PHYSICS

BOOKS - U-LIKE PHYSICS (HINGLISH)

MOVING CHARGES AND MAGNETISM

N C E R T Textbook Exercises

1. A circular coil of wire consisting of 100 turns, each of radius 8.0 cm, carries a current of 0.40 A. What is the magnitude field $\vec{B}$ at the centre of the coil?

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

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3. A long straight wire in the horizontal plane carries a current of 50A in north to south direction. Give the magnitude and direction of $\overrightarrow{B}$ at a point 2.5 m east of the wire.

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4. A horizontal overhead power line carries a current of 90 A in 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 3.0 cm wire carrying a current of 10 A is placed inside a solenoid perpendicular to its axis. The magnetic field inside the solenoid is given to be 0.27 T. What is the magnetic force on the wire ?

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7. Two long and parallel straight wire A and B carrying currents of 8.0 A and 5.0 A in the same direction are separated by a distance of 4.0 cm. Estimate the force on a 10 cm section of wire A.

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8. A closely wound solenoid 80 cm long has 5 layers of windings of 400 turns each. The diameter of the solenoid is 1.8 cm. If the current carried is 8.0 A , estimate the magnitude of $\overrightarrow{B}$ 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 12 A. The coil is suspended vertically and the normal to the plane of the coil makes an angle of 30° with the direction of a uniform horizontal magnetic field of magnitude 0.80

T. What is the magnitude of torque experienced by the coil?

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10. Two moving coil meters M_1 and M_2 have the following particulars:

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

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

(The spring constants are identical for the two meters).

Determine the ratio of (a) current sensitivity, and (b) voltaage sensitivity of M_2 and M_1.

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11. In a chamber, a uniform magnetic field of $6.5G(1G = 10^{-4}T)$ is maintained. An electron is shot into 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 Question 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 of the coil. Calculate the magnitude counter torque that must be applied to prevent the coil from turning.

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

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Additional Exercises

1. Two concentric circular coils X and Y of radii 16 cm and 10 cm, respectively, lie in the same vertical plane containing the north to south direction. Coil X has 20 turns and carries a current of 16A, coil Y has 25 turns and carries a current of 18 A. The sense of the current in X in antoclockwise, and clockwise in Y, for an observer looking at hte coils facing west. 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 $100G(1G = 10^{-4}T)$ is required which is uniform in a region of linear dimension about 10 cm and area of cross-section about $10^{-3}m^2$. The maximum current-carrying capacity of a given coil of wire is 15 A 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 of the required purpose. Assume the core is not ferromagnetic.

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3. For a circular coil of radius R and N 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 co-axial circular coil 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 ,

$$B = 0.72 \frac{\mu_0 NI}{R}$$, approximately.

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

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

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

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6. 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?

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7. 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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8. An electron emitted by heated cathode and accelerated through a potential difference of 2.0 kV, enters a region with uniform magnetic field of 0.15 T. 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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9. A magnetic field set up using Helmholtz coils is uniform in a small region and has a magnitude of 0.75 T. In the same region, a uniform electrostatic field is manitained in a direction normal to the common axis of the coils. A narrwo beam of (single species) charged particles all accelerated through 15 kV enters this region in a direction perpendicular to both the axis of the coils and the electrostaic field. If the beam remains undeflected when the

electrostatic field is $9.0 \times 10^{-5} V m^{-1}$, make a simple guess as to what the beam contains. Why is the answer not unique?

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

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

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

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11. The wries which connect the battery of an automobile to its starting motor carry a current of 300 A (for a short time). What is the force per unit length between the wires if they are 70 cm long and 1.5 cm apart ? Is the force attractive or repulsive?

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12. A uniform magnetic field of 1.5 T exists in a cylindrical region of radius 10.0 cm, its direction parallel to the axis along east to west. A wire carrying current of 7.0 A 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 axis,

(b) the wire in the N - S to northest - northwest direction.

(c) the wire in the N-S direction is lowered from hte axis by a distance of 6.0 cm ?

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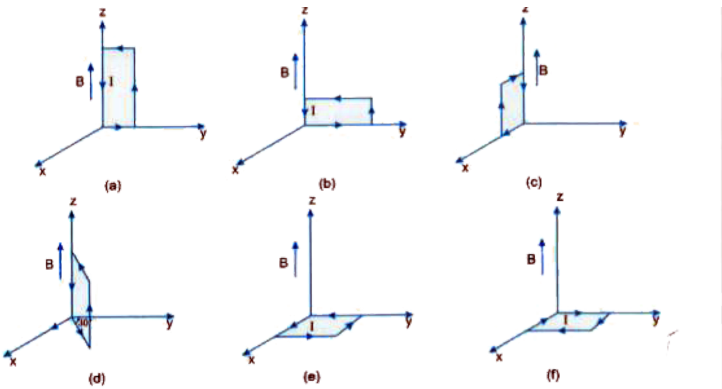
13. A unform magnetic field of 3000 G is established along the positive z-direction. A rectangular loop of sides 10 cm and 5 cm carries a current of 12 A . What is the torque on the loop in the different cases shown in the fig ? What is the force on each case? Which case corresponds to stable equilibrium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



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14. A circular coil of 20 turns and radius 10 cm is placed in a uniform magnetic field of 0.10 T normal to the plane of the coil. If the current in the coil is 5.0 A, what is the

(a) Total torque on the coil,

(b) Total force on the coil,

(c) Aerage 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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15. A solenoid 60 cm long and of radius 4.0 cm has a layers of windings of 300 turns each. A 2.0 cm long wire of mass 2.5 g lies inside the solenoid (near its centre) normal to its axis, both the wire and the axis of the solenoid are in the horizontal plane. The wireis connected through two leads parallel to the axis of hte solenoid to an external battery which supplies a current of 6.0 A 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 ? $g = 9.8 ms^{-2}$.

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

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

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Case Based Source Based Integrated Questions

1. When we consider a point charge q moving with a velocity $\vec{v}$ at a given time in presence of magnetic field $\vec{B}$, the charged particle experiences a magnetic force $\vec{F}_m = q\left[\vec{v} \times \vec{B}\right]$. The force was first given by H.A. Lorentz and is called the Lorentz magnetic force. The force depends on q, $\vec{v}$ and $\vec{B}$ and involves a vector product of $\vec{v}$ and $\vec{B}$. The force acts in a side ways direction perpendicular to both the velocity and magnetic field and the direction is given by right hand thumb rule for vector product. Obviously force on a negative charge is opposite to that on a positive charge.

A charged particle is placed at rest at a point P whose coordinates are (2,3,0) and a magnetic field $\vec{B} = 5 \times 10^{-3}\hat{k}$ is present here. What is the magnetic force experienced by the charge ?

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2. When we consider a point charge q moving with a velocity $\vec{v}$ at a given time in presence of magnetic field $\vec{B}$, the charged particle experiences a magnetic force $\vec{F}_m = q\left[\vec{v} \times \vec{B}\right]$. The force was first given by H.A. Lorentz and is called the Lorentz magnetic force. The force depends on q, $\vec{v}$ and $\vec{B}$ and involves a vector product of $\overrightarrow{v}$ and $\overrightarrow{B}$. The force acts in a side ways direction perpendicular to both the velocity and magnetic field and the direction is given by right hand thumb rule for vector product. Obviously force on a negative charge is opposite to that on a positive charge.

An electron enters a given region moving with an initial velocity $\overrightarrow{v} = 12.5\hat{i}ms^{-1}$ where a unifomr magnetic field $\overrightarrow{B} = B_0\hat{j}$ is also applied. What is the direction of force experienced by electron due to the magnetic field?

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3. When we consider a point charge q moving with a velocity $\vec{v}$ at a given time in presence of magnetic field $\vec{B}$, the charged particle experiences a magnetic force $\vec{F}_m = q\left[\vec{v} \times \vec{B}\right]$. The force was first given by H.A. Lorentz and is called the Lorentz magnetic force. The force depends on q, $\vec{v}$ and $\vec{B}$ and involves a vector product of $\vec{v}$ and $\vec{B}$. The force acts in a side ways direction perpendicular to both the velocity and magnetic field and the direction is given by right hand thumb rule for vector product. Obviously force on a negative charge is opposite to that on a positive charge.

Define SI unit of magnetic field on the basis of Lorentz force.

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4. When we consider a point charge q moving with a velocity $\vec{v}$ at a given time in presence of magnetic field $\vec{B}$, the charged particle experiences a magnetic force $\vec{F}_m = q\left[\vec{v} \times \vec{B}\right]$. The force was first given by H.A. Lorentz and is called the Lorentz magnetic force. The force depends on q, $\vec{v}$ and $\vec{B}$ and involves a vector product of $\vec{v}$ and $\vec{B}$. The force acts in a side ways direction perpendicular to both the velocity and magnetic field and the direction is given by right hand thumb rule for vector product. Obviously force on a negative charge is opposite to that on a positive charge.

Under what condition does a moving charge experience minimum force due to a magnetic field present there?

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5. When we consider a point charge q moving with a velocity $\overrightarrow{v}$ at a given time in presence of magnetic field $\overrightarrow{B}$, the charged particle experiences a magnetic force $\overrightarrow{F}_m = q\left[\overrightarrow{v} \times \overrightarrow{B}\right]$. The force was first given by H.A. Lorentz and is called the Lorentz magnetic force. The force depends on q, $\vec{v}$ and $\vec{B}$ and involves a vector product of $\vec{v}$ and $\vec{B}$. The force acts in a side ways direction perpendicular to both the velocity and magnetic field and the direction is given by right hand thumb rule for vector product. Obviously force on a negative charge is opposite to that on a positive charge.

When will a moving charge experience maximum force due to a magnetic field?

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6. A current circular conducting loop exerts a magnetic field both inside and outside it. The

magnetic field at the cetre of a current loop of radius 'R' and carrying a current I is given as :

$$B = \frac{\mu_0 I}{2R}$$

The magnetic field lines due to a circular current loop form closed loops. The direction of the magnetic field is given by the right hand thumb rule, which states that if one curls the palm of his right hand around the current loop with the fingers pointing in the direction of the current, the right hand thumb will give the direction of the magnetic field. From this law it is clear that the direction of magnetic field $\overrightarrow{B}$ is always perpendicular to the direction of flow of current or perpendicular to the plane of circular current loop.

Does a charge at rest produes a magnetic field around it?

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7. A current circular conducting loop exerts a magnetic field both inside and outside it. The magnetic field at the cetre of a current loop of radius 'R' and carrying a current I is given as :

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Draw the magnetic field lines due to a circular current loop placed in a horizontal plane.

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Draw the magnetic field lines due to a circular current loop placed in a horizontal plane.

An enamelled copper wire of length L is bent in the form of a circular loop and a curretn I is passed through it so that a magnetic field B is get up at its centre. Now the same wire is bent in the form of a circular coil having N turns and same current I is passed through it. What is the magnetic field develop at the centre of this coil?

View Text Solution

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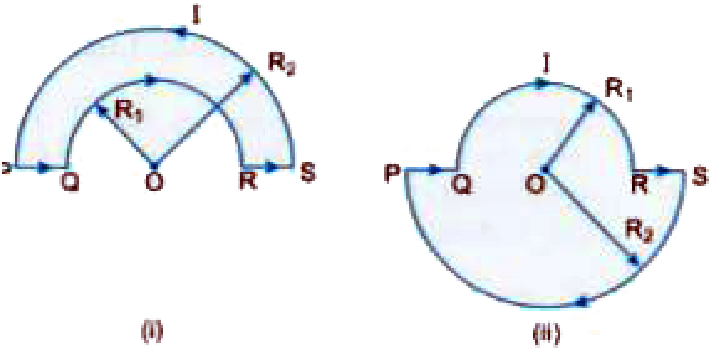

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Determine the magnetic field at the centre point O due to two concentric semicircular loops of radii R_1 and R_2 carrying a current I, when the loops of radii R_1 and R_2 carrying a current I, when the loops are arranged as shown in Fig.

View Text Solution

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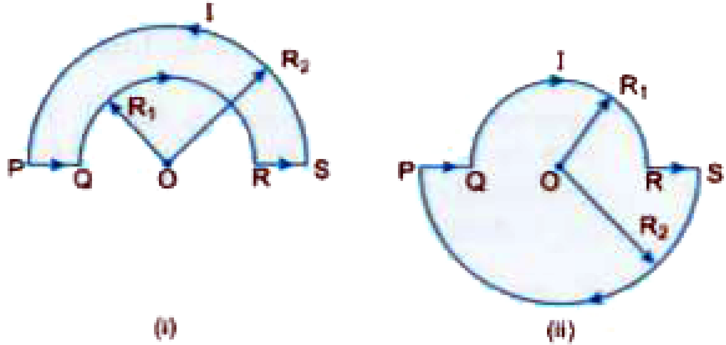

How is the magnetic field at O modified when the two loops are rearranged as shown in Fig.

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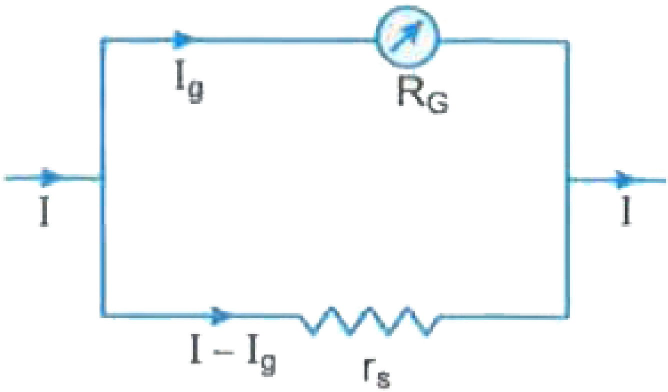
11. A moving coil galvanometer is a sensitive device which can be used as a detector to check if a curretn is flowing in a circuit. A galvanometer works on the principle that a current carrying coil placed in a radial magnetic field experiences a deflecting torque whose magnitudes is directly proportional to the electric current passing through it. The deflection ϕ is indicated by a pointer and is give as $\phi = \frac{NAB}{k} \cdot I.$

A galvonometer can be used to measure electric current flowing througha circuit direcly in ampere and its submultiples. For this purpose we join a small resistance $'r_s'$ in parallel to the galvonometer. Such a shunted galvonometer is called an ammeter. If a galvanomter, having a resistance R_G, givens full scale deflection for a current I_g and we want to measure a current ranging from $0 - I_g A$, then the value of shunt resistance will be

$$r_s = \frac{R_G \cdot I_g}{I - I_g}$$



Why do we use a radial magnetic field in a moving coil galvonometer?

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12. A moving coil galvanometer is a sensitive device which can be used as a detector to check if a curretn is flowing in a circuit. A galvanometer works on the principle that a current carrying coil placed in a radial magnetic field experiences a deflecting torque whose magnitudes is directly proportional to the electric current passing through it. The deflection ϕ is indicated by a pointer and is give as $\phi = \frac{NAB}{k} \cdot I.$

A galvonometer can be used to measure electric current flowing througha circuit direcly in ampere and its submultiples. For this purpose we join a small resistance $'r_s'$ in parallel to the galvonometer. Such a shunted galvonometer is called an ammeter. If a galvanomter, having a resistance R_G, givens full scale deflection for a current I_g and we want to measure a current ranging from $0 - I_g A$, then the value of shunt resistance will be

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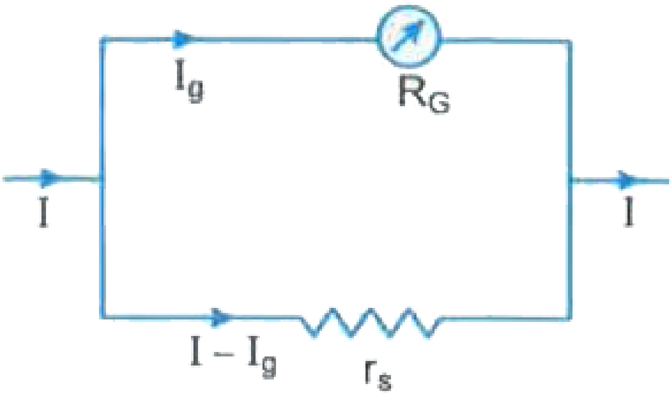

How is a radial magnetic field obtained?

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13. A moving coil galvanometer is a sensitive device which can be used as a detector to check if a curretn is flowing in a circuit. A galvanometer works on the principle that a current carrying coil placed in a radial magnetic field experiences a deflecting torque whose magnitudes is directly proportional to the electric current passing through it. The deflection ϕ is indicated by a pointer and is give as $\phi = \frac{NAB}{k} \cdot I.$

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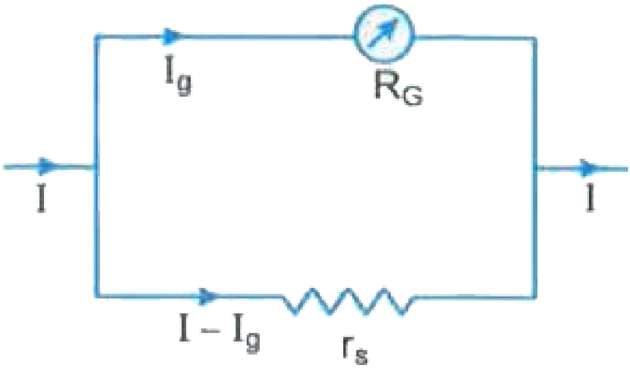

There is a moving coil galvonometer in which there are 30 divisions on either side of central zero mark. It gives full scale deflection for a current of $600 \mu A$. What is its current sensitivity ?

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14. A moving coil galvanometer is a sensitive device which can be used as a detector to check if a curretn is flowing in a circuit. A galvanometer works on the principle that a current carrying coil placed in a radial magnetic field experiences a deflecting torque whose magnitudes is directly proportional to the electric current passing through it. The deflection ϕ is indicated by a pointer and is give as $\phi = \frac{NAB}{k} \cdot I.$

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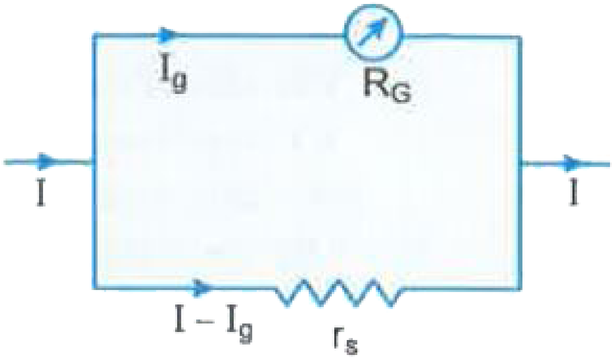

If you want to measure a current ranging 0 - 1.5 A using the above galvonometer. What shunt resistance should be joined with it ? Resistance of galvanometer coil is 300Ω.

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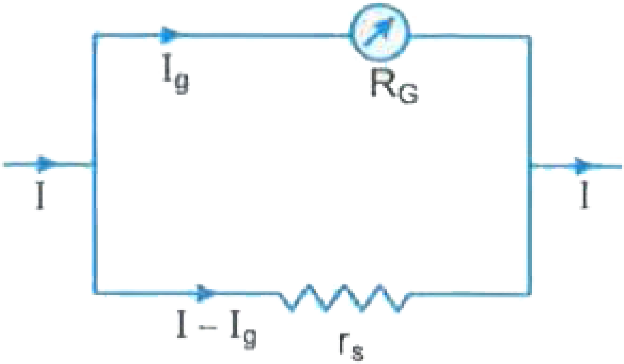

What is the net resistance of shunted galvanomter?

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16. A few countires are using powerful electromagnets to develop high speed trains, called maglev trains (also known as bullet trains). Maglev is short for 'magnetic levitation', which means that these trains will float over a guil way using the basic principles of magnets to replace the old steel wheel and track trains.

The big difference between a maglev train and a conventional train is that maglev trains do not have an engine. The engine for maglev trains is rather inconspicuous as instead of fossil fuels it uses magnetic field. The magnetised coil running along the track, called the guideway, repels the large magents on the trains's under carriage allowing the train to levitate between 1 to 10 cm above the guideway . This is called electrodyanmic suspension (EDS). Once the train is levitated, power is supplied to the coils within the guideway walls to create a unique system of magnetic fields that pull and push the train along the guideway. The electric current supplied to the coils in the guideway wall is constantly alternating to change the polarity of the magnetised coils. This change in polarity causes the magnetic field in fornt of the train to pull the vehicle forward, while the magnetic field behind the train adds more forward thrust.

Maglev trains float on a cushion of air eliminating friction. This lack of friction and the train's aerodynamic design allows these trains to reach unprecedented group transportation speed of $400 kmh^{-1}$ or even more.

The force which makes maglev move is

A. gravitational

B. magnetic force

C. eletric force

D. air drag

Answer: A

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The disadvantage of maglev trains is

A. less heat generated

B. less pollution

C. less wear and tear

D. high initial cost

Answer: B

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The levitation of the train is due to

A. mechanial force

B. electrostatic attraction

C. eletrostatic repulsion

D. magnetic repulsion

Answer: C

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Multiple Choice Questions

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

such that

A. $\overrightarrow{B}$ is at right angles to $\overrightarrow{v}$

B. $\overrightarrow{B}$ is parallel to $\overrightarrow{v}$

C. It obeys inverse cube law

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

Answer: A

View Text Solution

2. Magnetic field due to 0.1 A current flowing through a circular coil of radius 0.1 m and 1000 turns at the centre of the coil is

A. $2 \times 10^{-1} T$

B. $4.31 \times 10^{-2} T$

C. $6.28 \times 10^{-4} T$

D. $9.81 \times 10^{-4} T$

Answer: C

View Text Solution

3. A circular coil A has a radius R and current flowing through it is I. Another circular coil B has a radius 2R and if 2I is the current flowing throgh it, then the magneitc field at the centre of the circular coil are in the ratio (i.e, B_A to B_B) of

A. $4:1$

B. $2:1$

C. $3:1$

D. $1:1$

Answer: A

View Text Solution

4. In a cyclotron, a charged particle

A. Undergoes acceleration all the time

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

C. speeds up in a dee

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

Answer: B

View Text Solution

5. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of the magnetic field is

A. B

B. 2B

C. 4B

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

Answer: A

View Text Solution

6. A uniform electric field and a uniform magnetic field are produced, pointed in the same direction. An electron is projected with its velocity pointing in the same direction.

A. The electron will turn to its right

B. The electron will trun to its left

C. The electron velocity will increase in magnitude

D. The electron velocity will decrease in magnitude

Answer: D

View Text Solution

7. A proton enters a magnetic field of 1.5 T with a velocity of $2 \times 10^7 ms^{-1}$ at an angle of 30° with the field. The force on the proton will be

A. $2.4 \times 10^{-12} N$

B. $0.24 \times 10^{-12} N$

C. $24 \times 10^{-12} N$

D. $0.024 \times 10^{-12} N$

Answer: A

View Text Solution

8. An electron moving in a uniform magnetic field of B has its radius directly proportional to

A. its charge

B. magnetic field

C. speed

D. none of these

Answer: C

View Text Solution

9. Under the influence of a uniform magnetic field, a charged particle moves with constant speed v in a circle of radius r. The time period of revolution of the particle

A. depends on v and not on r

B. depends on r and not on v

C. is independent of both v and r

D. depends on both v and r

Answer: C

View Text Solution

10. An electron moves in a circular orbit with a uniform speed v. It produces a magnetic field B at the centre of the circle. The radius of the circle is proportional to

A. $\frac{B}{v}$

B. $\frac{v}{R}$

C. $\sqrt{\frac{v}{B}}$

D. $\sqrt{\frac{B}{v}}$

Answer: C

View Text Solution

11. A current I flows along the length of an infinitely long, straight, thin walled pipe. Then

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

B. the magentic field is zero only on the axis of the pipe

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

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

Answer: D

View Text Solution

12. A galvanometer coil has a resistance of 10Ω and the meter shows full scale deflection for a current of 1 mA. The shunt resistance required to convert the galvanometer into an ammeter of range 0 - 100 m A is about

A. 10Ω

B. 1Ω

C. 0.1Ω

D. 0.01Ω

Answer: C

View Text Solution

13. A galvanoment of resistance 25Ω gives full scale deflection for a current of 10 mA. What resistance is to be connected in its series so that it can work as a voltmeter of range 10 V ?

A. 10000Ω

B. 10025Ω

C. 975Ω

D. 9975Ω

Answer: D

View Text Solution

14. At a distance of 10 cm from a long staright wire carrying a current I, the magnetic field is 0.04 T. At a distance of 40 cm from the wire, the magnetic field will be

A. $0.01T$

B. $0.04T$

C. $0.16T$

D. $0.02T$

Answer: A

View Text Solution

15. Magnetic effect of current was discovered by

A. Ampere

B. Lorentz

C. Oersted

D. Faraday

Answer: C

View Text Solution

16. The magnetic field $\overrightarrow{dB}$ due to a small current element $\overrightarrow{dl}$ carrying a current I at a distance $\overrightarrow{r}$ is given as

A. $\overrightarrow{dB} = \frac{\mu_0}{4\pi} I \left[\frac{\overrightarrow{dI} \times \overrightarrow{r}}{r} \right]$

B. $\overrightarrow{dB} = \frac{\mu_0}{4\pi} I^2 \left[\frac{\overrightarrow{dl} \times \overrightarrow{r}}{r} \right]$

C. $\overrightarrow{dB} = \frac{\mu_0}{4\pi} I^2 \left[\frac{\overrightarrow{dl} \times \overrightarrow{r}}{r^2} \right]$

D. $\overrightarrow{dB} = \frac{\mu_0}{4\pi} I \left[\frac{\overrightarrow{dl} \times \overrightarrow{r}}{r^3} \right]$

Answer: D

View Text Solution

17. A circular coil of radius R carries an electric current. The magnetic field due to the coil at a point on the axis of the coil located at a distance r from the centre of the coil, such that $r > > R$, varies as

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

B. $\frac{1}{r^{3/2}}$

C. $\frac{1}{r^2}$

D. $\frac{1}{r^3}$

Answer: D

View Text Solution

18. The magnetic field B within the solenoid having n turns per unit length and carrying a current I is given by

A. $\mu_0 n I$

B. $4\pi\mu_0 n I$

C. nI

D. $\mu_0 n I l$

Answer: A

View Text Solution

19. A battery is connected between two points A and B on the circumference of a uniform conducting ring of radius r and r

View Text Solution

20. The direction of magnetic field lines close to a straight conductor carrying current will be

A. along the length of the conductor

B. radially outward

C. circular in a plane perpendicular to the conductor

D. helical

Answer: C

View Text Solution

21. In a current carrying long solenoid the magnetic field produced inside the solenoid does not depend upon

A. number of turns per unit length

B. current flowing

C. radius of the solenoid

D. all of the above three

Answer: C

View Text Solution

22. At a distance of 10 cm from a long straight wire carrying current the magnetic field is 0.04 T. At the distance of 20 cm, the magnetic field will be

A. $0.01T$

B. $0.02T$

C. $0.08T$

D. $0.16T$

Answer: B

View Text Solution

23. SI unit of magnetic permeability $\mu_0(\text{ or } \mu)$ is

A. Am^{-1}

B. TmA^{-1}

C. Tm

D. Am^2

Answer: B

View Text Solution

24. The current in the windings on a toroid is 2.0 A. There are 400 turns and the mean circumferential length is 40 cm. If the inside magnetic field be 1.0 T , the relative permeability of the core of torroid is approximately

A. 100

B. 200

C. 300

D. 400

Answer: D

View Text Solution

25. The path executed by a charged particle, whose motion is perpendicular to a uniform megnetic field, is

A. a straight line

B. an ellipse

C. a circle

D. a helix

Answer: C

View Text Solution

26. The radius of curvature of the path of a charged particle moving under a uniform , normal magnetic field is directly proportional to

A. the charge on the particle

B. the momentum of the particle

C. the energy of the particle

D. the strength of the magnetic field.

Answer: B

View Text Solution

27. A charged particle moves with a velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$. The magnetic force experienced by the particle is

A. always zero

B. zero if $\vec{v}$ and $\vec{B}$ are perpendicular

C. never zero

D. zero if $\overrightarrow{v}$ and $\overrightarrow{B}$ are parallel or antiparallel.

Answer: D

View Text Solution

28. A beam of well collimated cathode rays travelling with a speed of $5 \times 10^{-6} ms^{-1}$ enters a region of mutually perpendicular electric and magnetic fields and emerge undeviated from the region if $\left|\overrightarrow{B}\right| = 0.02T$. The magnitude of the electric field is

A. $10^{5} Vm^{-1}$

B. $2.5 \times 10^{8} Vm^{-1}$

C. $1.25 \times 10^{10} Vm^{-1}$

D. $2 \times 10^{3} Vm^{-1}$

Answer: A

View Text Solution

29. A charged particle enters a magnetic field B with its initial velocity v making an angle of $\frac{\pi}{4}$ and B. The path of the particle will be

A. a straight line

B. a circle

C. an ellipse

D. a helix

Answer: D

View Text Solution

30. An alpha particle and a proton travel with same velocity in a magnetic field perpendicular to the direction of their velocities. The ratio of the radii of their circular paths is

A. $4:1$

B. $1:4$

C. $2:1$

D. $1:2$

Answer: C

View Text Solution

31. A charged particle is released from rest in a region of steady uniform electric and magnetic field which are parallel to each other. The particle will move in a

A. straight line

B. circle

C. helix

D. cycloid

Answer: A

View Text Solution

32. Two thin long parallel wires separated by a distance 'd' are carrying same current I. The magnitude of the force per unit length exerted by one wire on the other is

A. $\frac{\mu_0 I^2}{d^2}$

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

C. $\dfrac{\mu_0 I}{2\pi d}$

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

Answer: B

View Text Solution

33. A current carrying loop is placed in a uniform magnetic field. The Torque acting on it does not depend upon

A. shape of the loop

B. area of the loop

C. magnitude of the current

D. magnetic field

Answer: A

View Text Solution

34. An electron moves with a constant speed v along a circle of radius r. Its magnetic moment will be (e = eletronic charge)

A. evr

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

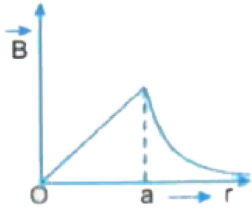
C. $\pi r^2 ev$

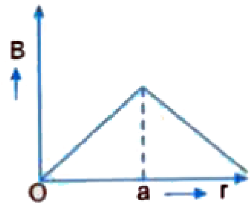
D. $2\pi rev$

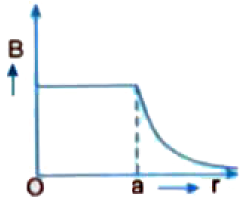
Answer: B

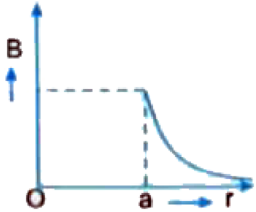
View Text Solution

35. The magnetic field B due to a straight conductor of uniform cross-section of radius 'a' and carrying a steady current varies with the distance 'r' from the centre of conductor as shown in graph .

A. 

B. 

C. 

D. 

Answer: A

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Fill In The Blanks

1. The magnetic permeability of free space is ....

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2. The magnitude of magnetic field at a distance 'r' from a long straight wire carrying a current I is given by B = ...

View Text Solution

3. Unit of ....is Wbm^{-2} and it may also be written as ....

View Text Solution

4. A galvanometer may be converted into an ammeter by connecting a sutable ....in its ....

View Text Solution

5. Resistance of an ideal ammeter is ....and that of an ideal voltmeter is ....

View Text Solution

6. ....current attract and ....currents repel.

View Text Solution

7. Numerical value of Bohr's magnetion is ....

View Text Solution

8. The radius of circular path for a charged particle of mass 'm' having charge q and kinetic energy K in a uniform , normal magnetic field B is ....

View Text Solution

9. A charge q is revolving in a circular path of radius r with a constant speed v. Its magnetic moment is given as $\left|\vec{\ }\right|$ = ...

View Text Solution

10. Two linear paraller conductors caryyng currents in the same direction ....each other but conductors carrying currents in mutually opposite directions ....

View Text Solution

11. A constant current I flows thorugh a thick wire of circular cross-section having a radius 'r'. Magnetic field at a point on its surfae is given as B = ...

.

View Text Solution

12. As per Ampere's circular law $\oint \vec{B} \,.\, \vec{d} \, l$ =.................... .

View Text Solution

True Or False

1. A point charge q moving with a velocity $\vec{v}$ at a given time in a magnetic field $\vec{B}$ experiences a force given as $F = q\left[\vec{v} \,.\, \vec{B}\right]$

View Text Solution

2. SI unit of magnetic field is called tesla, where $1T = 1\frac{N}{A} - m$

View Text Solution

3. An electron and a proton move in a uniform magnetic field with same speed directed perpendicular to the magnetic field. They experience force F_e and F_p respectively in mutually opposite directions, where $F_p = 1840F_e$.

View Text Solution

4. If the speed of a given charged particle moving on a circular path in a given magnetic field is doubled then the particle starts moving on a circular path of double radius.

View Text Solution

5. A postive charge projected along the axis of a current caryying solenoid coil moves undeviated from its orginal path.

View Text Solution

Assertion Reason Type Questions

1. Assertion (A) : A cyclotron is a device which is sued to accelerate positively charged ions.

Reason (R) : Cyclotron frequency depends on the velocity of positive ion.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false .

D. If the assertion is false but reason is true.

Answer: C

View Text Solution

2. Assertion (A) : If a proton and an alpha particle enter a uniform magnetic field normally with the same velocity, the time period of revolution of the alpha particle is double than that of proton.

Reason (R) : In a magneitc field the time period of revolution of a charged particle is directly proportional to its mass.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false .

D. If the assertion is false but reason is true.

Answer: B

View Text Solution

3. Assertion (A) : A cyclotron cannot accelerate neutrons.

Reason (R) : Neutron cannot accelerate neutrons.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false .

D. If the assertion is false but reason is true.

Answer: A

View Text Solution

4. Assertion (A) : If an electron, coming vertically from outer space, enters the earth's magnetic field, it is deflected towards west.

Reason (R) : Electron has negative charge.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false .

D. If the assertion is false but reason is true.

Answer: B

View Text Solution

5. Assertion (A) : An ammeter is connected in series of the current carrying circuit but a voltmeter is connected in parallel across those two points, potential difference between which is to be measured.

Reason (R) : Resistance of an ideal ammeter is zero but the resistance of an ideal voltmeter is infinite.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false .

D. If the assertion is false but reason is true.

Answer: A

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Very Short Answer Questions

1. Name the physical whose SI unit is Wbm^{-2}. Is it a scalar or vector quantity ?

View Text Solution

2. Write the expression in vector form for the magnetic force $\vec{F}$ acting on a charged particle moving with velocity $\overrightarrow{v}$ in the presence of a magnetic field $\overrightarrow{B}$. What is the direction of the magnetic force ?

View Text Solution

3. Use the expression $\overrightarrow{F} = q\left(\overrightarrow{v} \times \overrightarrow{B}\right)$ to define the SI unit of magnetic field.

View Text Solution

4. What is the value of absolute permeability of free space ? Give its units.

View Text Solution

5. Under what condition does an electron moving through a magnetic field experience maximum force ?

View Text Solution

6. Under what condition is the force acting on a charge moving through a uniform magnetic field minimum?

View Text Solution

7. In a certain arrangement, a proton does not get deflected while passing through a magnetic field region. Under what condition is it possible?

View Text Solution

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

View Text Solution

9. The force $\overrightarrow{F}$ experienced by a particle of charge q moving with velocity $\overrightarrow{v}$ in a magnetic field $\overrightarrow{B}$ is given by $\overrightarrow{F}=q\left(\overrightarrow{v}\times\overrightarrow{B}\right)$. Of these, name the pairs of vectors which are always at right angles to each other.

View Text Solution

10. 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?

View Text Solution

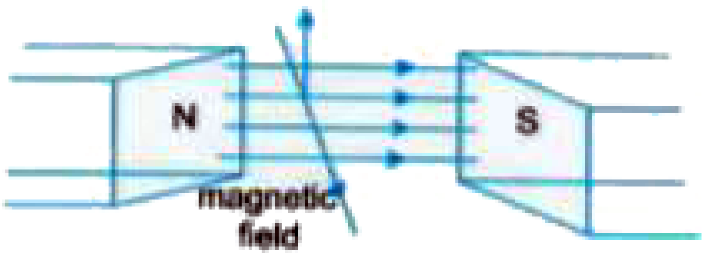
11. An electron in moving along positive x-axis in the presence of uniform magnetic field along positive y-axis. What is the direction of the force acting on it ?

View Text Solution

12. A beam of α-particle projected along +x - axis, experiences a force due to a magnetic field along the +y-axis. What is the direction of the magnetic field?

View Text Solution

13. A charged particle enters into a uniform magnetic foeld and experiences an upward force as indicated in the Fig. What is the charge sign on the partcle ?



View Text Solution

14. What is the direction of the force acting on a charged. Particle q moving with a velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$?

View Text Solution

15. A protom (or an electron) is moving in a uniform magnetic field. What is the path of the proton (or an electron) if it enters (i) parallel to the field, (ii) perpendicular to the field, and (iii) at an angle to the field?

View Text Solution

16. Two protons of equal kinetic energies enter a region of uniform magnetic field. The first proton enters normal to the field direction while the second enters at 30° to the field direction. Name the trajectories following by them.

View Text Solution

17. An electron does not suffer any deflection while passing through a region of uniform magnetic field. What is the direction of the magnetic field?

View Text Solution

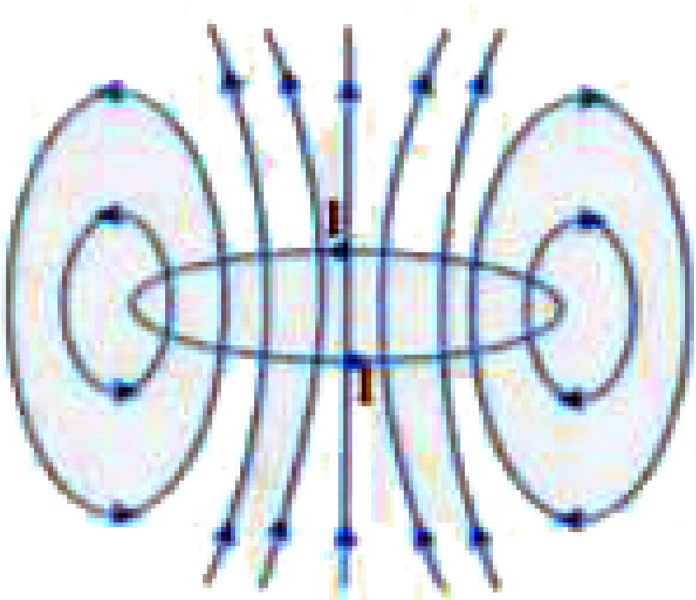
18. An electron and a proton moving with same speed enter the same magnetic field region at right angles to the direction of the field. For which of the two particles will the radius of the circular path be smaller?

View Text Solution

19. A particle of mass m and charge q moving with velocity v enters the region of uniform magnetic field at right angle to the direction of its motion. How does its kinetic energy get affected?

View Text Solution

20. Depict the direction of the magnetic field lines due to a circular current carrying loop.



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

View Text Solution

22. A charged particle is moving in a circular path under the action of the Lorentz force. How much work is done by the force in one revolution?

View Text Solution

23. An electron and a proton moving parallel to each other in the same direction with equal momentra, enter into a uniform magnetic field which is at right angles to their velocities. Trace their trajectories in the magnetic field.

View Text Solution

24. A proton is accelerated through a potential difference V, subjected to a uniform magnetic field acting normal to the velocity of the proton. If the potential difference is doubled, how will the radius of the circular path described by the proton in the magnetic field change?

View Text Solution

25. Two particles A and B of masses m and 2m have charges q and 2q respectively. Both these particle moving with velocities v_1 and v_2 respectively in the same direction enter the same magnetic field B acting normally to their direction of motion. If the two force F_A and F_B acting on them are in the ratio 1:2 , find the ratio of their velocities.

View Text Solution

26. Write the condition under which an electron will move undeflected in the presence of crossed electric and magnetic fields.

View Text Solution

27. Can a cyclotron be used to accelerate electron ? Why ?

View Text Solution

28. Describe the motion of a charged particle in a cyclotron if the frequency of the oscillating electric field were doubled.

View Text Solution

29. A coil of area 'A' , carrying a steady current I, has a magnetic moment $\vec{m}$ associated with it. Write the relation between $\vec{m}$, I and A in vector form.

View Text Solution

30. A current carrying loop, free to turn , is placed in a uniform magnetic field. What will be its orientation, relative to $\vec{B}$, in the equilibrium state?

D

View Text Solution

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

View Text Solution

32. Write the underlying principle of a moving coil galvanometer.

View Text Solution

33. What is the nature of the magnetic field in a moving coil galvanometer?

View Text Solution

34. What is the function of a uniform radial magnetic field in the moving coil galvanometer?

View Text Solution

35. What is the function of a soft iron core in a moving coil galvanometer?

View Text Solution

36. What is the resistance of an ideal (i) ammeter, (ii) voltmeter ?

View Text Solution

37. How can you increase the range of an ammeter?

View Text Solution

38. How can you enhance the range of a voltmeter?

View Text Solution

39. What is a Bohr magneton?

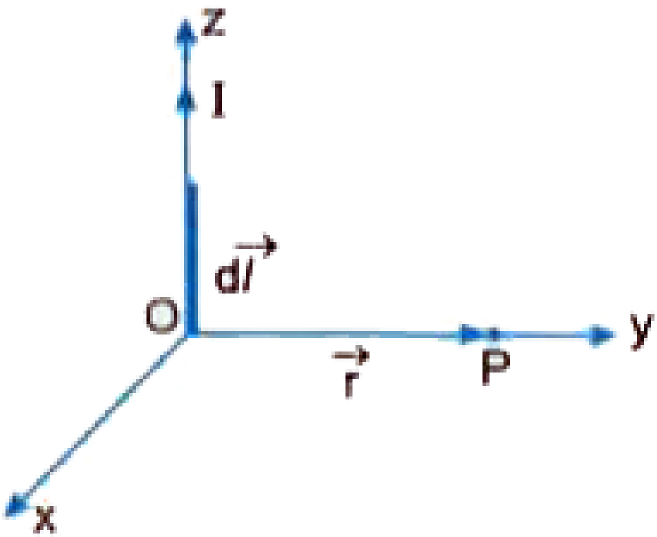
View Text Solution

Short Answer Questions

1. State Biot-Savart law.

A current I flows in a conductor placed perpendicular to the plane of the paper. Indicate the direction of the magnetic field due to a small element $\overrightarrow{d} l$ at point P situated at a distance $\overrightarrow{r}$

from the element as shown in figure.



View Text Solution

2. A circular coil of radius R carries a curretn. Find an expression for the magnetic field due to this coil at its centre. Also find the direction of field.

View Text Solution

3. (a) State Bio-Savart's law in vector form expressing the magnetic field due to an element $\vec{d}\,l$ carrying current I at a distance r from the element.

(b) Write the expression for the magnitude of the magnetic field at the centre of a circular loop of radius 'R' carrying a steady current I. Draw the field lines due to the current loop.

4. A long wire is first bent into a circular coil of one turn and then into a circular coil of smaller radius, having n identical turns. If the same current passes in both the cases, find the ratio of the magnetic fields produced at the centre in the two cases.

View Text Solution

5. A straight wire of length L is bent into a semicircular loop. Use Biot-Savart's to deduce an expression for the magnetic field at its centre due to the curretn I passing through it.

View Text Solution

6. State Ampere's circuital law and express it mathematically. Give the sign convention involved in the relation.

View Text Solution

7. State Ampere's circuital law, expressing it in the integral form.

View Text Solution

8. Explain how Biot-Savart's law enables one to express the Ampere's circuital law in the integral form , viz.,

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I$$

where I is the total current passing through the surface.

View Text Solution

9. State the principle of working of a cyclotron. Write two used of this machine.

View Text Solution

10. A charge 'q' moving along the X-axis with a velociyt $\overrightarrow{v}$ (fig) is subjected to a uniform magnetic field $\overrightarrow{B}$ acting along the Z-axis as it crosses the origin O.

(i) Trace its trajectory.

(ii) Does the charge gain kinetic energy as it enters the magnetic field? Justify your answer.

View Text Solution

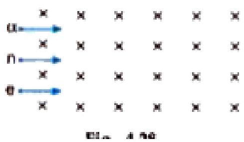
11. A proton and a deuteron, each moving with velocity $\overrightarrow{v}$, enter simultaneously in the region of magnetic field $\overrightarrow{B}$ acting normal to the direction of velocity. Trace their trajectories establishing the relationship between the two .

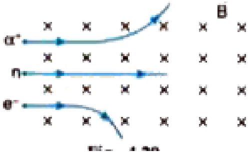
View Text Solution

12. 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" flow 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 inthe 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.

View Text Solution

13. A neutron , an electron and an alpha particle moving with equal velocities, enter a uniform magnetic field going into the plane of the paper as shown in fig. Trace their paths in the field and justify your answer.





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14. Two long straight parallel conductors carrying currents I_1 and I_2 along the same direction are separated by a distance 'd'. How does one explain the force of attraction between them?

If a third conductors carrying a current I_3 in the opposite direction is placed just in the middle of these conductors , find the resultant force acting on the third conductor.

View Text Solution

15. A current loop is considered a magnetic dipole. Explain. Also give an expression for its dipole moment.

View Text Solution

16. A circular coil of N turns and radius R carries a current I. It is unwound and rewound to make another coil of radius R/2, current I remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil.

View Text Solution

17. A coil of N turns and radius R carries I . It is unwound and rewound to make a square coil of side 'a' having same number of turns N. Keeping the curretn I same, find the ratio of the magnetic moments of the square coil and the circular coil.

View Text Solution

18. Define current sensitivity and voltage sensitivity of a galvanometer.

Increasing the current sensitivity may not necessarily increase the voltage sensitivity of a galvanometer. Justify.

View Text Solution

19. How do you convert a galvanometer into an ammeter ? Why is an ammeter always connected in series?

View Text Solution

20. Which one of the two , an ammeter or a milliammeter, has a higher resistance and why?

View Text Solution

21. How can a galvanometer be converted into a voltmeter to read a maximum potential difference of V ? Support your answer with related mathematical expression.

View Text Solution

22. A straight wire carrying a current of 5 A is bent into a semicircular arc of radius 2 cm as shown in the fig. Find the magnitude and direction of the magnetic field at the centre of the arc.

View Text Solution

23. 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 on it.

View Text Solution

24. An element $\vec{\Delta} = \Delta x \hat{i}$ is placed at the origin as shown (fig.) and carries a current I = 2 A . Find out the magnetic field at a point p on the y-axis at a distance of 1.0 m due to the element $\Delta x = 1cm$. Give the direction of the field produced.

View Text Solution

25. A long wire with a small current element of length 1 cm is placed at the origin and carries a current of 10 A along the X-axis. Find out the magnitude and direction of the magnetic field due to the element on the Y-axis at a distance 0.5 m from it.

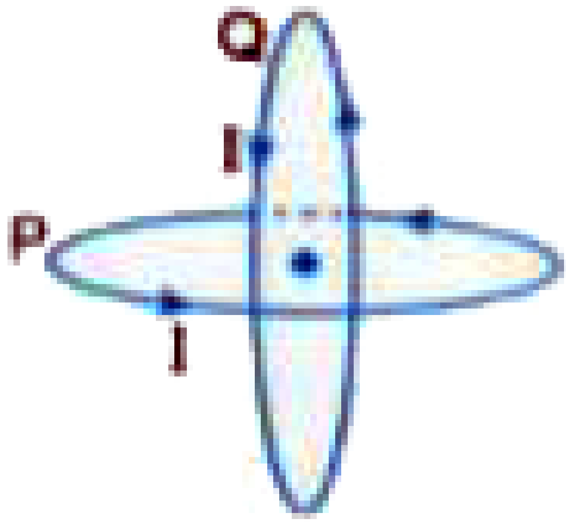
View Text Solution

26. Write the expression for the magnetic force $\overrightarrow{F}$ acting on a charged particle q moving with velocity $\overrightarrow{v}$ in the presence of the magnetic field $\overrightarrow{B}$ in a vector form.

Show that no work is done and no change in the magnitude of the velocity of the particle is produced by this force.

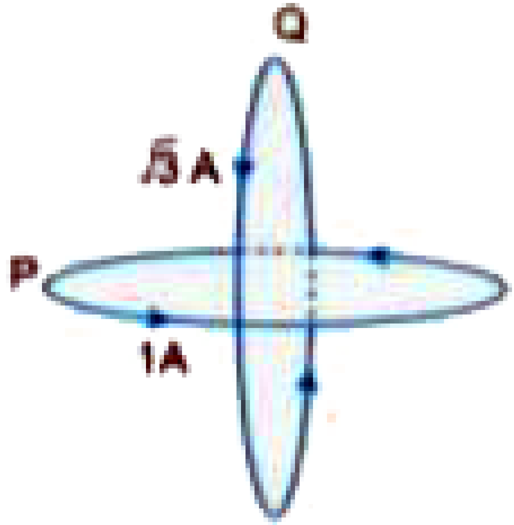
View Text Solution

27. Two identical circular wires P and Q each of radius R and carrying current 'I' are kept in perpendicular planes such that they have a common centre as shown in fig. Find the magnitude and direction of the net magnetic field at the common centre of the two coils.



View Text Solution

28. Two identical circular coils, P and Q each of radius R, carrying currents 1 A and $\sqrt{3}$ A respectively, are placed concentrically are perpendicualr to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the centre of the coils.



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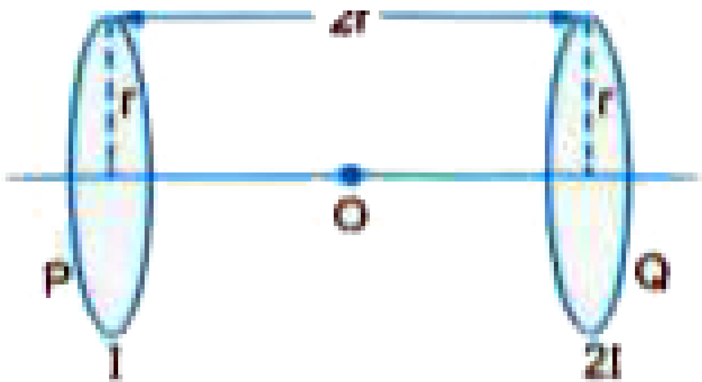
29. Two identical circular loops, P and Q, each of radius r and carrying currents I and 2 I respectively are lying in parallel planes such that they have a common axis. The direction of current in both the loops in clockwise as seen from O, which is euqidistant from both loops. Find the magnitude of the net magnetic field at point O.



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30. An α- particle and a proton of the same kinetic energy are in turn allowed to pass through a magnetic field $\overrightarrow{B}$, acting normal to the direction of motion of the particles. Calculate the ratio of radii of the circular paths described by them.

View Text Solution

31. A cyclotron, when being used to accelerate protons (mass = $1.67 \times 10^{-27} kg$, charge = $1.6 \times 10^{-19} C$) has a magnetic field of $\frac{\pi}{2}$ tesla applied normal to the plane of its does. What must be the value of the frequency of the applied alternating electric field to be used in it?

View Text Solution

32. Calculate the force per unit length on a long straight wire carrying current of 4 A due to a parallel wire carrying 6 A current . Distance between the wires is 3 cm.

View Text Solution

33. A square coil of side 10 cm has 20 turns and carries a current of 12 A. The coil is suspended vertically. The normal to the plane of the coil makes an angle of 30° with the direction of a uniform horizontal magnetic field. If the torque experienced by the coil equals 0.96 N - m, find the magnitude of the magnetic field.

View Text Solution

34. A square shaped plane coil of area $100 cm^2$ turns a carries a steady current of 5 A . It is placed in a uniform magnetic field of 0.2 T acting perpendicular to the plane of the coil. Calculate the torque on the coil when its when makes an angle of 60° with the direction of the field. In which orinetation will the coil be in stable equilibrium?

View Text Solution

35. A charged particle, having a charge q, is moving with a speed v along the x-axis. It enters a region of space where an electric field $\overrightarrow{E}\left(=E\hat{j}\right)$ and a magnetic field $\overrightarrow{B}$ are both present. The particle, on emerging from this region, is observed to be moving along the x-axis only. Obtain an expression for the magnitude of $\vec{B}$ in terms of v and E. Give the direction of $\vec{B}$.

View Text Solution

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

View Text Solution

37. A straight wire of length L and carrying a curretn I stays suspended horizontally in mid air in a region where there is a uniform magnetic field $\vec{B}$. The linear mass density of the wire is λ. Obtain the magnitude and direction of this magnitude field.

View Text Solution

38. A galvanometer of resistance 5Ω can be converted into a voltmeter of range 0 - V voltmeter of range 0 - V volts by connecting a resistance $R\Omega$ in series with it. How much resistance will be required to charge its range to $0 - \frac{V}{2}$ volts?

View Text Solution

39. A galvanometer has a resistance of 30Ω. It gives full scale deflection with a current of 2 mA. Calculate the value of the resistance needed to convert it into an ammeter of range 0 - 0.3 A.

View Text Solution

40. An ammeter of resistance 0.80Ω can measure current upto 1.0 A. What must be the value of shunt resistance to enable the ammeter to measure current upto 5.0 A ? What is the combined resistance of the ammeter and the shunt?

View Text Solution

41. A current I enters a uniform circular loop of radius R at point M and flows out at N as shown in the Fig. Obtain the net magnetic field at the centre O of the loop.

View Text Solution

Long Answer Questions I

1. Write using Biot-Savart law, the expression for the magnetic field $\vec{B}$ due to an element $\vec{d} \, l$ carrying current I at a distance $\vec{r}$ from it in vector form. Hence, derive the expression for the magnetic field due to a current loop of radius R at a point P distant x from its centre along the aixs of the loop.

View Text Solution

2. State Biot- Savart law. Use to obtain the magnetic field at a point due to a long, staright current carrying wire.

View Text Solution

3. A long solenoid of length 'l' having carries a current I. Deduce the expression for the magnetic field in the interior of the solenoid.

View Text Solution

4. Using Ampere's circuital law, obtain an expression for the magnetic field along the aixs of a current carrying solenoid of length l and having N number of turns.

View Text Solution

5. What does a toroid consist of ? Show that for an ideal toroid of closely wound turns, the magnetic field (i) inside the toroid is constant, and (ii) in the open space inside and exterior to the toroid is zero.

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6. An iron ring of relative permeability μ_r, has windings of insulated copper wire of n turns per unit length. When the current in the windings is I, find the expression for the magneitc field in the ring.

View Text Solution

7. A long straight wire of a circular cross-section (radius r) carries a steady current I. The current is distributed uniformly across the cross-section. Calculare the magnetic field at a point (a) outside the wire , (b) inside the wire. Draw a graph showing variation of magnetic field.

View Text Solution

8. Consider the motion of a charged particle of mass m and charge q moving with velocity $\overrightarrow{v}$ in a magnitude field $\overrightarrow{B}$. If $\overrightarrow{v}$ is perpendicular to $\overrightarrow{B}$, show that it describe a circular path having angular frequency $\omega = \frac{qB}{m}$

View Text Solution

9. Deduce an expression for the frequency of revolution of a charged particle in a magnetic field and show that it is independent of velocity or energy of the particle.

View Text Solution

10. A uniform magnetic field $\overrightarrow{B}$ is set up along the positive x-axis. A particle of charge q and mass m moving with a velocity $\overrightarrow{v}$ enters the field at the origin in X - Y plane such that it has velocity components both along and perpendicular to the magnetic field $\overrightarrow{B}$. Trace, giving reasons, the trajectory followed by the particle. Find out the expression for the distance moved by the particle along the magnetic field in one rotation.

View Text Solution

11. (a) Write the expression for the force $\vec{F}$ acting on a particle of mass m and charge q moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. Under what conditions will it move in (i) a circular path and (ii) a helical path?

(b) Show that the kinetic enery of the particle moving in magnetic field remains constant.

View Text Solution

12. (i) Obtian the expression for the cyclotron frequency.

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

View Text Solution

13. 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.

View Text Solution

14. Write the expression for the force $\vec{F}$ acting on a charged particle of charge q moving with a velocity $\vec{v}$ in the presence of both electric field $\vec{E}$ and magnetic field $\vec{B}$. Obtain the condition under which the particle moves underflected through the fields.

View Text Solution

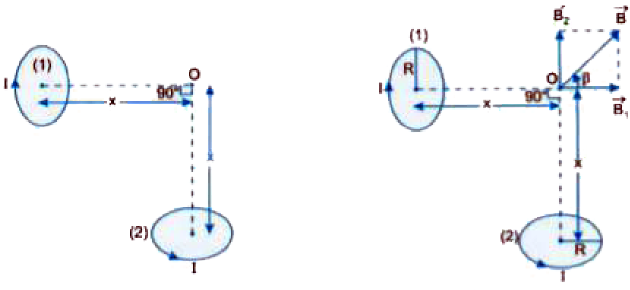
15. Two long straight parallel current conductors are kept at a distance d from each other in air. The direction of current in both the conductors is the same. Find the magnitude and direction of the force between them. Hence, define one ampere.

View Text Solution

16. A rectangle loop of size $l \times b$ carrying a steady current I is placed in a uniform magnetic field $\overrightarrow{B}$. Prove that the torque $\overrightarrow{\tau}$ acting on the loop is given by $\overrightarrow{\tau} = \overrightarrow{m} \times \overrightarrow{B}$, where $\overrightarrow{m}$ is the magnetic moment of the loop.

View Text Solution

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



View Text Solution

18. A circular coil of 200 turns and radius 10 cm is placed in a uniform magnetic field of 0.5 T, normal to the plane of the coil. If the current in the coil is 3.0 A, calculate the :

(i) Total troque on the coil, (ii) total force on the coil, (iii) average force on each electron on each electron in the coil, due to the magnetic field.

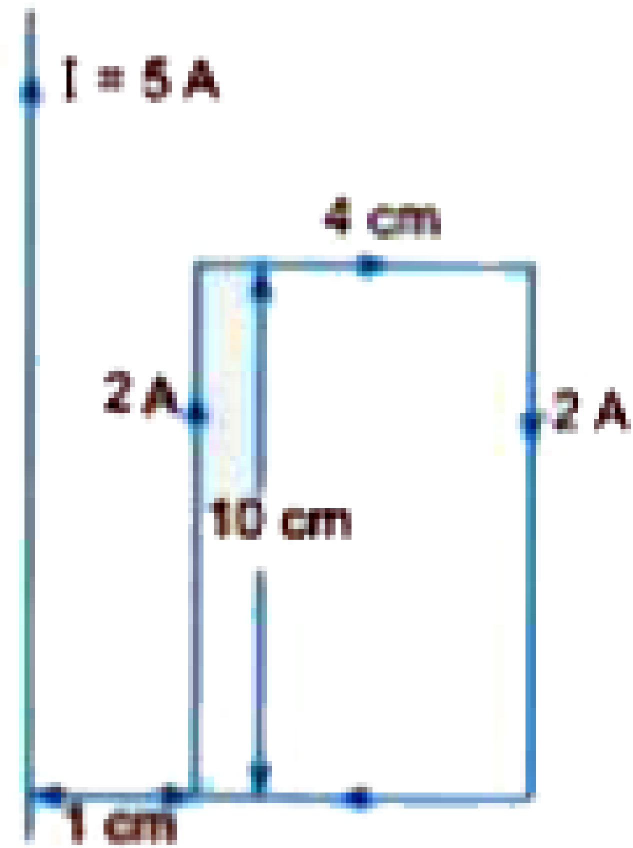
Assume, the area of cross-section of the wire to be $10^{-5}m^2$ and the free electron density as $10^{29}m^{-3}$.

View Text Solution

19. A rectangular loop of wire of size 4 cm $\times$ 10 cm carries a steady current of 2A. A straight long wire carrying 5A current is kept near the loop (fig). 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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20. A wire AB is carrying current of 12 A and is lying on the table. Another wire CD carrying 5 A is held directly above AB at a height of 1 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free. Give the direction of the current flowing in CD with respect to that remains suspended at its position when left free. Give the direction of the current flowing in CD with respect to that in AB . [Take the value of $g = 10ms^{-2}$]

View Text Solution

21. A circular coil, having 100 turns of wire of radius (nearly) 20 cm each, lies in the X-Y plane with its centre at the origin of coordinates. Find the magnetic field at the point $(0, 0, 20\sqrt{3}cm)$, when the coil carries a current of $\left(\frac{2}{\pi}\right)$ A.

View Text Solution

22. State the underlying principle of working of a moving coil galvonometer. Write two reasons why a galvometer cannot be used as such to measure current in a given circuit. Name any two factors on which the current sensitivity of a galvonometer depends.

View Text Solution

23. A moving coil galvonometer of resistance R_G gives a full scale deflection for current I_g. Use the suitable circuit diagram convert it into an ammeter of range 0 to $I(I > I_g)$. Deduce the expression for the shunt required for this conversion. Hence, write the expression for the resistance of the ammeter thus obtained.

View Text Solution

24. A moving coil galvonometer of resistance R_G gives a full scale deflection when a current I_g flows through its coil. It can be converted into an ammeter of range 0 to $I(I > I_g)$ when a shunt of resistance S is connected across its coil. If this galvanometer is converted into an ammeter of range 0 to 2I, find the expression for the shunt required in terms of S and and R_G.

View Text Solution

25. Briefly explain how you will convert a moving coil galvonometer into a voltmeter of given range.

View Text Solution

26. (a) State the principle of working of a galvonometer.

(b) A galvonometer of resistance G is converted into a voltmeter to measure upto 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 upto 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 upto 2 V. Also find the resistance G of the galvanometer in terms of R_1 and R_2 .

View Text Solution

27. (a) Define the current sensitivity of a galvonometer .

(b) The coil area of a galvonometer is $16 \times 10^{-4} m^2$. It consists of 200 turns of wire and is in a magnetic field of 0.2 T. The restoring torque constant of the suspended fibre is $10^{-6} Nm$ per degree . Assuming the magnetic field to be radial, calculate the maximum current that can be measured by the galvanometer if the scale can acomodate 30° deflection.

View Text Solution

28. A solenoid, of length 1.0 m, has a radius of 1 cm and has a total of 1000 turns wound on it. It carries a current of 5 A. Calculate the magnitude of the axial magnetic field inside the solenoid. If an electron were to move with a speed of $10^4 ms^{-1}$ along the axis of this current carrying solenoid, what would be the force experienced by electron ?

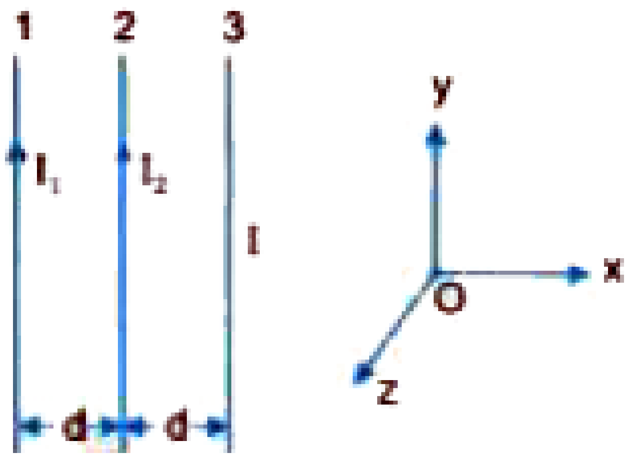
View Text Solution

29. Three long straight parallel wires are kept as shown in the fig. The wire (3) carries a current I.

(i) The direction of flow of current I in wire (3) is such that the net force on wire (1) due to the other two wires, becomes zero.

What will be the direction of current I in the two cases ?

Also obtain the relation between the magnitude of currents I_1, I_2 and I_3.



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30. An electron moves around the nucleus in a hydrogen atom of radius 0.51Å, with a velocity of $2 \times 10^5 ms^{-1}$. Calculate the following :

(i) the equivalent current due to orbital motion of electron,

(ii) the megnetic field produced at the centre of the nucleus,

(iii) the magnetic associated with the electron.

View Text Solution

31. A galvanometer with a coil of resistance 120 ohm shows full scale full scale deflection for a current of

2.5 mA. How will you convert the galvonometer into an ammeter of range 0 to 7.5 A ? Determine the net resistance of the ammeter. When an ammeter is put in a circuit, does it read slightly less or more than the actual current in the original circuit ? Justify your answer.

View Text Solution

32. Derive an expression for the magnetic moment $\vec{\mu}$ of an electron revolving around the nucleus in terms of its angular momentum $\vec{l}$. What is the direction of the magnetic moment of the electron with respect to its angular momentum?

View Text Solution

33. An 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 significance of negative sign.

View Text Solution

Long Answer Questions Ii

1. (a) Using Ampere's circuital law, obtain the expression for the magnetic field due to a long solenoid at a point inside the solenoid on its axis.

(b) In what respect is a toroid different from a solenoid ? Draw and copare the patern of the magnetic field lines in the two cases.

(c) How is the magnetic field inside a given solenoid made strong?

View Text Solution

2. Two striaght long parallel conductors carry currents I_1 and I_2 in the same direction. Deduce the expression for the force per unit length between

them.

Depict the pattern of magnetic field lines around

them.

(b) A rectangular current carrying loop EFGH is kept

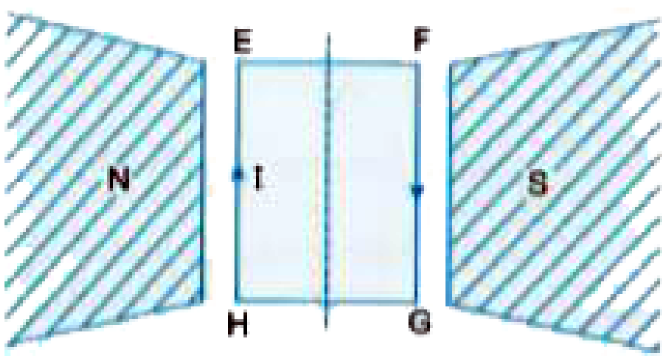
in a uniform magnetic field as shown in the fig.

(i) What is the direction of the magnetic moment of

the current loop ?

(ii) When is torque acting on the loop (A) maximum,

(B) zero?



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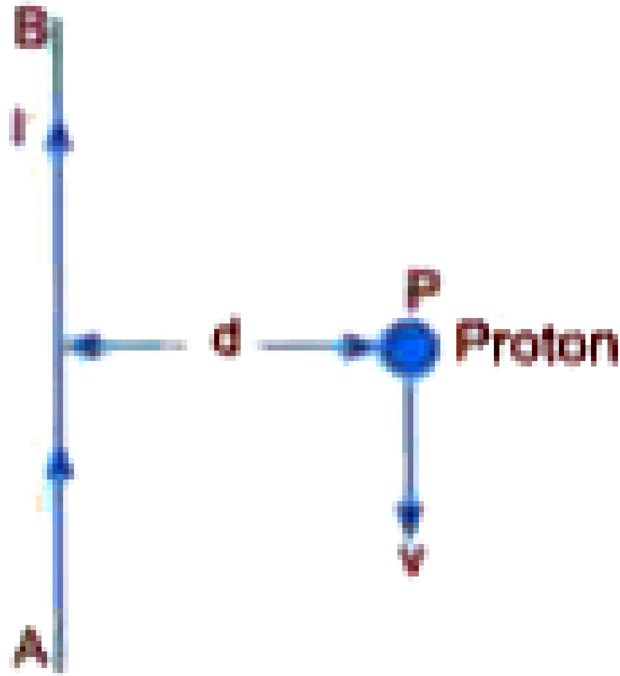
3. (a) Derie an expression for the force between two long parallel current carryng condcutors.

(b) Use this expression to define SI unit of current.

(c) A long straight wire AB carries a current I. A proton P travels with a speed v, parallel to the wire, at a distance d from it in a direction opposite to the current as shown in the fig. What is the force experienced by the proton and what is its direction?



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4. (a) Draw a schematic sketch of a cyclotron. Explain clearly the role of crossed electric and magnetic field in accelerating the charge. Hence , derive the expression for the kinetic energy aquired by the particles.

(b) An α- particle and proton are released from the center of the cyclotron and made to accelerate.

(i) Can both be accelerated at the same cyclotron frequency? Give resons to justify your answer.

(ii) when they are accelerated in turn, which of the two will have higher velocity at the exit slit of the dees?

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5. Explain with the help of a labelled diagram, the principle and construction of a cyclotron. Deduce an expression for the cyclotron frequency and show that it does not depend on the speed of the charged particle.

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6. Draw a schematic sketch of a cyclotron. Explain briefly how it works and how it is used to accelerate the charged particles.

(i) Show that time period of ions in a cyclotron is independent of both the speed and radius of circular path.

(ii) What is resonance condition ? How is it used to accelerate the charged particles?

View Text Solution

7. (a) With the help of a diagram, explain the principle and working of a moving coil galvanometer. (b) What is the imporance of a magnetic field and how is it produced ?

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

View Text Solution

8. (a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.

(b) Answer the following :

(i) Why is it necessary to introduce a cylindrical soft iron core inside the coil a galvanometer?

(ii) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain giving reason.

View Text Solution

9. (a) Derive the expression for the torque on a rectangular current carrying loop suspended in a uniform magnetic field.

(b) A proton and a deuteron having equal momenta enter in a region of uniform magnetic field at right angle to the direction of the field. Depict their trajectories in the field.

View Text Solution

10. (a) Explain, giving reasons, the basic difference in converting a galvanometer into (i) a voltmeter and (ii) an ammeter.

(b) Two long straight parallel conductors carrying steady currents I_1 and I_2 are separeted by a distance 'd' . Explain briefly, with the help of a suitable diagram, how the magnetic field due to one conductor acts on the other. Hence, deduce the expression for the force acting between the two conductors. Mention the nature of this force.

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11. (a) State Ampere's cicuital law. Use this law to obtain the expression for the magnetic field inside an air cored toriod of average radius 'R',having 'n' truns per unit length and carrying a steady current I.

(b) An observer to the left of a solenoid of N turns each of cross section area 'A' observes that a steady current I in it flows in the clockwise direction. Depict the magnetic field lines due to the solenoid specifying its polarity and show that it acts as a bar magnet of magnetic moment $m = NIA$.

View Text Solution

Self Assessment Test Section A Multiple Choice Questions

1. A wire in the form of a circular loop of one turn carrying a curretn I produces a magnetic field B at its centre. If the same wire is looped into a coil of 2 turns and carries the same current, then magnetic field produced at the cetre of coil is

A. B

B. 2B

C. 4 B

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

Answer: C

View Text Solution

2. The magentic field B at the centre O in fig. shown

is

A. $\frac{\mu_0 I}{4}\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

B. $\frac{\mu_0 I}{4}\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$

C. $\frac{\mu_0 I}{4}(R_1 - R_2)$

D. $\frac{\mu_0 I}{4}(R_1 + R_2)$

Answer: B

View Text Solution

3. The dimensions of the magnetic field B are

A. $MLT^{-2}A^{-1}$

B. $MT^{-2}A^{-1}$

C. ML^2TA^{-2}

D. $M^2LT^2A^{-1}$

Answer: B

View Text Solution

4. Two particle X and Y having equal charges, after being accelerated through the same potential differences, enter a region of uniform magnetic field B and describe circular paths of radii R_1 and R_2 respectively . The ratio of mass of X to that of Y is

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

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

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

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

Answer: C

View Text Solution

5. In a moving coil galvanometer the deflection ϕ of the coil is related to the electric current I by the relation

A. $I \propto \tan\phi$

B. $I \propto \sin\phi$

C. $I \propto \phi^2$

D. $I \propto \phi$

Answer: D

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Self Assessment Test Section A Fill In The Blanks

1. The current sensitivity of a moving coil galvanometer can be increased by reducing the ___________.

View Text Solution

2. Cyclotron frequency v = _________.

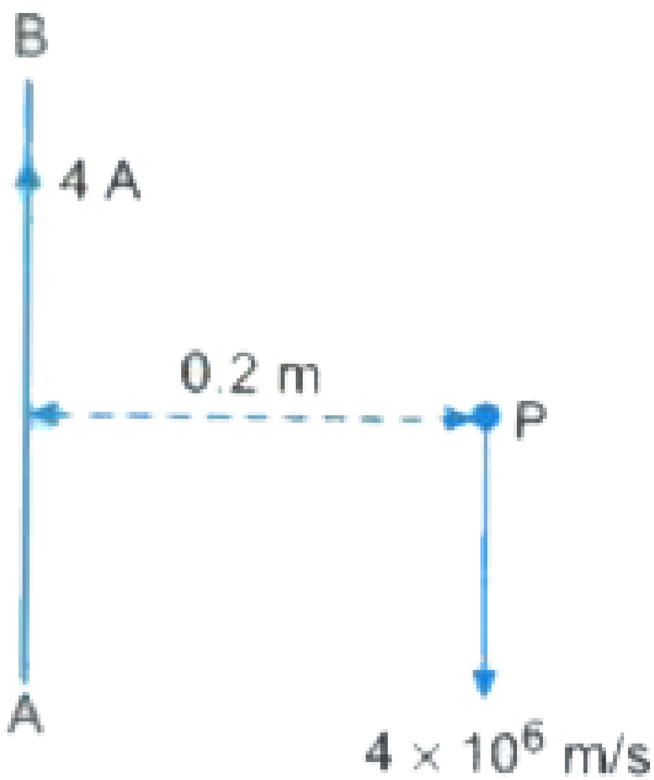
View Text Solution

3. A galvanometer is being converted into an ammeter by joining a shunt across it. Higher the range of ammeter ________ is the value of shunt resistance.

View Text Solution

Self Assessment Test Section B

1. A long straight wire AB carries a current of 4 A. A proton P travels at $4 \times 10^6 ms^{-1}$ parallel to the wire 0.2 m from it and in a direction opposite to the current as shown in the fig. Calculate the force which the magnetic field due to the current carrying wire exerts on the proton. Also specify its direction.



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

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Self Assessment Test Section C

1. A current of 4 mA is maintained in a circular loop of single tunn of 1 m circumference. The plane of the loop is parallel to a magnetic field of 0.2 T.

(i) Calculate the magnetic moment of the loop.

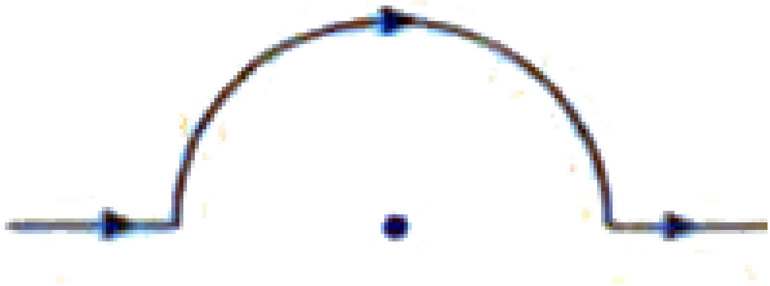
(ii) Calculate the magnitude of torque experienced by the loop.

View Text Solution

Self Assessment Test Section D

1. (a) Derive the expression for the magnetic field due to a current carrying coil of radius r at a distance x from the centre along the X-axis.

(b) A straight wire carrying a current of 5 A is bent into a semicular arc of radius 2 cm as shown in the fig. FInd th magnitude and direction of the magnetic field at the centre of the arc.



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