DPP – 6 (Magnetic Field & Force)

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Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/51

Q 1. A nonconducting disc of radius R is rotating about an axis passing through its centre and perpendicular to its plane with an angular velocity ω. Charge q is uniformly distributed over its surface. The magnetic moment of the disc is:

(a) $\frac{1}{4}q\omega R^2$ (b) $\frac{1}{2}q\omega R$ (c) qωR (d) $\frac{1}{2}q\omega R^2$

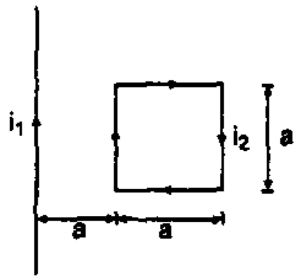
Q 2. A wire of length l is bent in the form of a circular coil of some turns. A current i flows through the coil. The coil is placed in a uniform magnetic field B. The maximum torque on the coil can be:

(a) $\frac{iBl^2}{4\pi}$ (b) $\frac{iBl^2}{\pi}$ (c) $\frac{iBl^2}{2\pi}$ (d) $\frac{2iBl^2}{\pi}$

Q 3. A rigid circular loop of radius r and mass m lies in the x-y plane on a flat table and has a current i flowing in it. At this particular place, the earth's magnetic field is $\vec{B} = B_x\hat{\imath} + B_z\hat{k}$. The value of i so that one edge of the loop lifts from the table is :

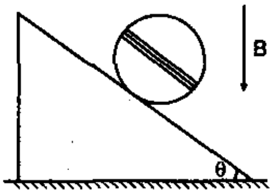
(a) $\frac{mg}{\pi r\sqrt{B_x^2+B_z^2}}$ (b) $\frac{mg}{\pi r B_z}$ (c) $\frac{mg}{\pi r B_x}$ (d) $\frac{mg}{\pi r\sqrt{B_x B_z}}$

Q 4. A current carrying square bop is placed near an Infinitely long current carrying wire as shown in figure. The torque acting on the loop is:



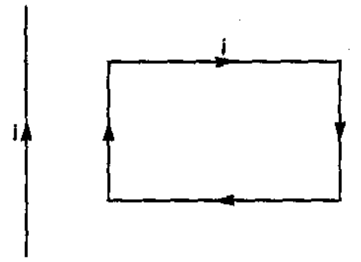
(a) $\frac{\mu_0}{2\pi}\left(\frac{i_1 i_2 a}{2}\right)$ (b) $\frac{\mu_0 i_1 i_2 a}{2\pi}$ (c) $\frac{\mu_0 i_1 i_2 a}{2\pi}$ In (2) (d) zero

Q 5. In the figure shown a coil of single turn is wound on a sphere of radius R and mass m. The plane of the coil is parallel to the plane and lies in the equatorial plane of the sphere. Current in the coil is i. The value of B if the sphere is in equilibrium is



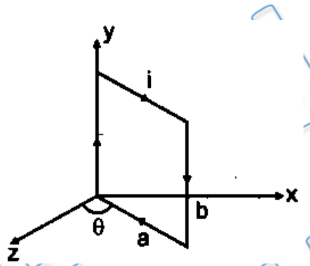
(a) $\frac{mg\cos\theta}{\pi iR}$ (b) $\frac{mg}{\pi iR}$ (c) $\frac{mg\tan\theta}{\pi iR}$ (d) $\frac{mg\sin\theta}{\pi iR}$

Q 6. A rectangular loop carrying a current i is situated near a long straight wire such that the wire is parallel to one of the sides of the loop and is in the plane of the loop. If steady current I is established In the wire as shown in the figure, the loop will:



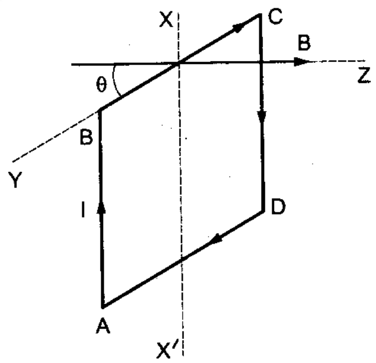
(a) rotate about an axis parallel to the wire
(b) move away from the wire
(c) move towards the wire
(d) remain stationary

Q 7. A rectangular loop (a x b) carries a current i. A uniform magnetic field $\vec{B} = B_0\hat{\imath}$ exists in space. Then :



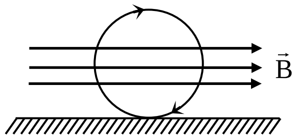
(a) torque on the loop is iab B_0 sin θ
(b) torque on the loop is in negative y-direction
(c) if allowed to move the loop turn so as to increase θ
(d) if allowed to move the loop turn so as to decrease θ

Q 8. The square loop ABCD, carrying a current I, is placed in a uniform magnetic field B, as shown. The loop can rotate about the axis XX'. The plane of the loop makes an angle θ (θ < 90°) with the direction of B. Through what angle will the loop rotate by itself before the torque on it becomes zero?



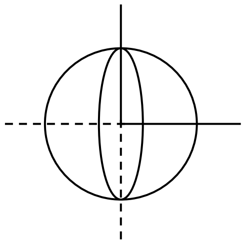
(a) θ (b) 90° – θ (c) 90° + θ (d) 180° – θ

Q 9. A conducting ring of mass 2 kg and radius 0.5 m is placed on a smooth horizontal plane. The ring carries a current i = 4A. A horizontal magnetic field B = 10 T is switched on at time t = 0 as shown in figure. The initial angular acceleration of the ring will be –



(a) 40 π rad/s^2 (b) 20 π rad/s^2
(c) 5 π rad/s^2 (d) 15 π rad/s^2

Q 10. Two insulated rings, one slightly smaller diameter than the other, are suspended along their diameter as shown, initially the planes of the rings are mutually perpendicular when a steady current is set up in each of them.



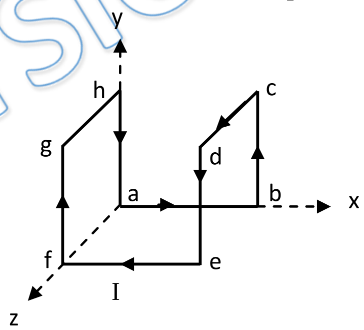
(a) The two rings rotate to come into a common plane
(b) The inner ring oscillates about its initially position
(c) The outer ring stays stationary while the inner one moves into the plane of the outer ring
(d) The inner ring stays stationary while the outer one moves into the plane of the inner ring

Q 11. A circular coil of radius R and a current I, which can rotate about a fixed axis passing through its diameter is initially placed such that its plane lies along magnetic field B. Kinetic energy of loop when it rotates through an angle 90° is : (Assume that I remains constant)

(a) π R^2BI (b) $\frac{\pi R^2 BI}{2}$ (c) 2πR^2BI (d) $\frac{3}{2}\pi R^2$I

Comprehension (Q.12 TO Q.14)

A current I amperes flows through a loop abcdefgha along the edge of a cube of width l metres as shown in figure. One corner 'a' of the loop lies at origin.



Q 12. This current path (abcdefgha) can be treated as a superposition of three square loops carrying current I. Choose the correct option?
(a) fghaf, fabef, ebcde (b) fghaf, fabef, fgdef
(c) fghaf, abcha, ebcde (d) fgdef, fabef, ebcde

Q 13. The unit vector in the direction of magnetic field at the the centre of cube abcdefgh of width l
(a) due to wire bcde is given by $\hat{\imath}$
(b) due to complete loop is given by -$\hat{\jmath}$
(c) due to ab and ef is given by $-\hat{\jmath}$

(d) due to ab and ef is given by $\hat{k}$

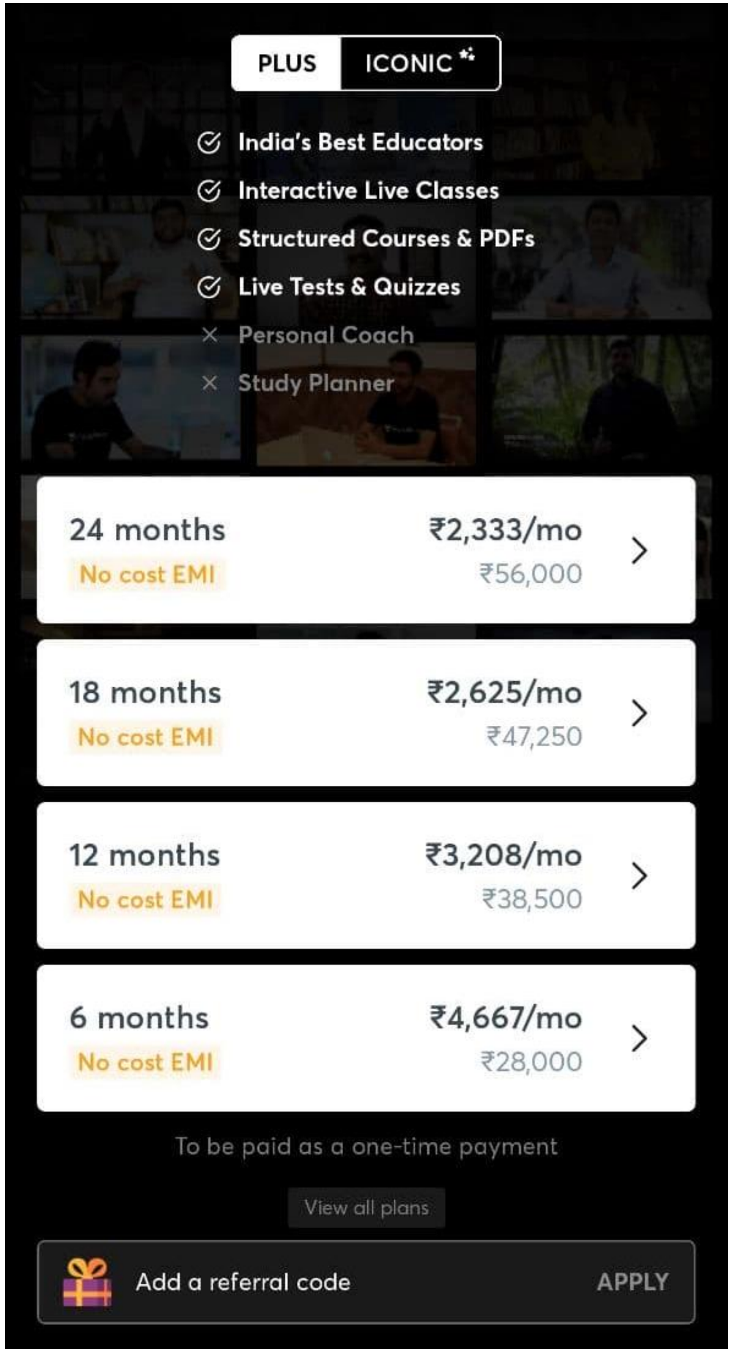
Q 14. Now if a uniform external magnetic field is $\vec{B} = \boldsymbol{B}_0\,\hat{j}$ is switched on, then the unit vector in the direction of torque due to external magnetic field ( ) acting on the current carrying loop (abcdefgha) is

(a) $\hat{k}$ (b) $-\hat{\imath}$

(c) $\frac{2\hat{\imath}-\hat{\jmath}}{\sqrt{5}}$ (d) none of these

Answer Key

Q.1 a	**Q.2 a**	**Q.3 c**	**Q.4 d**	**Q.5 b**
Q.6 c	**Q.7 a, b, d**	**Q.8 c**	**Q.9 a**	**Q.10 a**
Q.11 a	**Q.12 a**	**Q.13 b,c**	**Q.14 d**	



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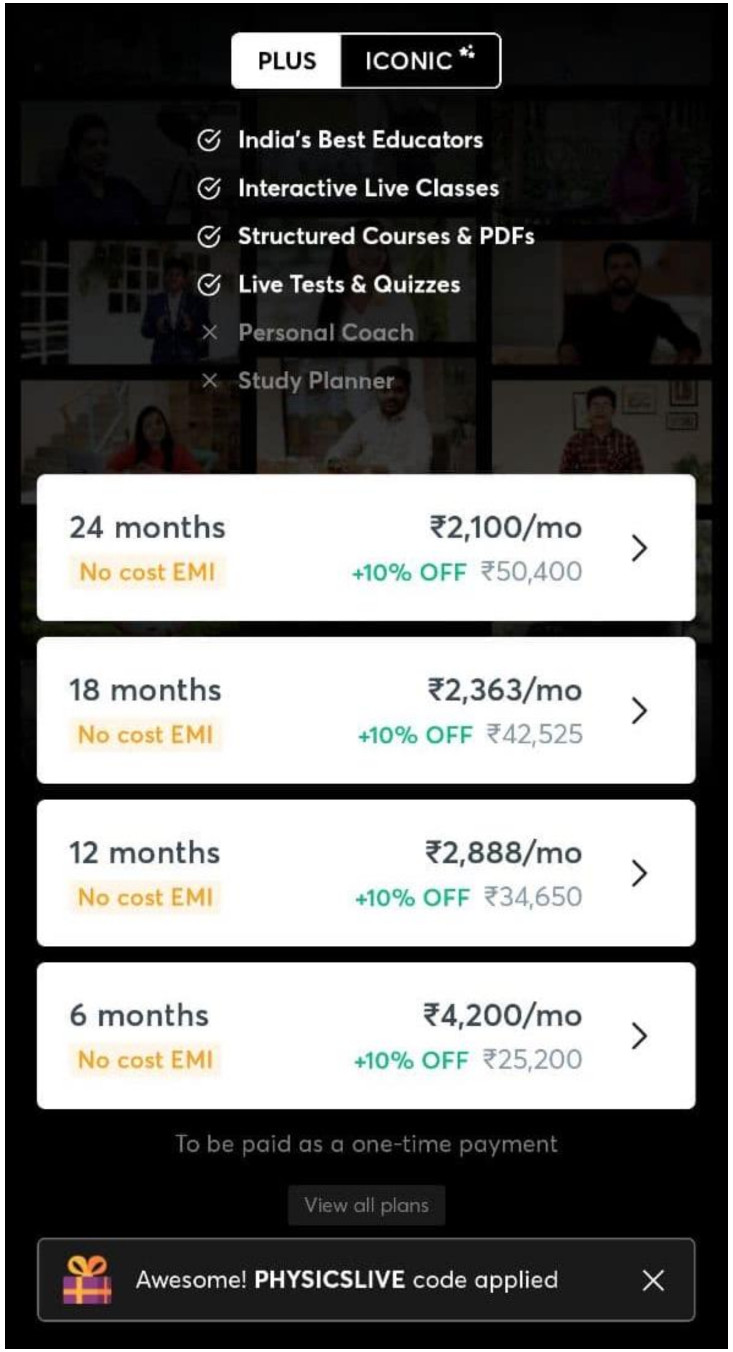
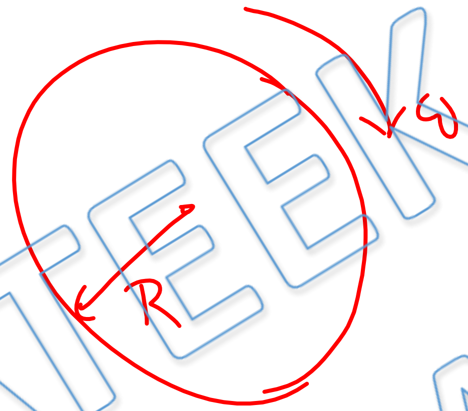


Written Solution

DPP-6 Magnetic Moment, Moving Coil Galvanometer

By Physicsaholics Team

Q.1) A nonconducting disc of radius R is rotating about an axis passing through its centre and perpendicular to its plane with an angular velocity ω. Charge q is uniformly distributed over its surface. The magnetic moment of the disc is:

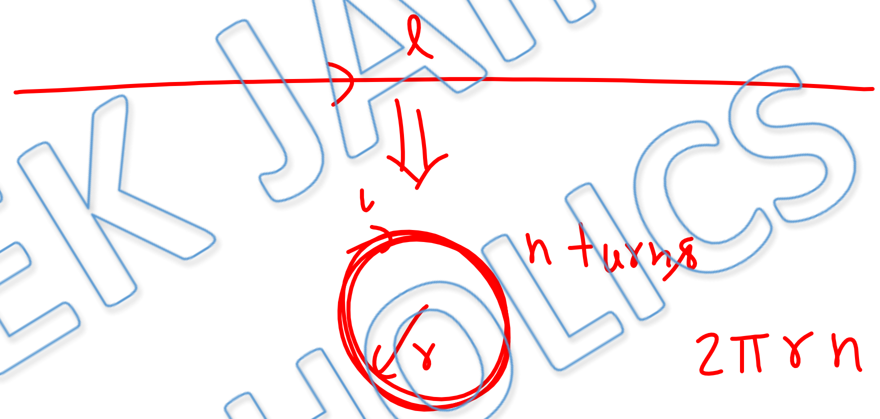


$$\frac{M}{L} = \frac{q}{2m}$$

$$M = \frac{q}{2m} \times \frac{mR^2}{2} \times \omega$$

(a) $\frac{1}{4} q\omega R^2$ (b) $\frac{1}{2} q\omega R$ (c) qωR (d) $\frac{1}{2} q\omega R^2$

Q.2) A wire of length l is bent in the form of a circular coil of some turns. A current i flows through the coil. The coil is placed in a uniform magnetic field B. The maximum torque on the coil can be:



$M = niA$

$= ni\pi\left(\frac{l}{2\pi n}\right)^2$

$M = \frac{il^2}{4\pi n}$

$2\pi r n = l$

$r = \frac{l}{2\pi n}$

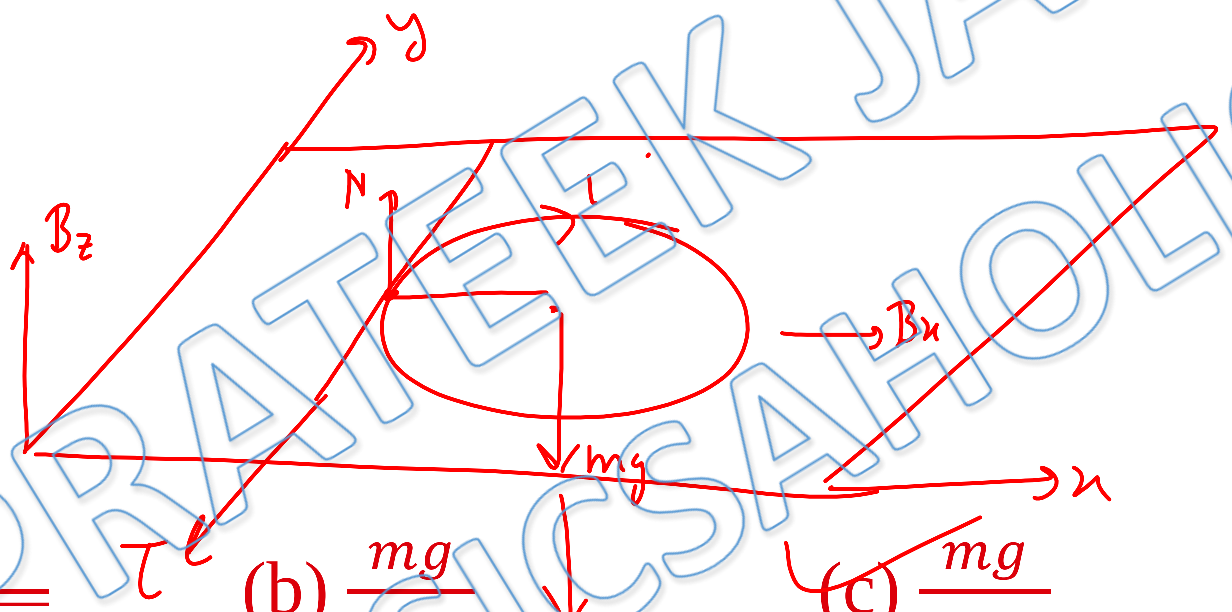
(a) $\frac{iBl^2}{4\pi}$ (b) $\frac{iBl^2}{\pi}$ (c) $\frac{iBl^2}{2\pi}$ (d) $\frac{2iBl^2}{\pi}$

$\tau = MB\sin\theta$

$\tau = \left(\frac{il^2}{4\pi n}\right)B\sin\theta$

$\tau_{max} = \frac{il^2 B}{4\pi}$

Q.3) A rigid circular loop of radius r and mass m lies in the x-y plane on a flat table and has a current i flowing in it. At this particular place, the earth's magnetic field is $\vec{B} = B_x\hat{\imath} + B_z\hat{k}$. The value of i so that one edge of the loop lifts from the table is :



$mgr = MB_x$

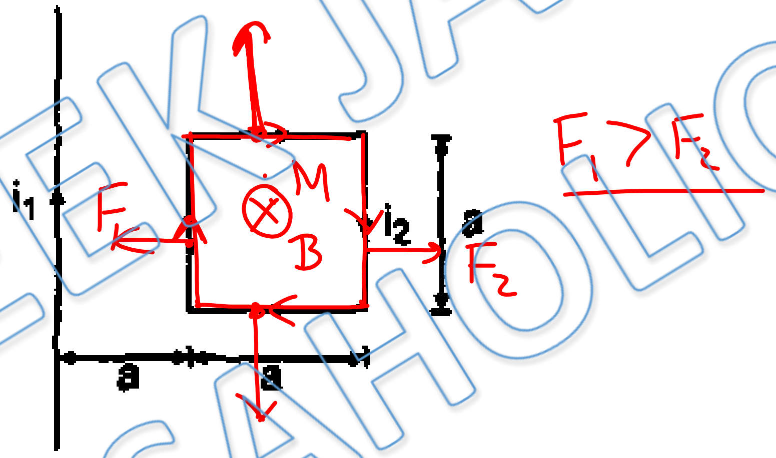
$mgr = i\pi r^2 B_x$

$i = \frac{mg}{r\pi B_x}$

$M = i\pi r^2$

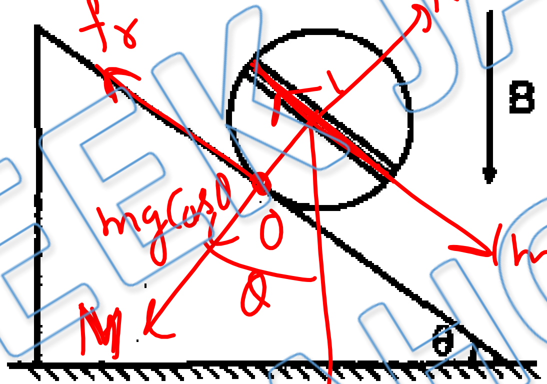
(a) $\frac{mg}{\pi r\sqrt{B_x^2+B_z^2}}$ (b) $\frac{mg}{\pi r B_z}$ (c) $\frac{mg}{\pi r B_x}$ (d) $\frac{mg}{\pi r\sqrt{B_x B_z}}$

Q.4) A current carrying square bop is placed near an Infinitely long current carrying wire as shown in figure. The torque acting on the loop is:



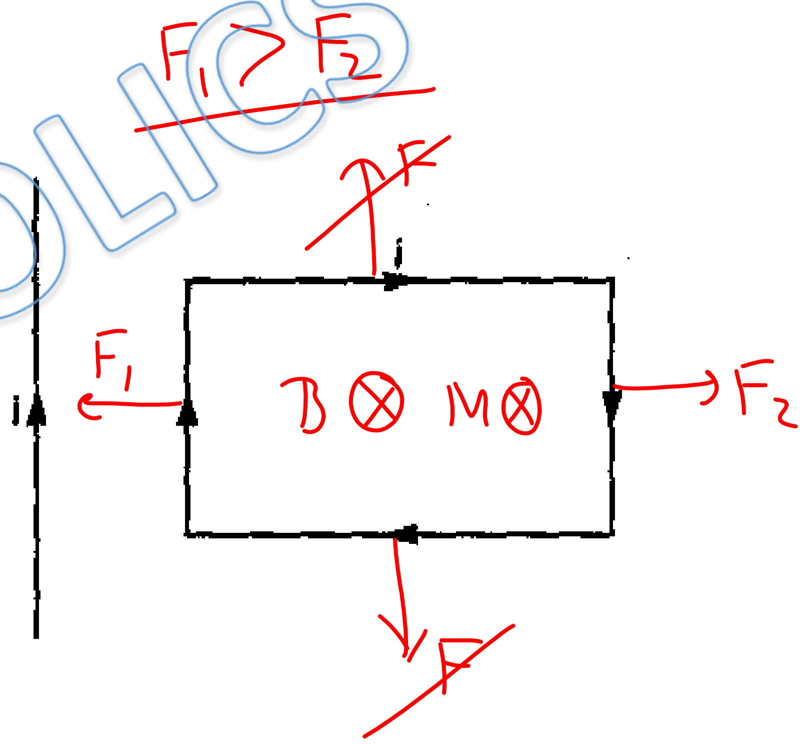
(a) $\frac{\mu_0}{2\pi}\left(\frac{i_1 i_2 a}{2}\right)$ (b) $\frac{\mu_0 i_1 i_2 a}{2\pi}$ (c) $\frac{\mu_0 i_1 i_2 a}{2\pi}$ In (2) (d) zero

Q.5) In the figure shown a coil of single turn is wound on a sphere of radius R and mass m. The plane of the coil is parallel to the plane and lies in the equatorial plane of the sphere. Current in the coil is i. The value of B if the sphere is in equilibrium is :



(a) $\frac{mg\cos\theta}{\pi iR}$ (b) $\frac{mg}{\pi iR}$ (c) $\frac{mg\tan\theta}{\pi iR}$ (d) $\frac{mg\sin\theta}{\pi iR}$

Q.6) A rectangular loop carrying a current i is situated near a long straight wire such that the wire is parallel to one of the sides of the loop and is in the plane of the loop. If steady current I is established In the wire as shown in the figure, the loop will:



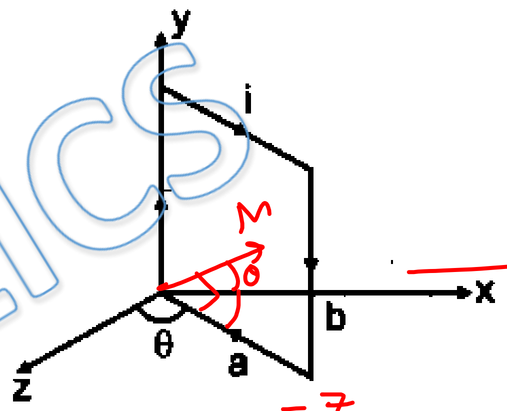
(a) rotate about an axis parallel to the wire

(b) move away from the wire

(c) move towards the wire

(d) remain stationary

Q.7) A rectangular loop (a x b) carries a current i. A uniform magnetic field $\vec{B} = B_0\hat{i}$ exists in space. Then :



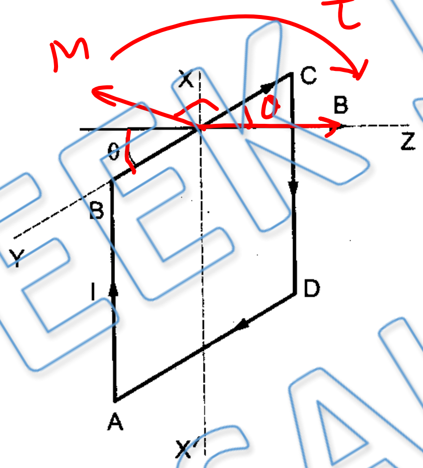
(a) torque on the loop is iab B_0 sin θ

(b) torque on the loop is in negative y-direction

(c) if allowed to move the loop turn so as to increase θ

(d) if allowed to move the loop turn so as to decrease θ

Q.8) The square loop ABCD, carrying a current I, is placed in a uniform magnetic field B, as shown. The loop can rotate about the axis XX'. The plane of the loop makes an angle θ (θ < 90°) with the direction of B. Through what angle will the loop rotate by itself before the torque on it becomes zero?



After rotation of angle $90+\theta$, $\vec{M} \parallel \vec{B}$

$\Rightarrow \tau = 0$

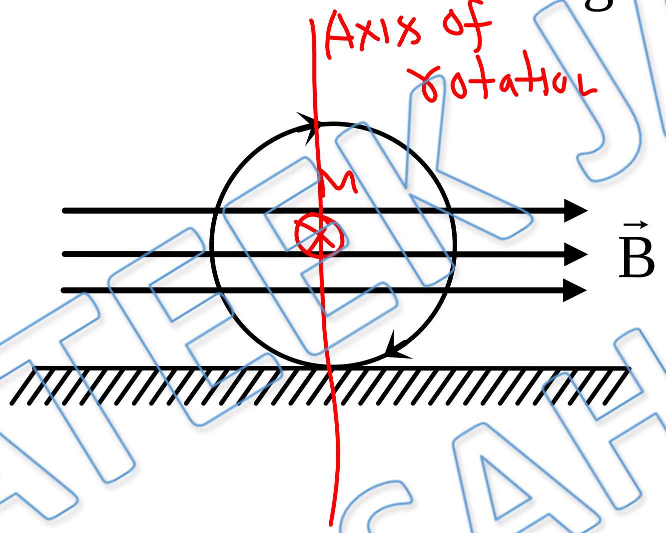
(a) θ

(b) 90° – θ

(c) 90° + θ

(d) 180° – θ

Q.9) A conducting ring of mass 2 kg and radius 0.5 m is placed on a smooth horizontal plane. The ring carries a current i = 4A. A horizontal magnetic field B = 10 T is switched on at time t = 0 as shown in figure. The initial angular acceleration of the ring will be –



(a) 40 π rad/s²

(b) 20 π rad/s²

(c) 5 π rad/s²

(d) 15 π rad/s²

$\tau = I\alpha$

$MB = \frac{mR^2}{2}\alpha$

$\alpha = \frac{2MB}{mR^2}$

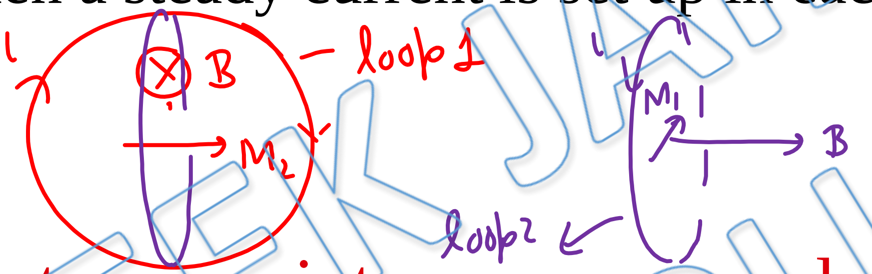
$= \frac{2 i \pi R^2 B}{m R^2}$

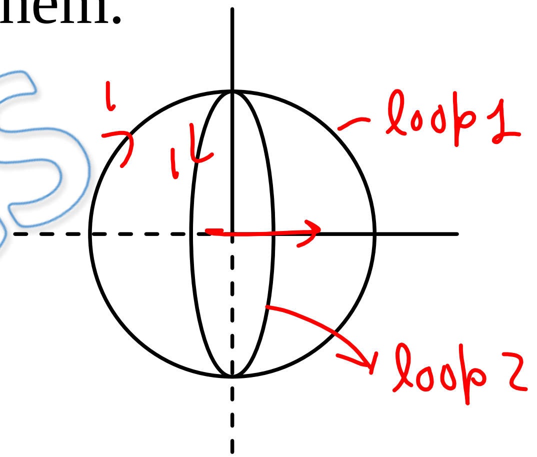
$= \frac{2 \times 4 \times \pi \times 10}{2}$

$= 40\pi$

Q.10) Two insulated rings, one slightly smaller diameter than the other, are suspended along their diameter as shown, initially the planes of the rings are mutually perpendicular when a steady current is set up in each of them.

τ will try to rotate M towards B





(a) The two rings rotate to come into a common plane

(b) The inner ring oscillates about its initially position

(c) The outer ring stays stationary while the inner one moves into the plane of the outer ring

(d) The inner ring stays stationary while the outer one moves into the plane of the inner ring

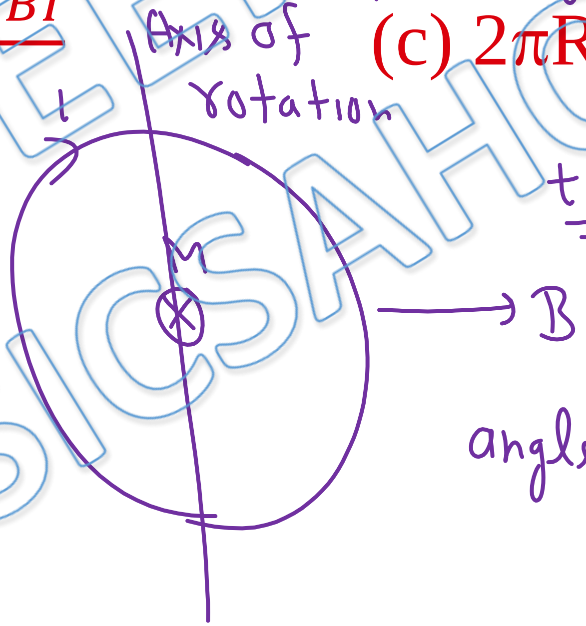
Q.11) A circular coil of radius R and a current I, which can rotate about a fixed axis passing through its diameter is initially placed such that its plane lies along magnetic field B. Kinetic energy of loop when it rotates through an angle 90° is : (Assume that I remains constant)

(a) $\pi R^2 BI$ (b) $\frac{\pi R^2 BI}{2}$ (c) $2\pi R^2 BI$ (d) $\frac{3}{2}\pi R^2 I$

$PE = -\vec{M}\cdot\vec{B}$

at $t=0$, $U_i = -MB\cos 90 = 0$

finally $U_f = -MB\cos 0 = -MB$



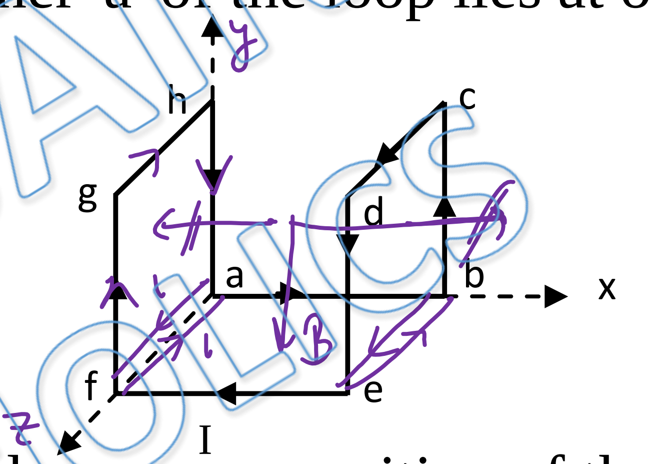
final KE = loss in PE = $MB = I\pi R^2 B$

angle b/w M & B = 90 at t=0

after rotating by 90 angle b/w $\vec{M}$ & $\vec{B}$ = 0

COMPREHENSION(Q.12 TO Q.14)

A current I amperes flows through a loop abcdefgha along the edge of a cube of width ℓ metres as shown in figure. One corner 'a' of the loop lies at origin.



Q.12) This current path (abcdefgha) can be treated as a superposition of three square loops carrying current I. Choose the correct option?

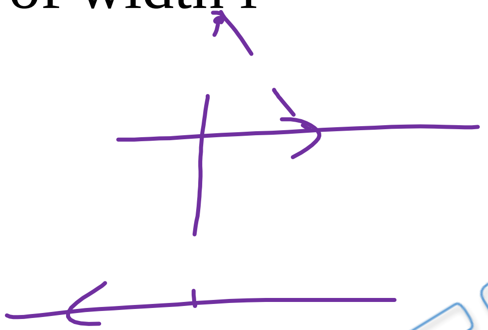
(a) fghaf, fabef, ebcde

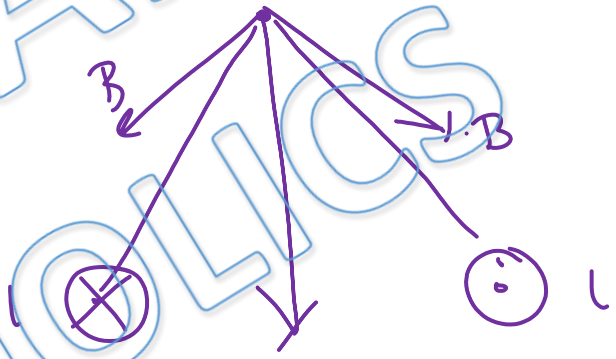
(b) fghaf, fabef, fgdef

(c) fghaf, abcha, ebcde

(d) fgdef, fabef, ebcde

Q.13) The unit vector in the direction of magnetic field at the the centre of cube abcdefgh of width l





(a) due to wire bcde is given by $\hat{\imath}$

(b) due to complete loop is given by $-\hat{\jmath}$

(c) due to ab and ef is given by $-\hat{\jmath}$

(d) due to ab and ef is given by $\hat{k}$

Q.14) Now if a uniform external magnetic field is $\vec{B} = \boldsymbol{B}_0\,\hat{j}$ is switched on, then the unit vector in the direction of torque due to external magnetic field ( ) acting on the current carrying loop (abcdefgha) is

$\vec{B} = B_0\hat{j}$

$\vec{M} = M_0(-\hat{j})$

(a) $\hat{k}$

(b) $-\hat{\imath}$

(c) $\frac{2\hat{\imath}-\hat{\jmath}}{\sqrt{5}}$

(d) none of these

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