PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

MAGNETISM AND MAGNETIC EFFECTS OF ELECTRIC CURRENT

Example

1. The horizontal component and vertical components of Earth's magnetic field at a

place are 0.15 G and 0.26 G respectively. Calculate the angle of dip and resultant magnetic field.

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2. Let the magnetic moment of a bar magnet be $\vec{p}_m$ whose magnetic length is d = 2l and pole strength is q_m. Compute the magnetic moment of the bar magnet when it is cut into two pieces

along its length

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3. Let the magnetic moment of a bar magnet be $\vec{p}_m$ whose magnetic length is d = 2l and pole strength is q_m. Compute the magnetic moment of the bar magnet when it is cut into two pieces

perpendicular to its length.

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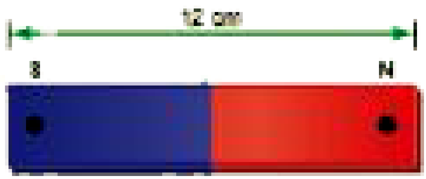
4. Compute the magnetic length of a uniform bar magnet if the geometrical length of the magnet is 12 cm. Mark the positions of magnetic pole points.



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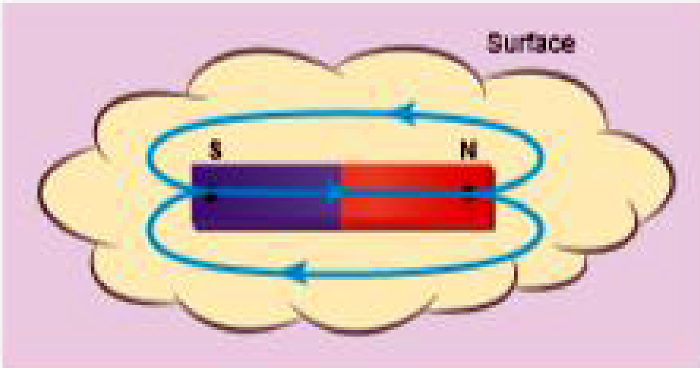
5. Calculate the magnetic flux coming out from the surface containing magnetic dipole (say, a bar magnet) as shown in figure.



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6. The repulsive force between two magnetic poles in air is $9 \times 10^{-3} N$. If the two poles are equal in strength and are separated by a distance of 10 cm, calculate the pole strength of each pole.

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7. A short bar magnet has a magnetic moment of $0.5JT^{-1}$. Calculate magnitude and direction of the magnetic field produced by the bar magnet which is kept at a distance of 0.1 m from the center of the bar magnet along axial line of the bar magnet and

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8. A short bar magnet has a magnetic moment of $0.5 JT^{-1}$. Calculate magnitude and direction of the magnetic field produced by the bar magnet which is kept at a distance of 0.1 m from the center of the bar magnet along normal bisector of the bar magnet.

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9. Show the time period of oscillation when a bar magnet is kept in a uniform magnetic field is $T = 2\pi\sqrt{\frac{1}{p_m B}}$ in second, where I represents moment of inertia of the bar magnet, p_m is the magnetic moment and is the magnetic field.

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10. Consider a magnetic dipole which on switching ON external magnetic field orient only in two possible ways i.e., one along the direction of the magnetic field (parallel to the field) and another anti-parallel to magnetic field. Compute the energy for the possible orientation. Sketch the graph.

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11. A coil of a tangent galvanometer of diametre 0.24 m has 100 turns. If the horizontal component of Earth's magnetic field is $25 \times 10^{-6} T$ then, calculate the current which gives a deflection of 60°.

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12. Compute the intensity of magnetisation of the bar magnet whose mass, magnetic moment and density are 200 g, $2Am^2$ and $8gcm^{-3}$, respectively.

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13. Using the relation $\vec{B} = \mu_o \left(\vec{H} + \vec{M} \right)$, show that $\chi_m = \mu_r - 1$.

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14. Two materials X and Y are magnetised, whose intensity of magnetisation are $500 Am^{-1}$ and $2000 Am^{-1}$, respectively. If the magnetising field is $1000 Am^{-1}$, then which one among these materials can be easily magnetized?.

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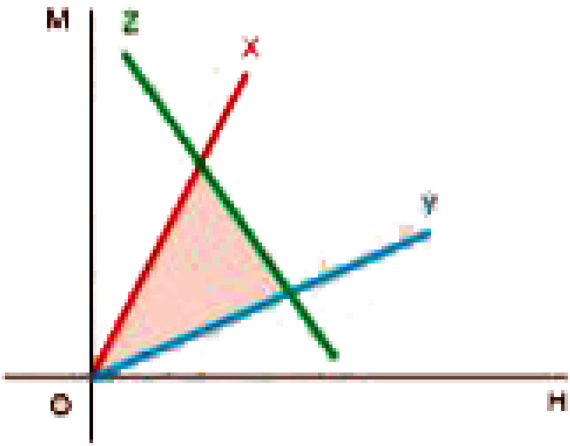
15. The following figure shows the variation of intensity of magnetisation with the applied magnetic field intensity for three magnetic materials X, Y and Z. Identify the materials X,Y and Z.



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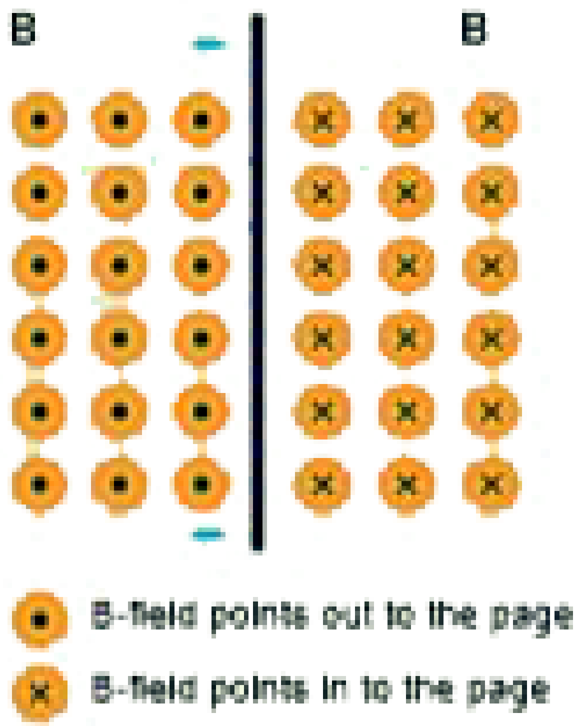
16. The magnetic field shown in the figure is due to the current carrying wire. In which direction does the current flow in the wire?.



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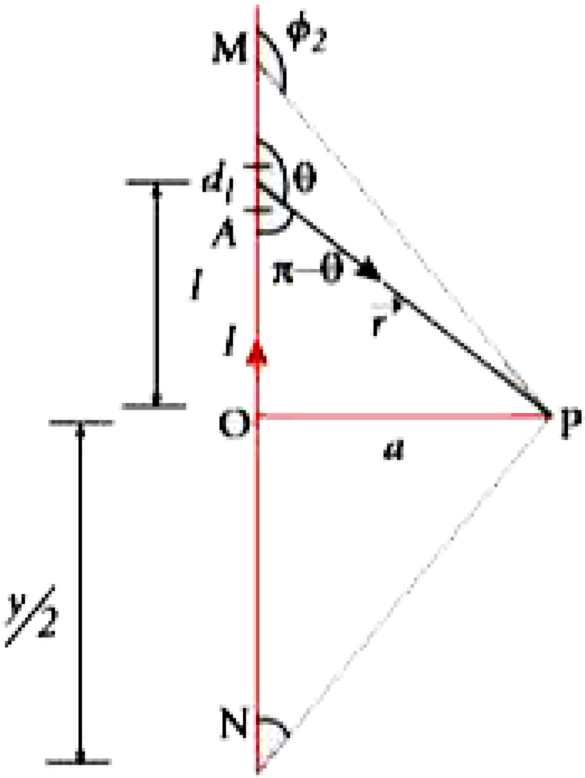
17. Calculate the magnetic field at a point P which is perpendicular bisector to current carrying straight wire as shown in figure.



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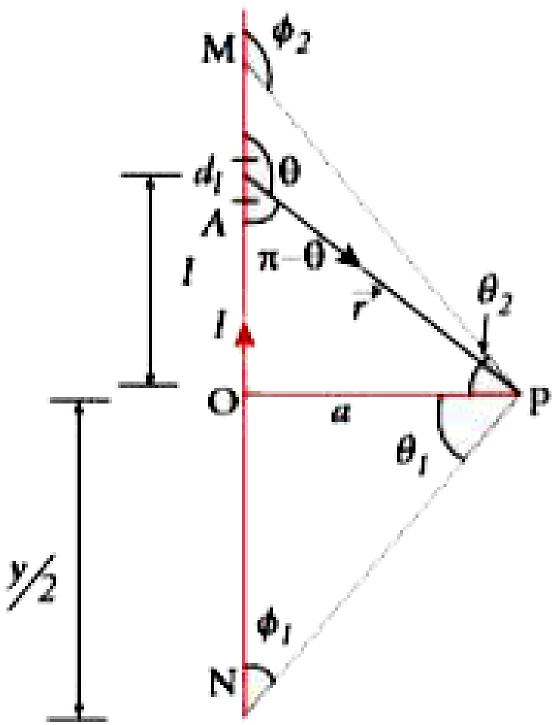
18. Show that for a straight conductor, the magnetic field

$$\vec{B} = \frac{\mu_o I}{4\pi a}(\cos\varphi_1 - \cos\varphi_2)\hat{n}$$

$$= \frac{\mu_o I}{4\pi a}(\sin\theta_1 + \sin\theta_2)\hat{n}$$



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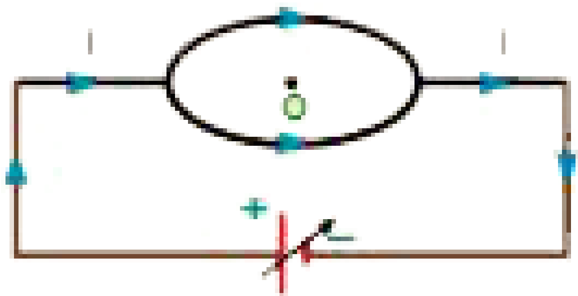
19. What is the magnetic field at the center of the loop shown in figure?



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20. Compute the magnitude of the magnetic field of a long, straight wire carrying a current of 1A at distance of 1m from it. Compare it with Earth's magnetic field.

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21. Calculate the magnetic field inside a solenoid, when

the length of the solenoid becomes twice and fixed number of turns

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22. Calculate the magnetic field inside a solenoid, when

both the length of the solenoid and number of turns are double

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23. Calculate the magnetic field inside a solenoid, when

the number of turns becomes twice for the fixed length of the solenoid Compare the results.

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24. A particle of charge q moves with velocity $\vec{v}$ along positive y - direction in a magnetic field $\vec{B}$. Compute the Lorentz force experienced by the particle

when magnetic field is along positive y-direction

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25. A particle of charge q moves with velocity $\vec{v}$ along positive y - direction in a magnetic field $\vec{B}$. Compute the Lorentz force experienced by the particle

when magnetic field points in positive z - direction

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26. A particle of charge q moves with velocity $\vec{v}$ along positive y - direction in a magnetic field $\overrightarrow{B}$. Compute the Lorentz force experienced by the particle

when magnetic field is in zy - plane and making an angle θ with velocity of the particle. Mark the direction of magnetic force in each case.

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27. Compute the work done and power delivered by the Lorentz force on the particle of charge q moving with velocity $\overrightarrow{v}$. Calculate the angle between Lorentz force and velocity of the charged particle and also interpret the result.

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28. An electron moving perpendicular to a uniform magnetic field 0.500 T undergoes circular motion of radius 2.80 mm. What is the speed of electron?

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29. A proton moves in a uniform magnetic field of strength 0.500 T magnetic field is directed along the x-axis. At initial time, t s = 0 , the proton has velocity $\vec{v} = \left(1.95 \times 10^5 \hat{i} + 2.00 \times 10^5 \hat{k}\right) ms^{-1}$.

Find

At initial time, what is the acceleration of the proton.

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30. A proton moves in a uniform magnetic field of strength 0.500 T magnetic field is directed along the x-axis. At initial time, t s = 0 , the proton has velocity

$$\vec{v} = \left(1.95 \times 10^5 \hat{i} + 2.00 \times 10^5 \hat{k}\right) ms^{-1}.$$

Find

Is the path circular or helical?. If helical, calculate the radius of helical trajectory and also calculate the pitch of the helix (Note: Pitch of the helix is the distance travelled along the helix axis per revolution).

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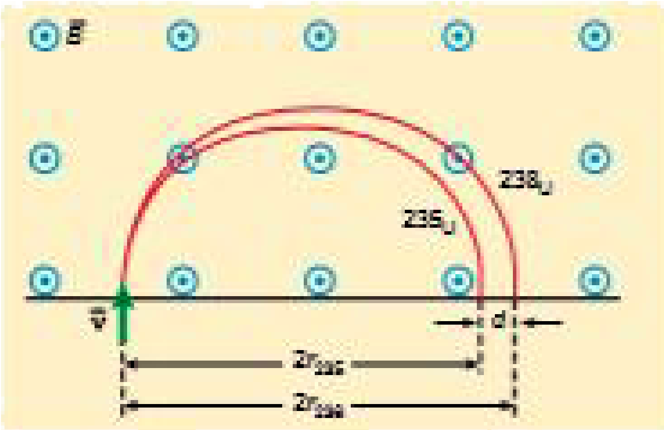
31. Two singly ionized isotopes of uranium $^{235}_{92}U$ and $^{238}_{92}U$ (isotopes have same atomic number but different mass number) are sent with velocity $1.00 \times 10^5 ms^{-1}$ into a magnetic field of strength 0.500 T normally. Compute the distance between the two isotopes after they complete a semi-circle. Also compute the time taken by each isotope to complete one semi-circular path. (Given: masses of the isotopes: $= 3.90 \times 10^{-25} kg$ and

$m_{238} = 3.95 \times 10^{-25} kg)$



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32. Let E be the electric field of magnitude $6.0 \times 10^{6} NC^{-1}$ and B be the magnetic field magnitude 0.83 T. Suppose an electron is accelerated with a potential of 200 V, will it show zero deflection?. If not, at what potential will it show zero deflection.

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33. Suppose a cyclotron is operated to accelerate protons with a magnetic field of strength 1 T. Calculate the frequency in which the electric field between two Dees could be reversed.

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34. A metallic rod of linear density is $0.25kgm^{-1}$ is lying horizontally on a smooth inclined plane which makes an angle of 45o with the horizontal. The rod is not allowed to slide down by flowing a current through it when a magnetic field of strength 0.25 T is acting on it in the vertical direction. Calculate the electric current flowing in the rod to keep it stationary.

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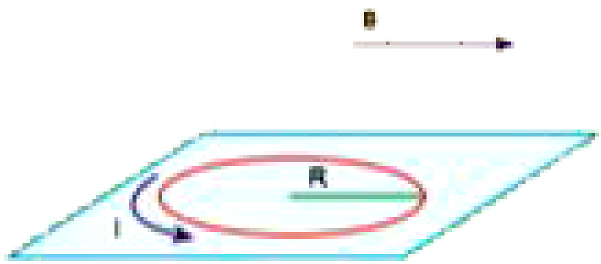
35. Consider a circular wire loop of radius R, mass m kept at rest on a rough surface. Let I be the current flowing through the loop and

$\vec{B}$ be the magnetic field acting along horizontal as shown in Figure. Estimate the current I that should be applied so that one edge of the loop is lifted off the surface?



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36. The coil of a moving coil galvanometer has 5 turns and each turn has an effective area of

$2 \times 10^{-2} m^2$. It is suspended in a magnetic field whose strength is $4 \times 10^{-2} Wbm^{-2}$. If the torsional constant K of the suspension fibre is $4 \times 10^{-9} Nm\text{deg}^{-1}$.

Find its current sensitivity in degree per micro - ampere.

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37. The coil of a moving coil galvanometer has 5 turns and each turn has an effective area of $2 \times 10^{-2} m^2$. It is suspended in a magnetic field whose strength is $4 \times 10^{-2} Wbm^{-2}$. If the torsional constant K of the suspension fibre is $4 \times 10^{-9} Nm\deg^{-1}$.

Calculate the voltage sensitivity of the galvanometer for it to have full scale deflection of 50 divisions for 25 mV.

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38. The coil of a moving coil galvanometer has 5 turns and each turn has an effective area of $2 \times 10^{-2} m^2$. It is suspended in a magnetic field whose strength is $4 \times 10^{-2} Wbm^{-2}$. If the torsional constant K of the suspension fibre is $4 \times 10^{-9} Nm\deg^{-1}$.

Compute the resistance of the galvanometer.

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39. The resistance of a moving coil galvanometer is made twice its original value in order to increase current sensitivity by 50%. Will the voltage sensitivity change? If so, by how much?.

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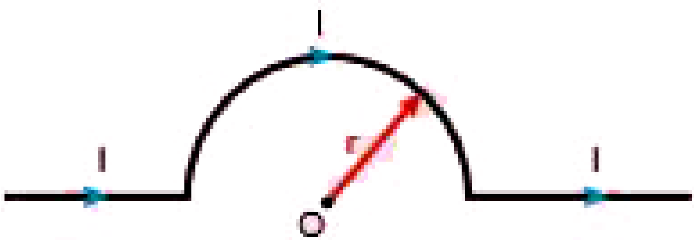
Evaluation I Multiple Choice Questions

1. The magnetic field at the center O of the following current loop is



A. $\frac{\mu I}{4r} \oplus$

B. $\frac{\mu_0 I}{4r} \odot$

C. $\frac{\mu_0 I}{2r} \otimes$

D. $\frac{\mu_0 I}{2r} \odot$

Answer: A

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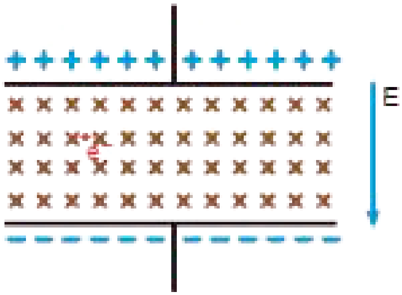
2. An electron moves straight inside a charged parallel plate capacitor of uniform charge density σ. The time taken by the electron to cross the parallel plate capacitor when the plates of the capacitor are kept under constant magnetic field of induction $\overrightarrow{B}$ is



H5CRWB

A. $\varepsilon_0 \frac{elB}{\sigma}$

B. $\varepsilon_0 \frac{lB}{\sigma l}$

C. $\varepsilon_0 \frac{lB}{e\sigma}$

D. $\varepsilon_0 \frac{lB}{\sigma}$

Answer: D

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3. The force experienced by a particle having mass m and charge q accelerated through a potential difference V when it is kept under perpendicular magnetic field $\vec{B}$ is

A. $\sqrt{\frac{2q^3BV}{m}}$

B. $\sqrt{\frac{q^3B^2V}{2m}}$

C. $\sqrt{\frac{2q^3B^2V}{m}}$

D. $\sqrt{\frac{2q^3BV}{m^3}}$

Answer: C

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4. A circular coil of radius 5 cm and 50 turns carries a current of 3 ampere. Th e magnetic dipole moment of the coil is

A. 1.0 amp $-m^2$

B. 1.2 amp - m^2

C. 0.5 amp - m^2

D. 0.8 amp - m^2

Answer: B

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5. A thin insulated wire forms a plane spiral of N = 100 tight turns carrying a current I = 8 m A (milli ampere). Th e radii of inside and outside turns are a = 50 mm and b = 100 mm respectively. The magnetic induction at the center of the spiral is

A. $5 \mu T$

B. $7\mu T$

C. $8\mu T$

D. $10\mu T$

Answer: B

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6. Three wires of equal lengths are bent in the form of loops. One of the loops is circle, another is a semi-circle and the third one is a square. They are placed in a uniform magnetic field and same electric current is passed through them. Which of the following loop configuration will experience greater torque ?

A. circle

B. semi-circle

C. square

D. all of them

Answer: A

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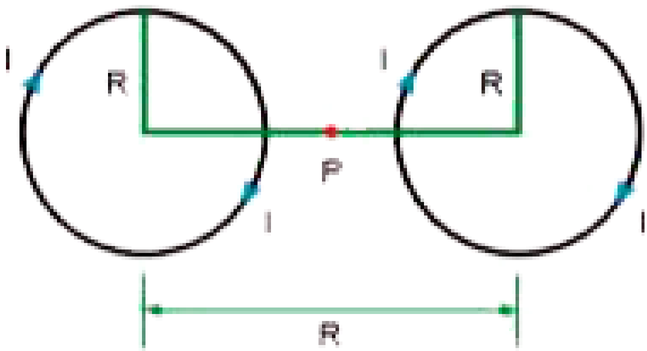
7. Two identical coils, each with N turns and radius R are placed coaxially at a distance R as shown in the figure. If I is the current passing through the loops in the same direction, then the magnetic field at a point P which is at exactly at $\frac{R}{2}$ distance between two coils is



A. $\frac{8N\mu_0 I}{\sqrt{5}R}$

B. $\frac{8N\mu_0 I}{5^{3/2}R}$

C. $\frac{8N\mu_0 I}{5R}$

D. $\frac{4N\mu_0 I}{\sqrt{5}R}$

Answer: B

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8. A wire of length l carries a current I along the Y direction and magnetic field is given by $\vec{B} = \frac{\beta}{\sqrt{3}}\left(\hat{i} + \hat{j} + \hat{k}\right)T$. The magnitude of Lorentz force acting on the wire is

A. $\sqrt{\frac{2}{\sqrt{3}}\beta Il}$

B. $\sqrt{\frac{1}{\sqrt{3}}\beta Il}$

C. $\sqrt{2}\beta Il$

D. $\sqrt{\frac{1}{2}\beta Il}$

Answer: A

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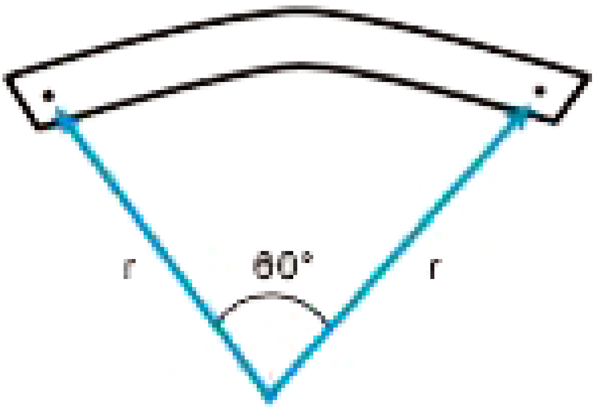
9. A bar magnet of length l and magnetic moment M is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be



A. M

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

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

D. $\frac{1}{2}M$

Answer: B

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10. A non-conducting charged ring of charge q, mass m and radius r is rotated with constant angular speed ω. Find the ratio of its magnetic moment with angular momentum is

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

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

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

D. $\frac{q}{4m}$

Answer: C

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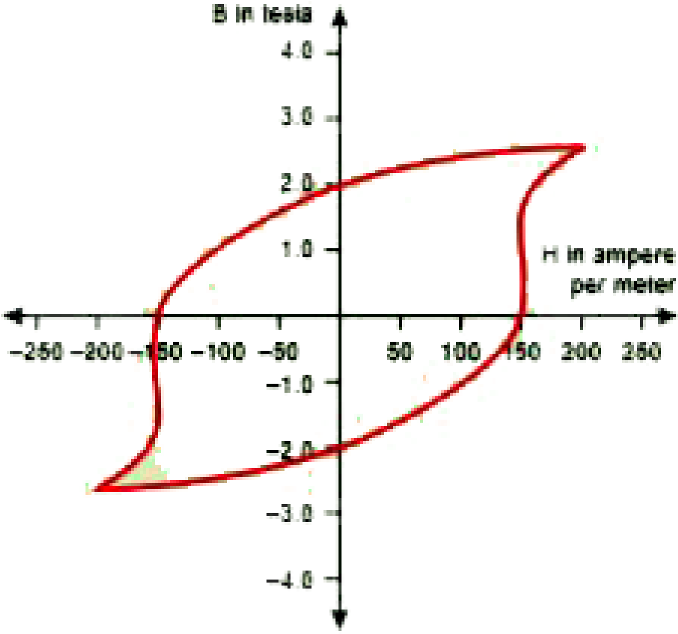
11. The BH curve for a ferromagnetic material is shown in the figure. The material is placed inside a long solenoid which contains 1000 turns/ cm. The current that should be passed in the solenonid to demagnetize the ferromagnet completely is



A. 1.00 m A (milli ampere)

B. 1.25 mA

C. 1.50 mA

D. 1.75 mA

Answer: B

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12. Two short bar magnets have magnetic moments $1.20 Am^2$ and $1.00 Am^2$ respectively. They are kept on a horizontal table parallel to each other with their north poles pointing towards the south. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the resultant horizontal magnetic induction at the midpoint O of the line joining their centers is (Horizontal components of Earth's magnetic induction is $3.6 \times 10^{-5} Wbm^{-2}$)

A. 3.60×10^{-5} Wb m^{-2}

B. 3.5×10^{-5} Wb m^{-2}

C. 2.56×10^{-4} Wb m^{-2}

D. 2.2×10^{-4} Wb m^{-2}

Answer: C

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13. The vertical component of Earth's magnetic field at a place is equal to the horizontal component. What is the value of angle of dip at this place?

A. 30°

B. 45°

C. 60°

D. 90°

Answer: B

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14. A flat dielectric disc of radius R carries an excess charge on its surface. The surface charge density is σ. The disc rotates about an axis perpendicular to its plane passing through the center with angular velocity ω. Find the magnitude of the torque on the disc if it is placed in a uniform magnetic field whose strength is B which is directed perpendicular to the axis of rotation

A. $\frac{1}{4}\sigma\omega\pi BR$

B. $\frac{1}{4}\sigma\omega\pi BR^2$

C. $\frac{1}{4}\sigma\omega\pi BR^2$

D. $\frac{1}{4}\sigma\omega\pi BR^4$

Answer: D

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15. A simple pendulum with charged bob is oscillating with time period T and let θ be the angular displacement. If the uniform magnetic field is switched ON in a direction perpendicular to the plane of oscillation then

A. time period will decrease but θ will remain constant

B. time period remain constant but θ will decrease

C. both T and θ will remain the same

D. both T and θ will decrease

Answer: C

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Evaluation Iv Numerical Problems

1. A bar magnet having a magnetic moment $\vec{M}$ is cut into four pieces i.e., first cut in two pieces along the axis of the magnet and each piece is further cut into two pieces. Compute the magnetic moment of each piece.

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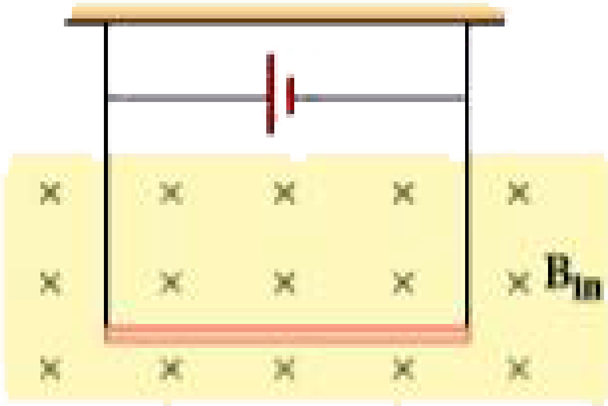
2. A conductor of linear mass density $0.2gm^{-1}$ suspended by two flexible wire as shown in figure. Suppose the tension in the supporting wires is zero when it is kept inside the magnetic field of 1 T whose direction is into the page. Compute the current inside the conductor and also the direction of the current. Assume $g = 10ms^{-2}$



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3. A circular coil with cross-sectional area $0.1cm^2$ is kept in a uniform magnetic field of strength 0.2 T. If the current passing in the coil is 3 A and plane of the loop is perpendicular to the direction of magnetic field. Calculate total torque on the coil

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4. A circular coil with cross-sectional area $0.1cm^2$ is kept in a uniform magnetic field of strength 0.2 T. If the current passing in the coil is 3 A and plane of the loop is perpendicular to the direction of magnetic field. Calculate total force on the coil

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5. A circular coil with cross-sectional area $0.1 cm^2$ is kept in a uniform magnetic field of strength 0.2 T. If the current passing in the coil is 3 A and plane of the loop is erpendicular to the direction of magnetic field. Calculate average force on each electron in the coil due to the magnetic field of the free electron density for the material of the wire is $10^{28} m^{-3}$.

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6. A bar magnet is placed in a uniform magnetic field whose strength is 0.8 T. Suppose the bar magnet orient at an angle 30° with the external field experiences a torque of 0.2 N m. Calculate:

the magnetic moment of the magnet

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7. A bar magnet is placed in a uniform magnetic field whose strength is 0.8 T. Suppose the bar magnet orient at an angle

30° with the external field experiences a torque of 0.2 N m. Calculate:

the work done by an applied force in moving it from most stable configuration to the most unstable configuration and also compute the work done by the applied magnetic field in this case.

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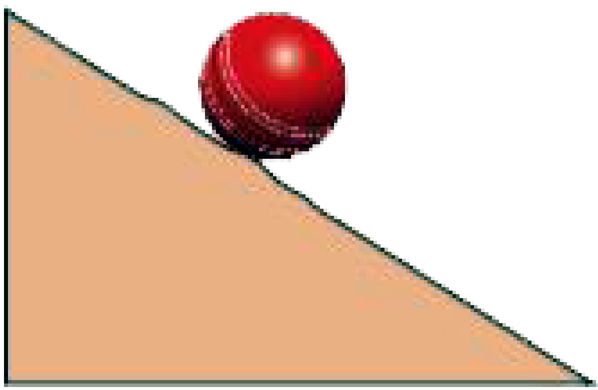
8. A non - conducting sphere has a mass of 100 g and radius 20 cm. A flat compact coil of wire with turns 5 is wrapped tightly around it with each turns concentric with the sphere. This sphere is placed on an inclined plane such that plane of coil is parallel to the inclined plane. A uniform magnetic field of 0.5 T exists in the region in vertically upward direction. Compute the current I required to rest the sphere in equilibrium.



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9. Calculate the magnetic field at the center of a square loop which carries a current of 1.5 A, length of each loop is 50 cm.

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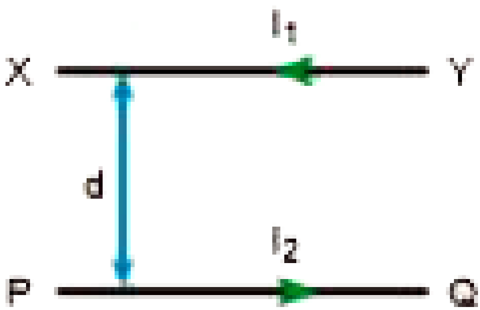
10. Let I_1 and I_2 be the steady currents passing through a long horizontal wire XY and PQ respectively. The wire PQ is fixed in horizontal plane and the wire XY be is allowed to move freely in a vertical plane. Let the wire XY is in equilibrium at a height d over the parallel wire PQ as shown in figure.



Show that if the wire XY is slightly displaced and released, it executes Simple Harmonic Motion (SHM). Also, compute the time period of oscillations.

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