) r > a$.





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52. A long conducting wire of radius 1 cm carrying current of 1 A placed with its axis coinciding with X-axis. Find the magnetic field at point having coordinates $(0.5 cm, 0.5 cm)$.

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53. एक छड़ चुंबक के ध्रुवो के बीच की दूरी 10 cm है । इसके मध्यबिंदु से 15 cm तथा 20 cm पर उसके अक्ष पर स्थित दो बिन्दुओ पर चुंबकीय क्षेत्रो का अनुपात निकाले ।

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54. A long conducting wire of radius 5 cm, carrying current of 2 A is placed with its axis coinciding with Y-axis and lies on XZ-plane. Calculate the magnetic field induction at point A (3 cm, 3 cm, 3 cm) and (8 cm, 8 cm, 8 cm) if relative magnetic permeability of conductor is 300.

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55. A solenoid of length 0.5 m has a radius of 1 cm and is made up of 500 turns, It carries a current of 5 A. What is the magnitude of magnetic field inside the solenoid?

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56. A one metre long solenoid carrying current of 10 A has a radius of 1 cm. Calculate the magnitude of magnetic field inside the solenoid if it has 500 turns per metre.

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57. The magnetic field inside a solenoid is

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58. A wire carrying current of 5 A is wound on a toroid in 4,000 turns, Calculate the magnetic field inside the core of toroid and outside the toroid if its inner radius is 15 cm and the outer radius is 18 cm.

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59. (a) State Ampere's circuital law, expressing it in the integral form.

(b) Two long coaxial inlsulated soenoids, S_1 and S_2 of equal lengths are would one over the other as shown in the figure. A steady current "I" flows through the inner solenoid S_1 to the other end B, which is connected to the outer solenoid S_2 through which the same current "I" flows in the opposite direction so as the come out at end A. If n_1 and n_2 are the number of turns per unit length, find the magnitude and direction of the net magnetic field at a point

(i) inside on the axis and

(ii) outside the combined system.

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Conceptual Questions

1. If a charged particle at rest experiences no electromagnetic force,

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2. Consider a charged particle moving with constant velocity inside a region of space where electric and magnetic field both are present. How can the fields and velocity be directed to achieve this state?

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3. A charged particle is moved along a magnetic field line. The magnetic force on the particle is

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4. In a region, steady and uniform electric and magnetic fields are present . These two fields are parallel to each other. A charged particle is released from rest in this region . The path of the particle will be a

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5. Suppose there is vertically upwards magnetic field. How will the particle deviate according 1. If positive charge is moving horizontally, in front of you, away from you? 2. If negative charge is moving horizontally, in front of you, towards you? 3. If positive charge is moving horizontally, in front of you, towards you? 4. If negative charge is moving horizontally, in front of you, away from you?

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6. If the magnetic force on a moving charged particle in a magnetic field becoms _____ the direction of motion of the particle, or its opposite direction, indicates the direction of magnetic field. [Fill in the blank

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7. How is our atmosphere different from the atmospheres on Venus and Mars ?

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8. What happens when a current carrying wire is placed in a magnetic field?

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9. A current carrying rectangular coil is placed in a uniform magnetic field. In which orientation, the coil will not tend to rotate

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10. The net charge in a current carrying wire is zero. Them, why does a magnetic field exert a force on it?

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11. In a conductor, there are free electrons which continuously move randomly but inside the volume of the conductor. When such a conductor is placed inside a magnetic field then what can you say about the magnetic forces acting on the system?

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

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13. A proton and an electron both moving with the same velocity v enter into a region of magnetic field directed perpendicular to the velocity of the particles. They will now move in cirular orbits such that

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14. There is one circular current carrying loop. A charged particle is projected with a certain speed along the axis of the coil. How will the coil exert magnetic force on the charged particle?

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15. An electric current flows in a wire from north to south.

What will be the direction of the magnetic field due to this wire at a point.

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16. A current loop of arbitrary shape lien in a uniform magnetic field B. show that the net magnetic force acting on the loop is zero.

Watch Video Solution

17. There is a long solenoid carrying electric current. Straight conductor carrying constant current is placed along the axis of the solenoid. How will the two systems apply magnetic force on each other?

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18. Electron, proton, He^{+} and Li^{+} are projected with the same speed perpendicular to a uniform magnetic field. Which particle will experience the maximum magnetic force?

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19. If a current flowing in a circular coil is in anticlockwise direction , then direction of magnetic field will be

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20. A current- carrying straight wire is kept along the axis of a circular loop carrying a current. The straight wire

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21. Quite often, connecting wires carrying currents in opposite directions are twisted together in using electrical appliances. Explain how it avoids unwanted magnetic fields.

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22. A proton beam is going from north to south and an electron beam is going from south to north. Neglecting the earth's magnetic field, the electron beam will be deflected

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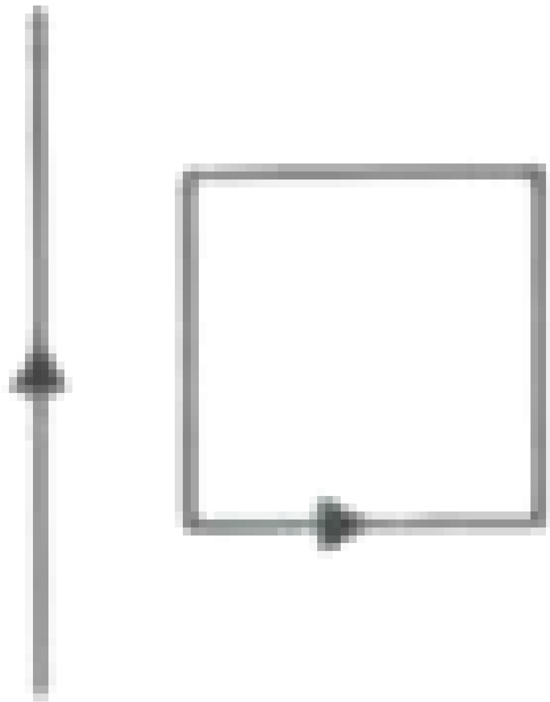
23. A fixed straight wire is near a movable square loop as shown in the figure below.



In which direction is the square loop supposed to move?

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24. There is one moving charge. What types of fields are associated with it?

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25. A charged particle is projected perpendicular to a uniform magnetic field. Describe area bounded by the path of particle inside magnetic field, in terms of its kinetic energy.

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26. Identical charged particles are accelerated through the same potential difference, and then made to enter in a region of uniform magnetie field. If R_1 and R_2 , are the radii of a circular paths followed by particles then what will be the ratio of their masses.

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27. Two long wires are placed parallel to each other. The current carried by these wires is, i_1 and i_2, respectively. Assume $i_1 > i_2$. When current is flowing in the same direction then magnetic field midway between the two wires is $20\mu T$. If direction of i_2, is reversed then magnetic field at the same point becomes $60\mu T$. What should be the ratio of currents?

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

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29. Can a time independent magnetic field set into motion an electron initially at rest? Why or why not?

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Tough & Tricky (PROBLEMS)

1. 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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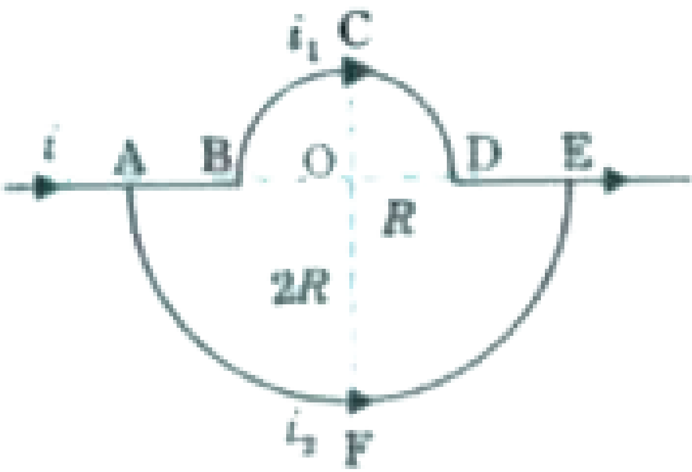
2. A wire of uniform cross section is used to make the given system. The radius of semicircle BCD is R and that of AFE is 2R while current I enters at point A.



Find the magnetic field intensity at point O in the figure if resistance per unit length of wire is λ.

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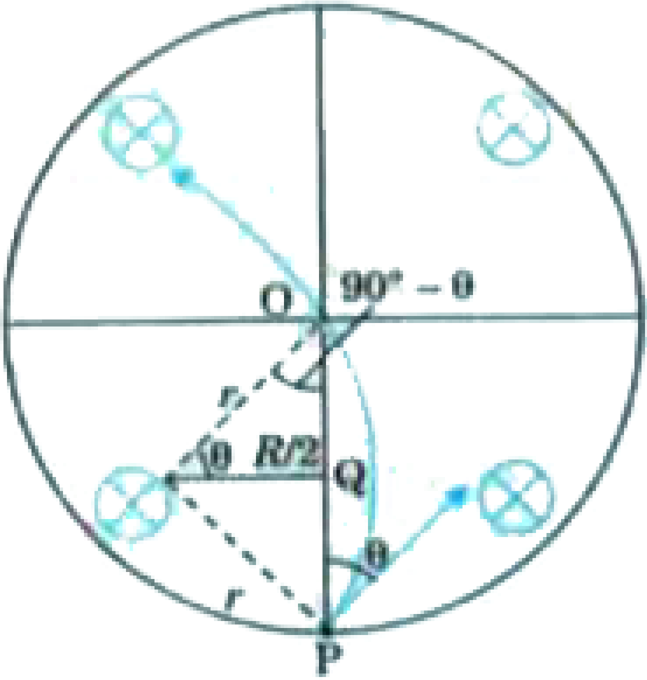
3. A uniform magnetic field is applied in a circular region of radius R as shown in the given figure. A charged particle of charge q and mass m enters with a velocity from point P along the line that is making an angle with the line segment OP, in the region of magnetic field.



The charged particle is found to pass through the centre of the circular region. Find the angle θ.

Given :

$B = 1T, R = 10cm, m = 6 \times 10^{-3}kg, q = 6 \times 10^{-2}C, v = 1/\sqrt{3}$

.

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4. A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected along the direction of the fields with a certain velocity then

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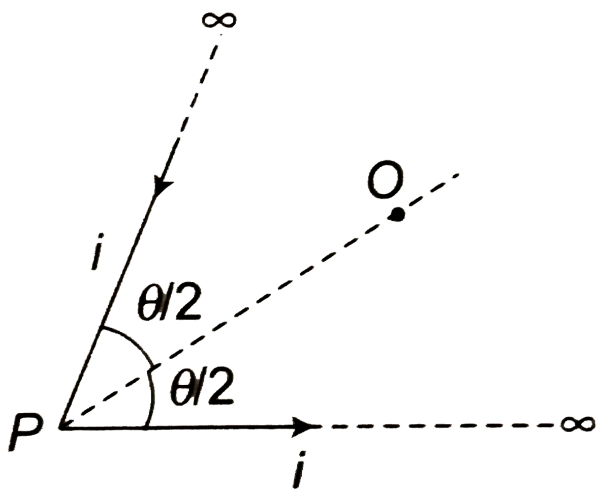
5. A long wire carrying a current i is bent to form a plane angle θ. The magnetic field at a point on the bisector of this angle situated at a distance d forms vertex is



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6. A capacitor of capacitance $100\mu F$ is connected to a battery of 20 volts for a long time and then disconnected from it. It is now connected across a long solenoid having 4000 turns per meter. It is found that the potential difference across the capacitor drops to 90% of its maximum value in 2.0 seconds. Estimate the average magnetic field produced at the centre of the solenoid during this period.

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7. A circular loop of radius R, carries current. At what distance from the centre of the loop along the axis, the magnetic field intensity becomes half of its magnetic field intensity at the centre. Given: $\sqrt[3]{4} = 1.5874 \& \sqrt{0.5874} = 0.7664.$

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

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9. The path of a charged particle moving in a uniform steady magnetic field cannot be a

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10. Let there be one sheet of infinite length and breadth is shown in the figure given below. Electric current is flowing along the length of sheet (perpendicular to the plane of paper). K is the electric current per unit width in this given sheet. Evaluate the magnetic field intensity near this sheet of current.

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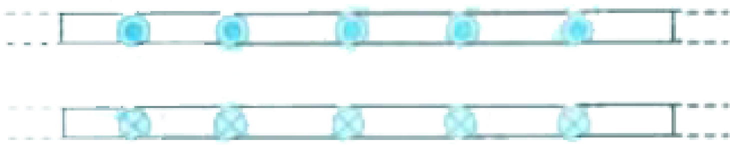
11. Two metal sheets of infinite width carrying current K per unit width, as shown in the figure, are kept parallel to each other. The direction of current in both the sheets is opposite to each other. A charged particle q of mass m is projected with a speed u perpendicularly into the plane of paper. What will be the radius of the circular path traversed by the charged particle due to magnetic field of sheets?



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12. A long, straight wire carries a current i. Let B_1 be the magnetic field at a point P at a distance d from the wire. Consider a section of length l of this wire such that the point P lies on a perpendicular bisector of the section. Let B_2 be the magnetic field at this point due to this section only. Find the value of d/l so that B_2 differs from B_1 by 1 %.

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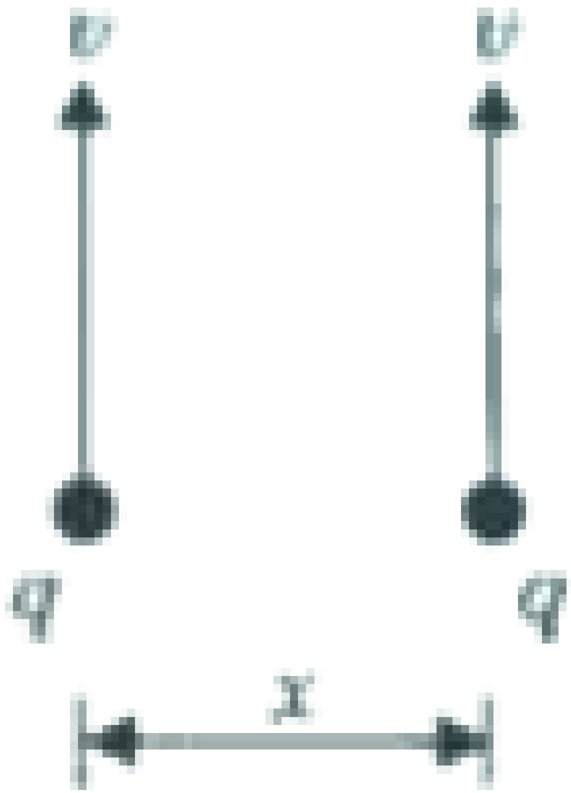
13. Two equal point charges q are moving parallel to each other with the same speed v as shown in the given figure. These charges can be same visualised as parallel currents in same direction and hence they will apply magnetic attraction on each other. What will be the magnetic force exerted by one on another? At what speed this magnetic force gets balanced by the electric repulsion between them?



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14. There is one long solenoid with turns per unit length. The radius of the solenoid is R and current flowing through it is I. There

is a charged particle having charge q and mass m projected from a point on axis of the solenoid, and in a direction perpendicular to the axis. Find the maximum possible speed with which the charged particle can be projected so as not to strike the solenoid.

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15. A metallic sphere rotates with angular speed and its surface charge density is o. Find the magnetic field intensity at the centre of sphere. Assume the radius of the sphere to be equal to R.

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NCERT FILE (NCERT Textbook Exercises)

1. A circular coil of wire consisting of 100 turns, each of radius 8.0 cm carries a current of0.40 A. What is the magnitude of the magnetic field B at the centre of the coil?

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2. A long straight wire carries a current of 35 A. What is the magnitude of the field $\vec{B}$ at a point 20 cm from the wire?

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3. 50 A current in north to south direction. Give the magnitude and direction of $\vec{B}$ at a point2.5 m east of the wire.

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4. A horizontal overhead power line carries a current of 90 A in the east-to-west direction. What is the magnitude and direction of the magnetic field due to the current 1.5 m below the line?

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5. What is the magnitude of magnetic force per unit length on a wire carrying a current of 8 A and making an angle of 30 with the direction of a uniform magnetic field of 0.15 T?

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6. A $3 \cdot 0cm$ wire carrying a current of $10A$ is placed inside a solenoid perpendicular to its axis. The magnetic field inside the solenoid is given to be $0 \cdot 27T$. What is the magnetic force on the wire?

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7. Two long and parallel straight wires A and B carrying currents of $8 \cdot 0A$ and $5 \cdot 0A$ in the same direction are separated by a distance of $4 \cdot 0cm$. Estimate the force on a $10cm$ section of wire A.

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8. A closely wound solenoid 80 cm long has 5 layers of windings of 400 terns each. The diameter of the solenoid is 1.8 cm. It the current carried is 8.0 A, estimate the magnitude of B inside the solenoid near its centre.

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9. A square coil of side 10 cm consists of 20 turns and carries a current of 12A. The coil is suspended vertically and the normal to the plane makes an angle of 30° with the direction of uniform magnetic field of 0.8 T. The torque acting on the coil is

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10. Two moving coil metres M_1 and M_2 have the following particular

$R_1 = 10\Omega, N_1 = 30, A_1 = 3.6 \times 10^{-3} m^2, B_1 = 0.25T,$

$R_2 = 14\Omega, N_2 = 42, A_2 = 1.8 \times 10^{-3} m^2, B_2 = 0.50T$

The spring constants are identical for the two metres. What is the ratio of current sensitivity and voltage sensitivity of $M_2 \ \text{to} M_1$?

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11. In a chamber, a uniform magnetic field of $6.5G\left(1G = 10^{-4}T\right)$ is maintained. An electron is shot into the field with a speed of $4.8 \times 10^6 ms^{-1}$ normal to the field. Explain why the path of the

electron is a circle. Determine the radius of the circular orbit. $(e = 1.6 \times 10^{-19} C, m_e = 9.1 \times 10^{-31} kg)$.

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12. In obtain the frequency of revolution of the electron in its circular orbit. Does the answer depend on the speed of the electron? Explain.

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13. (a) A circular coil of 30 turns and radius $8.0 cm$. Carrying a current of $6.0 A$ is suspended vertically in a uniform horizontal magnetic field of magnitude $1.0 T$. The field lines make an angle of 60° with the normal to the coil. Calculate the magnitude of the counter torque that must be applied to prevent the coil from turning.

(b) Would your answer change if the circular coil in (a) were replaced by a planar coil of some irregular shape that encloses the same area? (All other particulars are also unaltered).

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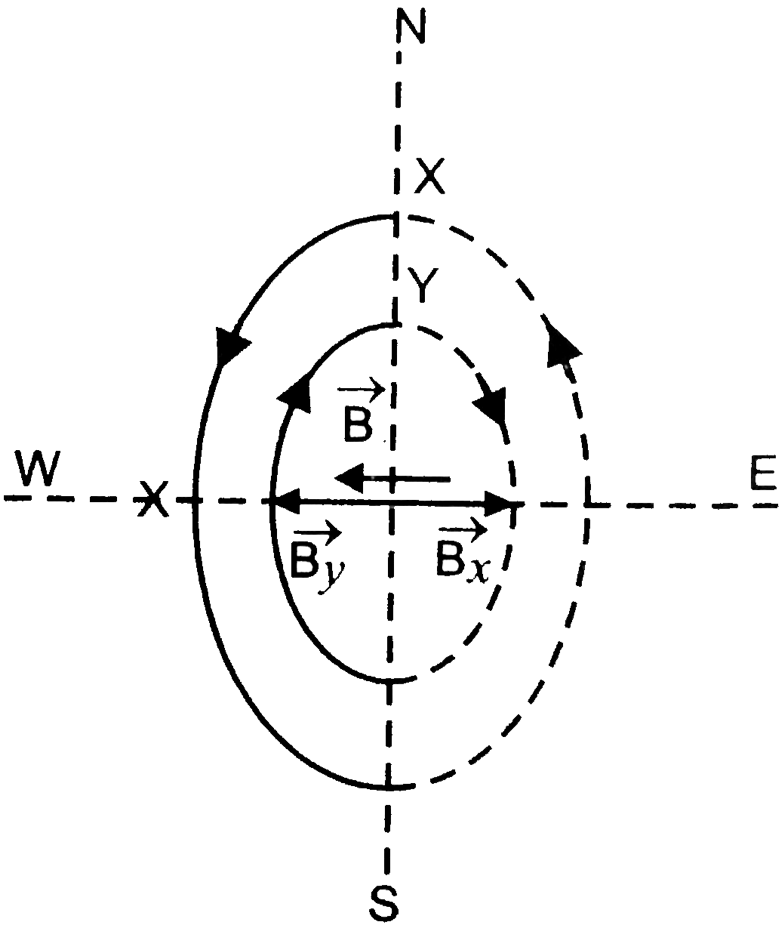
NCERT FILE (NCERT Additional Exercises)

1. Two concentric coil X and Y of radii $16cm$ and $10cm$ respectively lie in the same vertical plane containing the north-south direction. Coil X has 20 turns and carries a current of 16A, coil Y has 25 turns and carries a current of 18A. The sense of current in X is anti-clockwise and in Y, clockwise, for an observer looking at the coil facing west, Figure. Give the magnitude and direction of the net magnetic field due to the coils at their centre.



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2. A magnetic field of $100G\left(1G = 10^{-4}T\right)$ is required which is uniform in a region of linear dimension about $10cm$ and area of

crossection about $10^{-3} m^2$. The maximum current carrying capacity of a given coil of wire is $15A$ and the number of turns per unit length that can be wound round a core is at most $1000 turns m^{-1}$. Suggest some appropriate design particulars of a solenoid for the required purpose. Assume the core is not ferromagnetic.

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3. For a circular coil of radius R and N turns carrying current I, the magnitude of the magnetic field at a point on its axis at a distance x from its centre is given by $B = \frac{\mu_0 I R^2 N}{2(x^2 + R^2)^{3/2}}$

(a) Show that this reduces to the familiar result for field at the centre of the coil.

(b) Consider two parallel coaxial circular coils of equal radius R, and number of turns N, carrying equal currents in the same direction, and separated by a distance R. Show that the field on the axis around the mid-point between the coils is uniform over a distance that is small as compared to R and is given by $B = 0 \cdot 72\frac{\mu_0 NI}{R}$ approximately.

[Such as arrangement to produce a nearly uniform magnetic field over a small region is known as Helmholtz coils.]

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4. Toroid has a core (non-ferromagnetic) of inner radius 25 cm and outer radius 26 cm, around which 3500 turns of a wire wound. If the current in the wire is 11A, what is the magnetic field (a) outside the toroid, (b) inside the core of the toroid, and (c) in the empty space surrounded by the torroid.

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5. Answer the following questions:

(a) A magnetic field that varies in magnitude from point but has a constant direction (east to west) is set up in a chamber. A charged particle enters the chamber and travles undeflected along a straight path with constant speed. What can you say about the initial velocity of the particle?

(b) A charged particle enters an environment of a strong and non-uniform magnetic field varying from point to point both in magnitude and direction, and comes out of it following a complicated trajectory. Would its final speed equal the initial speed if it suffered no collisions with the environment?

(c) An electron travelling west to east enters a chamber having a uniform electrostatic field in north to south direction. Specify the direction in which a uniform magnetic field should be set up to prevent the electron from deflecting from its straight line path.

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6. An electron emmited by a heated cathode and accelerated through a potential difference of $2 \cdot 0kV$ enters a region with a uniform magnetic field of $0 \cdot 15T$. Determine the trajectory of the electron if the field (a) is transverse to its initial velocity (b) makes an angle of 30° with the initial velocity.

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7. A magnetic field set up using Helmholtz coils (described in Question 16 above) is uniform in a small region and has a magnitude of $0 \cdot 75T$. In the same region, a uniform electrostatic field is maintained in a direction normal to the common axis of the coils. A narrow beam of (single species) charged particles all accelerated through $15kV$ enters this region in a direction perpendicular to both the axis of the coils and the electrostatic field. If the beam remains undeflected when the electrostatic field is

$9 \times 10^5 Vm^{-1}$, make a simple guess so to what the beam contains. Why is the answer not unique?

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8. A straight horizontal conducting rod of length $0 \cdot 45m$ and mass $60g$ is suspended by two vertical wires at its end. A current of $5 \cdot 0A$ is set up in the rod through the wires. (a) What magnetic field should be set up normal to the conductor inorder that the tension in the wires is zero? (b) What will be the total tension in the wires if the direction of current is reversed, keeping the magnetic field same as before. (Ignore the mass of the wire) $g = 9 \cdot 8ms^{-2}$.

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9. The wires which connect the battery of an automobile to its starting motor carry a current of $300A$ (for a short time). What is the force per unit length between the wires if they are $70cm$ long and $1 \cdot 5cm$ apart? Is the force attractive or repulsive?

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10. A uniform magnetic field of $1 \cdot 5T$ is in cylindrical region of radius $10 \cdot 0cm$ with its direction parallel to the axis along east to west. A wire carrying current of $7 \cdot 0A$ in the north to south direction passes through this region. What is the magnitude and direction of the force on the wire if (a) the wire intersects the axes, (b) the wire is turned from N-S to north east-south west direction, (c) the wire in the N-S direction is lowered from the axis by a distance $6 \cdot 0cm$?

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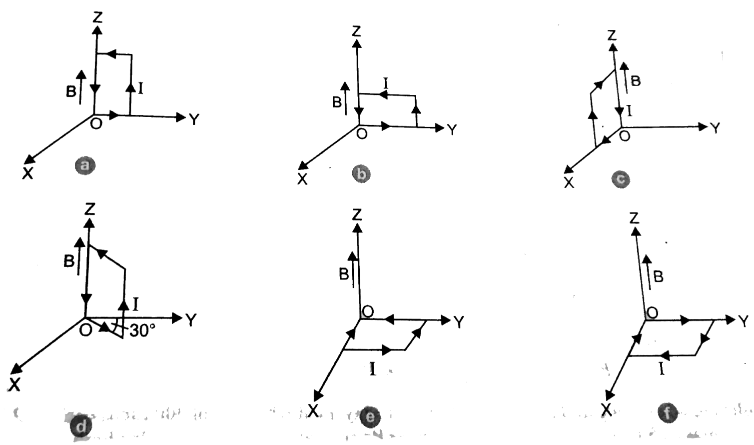
11. A uniform magnetic field of $3000G$ is established along the positive z-direction. A rectangular loop of sides $10cm$ and $5cm$ carries a current $12A$. What is the torque on the loop in the different cases shown in the figure. What is the force on each case? Which case corresponds to stable equilibrium?



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12. A circular coil of 20 turns and radius 10 cm is placed in a uniform magnetic field of 0.10 T normal to the coil. If the current in the coil is5.0 A, what is the

(a) total torque on the coil,

(b) total force on the coil,

(c) average force on each electron in the coil due to the magnetic field? (The coil is made of copper wire of cross sectional area $10^{-5}m^2$ and the free electron density in copper is given to be about $10^{29}m^{-3}$)

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13. A solenoid $60cm$ long and of radius $4 \cdot 0cm$ has 3 layers of windings of 300 turns each. A $2 \cdot 0cm$ long wire of mass $2 \cdot 5g$ lies inside the solenoid (near its centre) normal to the axis : both the wire and the axis of the solenoid are in the horizontal plane. The wire is connected through two leads parallel to the axis of solenoid to an external battery which supplies a current of $6 \cdot 0A$ in the wire. What value of current (with appropriate sense of circulation) in the windings of the solenoid can support the weight of the wire?

$g = 9 \cdot 8ms^{-2}$.

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14. A galvanometer coil has a resistance of 12Ω and the meter shows full scale deflection for a current of $3mA$. How will you convert the meter into a voltmeter of range 0 to 18V?

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15. A galvanometer coil has a resitance of 15Ω and the meter shows full scale deflection for a current of $4mA$. How will you convert the meter into an ammeter of range 0 to 6A?

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NCERT (Exemplar Problems) Objective Questions (MCQ Type - I)

1. Two charged particles traverse identical helical paths in a completely opposite sense in a uniform magnetic field $\overrightarrow{B} = B_0 \widehat{K}$

A. They have equal z-components of momenta

B. They must have equal charges.

C. They necessarily represent a particle-antiparticle pair.

D. The charge to mass ratio satisfies:

$$\left(\frac{e}{m}\right)_1 + \left(\frac{e}{m}\right)_2 = 0.$$

Answer: d

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2. Biot-Savart law indicates that the moving electrons (velocity $\vec{v}$) produce a magnetic field $\vec{B}$ such that

A. $B \perp v$

B. $B | | v$

C. it obeys the inverse cube law.

D. it is along the line joining the electron and point of observation.

Answer: A

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3. A current carrying circular loop of radius R is placed in the x-y plane with centre at the origin. Half of the loop with $x > 0$ is now bent so that it now lies in the y-z plane.

A. The magnitude of magnetic moment now diminishes.

B. The magnetic moment does not change.

C. The magnitude of B at $(0.0. z), z > \, > R$ increases.

D. The magnitude of B at $(0.0. z), z > \, > R$ is unchanged.

Answer: a

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4. An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true?

A. The electron will be accelerated along the axis.

B. The electron path will be circular about the axis.

C. The electron will experience a force at 45° to the axis and hence execute a helical path.

D. The electron will continue to move with uniform velocity along the axis of the solenoid.

Answer: D

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5. In a cyclotron, a charged particle

A. undergoes acceleration all the time.

B. speeds up between the dees because of the magnetic field.

C. speeds up in a dee.

D. slow down within a dee and speeds up between dees.

Answer: a

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6. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field $\overrightarrow{B}$. The work done to rotate the loop by 30° about an axis perpendicular to its plane is :

A. MB

B. $\sqrt{3}\frac{MB}{2}$

C. $\frac{MB}{2}$

D. zero.

Answer: d

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NCERT (Exemplar Problems) Objective Questions (MCQ Type - II)

1. The gyro-magnetic ratio of an electron in an H-atom, according to Bohr model, is

A. independent of which orbit it is in.

B. negative.

C. positive .

D. increases with the quantum number n.

Answer: a, b

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2. Consider a wire carrying a steady current, I placed in a uniform magnetic field $\vec{B}$ perpendicular to its length. Consider the charges inside the wire. It is known that magnetic forces do not work. This implies that

A. the motion of charges inside the conductor is unaffected by B since they do not absorb energy.

B. some charges inside the wire move to the surface as a result of B.

C. if the wire moves under the influence of B, no work is done by the force.

D. if the wire moves under the influence of B, no work is done by the magnetic force on the ions that is assumed fixed within the wire.

Answer: b, d

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3. Two identical current carrying coaxial loops, carry current I in an opposite sense. A simple amperian loop passes through both of them once. Calling the loop as C,

A. $\oint_C \overrightarrow{B} \cdot d\overrightarrow{l} = m_0 I.$

B. the value of $\oint_C \overrightarrow{B} \cdot d\overrightarrow{l}$ is independent of sense of C.

C. there may be a point on C where $\overrightarrow{B}$ and $d\overrightarrow{l}$ are perpendicular.

D. $\overrightarrow{B}$ vanishes everywhere on C.

Answer: b, c

Watch Video Solution

4. A cubical region of space is filled with some uniform electric and magnetic fields. An electron enters the cube across one of its faces with velocity $\overrightarrow{v}$ and a positron enters via opposite face with velocity $-\overrightarrow{v}$. At this instant,

A. the electric forces on both the particles cause identical accelerations.

B. the magnetic forces on both the particles cause equal accelerations.

C. both particles gain or loose energy at the same rate.

D. the motion of the centre of mass (CM) is determined by B alone.

Answer: b, c, d

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5. A charged particle would continue to move with a constant velocity in a region wherein,

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

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

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

D. $E = 0, B = 0.$

Answer: a, b, d

Watch Video Solution

NCERT (Exemplar Problems) (Very Short Answer Type Questions)

1. Verify that the cyclotron frequency $\omega = eB/m$ has the correct dimensions of $[T]^{-1}$.

Watch Video Solution

2. Show that a force that does no work must be a velocity dependent force.

Watch Video Solution

3. The magnetic force depends on $\vec{v}$ which depends on the inertial frame of reference. Does then the magnetic force differ from inertial frame to frame? Is it reasonable that the net acceleration has a different value in different frames of reference?

Watch Video Solution

4. Describe the motion of a charged particle in a cyclotron if the frequency of the radio frequency (rf) field were doubled.

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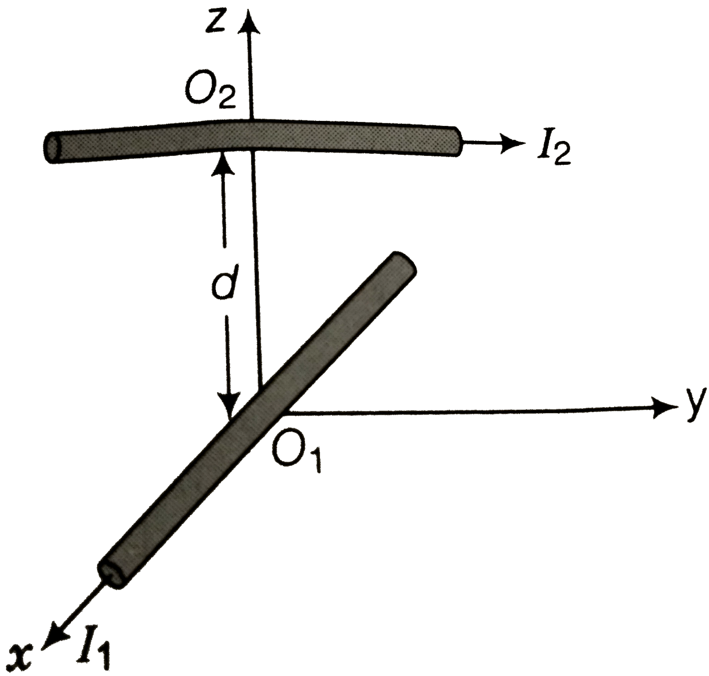


5.

Two long wires carrying current I_1 and I_2 are arranged as shown in figure the one carrying current I_1 is along is the x-axis. The other carrying current I_2 is along a line parallel to the y-axis given by x=0 and z=d. Find the force exerted at O_2 because of the wire along the x-axis.

Watch Video Solution

NCERT (Exemplar Problems) (Short Answer Type Questions)

1. A current carrying loop consists of 3 identical quarter circles of radius R, lying in the positive quadrants of the x-y, y-z and z-x planes with their centres at the origin, joined together. Find the direction and magnitude to $\overrightarrow{B}$ at the origin.

Watch Video Solution

2. A charged particle of charge e and mass m is moving in an electric field $\overrightarrow{E}$ and magnetic field $\overrightarrow{B}$. Constant dimensionless quantities and quantities of dimention $[T]^{-1}$.

Watch Video Solution

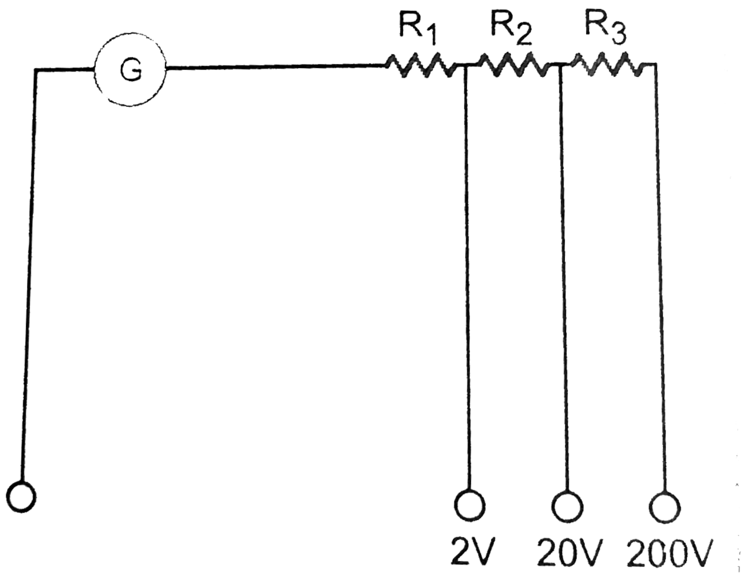
3. An electron enters with a velocity $\vec{v} = v_0 \hat{i}$ into a cubical region (faces parallel to coordinate planes) in which there are uniform electric and magnetic fields. The orbit of the electron is found to spiral down inside the cube in plane parallel to the x-y plane. Suggest a configuration of fields $\vec{E}$ and $\vec{B}$ that can lead to it.

Watch Video Solution

4. Do magnetic forces obey Newton's third law. Verify for two current elements $d\vec{l}_1 = dl\hat{i}$ located at the origin and $d\vec{l}_2 = dl\hat{j}$ located at (0, R, 0). Both carry current I.

Watch Video Solution

5. A multirange voltmeter can be constructed by using a galvanometer circuit as shown in figure. We want to construct a voltmeter that can measure 2V, 20V and 200V using a galvanometer of resistance 10Ω and that produces maximum deflection for current of $1mA$. Find R_1, R_2 and R_3 that have to be



used.

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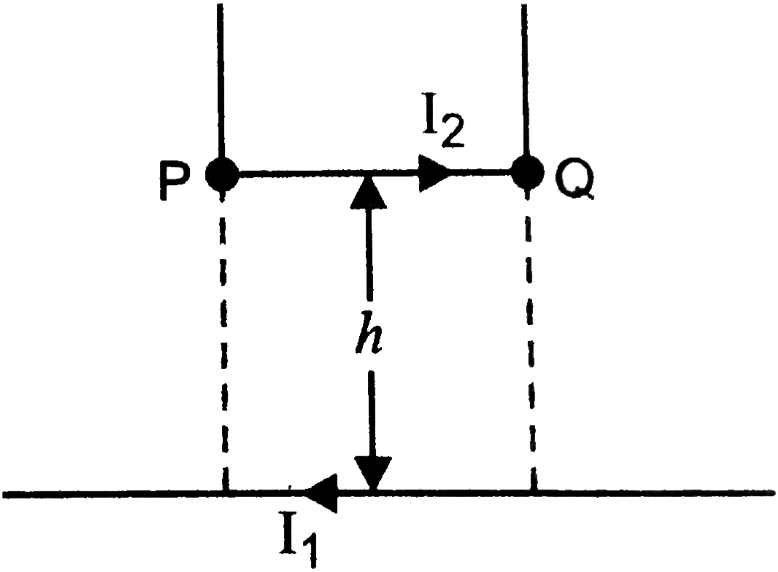
6. A long straight wire carrying current of $25A$ rests on a table as shown in figure. Another wire PQ of length 1m, mass $2 \cdot 5g$ carries the same current but in the opposite direction. The wire PQ is free to slide up and down. To what height will PQ rise?



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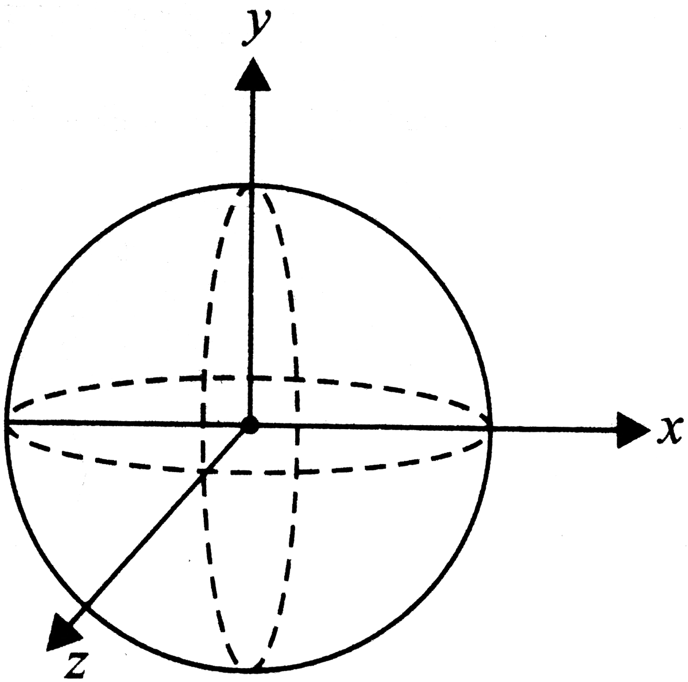
Higher Order Thinking Skills & Advanced Level

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



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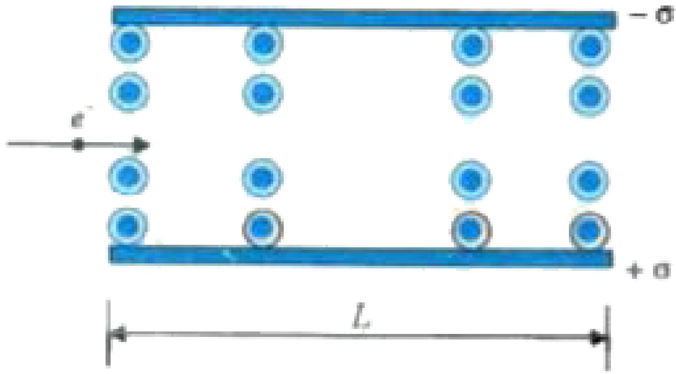
2. A uniform magnetic field (B) is applied between the plates of a capacitor in the outward direction as shown in the figure. Surface charge density on the capacitor plates is σ.



An electron is fired in between the plates, parallel to them, as shown in the figure. The electron is found to move straight in-between the plates of capacitor. Neglect the gravity. If L is the length of the plates then caleulate the time taken by the electron to cross the plates.

Watch Video Solution

3. A magnetic field of $\overrightarrow{B} = 1 \times 10^{-2}\hat{k}$ tesla applies a force of $\overrightarrow{F} = \left(36\hat{I} + 12\hat{j}\right) \times 10^{-23}$ newton on a proton. Calculate the velocity of proton.

View Text Solution

4. A charged particle is projected in a magnetic field of $\left(5\hat{I}+9\hat{j}\right)mT$ and its acceleration is found to be $\left(9\hat{I}-x\hat{j}\right)\times 10^{-6}m/s^2$. What should be the value of x?

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5. Protons and deuterons are accelerated through a same potential difference before they enter a region of uniform magnetic field applied perpendicular to their motion. If protons describe a circle of radius 10 cm then what will be the radius of circle of a deuteron?

View Text Solution

6. An electron beam with equivalent electric current I enters a region of crossed electric field and magnetic field B. Both the fields are uniform. It is found that the electron beam goes undeviated through the region of fields. After passing the field region, electrons hit a grounded target. How much force is exerted by the electron beam on urget? Assumem is the mass of electron and e its charge.

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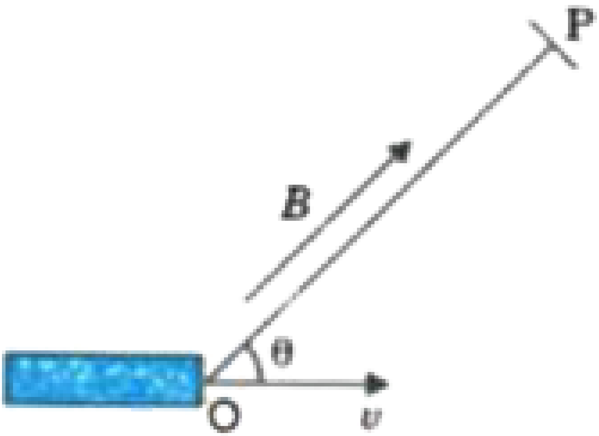
7. One electron gun is firing electrons with a speed V as shown in the figure. There is a target P which is to be hit. Electrons emerge from point O and line OP makes an angle with the direction of velocity of electrons. The length of OP is L.A uniform magnetic field B is applied parallel to line OP. Charge on the electron ise and the mass of electrons is m. What minimum magnetic field is needed so that electrons may hit the target P?



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8. A conducting cylinder of length L is placed on a rough horizontal floor. A horizontal magnetic field is applied perpendicular to the length of cylinder. F_1 and F_2 are the minimum forces required to move the cylinder for two possible directions of current, which can be passed through the cylinder. Calculate the coefficient of friction between the floor and the cylinder. Assume $F_1 > F_2$.

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9. An electron in a hydrogen atom is in an excited state and corresponding principal quantum number is n. Obtain the expression for orbital magnetic moment of electron. Charge on electron is e, mass of electron is m.

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10. An electron gun fires electrons after accelerating them through a potential difference V. Electrons are coming out from a tiny hole. Most of the electrons go straight but some of them make a slightly divergent angle. A uniform magnetic field can be set up along the direction of motion of electrons. These slightly diverged electrons are to be brought to focus at a distance l from the point of exit from the electron gun. If B_1 , is the minimum magnetic field needed to focus the electrons and B_2, is the next possible higher value of magnetic field, calculate e/m for the electrons.

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Revision Exercises (Very Short Answer Questions)

1. Is the steady electric current the only source of magnetic field? Justify your answer.

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2. Is the source of magnetic field analogue to the source of electric current.

Watch Video Solution

3. A magnetic compass shows a deflection when placed near a current-carrying wire. How will the deflection of the compass get affected if the current in the wire is increased? Support your answer with a reason.

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4. What is the relation between the SI unit and CGS unit of magnetic field?

Watch Video Solution

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

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6. What is the force experienced by a charged particle of charge moving from east to west with a velocity v in a magnetic field B, acting vertically downwards?

Watch Video Solution

7. What is the total force on a moving charge in a cubical region of cross magnetic and electric fields?

Watch Video Solution

8. A stationary charge experiences no magnetic Lorentz force. Why?

Watch Video Solution

9. A charged particle moves through a region of uniform magnetic field perpendicularly, Is the momentum of particle affected?

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10. चुम्बकीय पारगम्यता क्या है ? मात्रक लिखो ?

Watch Video Solution

11. Can a galvanometer as such be used for measuring the current? Explain.

Watch Video Solution

12. State the principle of moving coil galvanometer.

Watch Video Solution

13. What is the magnetic force experienced by a charged particle if velocity and magnetic field are parallel to each other?

Watch Video Solution

14. Show that the kinetic energy of the particle moving in a magnetic field remains constant

Watch Video Solution

15. Why are pole pieces of galvanometer made concave?

Watch Video Solution

16. What will be the path of a charged particle moving perpendicular to a uniform magnetic field?

Watch Video Solution

17. A neutron enters a magnetic field region, normally to the direction of magnetie field. Find the value of magnetic force on it.

Watch Video Solution

18. A porton and an electron travelling along parallel paths entre a regions of unifrom magnetic field, acting prependicular to their paths. Which of them will move in a circular path with higher frequncy?

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19. Which on the following will describe the smallest circle when projected with the same velocity v perpendicular to the magnetic field B: (i)α -particle (ii) β-particle?

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20. What do you mean by crossed fields?

Watch Video Solution

21. What is cyclotron frequency? Is it possible for a cyclotron to accelerate neutrons?

Watch Video Solution

22. A deuteron and an alpha particle having same momentum are in turn allowed to pass through a magnetic field B, acting normal to the direction of motion of the particles. Calculate the ratio of the radii of the circular paths described by them.

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23. A deutron and a proton are accelerated by the cyclotron. Can both be accelerated with the same oscillator frequency? Give reason to justify your answer.

Watch Video Solution

24. An $\alpha - \text{particle}$ and a proton of the same kinetic energy are in turn allowed to pass through a magnetic field $\vec{B}$, acting normal to

the direction of motion of the praricles. Calculate the ratio of radii of the circular paths described by them.

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25. Derive an expression for the force acting on a current carrying conductor placed in a uniform magnetic field. Name the rule which gives the direction of the force. Write the condition for which this force will have (i) maximum (ii) minimum value.

Watch Video Solution

26. (a) An iron ring of relative permeability μ_r has windings of insulated copper wire of n turns per metre. When the current in the windings is I, find the expression for the magnetic field in the ring.

(b) The susceptibility of a magnetic material is 0.9853. Identify the type of magnetic material. Draw the modification of the field pattern on keeping a piece of this material in a uniform magnetic field.

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27. An electron beam projected along + X-axis, experience a force due to a magnetic field along the + Y-axis. What is the direction of the magnetic field?

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28. Find the magnetic field induction at a point on the axis of a circular coil carrying current and hence find the magnetic field at the centre of circular coil carrying current.

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29. In a magnetic field the curvature of the path of a β-particle is greater than that of an α-particle of the same speed. Explain why.

Watch Video Solution

30. What do yo understand by magnetic dipole moment of the current loop.

Watch Video Solution

31. Find the force between two parallel conductors carrying currents (i) in the same direction (ii) in opposite directions and hence define one ampere.

Watch Video Solution

32. BIOT SAVART LAW

Watch Video Solution

33. What is the value of magnetic field near the end of a current carrying solenoid?

Watch Video Solution

34. Which rule is used to find the direction of field produced by a solenoid?

Watch Video Solution

35. Why should a solenoid tend to contract when a current passes through it?

Watch Video Solution

36. Toroid is

Watch Video Solution

37. A copper wire of length 7 metre is bent to form a circular loop. If i current flows through the loop, find out the magnitude of magnetic moment of the loop.

Watch Video Solution

38. What is the shape of the coils for an ideal toroid?

Watch Video Solution

39. Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why?

Watch Video Solution

40. Derive an expression for the force between two long parallel current carrying conductors. Use this expression to define SI unit of current.

Watch Video Solution

41. What type of force is acting between two parallel wires carrying current in the same direction? What happens if one of the current is reversed?

Watch Video Solution

42. If the distance between two parallel current carrying wires is doubled, what is the force between them?

Watch Video Solution

43. The force exerting between the two parallel current carrying conductors if F. If the current in each conductor is doubled, what is the value of force acting between them?

Watch Video Solution

44. Derive an expression for the force between two long parallel current carrying conductors. Use this expression to define SI unit of current.

Watch Video Solution

45. What is the torque on a current carrying loop placed in a uniform magnetic field?

View Text Solution

46. What is the value of torque when magnetic moment (m) and magnetic field are parallel or anti parallel?

Watch Video Solution

47. Two wires of equal lengths are bent in the form of two loops. One of the loops is square shaped whereas the other loop is circular. These are suspended in a uniform magnetic field and the same current is passed through them. Which loop will experience greater torque? Give reasons.

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48. Magnetic dipole moment of revolving electron is

Watch Video Solution

49. What is the correct value of Bohr magneton?

Watch Video Solution

50. What is torsional constant of the spring used in a galvanometer?

Watch Video Solution

51. What is the condition for steady angular deflection (ϕ) in moving coil galvanometer?

Watch Video Solution

52. What is current sensitivity? State ita SI unit.

Watch Video Solution

53. What is voltage sensitivity? State its SI unit.

Watch Video Solution

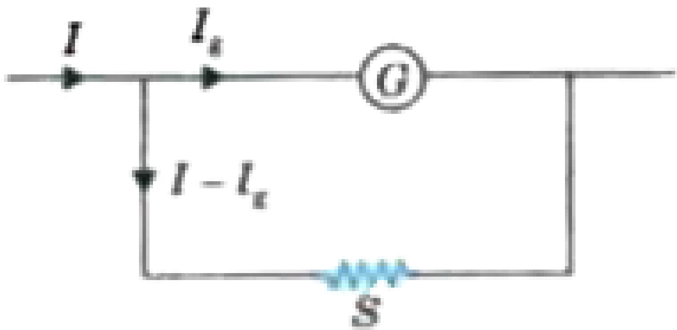
54. What is a sensitive galvanometer?

Watch Video Solution

55. What is shunt? State its uses. Find the relation for the current through shunt in terms of resistance of galvanometer and shunt.

Watch Video Solution

56. A galvanometer is connected as shown in the figure:



(a) This combination can be used as ________ . (voltmeter/rheostat/ammeter)

(b) Derive an expression to find the value of resistance S.

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57. Of the two identical galvanometers one is to be converted into an ammeter and another into a milliammeter. Which of the shunts will be of larger resistance?

Watch Video Solution

58. What will an ammeter measures when it is connected in parallel with a circuit? Will it still measure the current through the circuit?

View Text Solution

59. धारा के विद्युत - चुम्बकीय मात्रक एवं S.I. मात्रक लिखिए तथा इनमें परस्पर सम्बंध बताइए ।

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Revision Exercises (Additional Questions)

1. Tesla is a unit for measuring

A. Electric flux

B. Electric field

C. Magnetic induction

D. Magnetic flux

Answer: c

Watch Video Solution

2. A particle of mass m and charge q enters a magnetic field B perpendicularly with a velocity v, The radius of the circular path described by it will be

A. $\dfrac{mv}{vB}$

B. $\dfrac{mB}{qv}$

C. $\dfrac{mq}{vB}$

D. $\frac{qv}{mB}$

Answer: a

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3. Cyclotron is used to accelerate

A. Electrons

B. Neutrons

C. Positive ions

D. None of these

Answer: C

Watch Video Solution

4. What is the force acting on a moving charge in a uniform magnetic field? Discuss the cases when the force is maximum and minimum and define the unit of magnetic field $\vec{B}$.

Watch Video Solution

5. What is the force acting on a moving charge in a uniform magnetic field? Discuss the cases when the force is maximum and minimum and define the unit of magnetic field $\vec{B}$.

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6. A galvanometer can be converted into an ammeter by connecting

A. Low resistance in series

B. Low resistance in parallel

C. High resistance in series

D. High resistance in parallel

Answer: b

Watch Video Solution

7. A magnetic needle is kept in a non uniform magnetic field . It experiences

A. A force but not a torque

B. A force and a torque

C. Neither a force nor a torque

D. A torque but not a force

Answer: B

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8. No force is exerted by magnetic field on a stationary:

A. Electric dipole

B. Magnetic dipole

C. Current loop

D. Current carrying conductor

Answer: a

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9. A charged particle enters a magnetic field at an angle of 90° with the magnetic field. The path of the particle will be a/an

A. Helix

B. Ellipse

C. Circle

D. Straight line

Answer: c

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10. The magnetic field $d\overrightarrow{B}$ due to a small current element $d\overrightarrow{l}$ at a distance $\overrightarrow{r}$ and element carrying current i is,

A. $d\overrightarrow{B} = \frac{\mu_0}{4\pi} \cdot \frac{I\overrightarrow{dl} \times \overrightarrow{r}}{r}$

B. $d\overrightarrow{B} = \frac{\mu_0}{4\pi} \cdot \frac{I\overrightarrow{dl} \times \overrightarrow{r}}{r^2}$

C. $d\overrightarrow{B} = \frac{\mu_0}{4\pi} \cdot \frac{I\overrightarrow{dl} \times \overrightarrow{r}}{r^3}$

D. $d\overrightarrow{B} = \frac{\mu_0}{4\pi} \cdot \frac{I\overrightarrow{dl} \times \overrightarrow{r}}{r^4}$

Answer: c

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11. The direction of force experienced by the current carrying conductor in a uniform magnetic field a given by

A. Fleming's left hand rule

B. Fleming's right hand rule

C. Lenz's rule

D. Screw rule

Answer: a

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12. An electric charge q is moving with a velocity w in the direction of a magnetic field B. The magnetic force acting on the charge is

A. qvB

B. zero

C. $\frac{q}{vB}$

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

Answer: b

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13. A magnetic field can be produced by

A. a moving charge

B. a change electric field

C. none of these

D. both of these

Answer: D

Watch Video Solution

14. A charge q moves region in a electric field E and the magnetic field B both exist, then the force on its is

A. $q\left(\overrightarrow{v} \times \overrightarrow{B}\right)$

B. $q\overrightarrow{E} + q\left(\overrightarrow{v} \times \overrightarrow{B}\right)$

C. $q\overrightarrow{E} + q\left(\overrightarrow{B} \times \overrightarrow{v}\right)$

D. $q\overrightarrow{E} + q\left(\overrightarrow{E} \times \overrightarrow{v}\right)$

Answer: b

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15. A wire of length L carrying a current I is bent into a circle. The magnitude of the magnetic field at the centre of the circle is

A. $\frac{\pi^2 I}{l} \times 10^{-7}$

B. $\frac{\pi I}{l} \times 10^{-7}$

C. $\frac{\pi I}{l^2} \times 10^{-7}$

D. $\frac{\pi I^2}{l} \times 10^{-7}$

Answer: a

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16. A charged particle of mass m and charge q travels on a circular path of radius r that is perpendicular to a magnetic field B. The time taken by the particle to complete one revolution is

A. $\frac{2\pi mq}{B}$

B. $\frac{2\pi q^2 B}{m}$

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

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

Answer: D

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Revision Exercises (Fill in the Blanks)

1. .... is the space around a magnet where magnetic effect can be felt.

Watch Video Solution

2. The magnetic field near the centre of an infinite long straight current carrying conductor is .... Than the magnetic field near one of the end points.

Watch Video Solution

3. MAGNETIC FIELD DUE TO CURRENT CARRYING SOLENOID

Watch Video Solution

4. According to Ampère's circuital law, the circulation of magnetic field in a closed curve is equal to .... Times the total current enclosed within the closed curve.

Watch Video Solution

5. For a cylindrical current carrying conductor, the magnetic field at any point on the axis is.........

Watch Video Solution

6. Magnetic field induction at any point outside a toroid is ....

Watch Video Solution

7. Two parallel straight current carrying wires attract each other if the direction of current in both wires is ....

Watch Video Solution

8. A cyclotron is not suitable to accelerate electrons. Why?

Watch Video Solution

Watch Video Solution

9. When a current of 1 A pass through a galvanometer, deflection produced in it is........

Watch Video Solution

10. The resistance of an ideal ammeter is

Watch Video Solution

Revision Exercises (Short Answer Questions)

1. Derive the force exerted by a magnetic field on a moving charged particle.

Watch Video Solution

2. A charged particle moving with a uniform velocity $\vec{v}$ enters a region where uniform electric and magnetic fields $\vec{E}$ and $\vec{B}$ are present. It passes through the region without any change in its velocity. What can we conclude about the (i) relative direction of $\vec{E}$, $\vec{V}$ and $\vec{B}$? (ii) magnetic of $\vec{E}$ and $\vec{B}$?

or

Find the condition under which the charged particle moving with different speeds in the presence of electric and magnetic field vectors can be used to select charged particles of a particular speeds.

Watch Video Solution

3. Derive an expression for the force acting on a current carrying conductor placed in a uniform magnetic field. Name the rule which gives the direction of the force. Write the condition for which this force will have (i) maximum (ii) minimum value.

Watch Video Solution

4. Write the relation for the force $\overrightarrow{F}$ acting on a charge carrier q moving with a velocity $\overrightarrow{v}$ through a magnetic field $\overrightarrow{B}$ in vector notation. Using this relation, deduce the conditions under which this force will be

(i) maximum (ii) minimum. Under what condition will it move in (i) a circular path and (ii) a helical path?

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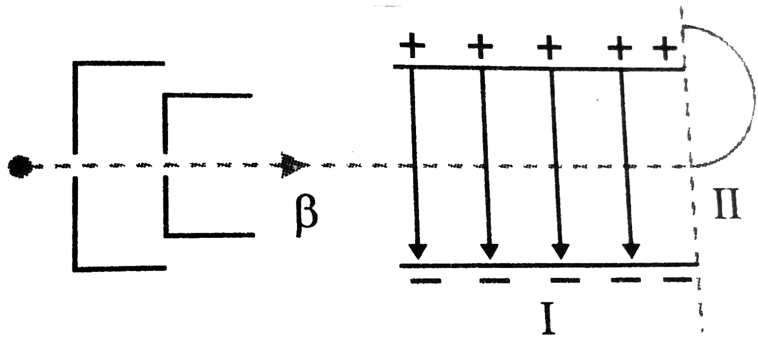
5. A charged particle q is moving in the presence of a magnetic field B which is inclined to an angle 30° with the direction of the motion of the particle. Draw the trajectory followed by the particle in the presence of the field and explain how the particle describes this path.

Watch Video Solution

6. State the Biot-Savart law. Use it to obtain an expression for magnetic field at the centre of a current carrying circular loop.

Watch Video Solution

7. A fine pencil of β-particles, moving with a speed v, enters a region (region I), where a uniform electric field and a uniform magnetic field are both present. These β-particles then move into region II where only the magnetic field, (out of the two fields present in region I) exists. The path of the β-particles, in the two regions is as shown in the figure.



(i) state the direction of magnetic field.

(ii) state the relation between E and B in region I.

(iii) Drive the expression for the radius of the circular path of the β-particle in region II.

(iv) If the magnitude of magnetic field, in region II is changed to n times its earlier value, (without changing the magnetic field in region I) find the factor by which the radius of this circular path would change.

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8. 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?

Watch Video Solution

9. Explain the principle and working of a cyclotron with the help of a schematic diagram. Write the expression for cyclotron frequency.

Watch Video Solution

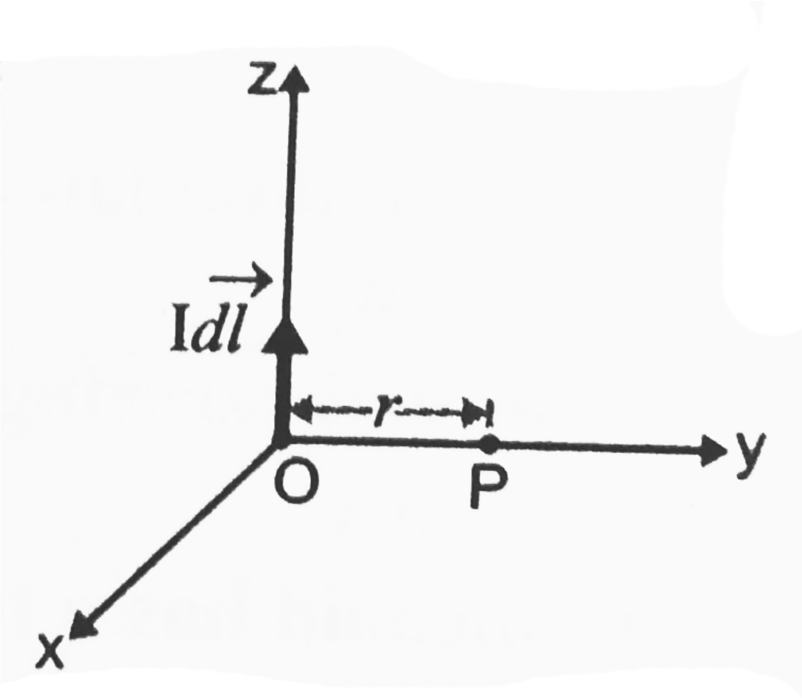
10. A cyclotron is not suitable to accelerate electrons. Why?

Watch Video Solution

11. Using Biot-Savart's law, derive an expression for magnetic field at any point on axial line of a current carrying circular loop. Hence, find magnitude of magnetic field intensity at the centre of circular coil.

Watch Video Solution

12. A current I flows in a conductor placed perpendicular to the plate of the paper. Indicate the direction of the magnetic field due to a small element $d\vec{l}$ at point P situated at a distance $\vec{r}$ from the element as shown in the figure.



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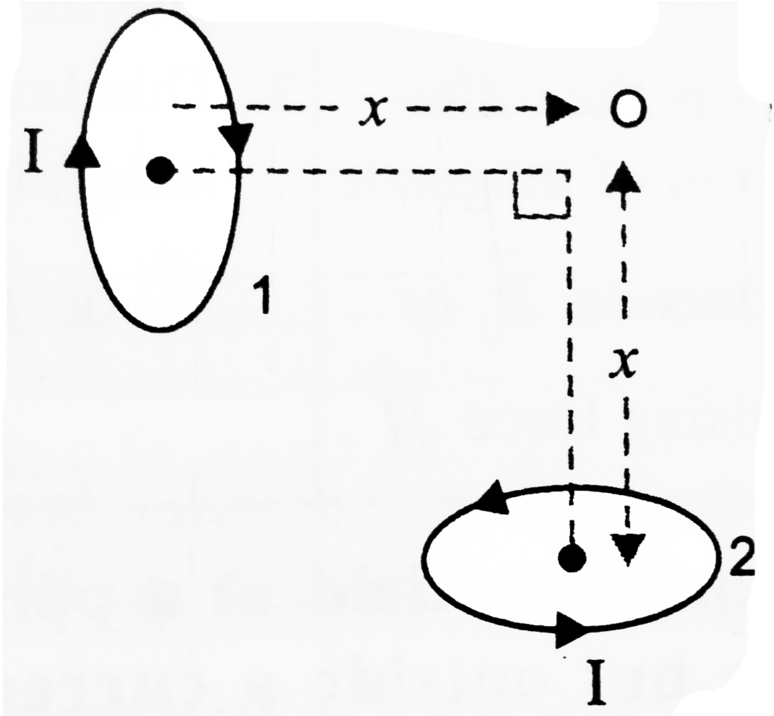
13. Two small circular loops, marked (1) and (2), carrying equal currents are placed with the geometrical axes perpendicular to each other as shown in figure. Find the magnitude and direction of the net magnetic field produced at the point O.



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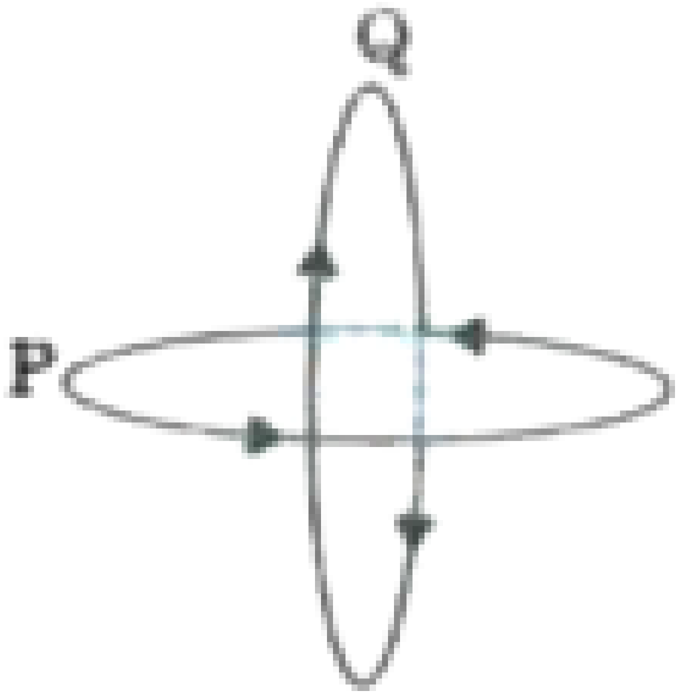
14. A wire of length L is bent around in the form of a coil having N turns of same radius . If a steady current I flows through it in a clockwise direction, find the magnitude and direction of the magnetic field produced at its centre.

Watch Video Solution

Watch Video Solution

15. Two identical coils P and Q each of radius R are lying in perpendicular planes such that they have a common centre. Find the magnitude and PC direction of the magnetic field at the common centre of the two coils, if they carry currents equal to land $\sqrt{3}I$ respectively.



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16. A rectangular coil of sides l and b carrying a current I is subjected to a uniform magnetic field $\vec{B}$ acting perpendicular to its plane. Obtain the expression for the torque acting on it.

Watch Video Solution

17. Define electric dipole moment. Is it a scalar or a vector? Derive the expression for the electric field of a dipole at a point on the equatorial plane of the dipole.

Watch Video Solution

18. Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Justify this statement.

Watch Video Solution

19. What is the function of the radial magnetic field in the moving coil galvanometer?

Watch Video Solution

20. Two protons P and Q moving with the same speed enter magnetic field B_1 and B_2 respectively at right angles to the field directions. If B_2 is greater than B_1 for which of the protons P and Q the circular path in the magnetic field will have a smaller radius?

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21. (a) How does a voltmeter differ from ammeter?

(b) What is the main function of soft iron core used in a moving coil galvanometer?

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22. State Ampere's circuital law. By using it derive an expression for magnetic field intensity at a point due to a straight current carrying conductor.

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23. (a) State the principle of working of a galvanometer.

(b) Agalvanometer of resistance G is converted into a voltmeter to measure up to V volts by connecting a resistance R_1 , in series with the coil. If a resistance R_2 is connected in series with it, then it can measure up to V/2 volts. Find the resistance, in terms of R_1 and R_2, required to be connected to convert it into a voltmeter that can read up to 2 V. Also find the resistance G of the galvanometer in terms of R_1 and R_2.

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24. A galvanometer of resistance G can be converted into a voltmeter of range $\theta - V$ volts by connecting a resistance R in series with it. How much resistance will be required to change its range from 0 to $V/2$?

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25. A electron of mass, m_e revolves around a nucleus of charge $+Ze$. Show that it behaves like a tiny magnetic dipole. Hence, prove that the magnetic moment associated with it is expressed as $\vec{\mu} = -\frac{e}{2m_e}\vec{L}$, where $\vec{L}$ is the orbital angular momentum of the electron. Give the signification of negative sign.

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26. A straight wire of 1.4 m long carries a current of 7 A at right angles to a uniform magnetic field of 0.01 T. Calculate the mechanical force acting on the wire due to the magnetic field.

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27. A wire of length l is bent in the form of a square and carries a current I. What is the value of its magnetic moment?

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28. State the factors on which the current sensitivity of a galvanometer is increased.

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Revision Exercises (Long Answer Questions)

1. Using Biot-Svart's law, derive the expression for the magnetic field in vector form at a point on the axis of a circular current loop.

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2. Determine the magnetic induction at the centre of a circular coil of radius r carrying a current I with the help of the Biot-Savart law.

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3. Derive an expression for the magnetic field along the axis of an air-cored solenoid, using Ampere's circuital law. Sketch the magnetic field lines for a finite solenoid. Explain why the field at the exterior mid point is weak while at the interior it is uniform and strong.

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4. Derive an expression for the force acting on a current carrying conductor placed in a uniform magnetic field. Name the rule which gives the direction of the force. Write the condition for which this force will have (i) maximum (ii) minimum value.

Watch Video Solution

5. Draw a schematic sketch of a cyclotron. Explain clearly the role of crossed electric and magnetic fields in accelerating the charge. Hence derive the expression for the kinetic energy by the particles.

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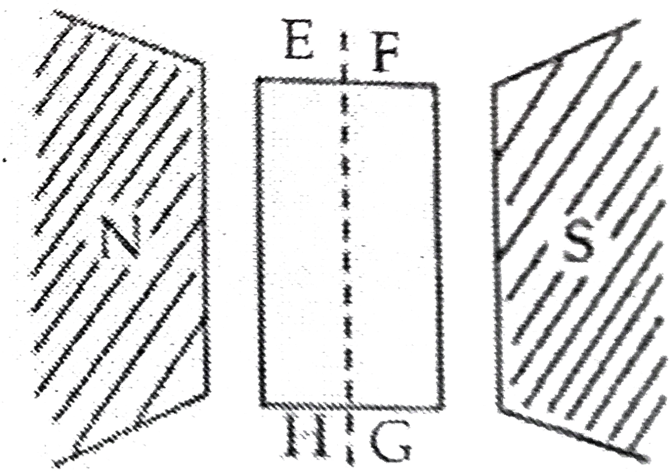
6. (a) Two straight long parallel conductors carry currents I_1 and I_2 in the same direction. Deduce the expression for the firce per unit length between them.

Depict the pattern of magnetic field lines around them.

(b) A rectangular current carrying loop EFGH is kept in a uniform magnetic field as shown in the figure.

(i) What is the direction of the magnetic moment of the current loop ?

(ii) What is the torque acting on the loop (A) maximum, (B) zero ?



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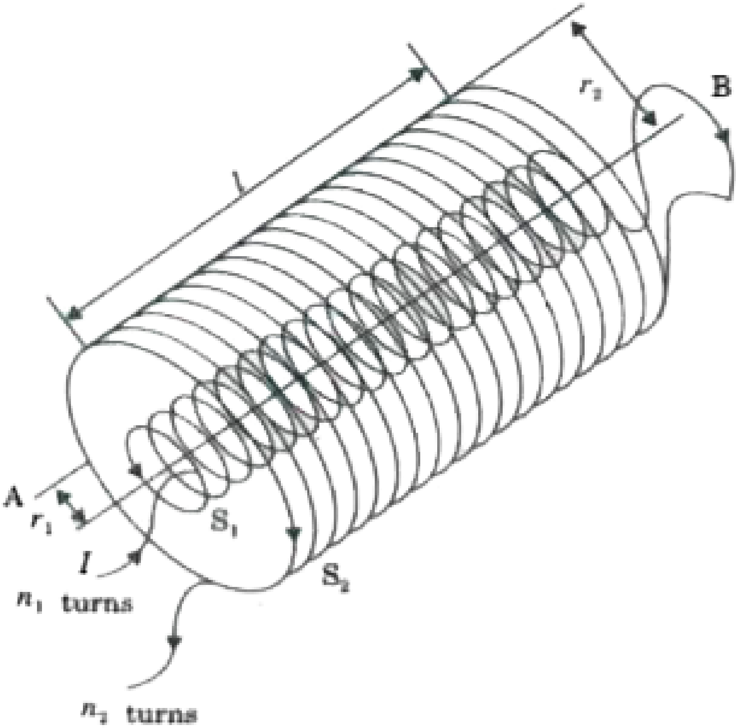
7. (a) State Ampère's circuital law expressing it in the integral form.

(b) Two long coaxial insulated solenoids S_1 and S_2 of equal lengths are wound one over the other as shown in the figure. A steady current 'I' flows through the inner solenoid S_1 , to the other end B which is connected to the outer solenoid S_2 , through which the same current 'I' flows in the opposite direction so as to come out at end A. If n_1 , and n_2 are the number of turns per unit length, find the magnitude and direction of the net magnetic field at a point (i) inside on the axis and (ii) outside the combined system.



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8. State Ampere's circuital law. Use this law to obtain the expression for the magnetic field inside an air cored toroid of average radius r having n-turns per unit length and carrying a steady current I.

Watch Video Solution

9. State the principle of moving coil galvanometer.

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10. (a) With the help of a diagram , explain the principle and working of a moving coil galvanometer .

(b) What is the importance of a radial magnetic field and how is it produced ?

(c) Why is it while using a moving coil galvometer as a voltmeter a high resistance in series is required whereas in an ammeter a shunt is used ?

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11. Find expression for work done in rotating a bar magnet in a uniform magnetic field.

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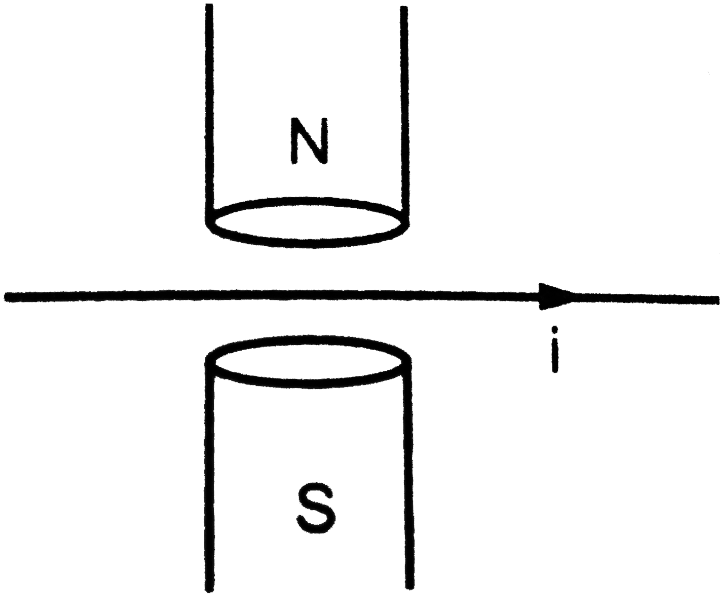
12. A magnetic field of strength 1.0 T is produced by a strong electromagnet in a cylindrical region of radius 4.0 cm as shown in . A wire, carrying a current of 2.0 A, is placed perpendiuclar to and intersecting the axis of the cylindreical region. Find the magnitude of the force acting on the wire.



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Revision Exercises (Numerical Problems)

1. Calculate the magnetic field at a distance of 5 cm from an infinite straight conductor carrying a current of 10 A.

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2. A circular coil of 0.2 m diameter has 100 turns and carries a current of 0.1 ampere. The intensity of magnetic field at the centre of the coil is -

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3. A uniform magnetic field of 6.5×10^{-4} T is maintained in a chamber. An electron enters into the field with a speed of 4.8×10^{6} m/s normal to the field. Explain why the path of the electron is a circle. Determine its frequency of revolution in the circular orbit. Does the frequency depend on the speed of the electron? Explain.

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4. The radius of dees in a cyclotron is 1.9 m and the magnetic field applied on the cyclotron is 0.8 T. Calculate the energy gained by an emergent proton in cyclotron in keV. Mass of proton is 1.67×10^{-27} kg.

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5. An α particle is moving with a velocity of $\left(7 \times 10^5 \hat{I} m/s\right)$ in a magnetic field of $\left(5\hat{I} + 9\hat{j}\right)$ T. Find the magnetic force acting on the particle.

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6. An electron is moving with a velocity of 5×10^7 m/s in a magnetic field of 6×10^{-4} T perpendicular to it. What is the frequency? Also find the energy of electron in MeV.

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7. An electron beam is passing through a magnetic field of 5×10^{-4} T and electric field of $3 \times 10^{5} Vm^{-1}$, both acting simultaneously. Calculate the speed of electrons if the electron beap goes undeviated. What will be radius of the path oh removal of electric field?

Watch Video Solution

8. The current carried by a horizontal wire of length 0.6 m and mass 5×10^{-3} kg/m is 5 A. Calculate the magnitude and direction of magnetic field which can support the weight of the wire. (Take $g = 10m / s^{2}$)

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9. A high resistance of 3,000 ohm is connected in series with a voltmeter. In so doing, the scale division becomes 300 times greater. Calculate the resistance of voltmeter.

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10. A current of $400 \mu A$ can deflect the coil of galvanometer by 40. Calculate the amount of current required to rotate the coil through 60. Also find the current sensitivity of the galvanometer.

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11. A galvanometer of resistance 30Ω shows a full scale deflection for a current of 2 mA. Calculate the value of resistance required to convert it into a voltmeter of range $0-5$ volt.

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12. Find the number of revolutions made by a proton in a cyclotron to attain one fourth of speed of light, if the maximum value of accelerating potential provided by the oscillator is 40 kV ? Take mass of the proton $= 1.67 \times 10^{-27}$ kg .

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13. A horizontal overhead power line carries a current of 30 A in the east to west direction. What is the magnitude and direction of the magnetic field due to the current at a point 1.5 m below the line?

$(\mu_0 = 4\pi \times 10^{-7} T - mA^{-1})$

Watch Video Solution

14. A rectangular loop carryinig current I is located near an infinite long straight conductor carrying current I as shown in the figure.

The loop,

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15. A 0.5 m long solenoid has 500 turns and has a flux density of 2.52×10^{-3}T at its centre. Find the current in the solenoid.

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16. A solenoid consists of 250 turns of wire and has a length of 20 cm. Calculate the magnitude of the magnetic field inside the solenoid if it carries a current of 1A.

Watch Video Solution

17. Two long, parallel straight wires are separated by a distance of 0.2 cm and carry current of 10 A and 8 A.

Find the magnitude of the attractive force exerted on 1 m length of one wire by the other wire.

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18. A square shaped plane coil of area $100cm^2$ of 200 turns carries a steady current of $5A$. It is placed in a uniform magnetic field of $0 \cdot 2T$ acting perpendicular to the plane of the coil. Calculate the torque on the coil when its plane makes an angle of 60° with the direction of the field. In which orientation will the coil be in stable equilibrium?

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COMPETITION FILE (A. MULTIPLE CHOICE QUESTIONS)

1. Select the correct statement:

A. The speed of a charged particle may increase in a non-uniform magnetic field.

B. The speed of a charged particle may increase in a uniform magnetic field.

C. A charged particle can be accelerated by a magnetic field.

D. A charged particle cannot be accelerated by a magnetic field.

Answer: c

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2. If a charged particle kept at rest experiences an electromagnetic force,

A. electric field must be present.

B. magnetic field must be present.

C. electric field may be present.

D. both electric and magnetic field must be present.

Answer: a

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3. 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. Along the positive Z-direction.

B. Along the negative Z-direction.

C. Along the positive Y-direction.

D. Along the negative Y-direction.

Answer: b

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4. a charged particle moves in a gravity free space without change in velocity. Which of the following is/are possible?

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

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

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

D. $E = 0, B = 0$

Answer: C

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5. A conducting circular loop of radius r carries a constant current i. It is placed in a uniform magnetic field B such that B is perpendicular to the plane of loop. What is the magnetic force acting on the loop?

A. 0

B. $2\pi IRB$

C. πIRB

D. $2IRB$

Answer: A

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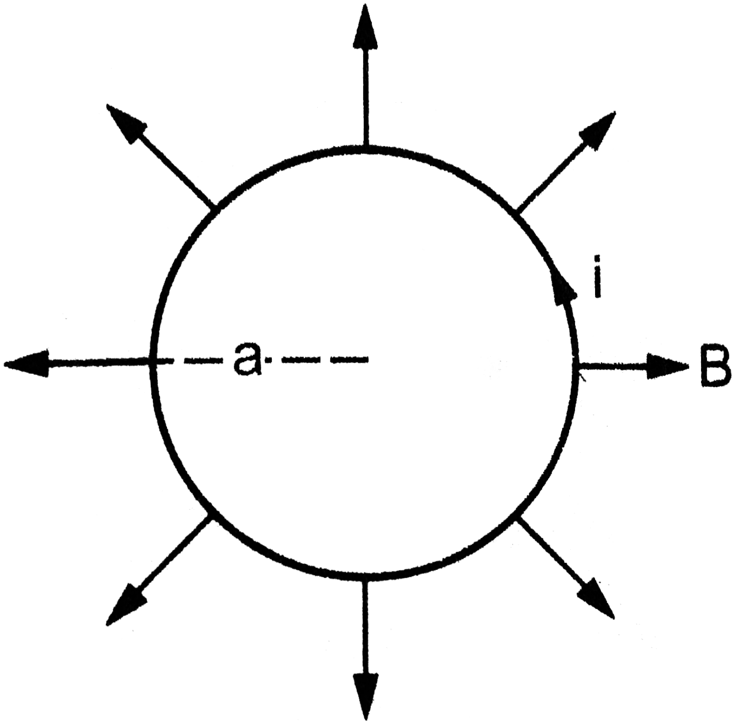
6. A circular loop of radius a, carrying a current I, is placed in a tow dimensional magnetic field. The centre of the loop coincides with the centre of the filed The strenght of the magnetic field at the pariphery of the loop is B. find the magnetic force on the wire.



A. 0

B. $2\pi IRB$, outward

C. πIRB , outward

D. $2\pi IRB$, inward

Answer: b

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7. A proton is moving perpendicular to the magnetic field with speed v and it is found that the proton takes T time to complete its circular path once. If the speed of the particle is increased to 2v, then how much time will it take to complete the circle?

A. T

B. $T/2$

C. $2T$

D. $4T$

Answer: a

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

A. $\frac{mV}{qB}$

B. $\sqrt{\frac{2mV}{qB}}$

C. $\sqrt{\frac{2mV}{qB^2}}$

D. $\sqrt{\frac{mV}{qB^2}}$

Answer: c

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9. An alpha particle and a deuteron are accelerated in a cyclotron. If K_1 and K_2 be the maximum kinetic energy acquired by the alpha particle and the deuteron, respectively, then K_1 / K_2 would be:

A. 2

B. $\sqrt{2}$

C. 1

D. 4

Answer: a

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10. Two straight long conductors AOB and COD are perpendicular to each other and carry currents I_1 and I_2. The magnitude of the magnetic induction at a point P at a distance d

from the point o in a direction perpendicular to the plane $ABCD$ is :

A. $\dfrac{\mu_0\sqrt{i_1^2 + i_2^2}}{2\pi d}$

B. $\dfrac{\mu_0(i_1 + i_2)}{2\pi d}$

C. $\dfrac{\mu_0(i_1 - i_2)}{2\pi d}$

D. $\dfrac{\mu_0\sqrt{i_1^2 - i_2^2}}{2\pi d}$

Answer: A

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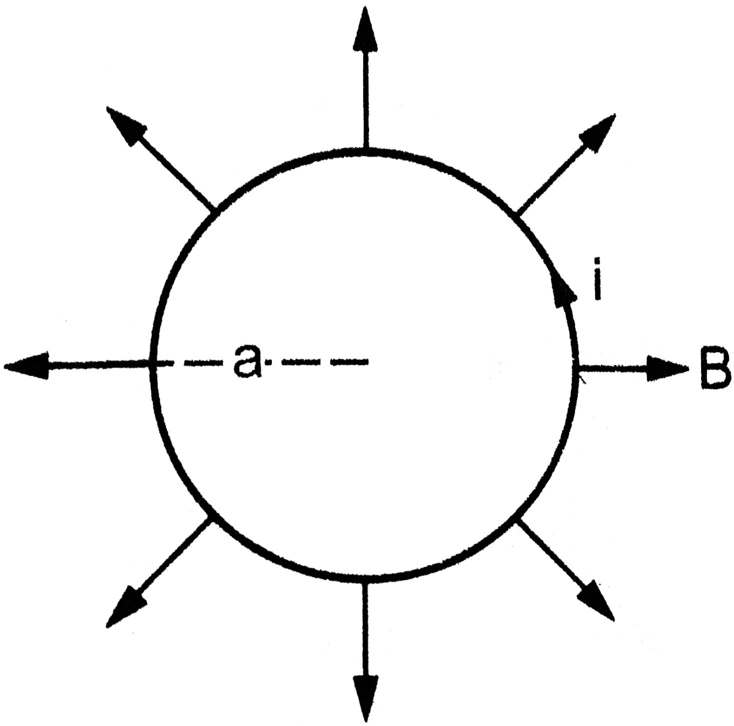
11. A circular loop of radius a, carrying a current I, is placed in a tow dimensional magnetic field. The centre of the loop coincides with the centre of the filed The strenght of the magnetic field at the pariphery of the loop is B. find the magnetic force on the wire.



A. Smaller loop experiences a net force.

B. Smaller loop experiences a netforce and torque.

C. Smaller loop experiences a net torque.

D. Smaller loop experiences no force and no torque.

Answer: c

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12. An identical electric current is passed through two coils and it is found that both are producing equal magnetic field at their centres. If the ratio of the number of turns in the two coils is $7:19$, then what should be the ratio of their radii?

A. $19:7$

B. $1:1$

C. $7:19$

D. $1:4$

Answer: C

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13. There is one circular loop of a uniform wire whose radius is R. Electric current I enters at one point on its circumference and leaves at a diametrically opposite point. What will be the net magnetic field intensity at the centre of the loop?

A. $\frac{\mu_0 i}{4r}$

B. $\frac{\mu_0 i}{2r}$

C. $\frac{\mu_0 i}{r}$

D. Zero

Answer: d

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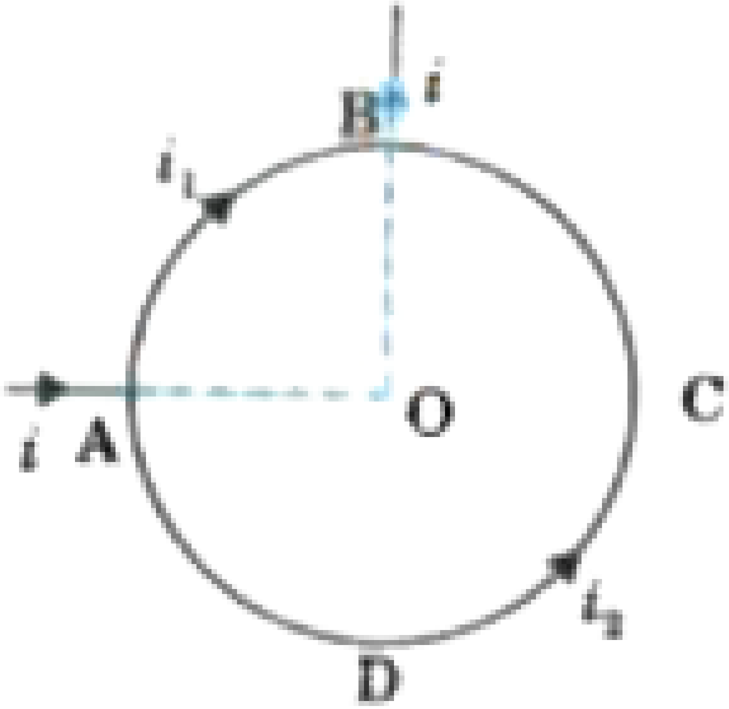
14. There is a circular loop of current of radius , as shown in figure: If current enters at point A and leaves at point B where

$\angle AOB$ is 90° and the wire of the loop is of uniform cross section area, then calculate the magnetic field intensity at the centre of the loop.



A. 0

B. $\dfrac{3\mu_0 i}{16r}$

C. $\dfrac{\mu_0 i}{32r}$

D. $\dfrac{3\mu_0 i}{32r}$

Answer: A

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15. If a thin wire of length L is given the shape of a regular polygon of n sides and current I flows through it, what will be the net magnetic field at the centre of the polygon if n is infinity?

A. $\frac{\mu_0 n i}{2L}$

B. $\frac{\mu_0 n i}{2\pi L}$

C. $\frac{\mu_0 \pi i}{L}$

D. $\frac{\mu_0 n \pi i}{L}$

Answer: c

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16. If a square frame of side L is made from a uniform wire and current I is flowing through it and its magnetic field intensity at the centre is B_1. When the same current is passed through the circular loop whose circumference is same as that of the square, the magnetic field at the centre is B_2. What will be B_1 / B_2 ?

A. $\frac{4\sqrt{2}}{\pi^3}$

B. $\frac{8\sqrt{2}}{\pi^3}$

C. $\frac{4\sqrt{2}}{\pi^2}$

D. $\frac{8\sqrt{2}}{\pi^2}$

Answer: D

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17. There is one circular loop of wire of radius a, carrying current i. At what distance from its centre on its axis will the magnetic field intensity become $\frac{1}{2\sqrt{2}}$ times at the centre?

A. a

B. 2a

C. $3a/2$

D. $a/3$

Answer: a

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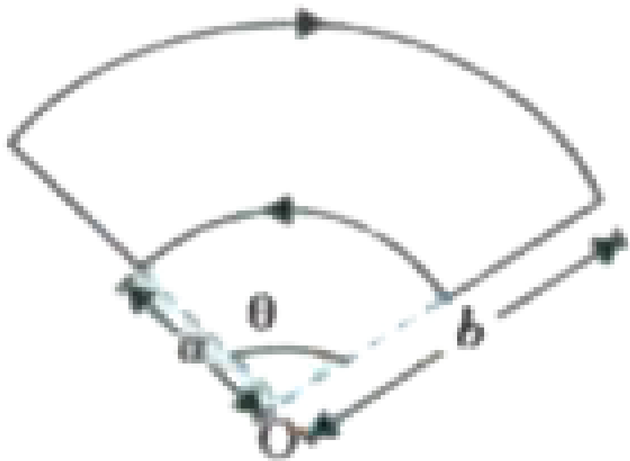
18. In the following figure a current loop is shown which is made from two circular arcs of radii a and $b(a < b)$, connected by radial wires. Calculate the magnetic field at the centre O.



A. $\dfrac{\mu_0 i\theta}{4\pi ab}(b-a)$, inwards

B. $\dfrac{\mu_0 i\theta}{4\pi ab}(b-a)$, outwards

C. $\dfrac{\mu_0 i\theta}{3\pi ab}(b-a)$, inwards

D. Zero

Answer: B

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19. If a charged particle having charge q is moving in a circular path of radius R with a uniform speed u, what would be the magnetic field at the centre?

A. $\frac{\mu_0 q v}{2\pi R^2}$

B. $\frac{\mu_0 q v}{3\pi R^2}$

C. $\frac{\mu_0 q v}{\pi R^2}$

D. $\frac{\mu_0 q v}{4\pi R^2}$

Answer: D

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20. A positively charged particle is moving towards the east direction and is found to get deviated towards south. What is the possible direction of the magnetic field?

A. West

B. Upward

C. Downward

D. North

Answer: b

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21. There is a uniform magnetic field and a charged particle is given an initial velocity at an acute angle to the direction of the magnetic field. What kind of path will the particle follow?

A. Circle

B. Straight line

C. Helical path with a non-uniform pitch.

D. Helical path with a uniform pitch.

Answer: d

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22. Uniform electric and magnetic fields are applied along the same direction and a negatively charged particle is given an initial velocity at an acute angle with the direction of the fields. What kind of a path will the particle follow?

A. Helical path with an increasing pitch.

B. Helical path with a decreasing pitch.

C. Helical path with an increasing pitch followed by a decreasing pitch.

D. Helical path with a decreasing pitch followed by an increasing pitch.

Answer: D

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23. There is a beam of electrons and protons in which both the particles are moving with the same velocity, entering a thin region, where a uniform magnetic field is applied perpendicular to the motion of beam. The protons and the electrons

A. will be deviated in the same direction

B. will be deviated in opposite directions with a different angle of deviation

C. will be deviated in an opposite direction with a same angle of deviation

D. will not deviate

Answer: b

View Text Solution

24. Which of the following particles will take the least time to complete a circle when projected with the same velocity perpendicular to a uniform magnetic field?

A. He^{+}

B. Li^{+}

C. Electron

D. Proton

Answer: c

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25. There is a flat circular current coil placed in a uniform magnetic field in such a manner that its magnetic moment is opposite to the direction of the magnetic field. The coil is

A. in neutral equilibrium

B. in stable equilibrium

C. in unstable equilibrium

D. not in equilibrium

Answer: c

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26. In a region of space, there is a possiblity of electric or magnetic field. We have to distinguish whether it is electric or magnetic field, using charged particles of same polarity, which can be fired in the field. This can be done by firing charges

A. perpendicular to the field

B. parallel to the field

C. with different speeds

D. from opposite directions

Answer: d

View Text Solution

27. A conducting wire of length L is bent in the form of an equilateral triangle. If current I is made to pass through it, then calculate the magnetic field intensity at the centre of the triangle.

A. $\frac{27\mu_0 I}{4\pi L}$

B. $\frac{27\mu_0 I}{2\pi L}$

C. $\frac{27\mu_0 I}{5\pi L}$

D. $\frac{27\mu_0 I}{7\pi L}$

Answer: B

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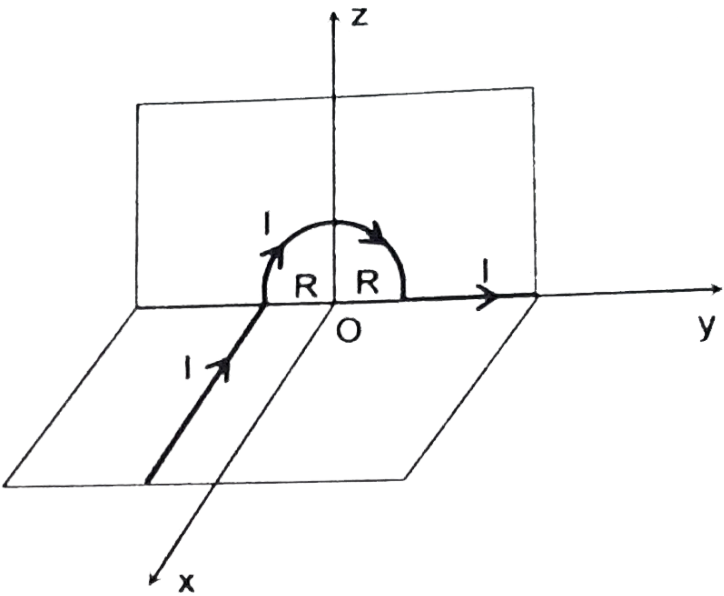
28. A long wire carrying current 'I' is bent into the shape as shown in the figure. The net magnetic field intensity at the centre 'O' is



A. $\dfrac{\mu_0 I}{2\pi R}(\pi + 1)$

B. $\dfrac{\mu_0 I}{4\pi R}(\pi^2 + 1)$

C. $\dfrac{\mu_0 I}{4\pi R}(\pi - 1)$

D. $\dfrac{\mu_0 I}{4\pi R}(\pi + 1)$

Answer: D

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29. There is one circular loop of wire of radius R, carrying current I and magnetic field at its centre is B_0, due to its own current. The loop is bent along its diameter at right angle. What will be the net magnetic field at the centre of the loop?

A. $\frac{B_0}{\sqrt{2}}$

B. $B_0\sqrt{2}$

C. $2B_0\sqrt{2}$

D. $B_0\sqrt{3}$

Answer: a

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30. A uniform magnetic existing in space is $\vec{B} = \left(2\hat{I} + 3\hat{j} - 5\hat{k}\right)$ tesla . At one instant of time, the force experienced by a $2\mu C$ point charge is $\overrightarrow{F} = \left(x\hat{I} - 2\hat{j} + 2\hat{k}\right)$ N. What should be the value of x ?

A. 4

B. 8

C. 16

D. 0

Answer: b

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31. Electric field and magnetic field in a region of space are given by $\overrightarrow{E} = E_0\hat{I}$ and $\overrightarrow{B} = -B_0\hat{k}$, respectively. A positively charged particle $(+q)$ is released from rest at the origin. When the particle reaches a point $P(x, y, z)$, then it attains kinetic energy K that is equal to

A. qB_0x

B. qB_0y

C. qE_0y

D. qE_0x

Answer: d

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32. A vertical wire carries a current in upward direction. An electron beam sent horizontally towards the wire will be deflected

A. Towards left

B. Towards right

C. Downwards

D. Upwards

Answer: d

Watch Video Solution

33. A charged particle(q) is projected perpendicular to a uniform magnetic field (B) with speed u. A is the area bounded by the path followed by electrons. K is kinetic energy of the particle. Then how will the graph between A and K be?

A. Straight line

B. Parabola

C. Ellipse

D. None of these

Answer: a

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34. A proton beam is fired from west to east and an electron beam is fired parallel to it in the same direction. Force on the electron beam will be

A. upwards

B. downwards

C. towards the proton beam

D. away from the proton beam

Answer: d

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35. There are two straight conductors, carrying currents i_1 and i_2. Both the conductors are kept parallel to each other at a separation 2d. The magnetic field is measured at a point midway between the conductors. Magnetic field intensity at the above specified point is 20μT when both the wire carry current in the same direction but it becomes $80\mu T$ when the current in one of them is reversed. Assume $i_1 > i_2$ and find i_1/i_2.

A. 2

B. $5/3$

C. 4

D. $7/3$

Answer: B

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36. Two particles X and Y with equal charges, after being accelerated throuhg the same potential difference, enter a region of uniform magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of the mass of X to that of Y is

A. $\frac{R_1}{R_2}$

B. $\sqrt{\frac{R_1}{R_2}}$

C. $\left(\frac{R_1}{R_2}\right)^2$

D. None of these

Answer: c

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37. A charged particle is moved along a magnetic field line. The magnetic force on the particle is

A. perpendicular to the velocity only

B. perpendicular to the magnetic field only

C. perpendicular to both the velocity and the magnetic field

D. Zero

Answer: D

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38. There is a circular loop carrying current and another straight wire carrying current is placed along its axis. The straight wire

A. will apply radial inward force on the circular loop.

B. will apply radial outward force on the circular loop.

C. will apply force radially inward or outward, depending on the direction of currents.

D. will not exert any force on the circular loop.

Answer: D

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COMPETITION FILE (B. MULTIPLE CHOICE QUESTIONS)

1. A beam of electrons passes underfected throgh unifromly perpendicular electric and magnetic fields. If the electric field is swiched off, and the same magnetic field is maintained the electrons move:

A. in a circular orbit

B. along a parabolic path

C. along a straight line

D. in an elliptical orbit.

Answer: a

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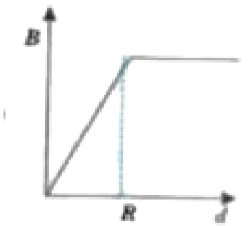
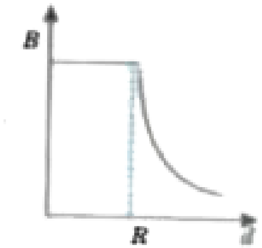
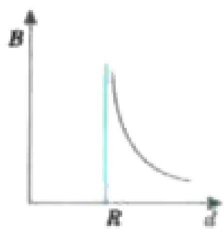
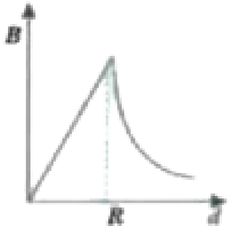
2. A cylindrical conductor of radius R is carrying constant current. The plot of the magnitude of the magnetic field, B with the distance, d from the centre of the conductor , is correctly represented by the figure:

A. 

B. 

C. 

D. 

Answer: d

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3. The magnetic force acting on a charged particle of charge $-2\mu C$ in a magnetic field of $2T$ acting y direction, when the particle velocity is $\left(2i + 3\hat{j}\right) \times 10^6 ms^{-1}$, is

A. 4 N in direction

B. 8 N in Y direction

C. 8 N in Z direction

D. 8 N in - Z direction

Answer: d

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4. A thin ring of radius R meter has charge q coulomb uniformly spread on it. The ring rotates about its axis with a constant frequency of f revolution/s. The value of magnetic induction in Wbm^{-2} at the centre of the ring is

A. $\frac{\mu_0 q f}{2R}$

B. $\frac{\mu_0 q f}{2\pi R}$

C. $\frac{\mu_0 q}{2\pi f R}$

D. $\frac{\mu_0 q}{2 f R}$

Answer: A

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5. In mass spectrometer used for measuring the masses of ions, the ions are initaily accerlerated by an electric potential V and then made to describe semicircular paths of radius R using a magnetic field B.if V and B are kept constant, the ratio $\left(\frac{\text{charg e on the ion}}{\text{mass of the ion}}\right)$ will be propertional to:

A. $\frac{1}{R^2}$

B. R^2

C. R

D. $\frac{1}{R}$

Answer: a

Watch Video Solution

6. Current sensitivity of a moving coil galvanometer is 5 div/mA and its voltage sensitivity (angular deflection per unit voltage applied) is 20 div/V. The resistance of the galvanometer is

A. 250Ω

B. 25Ω

C. 40Ω

D. 500Ω

Answer: A

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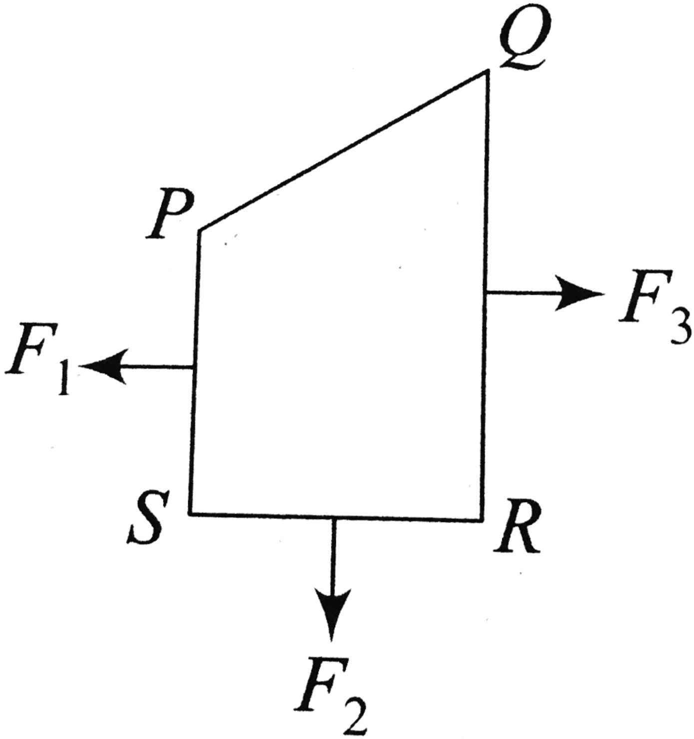
7. A closed loop $PQRS$ carrying a current is place in a unifrom magnetic forces on segments PS, SR and RQ are F_1, F_2 and F_3 respectively and are in the plane of the paper and along the directions shown, the force on the segment QP is



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

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

C. $F_3 - F_1 + F_2$

D. $F_3 - F_1 = F_2$

Answer: a

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8. A circular disc of radius $0.2m$ is placed in a uniform magnetic fied of induction $\frac{1}{\pi}\left(\frac{Wb}{m^2}\right)$ in such a way that its axis makes an angle of 60° with The magnetic flux linked with the disc is

A. 0.06 Wb

B. 0.08 Wb

C. 0.01 Wb

D. 0.02 Wb

Answer: d

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9. A square current carrying loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is $\overrightarrow{F}$, the net force on the remaining three arms of the loop is

A. $-3\overrightarrow{F}$

B. $\overrightarrow{F}$

C. $3\overrightarrow{F}$

D. $-\overrightarrow{F}$

Answer: D

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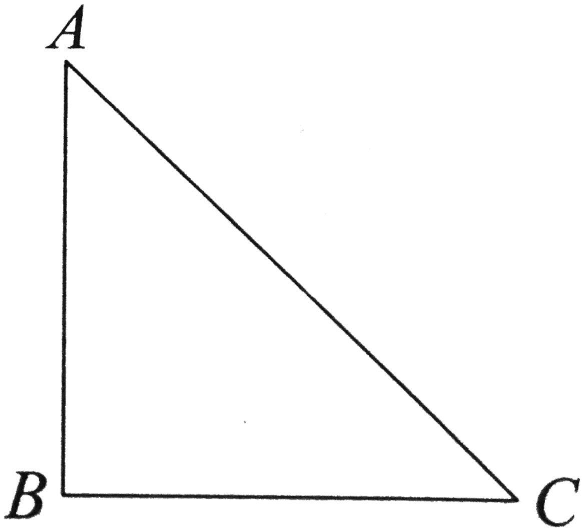
10. A current carrying closed loop in the from of a right angle isoseles triangle ABC is placed in a unifrom magnetic fild acting along AB. If the magnetic force on the arm BC is F, the force on the arm AC is



A. $-\sqrt{2}\vec{F}$

B. $-\vec{F}$

C. $\vec{F}$

D. $\sqrt{2}\vec{F}$.

Answer: b

Watch Video Solution

11. A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected along the direction of the fields with a certain velocity then

A. will turn towards right of direction of motion

B. speed will decrease

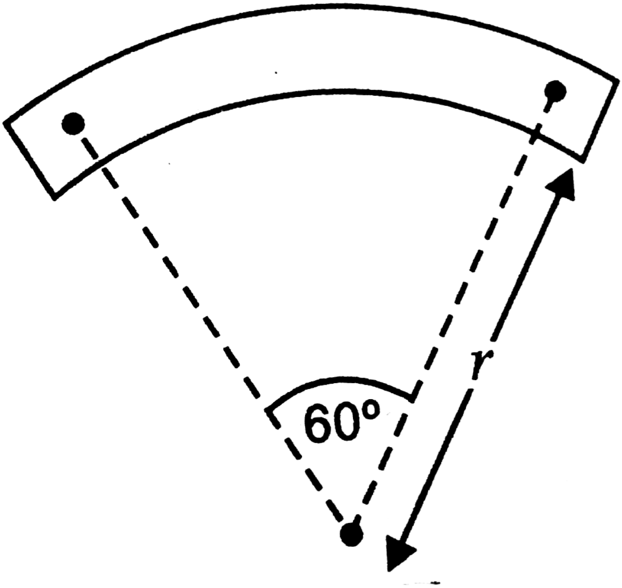
C. speed will increase

D. will turn towards left direction of motion.

Answer: b

Watch Video Solution

12. A bar magnet of lenth l and magnetic dipole moment 'M' is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be



A. $\frac{3}{\pi}M$

B. $\frac{2}{\pi}M$

C. $\frac{M}{2}$

D. M.

Answer: a

Watch Video Solution

13. A current loop in a magnetic field

A. can be in equilibrium in one orientation

B. can be in equilibrium in two orientations, both the equilibrium states are unstable

C. can be in equilibrium in two orientations, one stable while the other is unstable

D. experiences a torque whether the field is uniform or non uniform in all orientations.

Answer: C

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14. When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ toward west. The electric and magnetic fields in the room are

A. $\frac{ma_0}{e}\text{west}, \frac{2ma_0}{ev_0}\text{down}$

B. $\frac{ma_0}{e}\text{east}, \frac{3ma_0}{ev_0}\text{up}$

C. $\frac{ma_0}{e}\text{east}, \frac{3ma_0}{ev_0}\text{down}$

D. $\frac{ma_0}{e}\text{west}, \frac{2ma_0}{ev_0}\text{up.}$

Answer: a

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15. Two identical long conducting wires AOB and Cod are placed at right angles to each other, with one above other such that O is their common point for the two. The wires carry I_1 and I_2 currents, respectively. Points P is lying at distance d form O along a direction perpendicular to the plane containing the wires. The magnetic field at the point P will be

A. $\frac{\mu_0}{2\pi d}\left(\frac{I_1}{I_2}\right)$

B. $\frac{\mu_0}{2\pi d}(I_1 + I_2)$

C. $\frac{\mu_0}{2\pi d}(I_1^2 - I_2^2)$

D. $\frac{\mu_0}{2\pi d}(I_1^2 + I_2^2)^{1/2}$

Answer: d

Watch Video Solution

16. An electron moving in a circular orbit of radius r makes n rotation per secound. The magnetic field produced at the centre has magnitude

A. Zero

B. $\frac{\mu_0 n^2 e}{r}$

C. $\frac{\mu_0 \neq}{2r}$

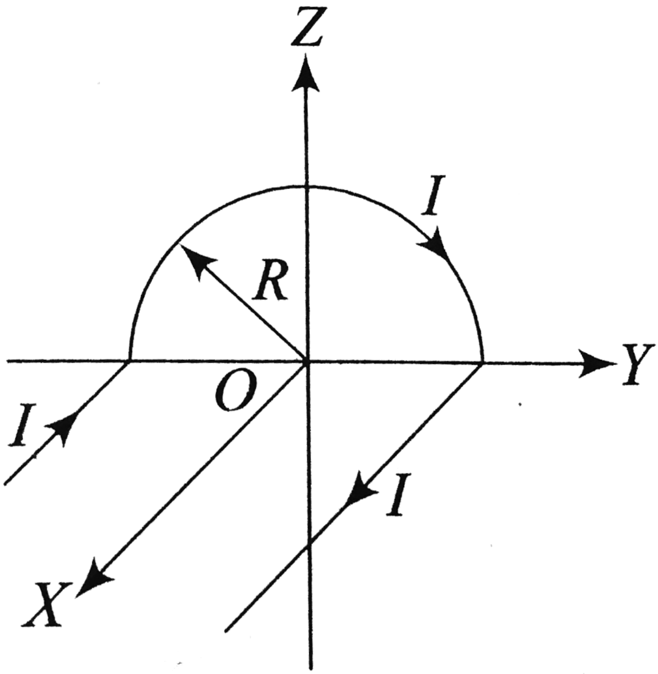
D. $\frac{\mu_0 \neq}{2\pi r}$.

Answer: c

Watch Video Solution

17. A wire carrying current I has the shape as shown in the adjoining figure. Linear parts of the wire are very long and parallel to X-axis while semicicular portion of radius R is lying in $Y-Z$

plane. Magnetic field at point O is



A. $\overrightarrow{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i} - 2\hat{k}\right)$

B. $\overrightarrow{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i} + 2\hat{k}\right)$

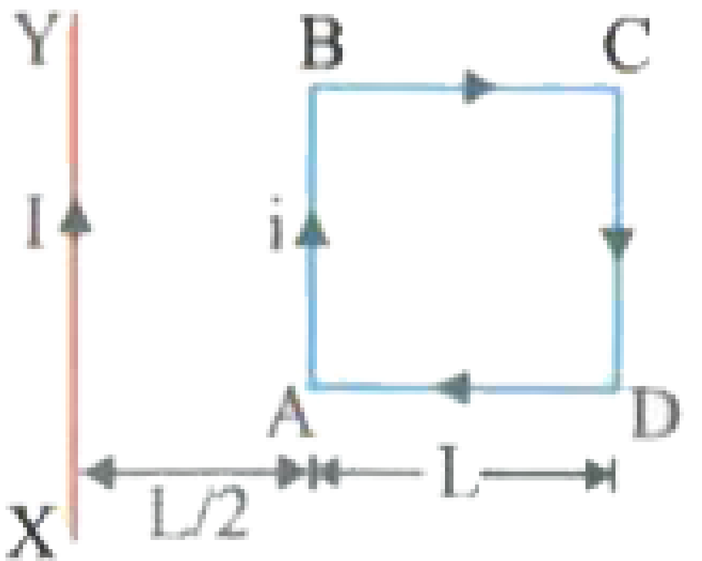
C. $\overrightarrow{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i} - 2\hat{k}\right)$

D. $\overrightarrow{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{i} + 2\hat{k}\right)$

Answer: b

Watch Video Solution

18. A square loop of ABCD carrying a current i, is placed near and coplanar with a long straight conductor XY carrying a current I, the net force on the loop will be



A. $\dfrac{\mu_0 I i}{2\pi}$

B. $\dfrac{2\mu_0 I i L}{3\pi}$

C. $\dfrac{\mu_0 I i L}{2\pi}$

D. $\frac{2\mu_0 I i}{3\pi}$

Answer: d

Watch Video Solution

19. A long straight wire of radius a carries a steady current I. The current is uniformly distributed over its cross-section. The ratio of the magnetic fields B and B' , at radial distances $\frac{a}{2}$ and $2a$ respectively from the axis of the wire is:

A. $\frac{1}{2}$

B. 1

C. 4

D. $\frac{1}{4}$

Answer: B

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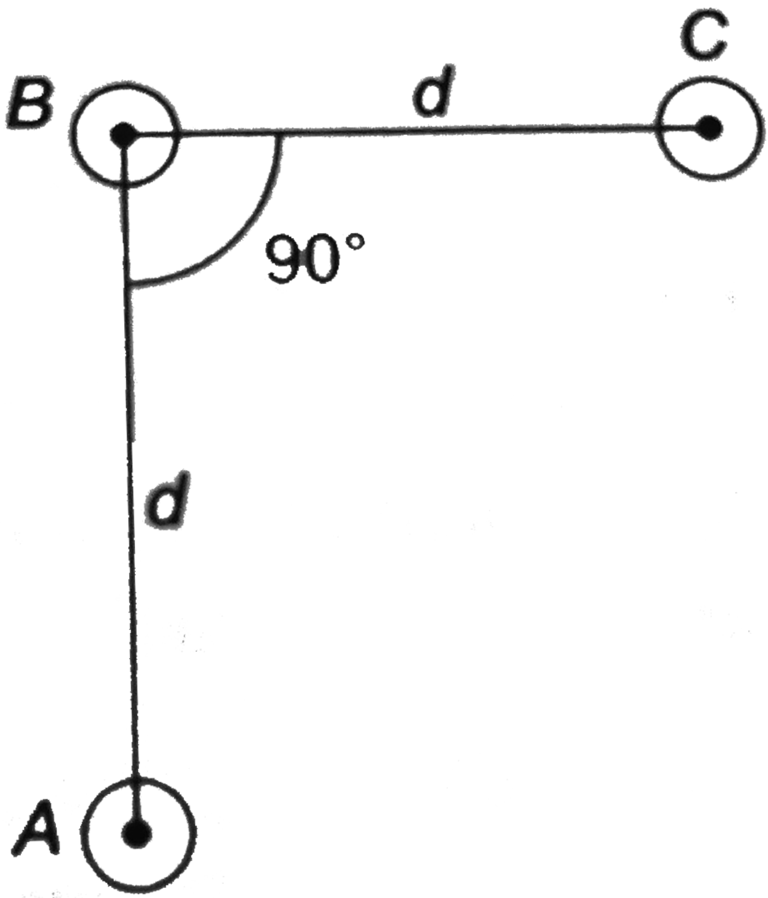
20. An arrangment of three parallel staright wires placed perpendcular to plane of paper carrying same current I along the same direction is shown in figure. Magnitude of force per unit length on the middle wire $'B'$ is given by



A. $\dfrac{\mu_0 i^2}{2\pi d}$

B. $\dfrac{2\mu_0 i^2}{\pi d}$

C. $\dfrac{\sqrt{2}\mu_0 i^2}{\pi d}$

D. $\dfrac{\mu_0 i^2}{\sqrt{2}\pi d}$

Answer: d

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21. A 250-turns rectangular coil of length 2.1 cm and width 1.25 cm carries a current of $85\mu A$ and subjected to magnetic field of strength $0.85T$. Work done for rotating the coil by 180° against the torque is

A. $9.48\mu J$

B. $4.55\mu J$

C. $2.3\mu J$

D. $1.15\mu J$

Answer: A

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

A. both momentum and kinetic energy of the particle are not constant.

B. both momentum and kinetic energy of the particle are constant.

C. kinetic energy changes but the momentum is constant.

D. the momentum changes but the kinetic energy is constant.

Answer: D

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23. Two identical conducting wires AOB and COD are placed at right angles to each other. The wire AOB carries an electric current I_1 and COD carries a current I_2. The magnetic field on a point lying at a distance d from O, in a direction perpendicular to the plane of the wires AOB and COD, will be given by

A. $\frac{\mu_0}{2\pi d}\left(I_1^2 + I_2^2\right)^{1/2}$

B. $\frac{\mu_0}{2\pi d}(I_1 + I_2)$

C. $\frac{\mu_0}{2\pi d}\left(I_1^2 + I_2^2\right)$

D. $\frac{\mu_0}{2\pi}\left(\frac{I_1 + I_2}{d}\right)^{1/2}$

Answer: a

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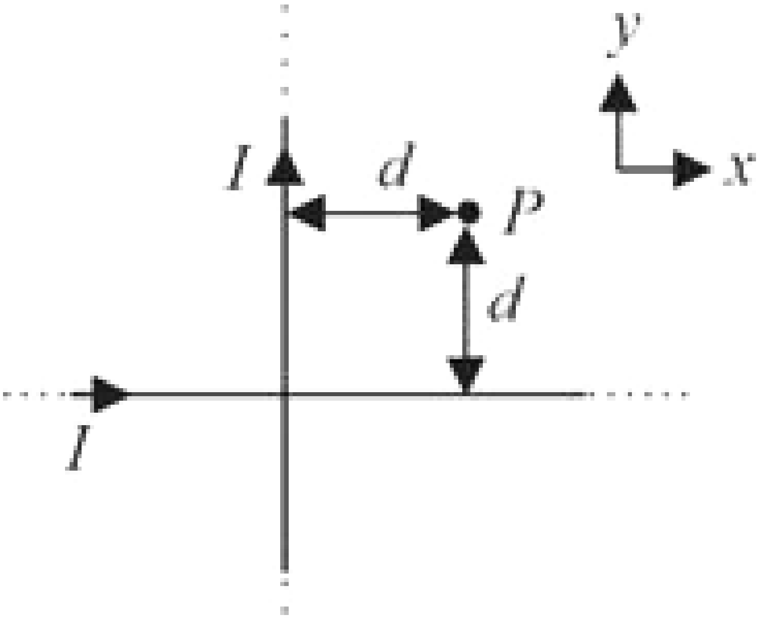
24. Two very long, straight, and insulated wires are kept at 90° angle from each other in xy-plane as shown in the figure. These wires carry currents of equal magnitude I, whose directions are shown in the figure. The net magnetic field at point will be:



A. $\frac{\mu_0 I}{2\pi d}(\widehat{x}+\hat{y})$

B. $\frac{+\mu_0 I}{\pi d}(\hat{z})$

C. zero

D. $-\dfrac{\mu_0 l}{2\pi d}(\widehat{x}+\hat{y})$

Answer: c

Watch Video Solution

25. A current I flows along the lenght of an infinetely long, straight, thin walled pipe. Then

A. the magnetic field is different at different points inside the pipe.

B. the magnetic field at any point inside the pipe is zero.

C. the magnetic field at all points inside the pipe is the same, but not zero.

D. the magnetic field is zero only on the axis of the pipe.

Answer: b

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26. A horizontal overheadpowerline is at height of $4m$ from the ground and carries a current of $100A$ from east to west. The magnetic field directly below it on the ground is

$(\nu_0 = 4\pi \times 10^{-7} TmA^{-1}$

A. $2.5 \times 10^{-7} T$ northward

B. $2.5 \times 10^{-7} T$ southward

C. $5 \times 10^{-6} T$ northward

D. $5 \times 10^{-6} T$ southward.

Answer: d

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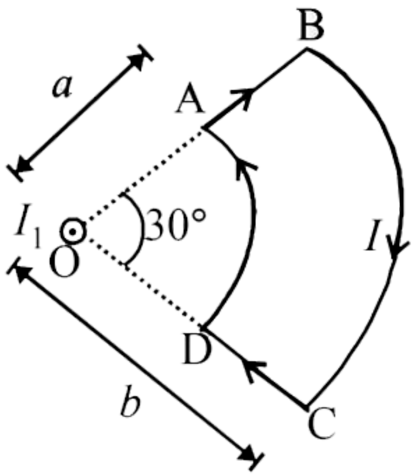
27. A current loop $ABCD$ is held fixed on the plane of the paper as shown in figure. The arcs $BC(radius = b)$ and $DA(radius = a)$ of the loop are joined by two straight wires AB and CD at the origin O is 30^(@). $A \neg herstraightth \in wirewithsteadycurrent$ I_(1)` flowing out of the plane of the paper is kept at the origin .



Due to the process of the current I_1 at the origin:

A. the force on AB and DC are zero

B. the force on AD and BC are zero

C. the magnitude of the net force on the loop is given by

$$\frac{I_1 I}{4\pi}\mu_0\left[2(b-a)+\frac{\pi}{3}(a+b)\right]$$

D. the magnitude of the net force on the loop is given by

$$\frac{\mu_0 I I}{24ab}(b-a).$$

Answer: b

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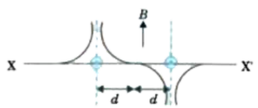
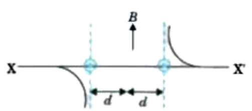
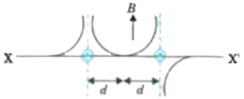
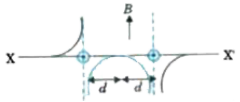
28. Two long parallel wires are at a distance $2d$ apart. They carry steady equal currents flowing out of the plane of the paper , as shown. The variation of the magnetic field B along the line XX is given by

A. 

B. 

C. 

D. 

Answer: a

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29. An electron, a proton and an alpha particle having the same kinetic energy are moving in circular orbits of radii r_e, r_p, r_α respectively in a uniform magnetic field B. The relation between r_e, r_p, r_α is:

A. $r_e < r_p < r_\alpha$

B. $r_e < r_\alpha < r_p$

C. $r_e > r_p = r_\alpha$

D. $r_e < r_p = r_\alpha$

Answer: D

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30. A thin circular disk of radius R is uniformly charged with density $\sigma > 0$ per unit area.The disk rotates about its axis with a uniform angular speed ω.The magnetic moment of the disk is :

A. $\pi R^4 \sigma \omega$

B. $\frac{\pi R^4}{2} \sigma \omega$

C. $\frac{\pi R^4}{4} \sigma \omega$

D. $2\pi R^4 \sigma \omega$

Answer: c

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31. A current I flows an infinitely long wire with cross section in the form of a semi - circular ring of radius R. The magnitude of the magnetic induction along its axis is :

A. $\dfrac{\mu_0 I}{2\pi^2 R}$

B. $\dfrac{\mu_0 I}{2\pi R}$

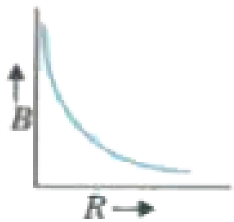
C. $\dfrac{\mu_0 I}{4\pi^2 R}$

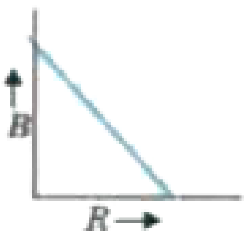
D. $\dfrac{\mu_0 I}{\pi^2 R}$

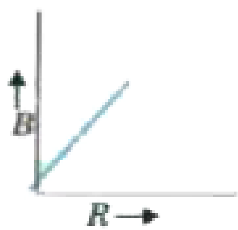
Answer: B

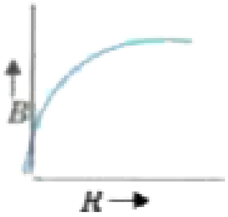
Watch Video Solution

32. A charge Q is uniformly distributed over the surface of non - conducting disc of radius R. The disc rotates about an axis perpendicular to its plane and passing through its centre with an angular to its plane and passing through its centre of the disc. If we keep both the amount of charge placed on the disc and its angular velocity to be constant and vary the radius of the disc then the variation of the magnetic induction at the centre of the disc will br represented by the figure:

A. 

B. 

C. 

D. 

Answer: A

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33. Proton , deuton and alpha particle of same kinetic energy are moving in circular trajectories in a constant magnetic field. The radii of proton , deuteron and alpha particle are respectively r_p, r_d and r_α. Which one of the following relation is correct?

A. $r_\alpha = r_d > r_p$

B. $r_\alpha = r_p = r_d$

C. $r_\alpha = r_p < r_d$

D. $r_\alpha > r_d > r_p$.

Answer: c

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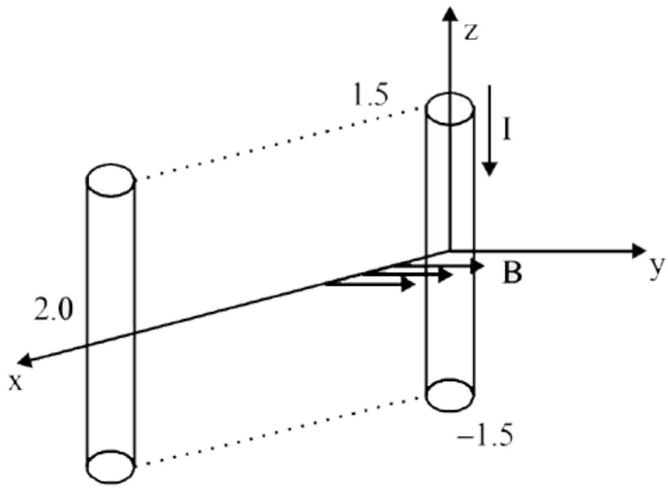
34. A conductor lies along the z-axis at $-1.5 \leq z < 1.5m$ and carries a fixed current of $10.0A$ in $-\hat{a}_z$ direction (see figure). For a field $\overrightarrow{B} = 3.0 \times 10^{-4} e^{-0.2x} \hat{a}_y T$, find the power required to move the conductor at constant speed to $x = 2.0m, y = 0m$ in $5 \times 10^{-3} s$. Assume parallel motion along the $x - a\xi s$.



A. 29.7 W

B. 1.57 W

C. 2.97 W

D. 14.85 W

Answer: c

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35. Two coaxial solenoids of different radius carry current I in the same direction. $\overrightarrow{F_1}$ be the magnetic force on the inner solenoid due to the outer one and $\overrightarrow{F_2}$ be the magnetic force on the outer solenoid due to the inner one. Then

A. $\overrightarrow{F}_1 = \overrightarrow{F}_2 = 0$

B. $\overrightarrow{F}_1$ is radially inwards and $\overrightarrow{F}_2$ is radially outwards

C. $\overrightarrow{F}_1$ is radially inwards and $\overrightarrow{F}_2 = 0.$

D. $\overrightarrow{F}_1$ is radially outwards and $\overrightarrow{F}_2 = 0$.

Answer: A

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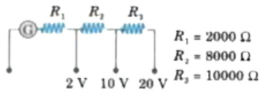
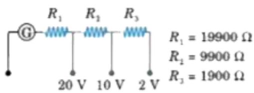
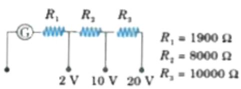
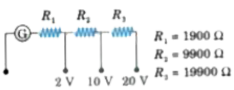
36. A galvanometer of resistance 100Ω has 50 divisions on its scale and has sensitivity of 20μA/ division. It is to be converted to a voltmeter with three ranges, of $0 - 2V, 0 - 10V$ and $0 - 20V$. The appropriate circuit to do so is:

A. 

B. 

C. 

D. 

Answer: c

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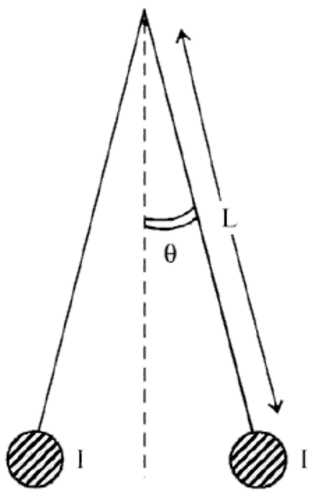
37. Two long current carrying thin wires , both with current I, are held by insulating threads of length L and are in equilibrium as shown in the gigure , With threads making an angle θ with the vertical . If wires have mass λ per unit length then the value of I is :



A. $\sin\theta\sqrt{\dfrac{\pi\lambda gL}{\mu_0\cos\theta}}$

B. $2\sin\theta\sqrt{\dfrac{\pi\lambda gL}{\mu_0\cos\theta}}$

C. $2\sqrt{\dfrac{\pi g L}{\mu_0}\tan\theta}$

D. $\sqrt{\dfrac{\pi\lambda g L}{\mu_0}\tan\theta}$.

Answer: b

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

A. $\dfrac{\pi^2}{8}$

B. $\dfrac{\pi^2}{16\sqrt{2}}$

C. $\dfrac{\pi^2}{16}$

D. $\frac{\pi^2}{8\sqrt{2}}$

Answer: b

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39. A galvanometer having a coil resistance of 100ω gives a full scale deflection , when a current of $1mA$ is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of $10A$, is :

A. 0.01Ω

B. 2Ω

C. 0.1Ω

D. 3Ω

Answer: a

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40. A charge q is spread uniformly over an insulated loop of radius r. If it is rotated with an angular velocity ω with respect to normal axis then the magnetic moment of the loop is :

A. $\frac{3}{2}q\omega r^2$

B. $\frac{1}{2}q\omega r^2$

C. $q\omega r^2$

D. $\frac{4}{3}q\omega r^2$

Answer: b

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41. The sensitivity of a galvanometer is 60 division /A . When a shunt is used, its sensitivity becomes 10 division/A. If the galvanometer is of resistance 20Ω, the value of shunt used is

A. 4Ω

B. 5Ω

C. 20Ω

D. 2Ω

Answer: a

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42. In a circuit for finding the resistance of a galvanometer by half deflection method, a 6 V battery and a high resistance of 11 $k\Omega$ are used. The figure of merit of the galvanometer is 60 $\mu A/\text{division}$. In the absence of shunt resistance, the galvanometer produces a deflection of $\theta = 9$ divisions when current flows in the circuit. The value of the shunt resistance that can cause the delflection of $\theta / 2$, is closet to :

A. 550Ω

B. 220Ω

C. 55Ω

D. 110Ω

Answer: d

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43. The dipole moment of a circular loop carrying a current I, is m and the magnetic field at the centre of the loop is B_1 . When the dipole moment is doubled by keeping the current constant, the magnetic field at the centre of the loop is B_2 . The ratio $\frac{B_1}{B_2}$ is:

A. $\sqrt{2}$

B. $\frac{1}{\sqrt{2}}$

C. 2

D. $\sqrt{3}$.

Answer: a

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44. A magnetic needle lying parallel to a magnetic field requires $W units$ of work to turn it through 60°. The torque needed to maintain the needle in this position will be

A. $\sqrt{3}W$

B. W

C. $\dfrac{W}{\sqrt{2}}$

D. $\dfrac{W}{\sqrt{3}}$

Answer: A

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45. Two identical magnetic dipoles of magnetic moments $2Am^2$ are placed at a separation of $2m$ with their axes perpendicular to each other in air. The resultant magnetic field at a mid point between the dipole is

A. $4\sqrt{5} \times 10^{-5}T$

B. $2\sqrt{5} \times 10^{-5}T$

C. $4\sqrt{5} \times 10^{-7}T$

D. $2\sqrt{5} \times 10^{-7}T$

Answer: d

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46. A Helmholtz coil has a pair of loops, each withN turns and radius R. They are placed coaxially at distance R and the same current I flows through the loops in the same direction. The magnitude of magnetic field at P, midway between the centres A and C, is given by [Refer to figure given below]:

A. $\dfrac{8NI\mu_0}{5^{1/2}R}$

B. $\dfrac{4Ni\mu_0}{5^{3/2}R}$

C. $\dfrac{4NI\mu_0}{5^{1/2}R}$

D. $\dfrac{8NI\mu_0}{5^{3/2}R}$

Answer: d

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47. The magnetic field at a point midway between two parallel long wires carrying currents in the same direction is $10\mu T$. If the direction of the smaller current among them is reversed, the field becomes $30\mu T$. The ratio of the larger to the smaller current in them is

A. $3:1$

B. $2:1$

C. $4:1$

D. $3:2$

Answer: b

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48. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of $40\pi \text{rad s}^{-1}$ about its axis, perpendicular to its plane. If the magnetic field at its centre is $3.8 \times 10^{-9} T$, then the charge carried by the ring is close to $\left(\mu_0 = 4\pi \times 10^{-7} N / A^2\right)$

A. $2 \times 10^{-6} C$

B. $7 \times 10^{-6} C$

C. $4 \times 10^{-5} C$

D. $3 \times 10^{-5} C$

Answer: d

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49. A galvanometer with its coil resistance 25Ω requires a current of 1 mA for its full deflection. In order to construct an ammeter to read up to a current of 2A, the approximate value of the shunt resistance should be :

A. 1.25×10^{-2}

B. 2.5×10^{-3}

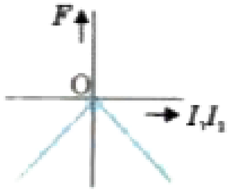
C. 2.5×10^{-2}

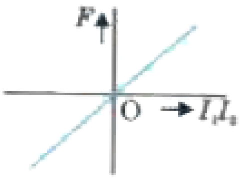
D. 1.25×10^{-3}

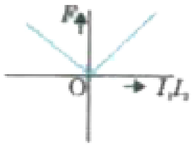
Answer: a

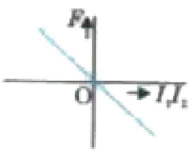
Watch Video Solution

50. Two long straight parallel wires, carrying (adjustable) currents I_1 and I_2 are kept at a distance d apart. If the force F between the two wires is taken as positive when the wire repel each other and negative when the wires attract each other, the graph showing the dependence of F, on the product $I_1 I_2$ would be:

A. 

B. 

C. 

D. 

Answer: d

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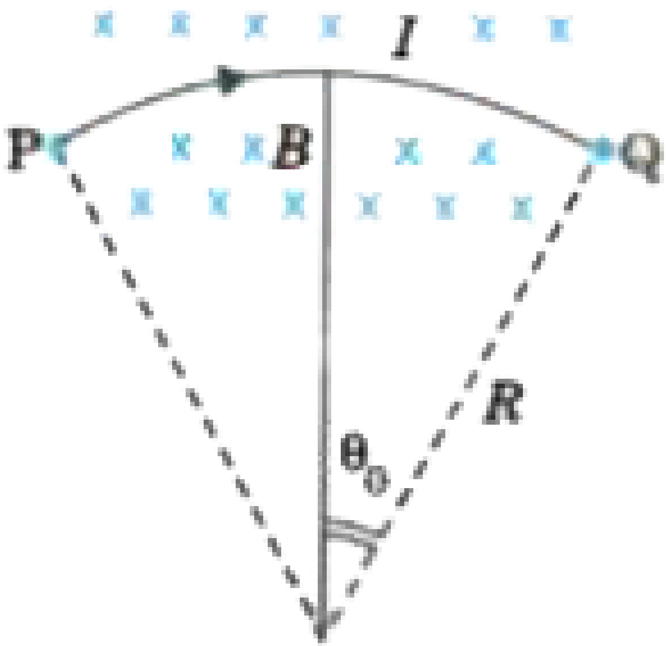
51. A wire carrying current I is tied between points P and Q and is in the shape of a circular arch of radius R due to a uniform magnetic field B (perpendicular to the plane of the paper, shown by cross marked) in the vicinity of the wire. If the wire subtends and angle $2\theta_0$ at the centre of the circle of which it forms an arch) then the tension in the wire is:



A. IBR

B. $\dfrac{IBR}{\sin\theta_0}$

C. $\frac{IBR}{2\sin\theta_0}$

D. $\frac{IBR\theta_0}{\sin\theta_0}$

Answer: a

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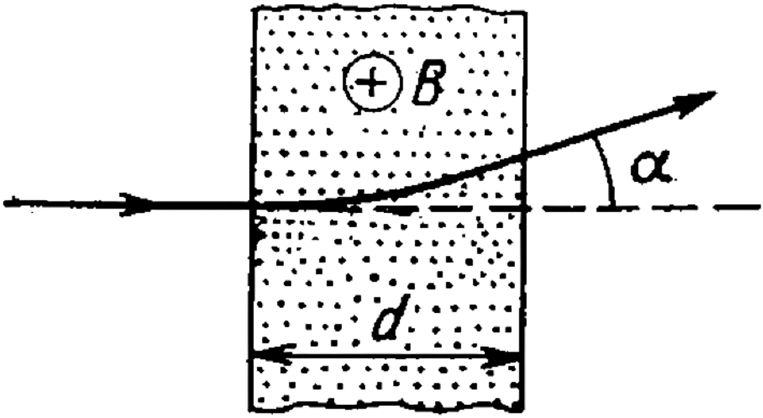
52. A proton accelarted by a potential differnce $V = 500kV$ fieles through a unifrom transverse magnetic filed the induction $B = 0.54T$. The field occupies a region of space $d = 10cm$ in thickness (Fig). Find the angle α through which the proton deviates from the initial direction of its motion.



A. $\frac{B}{2}\sqrt{\frac{qd}{mV}}$

B. $\frac{B}{d}\sqrt{\frac{d}{2mV}}$

C. $Bd\sqrt{\frac{q}{2mV}}$

D. $qV\sqrt{\frac{Bd}{2m}}$

Answer: c

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53. A $25cm$ long solenoid has radius $2cm$ and 500 total number of turns. It carries as current of $15A$.If it is equivalent to a magnet of the same size and magnetization $\overline{M}$ (magnetic moment//volume) then $\left|\overline{M}\right|$ is:

A. $3\pi Am^{-1}$

B. $30000Am^{-1}$

C. $300Am^{-1}$

D. $30000Am^{-1}$

Answer: b

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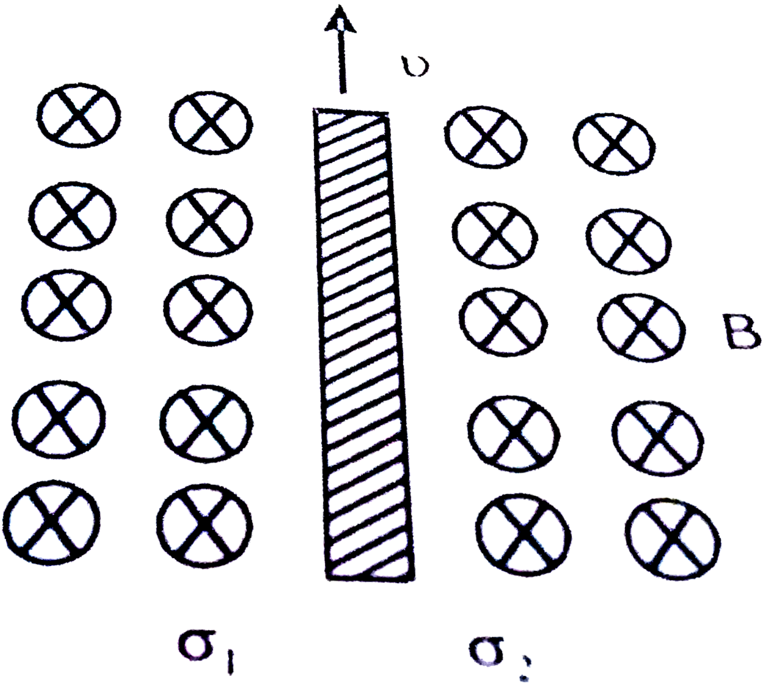
54. Consider a thin metallic sheet perpendicular to the plane of the paper moving with speed v in a uniform magnetic field B going into the plane of the paper (See figure.) If charge den- sities

σ_1 and σ_2 are induced on the left and right surfaces, respectively, of the sheet then (ignore fringe effects.)



A. $\sigma_1 = \frac{\varepsilon_0 vB}{2}, \sigma_2 = \frac{-\varepsilon_0 vB}{2}$

B. $\sigma_1 = \frac{-\varepsilon_0 vB}{2}, \sigma_2 = \frac{\varepsilon_0 vB}{2}$

C. $\sigma_1 = \varepsilon_0 vB, \sigma_2 = -\varepsilon_0 vB$

D. $\sigma_1 = \sigma_2 = \varepsilon_0 vB$

Answer: c

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55. A conducting metal circular-wire-loop of radius r is placed perpendicular to a magnetic field which varies with time as $B = B_0 e^{-t/\tau}$, where B_0 and τ are constants, at time = 0. If the resistance of the loop is R then the heat generated in the loop after a long time $(t \to \infty)$ is :

A. $\frac{\pi^2 r^4 B_0^2 R}{\tau}$

B. $\frac{\pi^2 r^4 B_0^2}{2\tau R}$

C. $\frac{\pi^2 r^4 B_0^4}{2\tau R}$

D. $\frac{\pi^2 r^4 B_0^2}{\tau R}$

Answer: b

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56. To know the resistance of a galvanometer by half deflection method, a battery of emf V and resistance R is used to deflect the galvanometer by angle θ . If a shunt of resistance is needed to get half deflection then, G, R and S are related by the equation :

A. $2S(R+G)=RG$

B. $S(R+G)=RG$

C. $2S=G$

D. $2G=S$

Answer: b

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57. A 50Ω resistance is connected to a battery of 5 V. A galvanometer of resistance 100Ω is to be used as an ammeter to measure current through the resistance, for this a resistancer r_s is connected to the galvanometer. Which of the following connections should be employed if the measured current is within 1% of the current without the ammeter in the circuit?

A. $r_s = 0.5\Omega$ in parallel with the galvanometer

B. $r_s = 0.5\Omega$ in series with the galvanometer

C. $r_s = 1\Omega$ in series with galvanometer

D. $r_s = 1\Omega$ in parallel with galvanometer

Answer: a

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58. In a certain region static electric and magnetic fields exist. The magnetic field is given by $\overrightarrow{B} = B_0\left(\hat{i} + 2\hat{j} - 4\hat{k}\right)$. If a test charge moving with a velocity, $\overrightarrow{v} = v_0\left(3\hat{i} - \hat{j} + 2\hat{k}\right)$ experience no force in that region, then the electric field in the region, in SI units, is-

A. $\overrightarrow{E} = -v_0 B_0 \left(3\hat{I} - 2\hat{j} - 4\hat{k}\right)$

B. $\overrightarrow{E} = -v_0 B_0 \left(\hat{I} + \hat{j} + 7\hat{k}\right)$

C. $\overrightarrow{E} = v_0 B_0 \left(14\hat{j} + 7\hat{k}\right)$

D. $\overrightarrow{E} = -v_0 B_0 \cdot 14\hat{j} + 7\hat{k}\Big)$

Answer: D

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59. A magnetic dipole in a constant magnetic field has

A. maximum potential energy when the torque is maximum.

B. zero potential energy when the torque is minimum

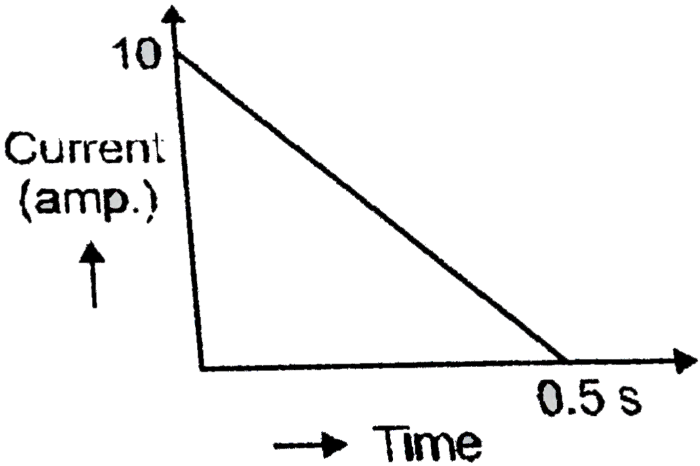
C. zero potential energy when the torque is maximum.

D. minimum potential energy when the torque is maximum.

Answer: C

Watch Video Solution

60. In a coil of resistance 100Ω , a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is



A. $200Wb$

B. $225Wb$

C. $250Wb$

D. $275Wb$

Answer: c

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61. When a current of 5mA is passed through a galvanometer having a coil of resistance 15Ω, it shows full sacle deflection. The value of the resistance to be put in series with the galvanometer to convert it into a voltmeter of range $0 - 10V$ is:

A. $1.985 \times 10^3\Omega$

B. $2.045 \times 10^3\Omega$

C. $2.535 \times 10^3\Omega$

D. $4.005 \times 10^3\Omega$

Answer: a

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62. A negative test charge is moving mear a long straight wire carrying a current. The force acting on the test charge is parallel to the direction of the current. The motion of the charge is:

A. away from the wire

B. towards the wire

C. parallel to the wire along the current

D. parallel to the wire opposite to the current

Answer: b

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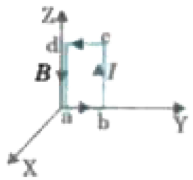
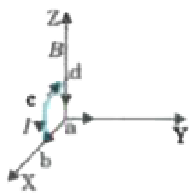
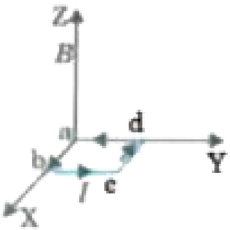
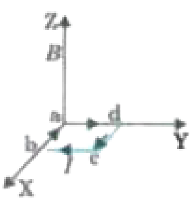
63. A uniform magnetic field B of0.3 T is along the positive Z-direction. A rectangular loop (abed) of sides $10cm \times 5cm$ carries a current I of 12 A. Out of the following different orientations which one corresponds to stable equilibrium?

A. 

B. 

C. 

D. 

Answer: c

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64. A particle of the charged q and $mass m$ moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on

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

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

C. $q \text{ and } m$

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

Answer: C

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65. A particle of mass m and charge q moves with a constant velocity v along the positive x direction. It enters a region containing a uniform magnetic field B directed along the negative z direction, extending from $x = a$ to $x = b$. The minimum value of v required so that the particle can just enter the region $x > b$ is

A. qbB/m

B. $q(b-a)B/m$

C. qaB/m

D. $q(b+a)B/2m$

Answer: b

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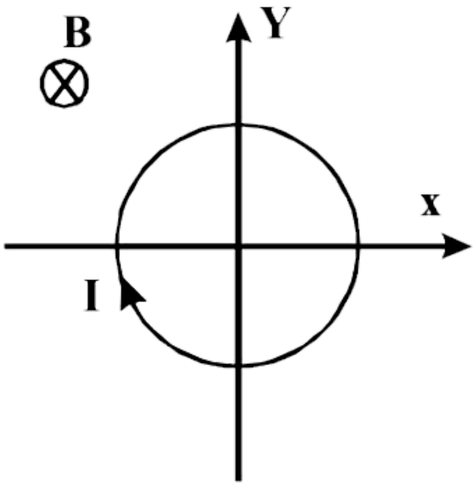
66. A conducting loop carrying a current I is placed in a uniform magnetic field pointing into the plane of the paper as shown. The loop will have a tendency to



A. contract

B. expand

C. move towards positive X- axis

D. move towards negative X - axis.

Answer: b

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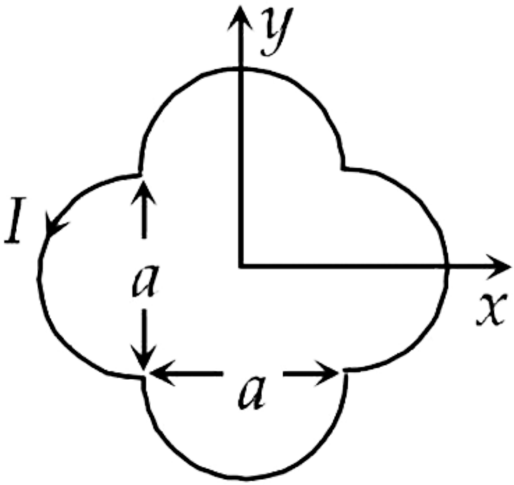
67. A loop carrying current I lies in the $x - y$ plane as shown in the figure . The unit vector $\hat{k}$ is coming out of the plane of the paper . The magnetic moment of the current loop is



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

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

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

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

Answer: b

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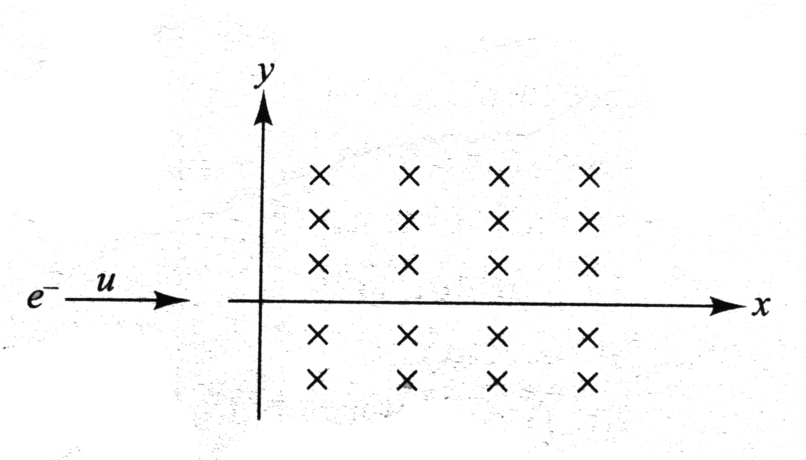
68. An electron moving with a speed u along the positive x-axis at $y = 0$ enters a region of uniform magnetic field which exists to the right of y-axis. The electron exits from the region after some time with the speed v at coordinate y, then



A. $v > u, y < 0$

B. $v = u, y > 0$

C. $v > u, y > 0$

D. $v = u, y < 0$

Answer: d

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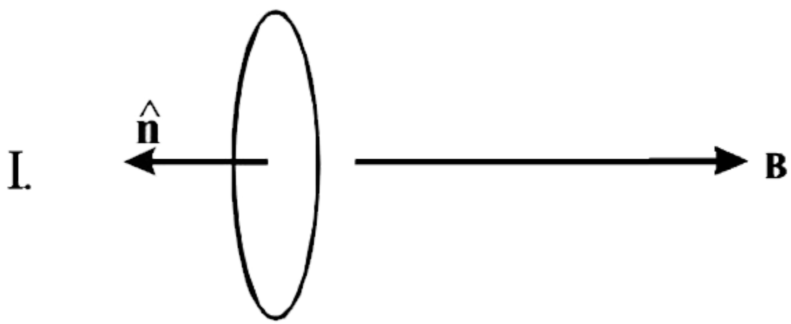
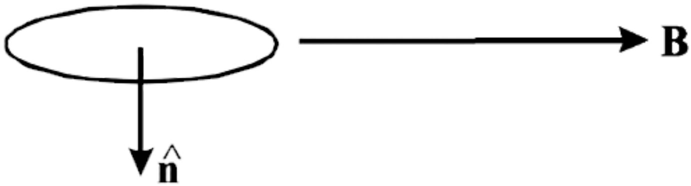
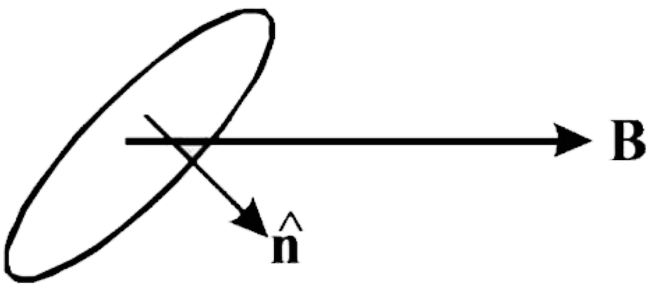
69. A current carrying loop is placed in a uniform magnetic field in four different orientations , I,ii,iii & iv arrange them in the decreasing order of potential Energy`



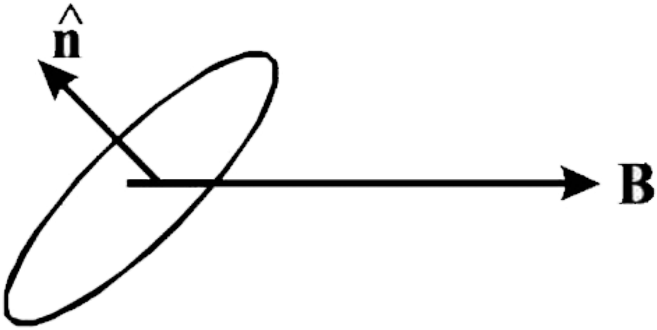
II.



III



IV



A. $I > III > II > IV$

B. $I > II > III > IV$

C. $I > IV > II > III$

D. $III > IV > I > II$

Answer: C

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70. An ionized gas contains both positive and negative ions . If it is subjected simultaneously to an electric field along the $+x$ - direction and a magnetic field along the $+y$ - direction and the negative ions towardws $-y$ - direction

A. positive ions deflect towards $+Y$ direction and negative ions towards $-Y$ direction.

B. all ions deflect towards $+Y$ direction.

C. all ions deflect towards $-Y$ direction.

D. positive ions deflect towards $-Y$ direction and negative ions towards $+Y$ directions.

Answer: c

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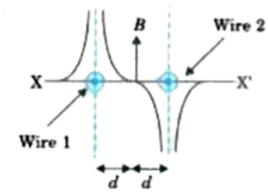
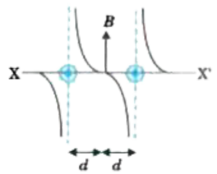
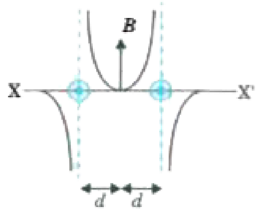
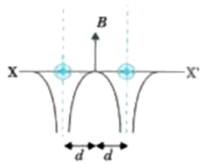
71. Two long parallel wires are at a distance $2d$ apart. They carry steady equal currents flowing out of the plane of the paper , as shown. The variation of the magnetic field B along the line XX is given by

A. 

B. 

C. 

D. 

Answer: b

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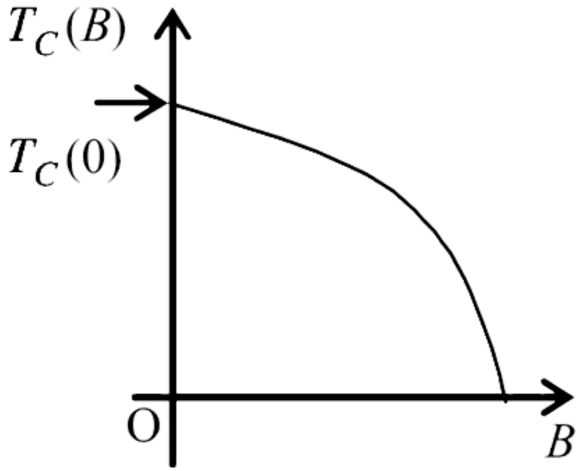
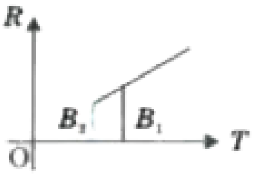
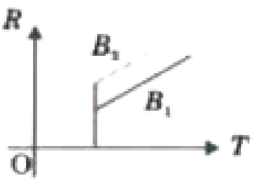
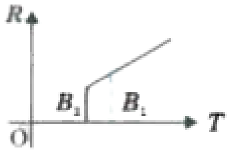
72. Electrical resistance of certain materials, known as superconductors, changes abruptly from a nonzero value of zero as their temperature is lowered below a critical temperature $T_C(0)$. An interesting property of super conductors is that their critical temperature becomes smaller than $T_C(0)$ if they are placed in a magnetic field, i.e., the critical temperature $T_C(B)$ is a function of the magnetic field strength B. The dependence of $T_C(B)$ on B is shown in the figure.

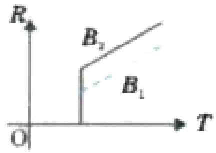


In the graphs below, the resistance R of a superconductor is shown as a function of its temperature T for two different magnetic fields B_1(solid line) and B_2 (dashed line). If B_2 is larget than B_1 which of the following graphs shows the correct variation of R with T in these fields?

A. 

B. 

C. 

D. 

Answer: a

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73. A superconductor has $T_c(0) = 100K$. When a magnetic field of $7 \cdot 5 tesla$ is applied, its T_c decreases to $75K$. For this material, one can definitely say that when

A. $B = 5 \quad \text{tesla}, \quad T_C = 80K$

B. $B = 5 \quad \text{tesla}\,, \quad 75K < T_C < 100$

C. $B = 10 \quad \text{tesla}, \quad 75K < T_C < 100K$

D. $B = 10 \text{ tesla}, \ T_C = 70K$

Answer: b

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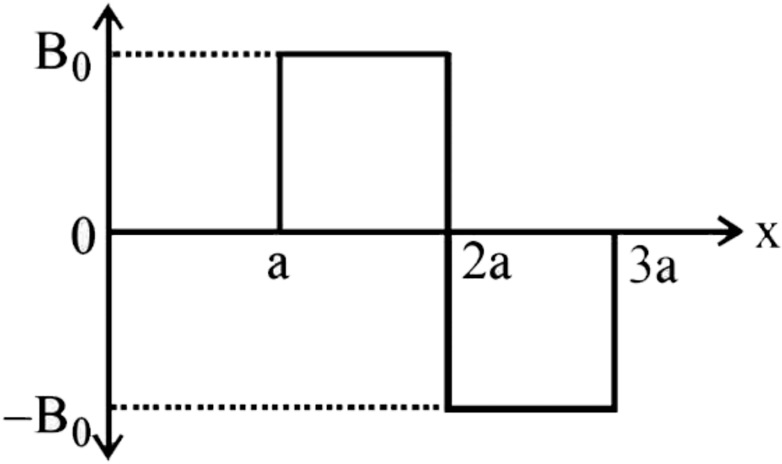
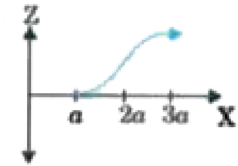
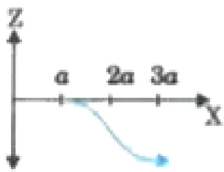
74. A magnetic field $\overrightarrow{B} = B_0\hat{j}$, exists in the region $a < x < 2a$, and $\overrightarrow{B} = -B_0\hat{j}$, in the region $2a < x < 3a$, where B_0 is a positive constant . A positive point charge moving with a velocity $\overrightarrow{v} = v_0\hat{i}$, where v_0 is a positive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

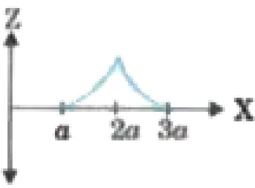




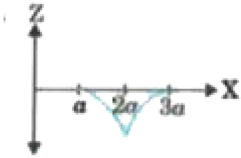
A.



B.



C.

D. 

Answer: a

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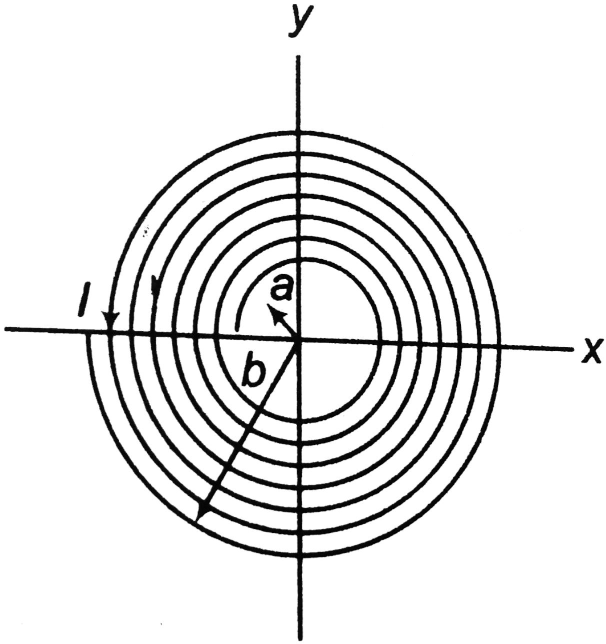
75. A long insulated copper wire is closely wound as a spiral of N turns. The spiral has inner radius a and outer radius b. The spiral lies in the xy-plane and a steady current I flows through the wire.

The z-component of the magetic field at the centre of the spiral is



A. $\frac{\mu_0 NI}{2(b-a)} \quad \text{In} \left(\frac{b}{a}\right)$

B. $\frac{\mu_0 NI}{2(b-a)} \quad \text{In} \left(\frac{b+a}{b-a}\right)$

C. $\frac{\mu_0 NI}{2b} \quad \text{In} \left(\frac{b}{a}\right)$

D. $\frac{\mu_0 NI}{2b} \quad \text{In}\left(\frac{b+a}{b-a}\right)$

Answer: a

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76. Consider the motion of a positive point charge in a region where area simultaneous uniform electric and magnetic fields $\overrightarrow{E} = E_0\hat{j}$ and $\overrightarrow{B} = B_0\hat{j}$. At time $t = 0$, this charge has velocity $\overrightarrow{v}$ in the $x - y$plane , making an angle θ with the $x - a\xi s$. Which of the following option(s) is (are) correct for time $t > 0$?

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

B. If $\theta = 0^\circ$, the charge undergoes helical motion with constant pitch along the Y-axis.

C. If $\theta = 10^\circ$ the charge undergoes helical motion with its pitch increasing with time, along the Y-axis.

D. If $\theta = 90^\circ$, the charge undergoes linear but accelerated motion along the Y-axis.

Answer: c

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77. An infinitely long hollow conducting cylinder with inner radius $\frac{r}{2}$ and outer radius R carries a uniform current ra density along its length . The magnitude of the magnetic field , $\left|\overrightarrow{B}\right|$ as a function of the radial distance r from the axis is best represented by

A.

B.

C.

D.

Answer: d

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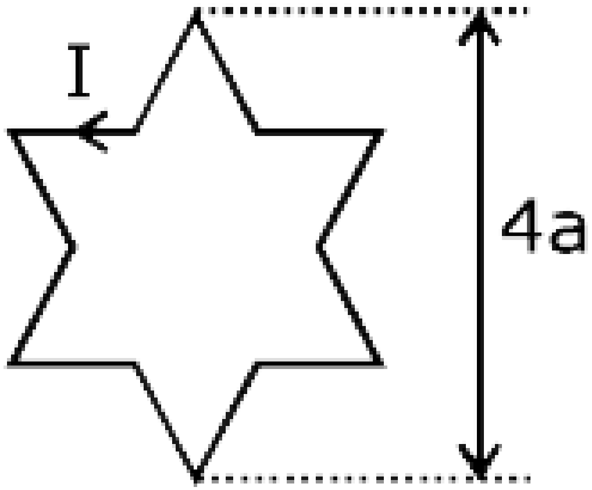
78. A symmetric star shaped conducting wire loop is carrying a steady state current I as shown in the figure. The distance between the diametrically opposite vertices of the star is 4a. The magnitude of the magnetic field at the center of the loop is



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

B. $\frac{\mu_0 I}{4\pi a} 6\left[\sqrt{3}+1\right]$

C. $\frac{\mu_0 I}{4\pi a} 3\left[2-\sqrt{3}\right]$

D. $\frac{\mu_0 I}{4\pi a} 3[\sqrt{3} - 1]$

Answer: a

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

A. When the particle re-enters region 1 through the longest possible path in region 2, the magnitude of the change in its linear momenturn between P_1 and the farthest point from Y-axis is $p/\sqrt{2}$.

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

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

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

Answer: d

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COMPETITION FILE (C. MULTIPLE CHOICE QUESTIONS)

1. A uniform current I is flowing in a long wire of radius R. If the current is uniformly distributed across the cross-sectional area of the wire, then

A. magnetic field inside the cylinder increases linearly from zero at the centre

B. magnetic field will be maximum at a point on its axis

C. magnetic field will be maximum at a point on its surface

D. magnetic field is minimum at a point on its surface

Answer: a, c

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2. A long cylindrical wire carries a steady current which is uniformly distributed across its cross section. Which of the following is true?

A. Magnetic field is zero at the centre.

B. Electric field is zero at the centre.

C. Electric field just outside the cylinder is zero.

D. Magnetic field just outside the cylinder is zero.

Answer: a, c

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3. If there is one hollow metallic tube which carries current uniformly distributed over its surface, which of the statements is correct?

A. Magnetic field intensity inside the tube remains constant, and it is not zero.

B. Magnetic field intensity inside the tube is same as its value on surface.

C. Magnetic field is zero everywhere inside the tube.

D. Magnetic field for points outside is same as magnetic field produced by a straight wire kept along the axis of tube.

Answer: c, d

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4. Consider a wire carrying a steady current, I placed in a uniform magnetic field $\overrightarrow{B}$ perpendicular to its length. Consider the charges inside the wire. It is known that magnetic forces do not work. This implies that

A. Maximum possible magnetic field is $B_0 + \frac{\mu_0 I}{2\pi R}$

B. Minimum magnetic field at some point is zero if $R < \frac{\mu_0 I}{2\pi B_0}$

C. Minimum magnetic field at some point is $B_0 - \frac{\mu_0 I}{2\pi R}, \quad \text{if} \quad R > \frac{\mu_0 I}{2\pi B_0}$

D. Magnetic field at a point on its axis is B_0.

Answer: a, b, c, d

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5. A long, straight wire carries a current along the z-axis. One can find two points in the x-y plane such that

A. the directions of the field are opposite to each other

B. the directions of the field are parallel to each other

C. the magnitude of the magnetic fields is equal

D. the magnetic fields are equal

Answer: a, b, c

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6. In which of the following cases, will the charged particles not experience any electromagnetic force?

A. Charge is at rest inside the magnetic field

B. Charge is at rest inside the electric field

C. Charge is moving in the direction of the electric field

D. Charge is moving in the direction of the magnetic field

Answer: a, d

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7. There is one conducting disc of radius r rotating about its axis with angular speed ω. There is a uniform magnetic field B, applied in the region as shown in the figure perpendicular to the plane of disc.

O is the centre of disc and Pis a point on its periphery, Which statment is true in the context of the same?

A. There is a flow of current between 0 and the rim of disc

B. Point O is at lower potential than P

C. There is no emf induced in the disc

D. Potential difference between O and P is $\frac{1}{2}B\omega r^2$

Answer: b, d

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8. A circular loop of radius $0 \cdot 2m$ carrying a current of $1A$ is placed in a uniform magnetic field of $0 \cdot 5T$. The magnetic field is perpendicular to the plane of the loop. What is the force experienced by the loop?

A. Circular loop will develop tensile stress

B. Circular loop will develop compressive stress

C. No net force will act on circular loop

D. Circular loop will develop tensile or compressive stress depending on the direction of the current and the magnetic field

Answer: c, d

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9. For a current loop we can define magnetic moment μ .

A. μ is a vector quantity

B. μ is a scalar quantity

C. Direction of μ is perpendicular to the plane of coil

D. Direction of μ depends on the direction of the current

Answer: a, c, d

View Text Solution

10. Magnetic field is applied perpendicular to the plane of paper as shown in the figure. Circular loop is translating with a velocity v as shown in the figure.

A. Point B is at higher potential than D

B. Point D is at higher potential than B

C. Points A and Care at same potential

D. Point A is higher potential than B

Answer: b, c, d

View Text Solution

11. In a coaxial, straight cable, the central conductor and the outer conductor carry equal currents in opposite directions. The magnetic field is zero.

A. zero at a point on axis of inner cable

B. zero at a point outside the cable

C. maximum at the surface of inner cable

D. zero in between inner and outer cable

Answer: a, b, c

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12. A positive charge is moving towards an observer. The direction of magnetic induction lines is

A. Anticlockwise, if charge is positive

B. Anticlockwise, if charge in negative

C. Clockwise, if charge is positive

D. Clockwise, if charge is negative

Answer: a, d

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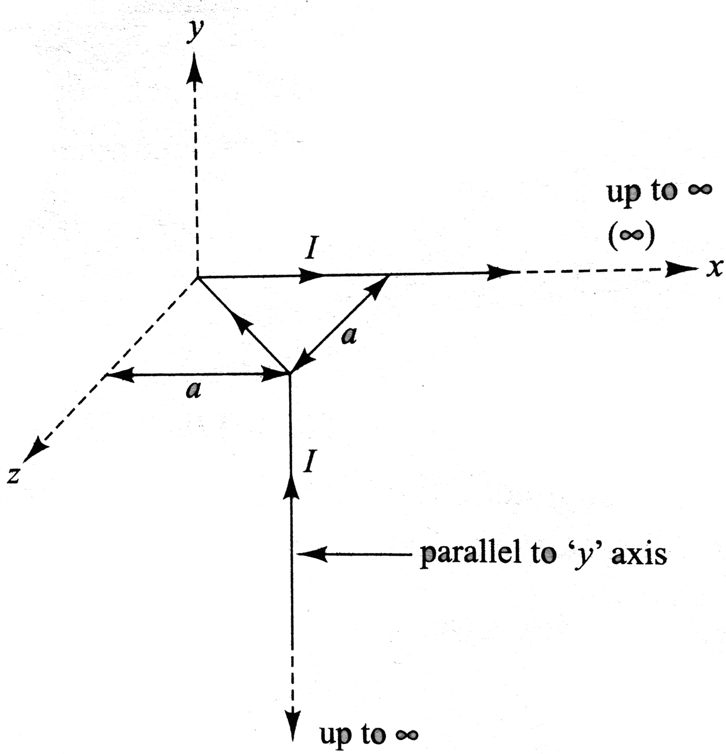
13. The magnetic field at the origin due to the current flowing in the wire is



A. $\frac{\mu_0}{4\pi}\frac{i\overrightarrow{dl}\times\overrightarrow{r}}{r^3}$

B. $-\frac{\mu_0}{4\pi}\frac{i\overrightarrow{dl}\times\overrightarrow{r}}{r^3}$

C. $-\frac{\mu_0}{4\pi}\frac{i\overrightarrow{dl}\times\overrightarrow{r}}{r^3}$

D. $\frac{\mu_0 i}{4\pi}\frac{\overrightarrow{r}\times\overrightarrow{dl}}{r^3}$

Answer: c, d

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14. If a charged particle kept at rest experiences an electromagnetic force,

A. Electric field must be zero

B. Electric field may or may not be zero

C. Magnetic field must be zero

D. Magnetic field may or may not be zero

Answer: a, d

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

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

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

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

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

Answer: a, b, d

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16. if a charged particle projected in a gravity free room deflects,

A. Electric field must be present

B. Magnetic field must be present.

C. Both, the electric field and the magnetic field, can not be zero.

D. The electric and magnetic field, both, may be nonzero.

Answer: c, d

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17. An electron and a proton are moving on straight parallel paths with same velocity. They enter a semi infinite region of uniform magnetic field perpendicular to the velocity.

Which of the following statement(s) is /are true?

A. Electron and proton will never come out from the magnetic field

B. Both, the electron and proton will come out of fields with their velocities parallel to each other.

C. Both particles will come out simultaneously.

D. Both particles will come out at different instants

Answer: b, d

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18. A particle with charge g and mass m is moving with velocity V ,normal to the boundary of the thin region of uniform magnetic field, applied perpendicular to the velocity as shown in the figure.

Width of the region is d.

A. Particle will deviate by 180° if $V < \frac{qBd}{m}$

B. Particle will deviate by 90° if velocity is slightly greater than $\frac{qBd}{m}$

C. Particle will not come back if $V > \frac{qBd}{m}$

D. Angle of deviation will be less than 90° if $V > \frac{qBd}{m}$

Answer: a, b, c, d

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19. Two long conducting wires are placed parallel to each other at a distance d. Current carried by the wires is i_1 and i_2. If F is the force acting between them, per unit of length, then which of the following statments is true?

A. F is proportional to $i_1 i_2$

B. F is inversely proportional to d

C. F will be attraction if currents are in the same direction

D. F will be repulsive if currents are in the same direction

Answer: a, b, c

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20. An electron is rotating in a circular orbit with angular speed co.

Radius of the circle is R.

A. Magnetic field at the centre of the circle is zero

B. Equivalent current is $\frac{e\omega}{2\pi}$

C. Magnetic dipole moment is $\frac{1}{2}e\omega R^2$

D. Magnetic field at the centre is $\frac{\mu_0 e\omega}{4\pi R}$

Answer: b, c, d

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21. Current I_1 is flowing out from the plane of paper. A steady state current I_2 is flowing in the loop ABCD :

A. the net force is zero

B. the net torque is zero

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

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

Answer: a, c

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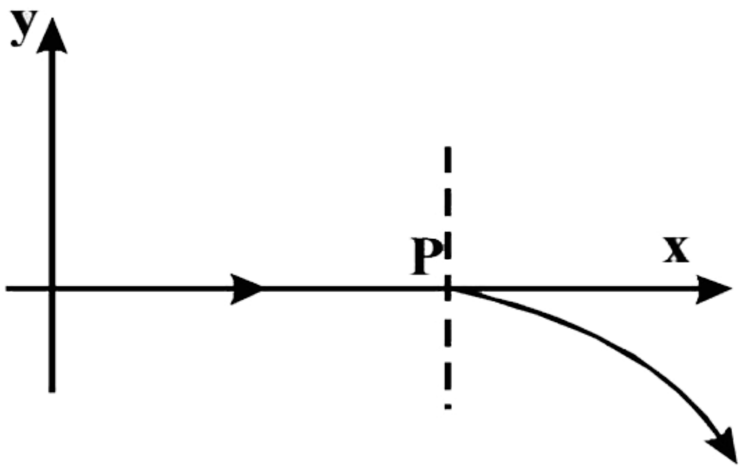
22. For a positively charged particle moving in a $x - y$ plane initially along the $x - a\xi s$, there is a sudden change in its path due to the presence of electric and//or magnetic fields beyond p . The curved path is shown in the $x - y$plane and is found to be non - circular. Which one of the following combinations is possible ?



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

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

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

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

Answer: a, b

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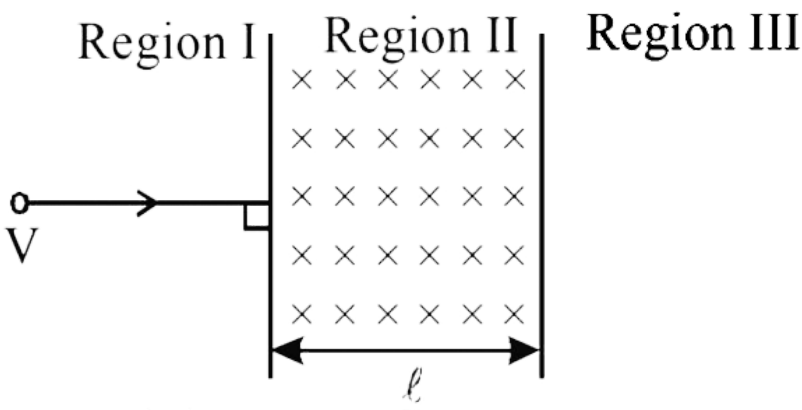
23. A particle of mass $m$and charge q, moving with velocity v enters Region II normal to the boundary as shown in the figure. Region II has a uniform magnetic field B perpendicular to the plane of the paper . The length of the region II is l. Choose the correct choice(s).



A. The particle enters region III only if its velocity $V > \frac{qlB}{m}$

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

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

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

Answer: a, c, d

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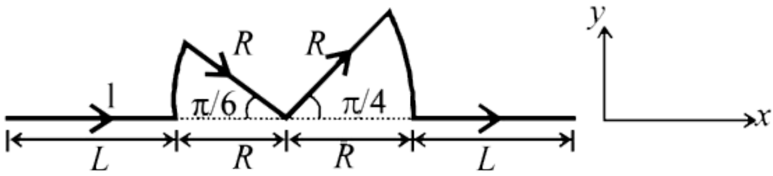
24. A conductor (shown in the figure) carrying constant current I is kept in the $x-y$ plane in a uniform magnetic field $\vec{B}$. If $\vec{F}$ is the magnitude of the total magnetic force acting on the conductor, then the correct statement(s) is (are)



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

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

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

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

Answer: a, b, c

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25. An electron and a proton are moving on straight parallel paths with same velocity. They enter a semi infinite region of uniform magnetic field perpendicular to the velocity.

Which of the following statement(s) is /are true?

A. They will never come out of the magnetic field region.

B. They will come out travelling along parallel paths.

C. They will come out at the same time.

D. They will come out at different times.

Answer: b, d

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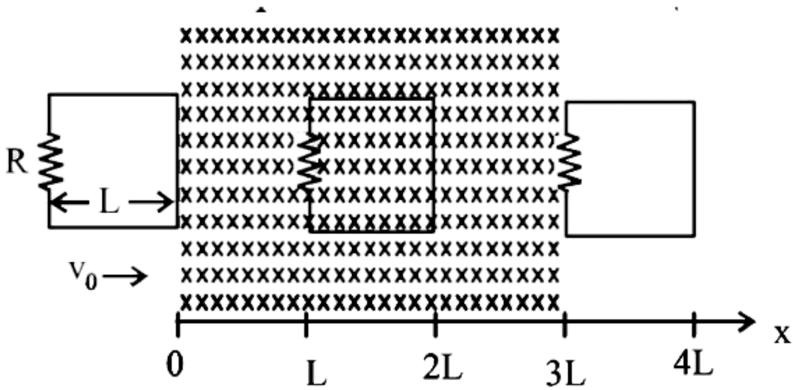
26. A rigid wire loop of square shape having side of length L and resistance R is moving along the x-axis with a constant velocity v_0

in the plane of the paper. At $t = 0$, the right edge of the loop enters a region of length 3L where there is a uniform magnetic field B_0 into the plane of the paper, as shown in the figure. For sufficiently large v_0 the loop eventually crosses the region. Let x be the location of the right edge of the loop. Let v(x), I(x) and F(x) represent the velocity of the loop, current in the loop, and force on the loop, respectively, as a function of x. Counter-clockwise current is taken as positive.



. Which of the following schematic plot(s) is (are) correct? (Ignore gravity)

A.

B.

C.

D.

Answer: b,d

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27. A particle of mass M and positive charge Q, moving with a constant velocity $\overrightarrow{u_1} = 4\hat{i} ms^{-1}$, enters a region of uniform static magnetic field , normal to the $x - y$ plane. The region of the magnetic field extends from $x = 0$ to $x = L$ for all values of y. After passing through this region, the particle emerges on the other side after $10 milli \sec onds$ with a velocity $\overrightarrow{u_2} = 2\left(\sqrt{3\hat{i} + \hat{j}}\right)ms^{-1}$. The correct statement(s) is (are)

A. The direction of the magnetic field is -Z direction.

B. The direction of the magnetic field is $+Z$ direction.

C. The direction of the magnetic field $\frac{50\pi M}{3Q}$ units.

D. The magnitude of the magnetic field $\frac{100\pi M}{3Q}$ units.

Answer: a, c

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28. A steady current I flows along an infinitely long hollow cylindrical conductor of radius R. This cylinder is placed coaxially inside an infinite solenoid of radius $2R$. The solenoid has a n turns per unit length and carries a steady current I. Consider a point p at a distance r from the common axis . The correct statement(s) is (are)

A. In the region $0 < r < R$, the magnetic field is non - zero.

B. In the region $R < r < 2R$. The magnetic field is along the common axis.

C. In the region $R < r < 2R$, the magnetic field is tangential to the circle of radius r, centred on the axis.

D. In the region $r > 2R$, the magnetic field is non - zero.

Answer: a, d

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COMPETITION FILE (D. MULTIPLE CHOICE QUESTIONS)

1. The magnetic field B inside a long solenoid, carrying a current of 5.00 A, is $\left(3.14 \times 10^{-2}\right)$ T. Find the number of turns per unit length of the solenoid.

A. $\frac{K}{2I}$

B. $\frac{K}{2\mu_0 I}$

C. $\frac{\mu_0 K}{2I}$

D. $\frac{K}{I}$

Answer: a

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2. There is one infinitely long strip of current with a large width , carrying current K per unit width. There is one long solenoid which carries current I. The solenoid is kept near the sheet with its axis parallel to the width of sheet and it is found that the magnetic field near the centre of the solenoid is zero.

If the solenoid is rotated by a 90° angle from the previous placement, in such a manner that its axis is parallel to the direction of current, what will be the net magnetic field near the centre of the solenoid?

A. $\frac{\mu_0 K}{2}\sqrt{2}$, perpendicular to the plane of strip

B. $\mu_0 K\sqrt{2}$, parallel to the plane of strip

C. $\frac{\mu_0 K}{2}\sqrt{2}$, parallel to the plane of strip

D. $\frac{\mu_0 K}{2}\sqrt{5}$, parallel to the plane of strip

Answer: c

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3. There is one infinitely long strip of current with a large width , carrying current K per unit width. There is one long solenoid which carries current I. The solenoid is kept near the sheet with its axis parallel to the width of sheet and it is found that the magnetic field near the centre of the solenoid is zero.

If the solenoid is further rotated in such a manner that its length is perpendicular to the sheet and current and one end of the solenoid is near the sheet, what will be the net magnetic field at the centre of this end of solenoid?

A. $\frac{\mu_0 K\sqrt{5}}{4}$, parallel to the strip

B. $\frac{\mu_0 K\sqrt{5}}{4}$, at an angle $\tan^{-1}$ (1/2) with the plane of strip

C. $\frac{\mu_0 K\sqrt{5}}{4}$, at an angle $\tan^{-1}(2)$ with the plane of strip

D. $\frac{\mu_0 K\sqrt{2}}{4}$, parallel to the strip

Answer: b

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4. A uniform magnetic field B is applied in a region that is outwards, perpendicular to the plane of paper, as shown in the figure.

Two charges of the same magnitude 4, of opposite polarity, are projected towards each other with the same speed v. Both the particles are having same masam. Let Vo be the maximum magnitude of so that the particles do not collide. Here we have to neglect the electric force of repulsion between the charges.

What will be the magnitude of v_0 ?

A. $\dfrac{qBD}{m}$

B. $\dfrac{qBD}{2m}$

C. $\dfrac{qD}{2mB}$

D. $\dfrac{qB}{2m}$

Answer: b

View Text Solution

5. A uniform magnetic field B is applied in a region that is outwards, perpendicular to the plane of paper, as shown in the figure.

Two charges of the same magnitude 4, of opposite polarity, are projected towards each other with the same speed v. Both the particles are having same masam. Let Vo be the maximum magnitude of so that the particles do not collide. Here we have to neglect the electric force of repulsion between the charges.

If the particles are projected with $v_0/2$, then what can be the minimum separation between them?

A. $D/8$

B. $D/6$

C. $D/4$

D. $D/2$

Answer: d

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6. A uniform magnetic field B is applied in a region that is outwards, perpendicular to the plane of paper, as shown in the figure.

Two charges of the same magnitude 4, of opposite polarity, are projected towards each other with the same speed v. Both the particles are having same masam. Let Vo be the maximum magnitude of so that the particles do not collide. Here we have to neglect the electric force of repulsion between the charges.

If the particles are projected with $2v_0$, then how much time will the particles take to collide?

A. $\frac{\pi m}{8qB}$

B. $\frac{\pi m}{12qB}$

C. $\frac{\pi m}{6qB}$

D. $\frac{2\pi m}{7qB}$

Answer: c

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7. A uniform magnetic field B is applied in a region that is outwards, perpendicular to the plane of paper, as shown in the figure.

Two charges of the same magnitude 4, of opposite polarity, are projected towards each other with the same speed v. Both the particles are having same masam. Let Vo be the maximum magnitude of so that the particles do not collide. Here we have to neglect the electric force of repulsion between the charges.

If the particles are projected with $2v_0$ and collision between them is perfectly inelastic, then what path is followed by the particles after collision? (Neglect other forces)

A. Straight line

B. Circle

C. Parabolic

D. The particles will come to rest.

Answer: a

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8. In a thin rectangular metallic strip a constant current I flows along the positive x-direction, as shown in the figure. The length, width and thickness of the strip arel, ω and d, respectively.

A uniform magnetic field B is applied on the strip along the positive y direction. Due to this, the charge carriers experience a met deflection along the 2-direction. This results in accumulation of charge carriers on the surface PQRS and appearance of equal and opposite charge on the face opposite to PQRS. A potential difference along the 2 direction is thus developed, Charge accumulation continues until the magnetic force is balanced by the electric force. The current is assumed to be uniformly distributed on the cross section of the strip and carried by electrons.

Consider two different metallic strips (1 and 2) of the same material. Their lengths are the same, widths are ω_1 and ω_2 and thickness are d_i and d_2, respectively. Two points K and M are symmetrically located on the opposite faces parallel to the x-y plane (see figure). V_1 and V_2 are the potential differential differences between K and M in strips 1 and 2, respectively. Then, for a given current I flowing through them in a given magnetic field strength B, the correct statement(s) is (are)

A. If $\omega_1 = \omega_2$ and $d_1 = 2d_2$, then $V_2 = 2V_1$

B. If $\omega_1 = \omega_2$ and $d_1 = 2d_2$, then $V_2 = V_1$

C. If $\omega_1 = 2\omega_2$ and $d_1 = d_2$, then $V_2 = 2V_1$

D. If $\omega_1 = 2\omega_2$ and $d_1 = d_2$, then $V_2 = V_1$

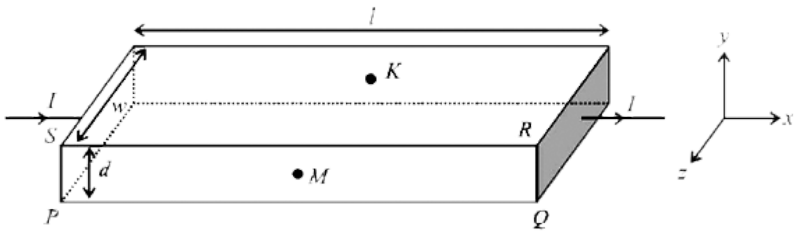
Answer: a, d

View Text Solution

9. In a thin rectangular metallic strip a constant current I flows along the positive x-direction , as shown in the figure. The length , width and thickness of the strip are $l, w \text{ and } d$, respectively.

A uniform magnetic field $\overrightarrow{B}$ is applied on the strip along the positive $y - direction$. Due to this, the charge carriers experience a net deflection along the $z - direction$. This results in accumulation of charge carriers on the surface $PQRS$ ansd apperance of equal and opposite charges on the face opposite to $PQRS$. A potential difference along the $z - direction$ is thus developed. Charge accumulation contiues untill the magnetic force is balanced by the electric force. The current is assumed to be uniformly distributed on the cross- section of the strip and carried by electrons.

Consider two different metallic strips $(1 \text{ and } 2)$ of same dimensions n_1 and n_2, repectrively . Strip 1 is placed in magnetic field B_1 and strip 2 is placed in magnetic field B_2 , both along positive $y - directions.$ Then V_1 and V_2 are the potential differences developed between K and M in strips 1 and 2 , respectively . Assuming that the current I is the same for both the strips, the correct option(s) is (are)



A. If $B_1 = B_2$ and $n_1 = 2n_2,$ then $V_2 = 2V_1$

B. If $B_1 = B_2$ and $n_1 = 2n_2,$ then $V_2 = V_1$

C. If $B_1 = 2B_2$ and $n_1 = n_2,$ then $V_2 = 0.5V_1$

D. If $B_1 = 2B_2 \text{ and } n_1 = n_2, \text{ then } V_2 = V_1$

Answer: a, c

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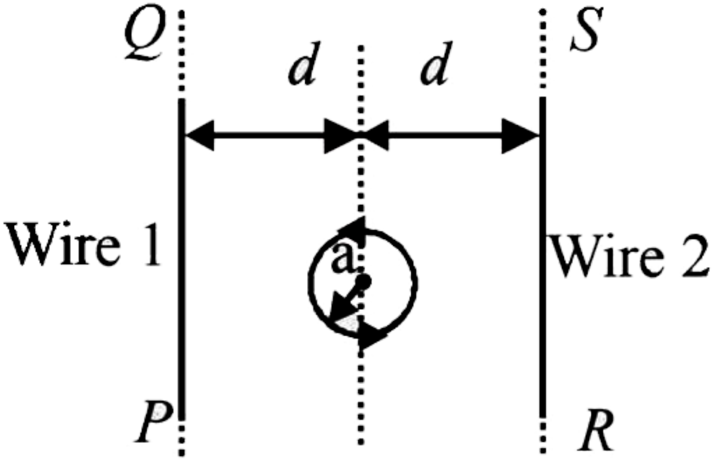
10. The figure shows a circular loop of radius a with two long parallel wires $(\nu mbered 1 \text{ and } 2)$ all in the plane of the paper . The distance of each wire from the centre of the loop is d. The loop and the wire are carrying the same current I. The current in the loop is in the counterclockwise direction if seen from above.

(q) The magnetic fields(B) at P due to the currents in the wires are in opposite directions.

(r) There is no magnetic field at P.

(s) The wires repel each other.



(4) When $d \approx a$ but wires are not touching the loop , it is found that the net magnetic field on the axis of the loop . In that case

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

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

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

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

Answer: c

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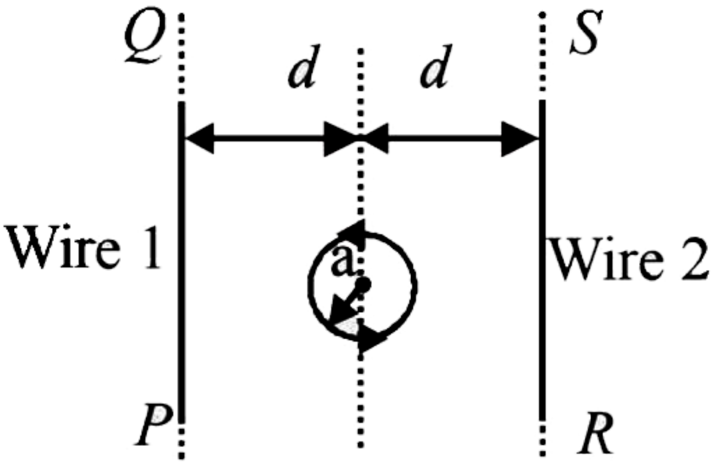
COMPETITION FILE (ASSERTION TYPE QUESTIONS)

1. The figure shows a circular loop of radius a with two long parallel wires $(\nu mbered1 \text{ and } 2)$ all in the plane of the paper . The distance of each wire from the centre of the loop is d. The loop and the wire are carrying the same current I. The current in the loop is in the counterclockwise direction if seen from above.

(q) The magnetic fields(B) at P due to the currents in the wires are in opposite directions.

(r) There is no magnetic field at P.

(s) The wires repel each other.



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

A. $\frac{\mu_0 I^2 a^2}{d}$

B. $\frac{\mu_0 I^2 a^2}{2d}$

C. $\frac{\sqrt{3}\mu_0 I^2 a^2}{d}$

D. $\frac{\sqrt{3}\mu_0 I^2 a^2}{2d}$

Answer: b

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2. Assertion When a charged particle moves perpendicular to a uniform magnetic field then its momentum remains constant.

Reason Magnetic force acts perpendicular to the velocity of the particle.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: a

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3. Is the magnetic field formed in a solenoid is uniform or non-uniform?

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: b

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4. Assertion: Magnetic moment of a current loop does not depend on the shape of the loop.

Reason: Magnetic moment is a vector quantity and its direction is perpendicular to its plane.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: b

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5. Assertion: Magnetic field can always accelerate the charged particle, if it is not moving, parallel or antiparallel to the magnetic field.

Reason: When the velocity of a charged particle makes an angle other than 0° or 180°, magnetic force is nonzero.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: a

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6. A charged particle entering a magnetic field from outside in a direction perpendicular to the field

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: a

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7. If a charged particle at rest experiences no electromagnetic force, then

The electric field must be zero

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: c

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8. A current carrying conductor placed in a uniform magnetic field , experience

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: a

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9. A charged particle is fired at an angle θ to a uniform magnetic field directed along the x-axis. During its motionalong a helical path, the particle will

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: a

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

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

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: c

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COMPETITION FILE (MATRIX MATCH TYPE QUESTIONS)

1. Each question contains statements given in two columns, which have to be matched. Statements in column-I are labelled as A, B, C and D whereas statements in column-II are labelled as p, q, r and s.

Match the entries of column-I with appropriate entries of column-IL. Each entry in column-I may have one or more than one correct option from column-II. The answers to these questions have to be appropriately bubbled as illustrated in the given example. If the correct matches are $A \to (q, r), B \to (p, s), C \to (r, s)$ and $D \to (q)$, then correctly bubbled matrix will look like the following:

In a region of space, only electric or magnetic or both are possible , Other fields are to be neglected .

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COMPETITION FILE (INTEGER TYPE QUESTIONS)

1.

Magnetic field at the centre of circular portion of wire is found to be $\mu_0 I / nr$. What is the value of n?

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2. An electron is rotating in a circle of radius $5 \times 10^{-11} m$. It completea 3×10^{9} revolutions per second. Magnetic field intensity at the centre of circle is found to be $n \times 10^{-10}$. Calculate the value of n?

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

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4. A moving coil galvanometer has 50 turns and each turn has an area 210 . The magnetic field produced by the magnet inside the galvanometer is 0.02 . The torsional constant of the suspension wire is 10 . When a current flows through the galvanometer, a full scale deflection occurs if the coil rotates by 0.2 . The resistance of the coil of the galvanometer is 50 . This galvanometer is to be converted into an ammeter capable of measuring current in the range 01.0 . For this purpose, a shunt resistance is to be added in parallel to the galvanometer. The value of this shunt resistance, in , is ________.

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5. Cathode ray beam is accelerated through a potential difference of V and then made to enter in a crossed electric field (E) and magnetic field (B) and it is found that beam goes un-deflected. If we can write specific charge of cathode ray as $\frac{E^2}{nVB^2}$, then what will be the value of n?

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6. There is circular coil of radius R carrying current i. There is a point on the axis of circular coil at a distance from the centre. Bis magnetic field intensity at this point. For $r > \; > R$, it is found that $B \propto \frac{1}{r^n}$. What is value of n?

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7. There is one cylindrical wire of radius a carrying current I which is uniformly distributed across its cross section. Let B_1 is magnetic field intensity at a point distance a/2 from the centre and B_2 , is magnetic field intensity at a point distance 2a from the centre. Calculate $B_1 \,/\, B_2$.

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8. An electron is moved perpendicular to magnetic field and it takes time t_1 to complete its circle. When electron is moved with double the speed and magnetic field intensity is halved then electron takes time t_2 to complete its circle. Calculate t_1 / t_2).

9. A particular length of wire is turned around to make a circle and current is made to pass through it. Let B_1 is magnetic field intensity at its centre. When the same length of wire is used to make coil with three turns then for the same magnitude of current magnetic field intensity at the centre becomes B_2 . Calculate B_2 / B_1 .

10. A galvanometer gives full scale deflection with $0.006A$ current. By connecting it to a 4990Ω resistance, it can be converted into a voltmeter of range $0.30V$. If connected to a $\frac{2n}{249}\Omega$ resistance, it becomes an ammeter of range $0 - 1.5A$. the value of n is

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CHAPTER PRACTICE TEST

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

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2. 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?

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3. Why is phosphor bronze alloy preferred for the suspension wire of a moving coil galvanometer?

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4. Dimensional formula of magnetic field is :-

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5. A charged particle moves through a region of uniform magnetic field perpendicularly. Is the momentum of particle affected ?

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6. A coil of 'N turns and radius 'R' carries a current I. It is unwound and rewound to make a square coil of side 'n'having same number of turns 'N'. Keeping the current I same, find the ratio of the magnetic moments of the square coil and the circular coil.

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7. A wire of length $L metre$, carrying a current Iampere is bent in the form of a circle . The magnitude of its magnetic moment is .... $MKS units$.

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8. Deduce an expression for the frequency of revolution of a charged particle in a magnetic field and show that it is independent of the velocity or energy of the particle.

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9. An α particle is moving with a velocity of $\left(7 \times 10^5 \hat{i} m / s\right)$ in a magnetic field of $\left(5\hat{i} + 9\hat{j}\right)$. T . Find the magnetic force acting on the particle.

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10. What is the change in the energy of a charged particle when it enters in a magnetic field and experiences a magnetic force ?

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11. A moving coil galvanometer consists of a coil of N turns are area A suspended by a thin phosphor bronze strip in radial magnetic field B. The moment of inertia of the coil about the axis of rotation is I and c is the torsional constant of the phosphor bronze strip. When a current i is passed through the coil, it deffects through an angle θ

Magnitude of the torque experienced by the coil is independent of

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12. State Ampere's circuital law. Use this law to obtain the expression for the magnetic field inside an air cored toroid of average radius r having n-turns per unit length and carrying a steady current I.

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13. State the working principle of a moving coil galvanometer. Under what conditions the galvanometer can be more sensitive? Explain.

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