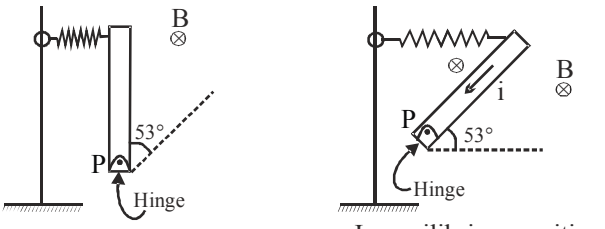
SECTION-I

Single Correct Answer Type 6 Q. [3 M (–1)]

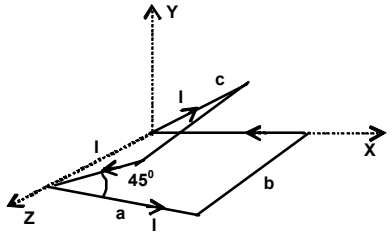
1. A thin uniform rod with negligible mass and length ℓ is attached to the floor by a frictionless hinge at point P. A horizontal spring with force constant k connects the other end to wall. The rod is in a uniform magnetic field B directed into the plane of paper. What is extension in spring in equilibrium when a current *i* is passed through the rod in direction shown. Assuming spring to be in natural length initially.



Spring in relaxed position In equilibrium position

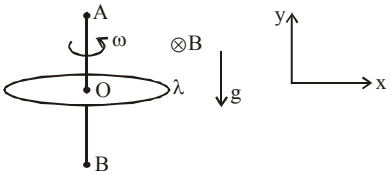
(A) $\frac{5i\ell B}{8k}$ (B) $\frac{3i\ell B}{8k}$ (C) $\frac{5i\ell B}{4k}$ (D) $\frac{5i\ell B}{6k}$

2. Find the magnetic dipole moment of the rectangular loop shown in the figure. Sides, a = 3m, b = 4m and c = 2m, current in the loop I = 1 Amp



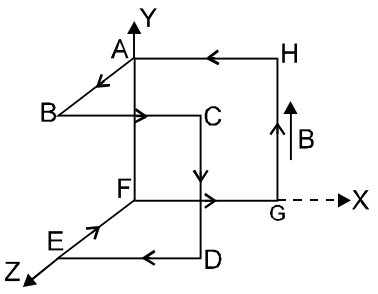
(A) 11.8 Am^2 (B) 15.8 Am^2 (C) 13.8 Am^2 (D) 12.8 Am^2

3. Diagram shows a charged disc rigidly fixed to a rotation axis AB (That passes through the centre of mass of disc and is perpendicular to the plane containing disc). Disc is set into rotation with constant angular speed 'ω' in a magnetic field as shown in the figure. Choose the INCORRECT statement :-



(A) Torque on disc due to reaction force of axis is along positive x-axis.
(B) Torque of magnetic field on the disc is same about any axis.
(C) Torque of gravity about the axis of rotation is non-zero.
(D) Net torque on disc is zero.

4. The given fig. shows a coil bent with AB = BC = CD = DE = EF = FG = GH = HA = 1 m and carrying current 1 A. There exists in space a vertical uniform magnetic field of 2 T in the y-direction. Then find out the torque (in vector form) on the loop.



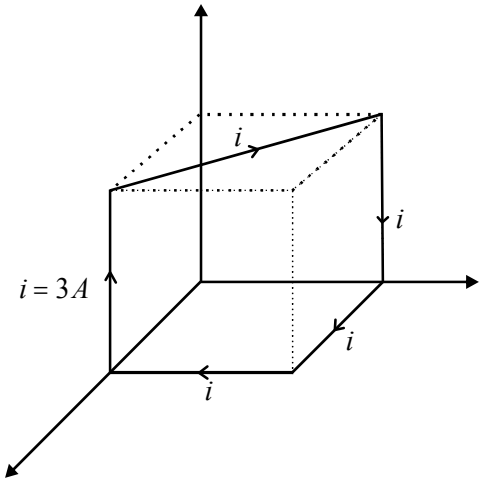
(A) $2\hat{k}$

(B) $-2\hat{k}$

(C) $2\hat{j}$

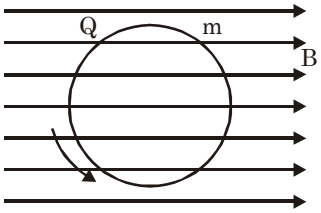
(D) $-2\hat{j}$

5. A wire carrying 3A current is wrapped around a non - conducting cube of side 1m as shown below. The magntidude of net magnetic moment due to the loop will be :-



(A) $\frac{9}{2}$ unit (B) $\frac{1}{\sqrt{3}}$ *unit* (C) 9 unit (D) None of these

6. A thin uniform ring of mass m and having electric charge Q uniformly distributed rotates around an axis perpendicular to its plane and going through its center. The angular momentum of the ring is 7.5×10^{-4} kg-m^2/s. The ring is in a homogeneous magnetic field of a field strength of 0.1 T and the lines of the magnetic induction are parallel with the plane of the ring. Torque exerted on the ring is ? [The specific charge (charge-mass ratio) of the ring is Q/m = 10^{-5} C/kg].



(A) 3.75×10^{-10} (N-m) upward along the plane
(B) 3.75×10^{-10} (N-m) downward along the plane
(C) 7.5×10^{-10} (N-m) upward along the plane
(D) none of these

Multiple Correct Answer Type 2 Q. [4 M (–1)]

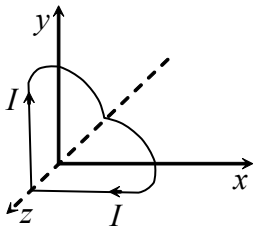
7. A circular current carrying loop of radius R is bent about its diameter by 90° and placed in a magnetic field $\vec{B} = B_0(\hat{i} + \hat{j})$ as shown in figure.

(A) The torque acting on the loop is zero

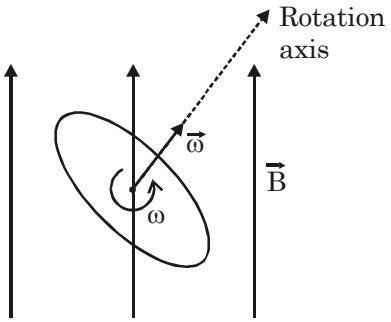
(B) The magnetic moment of the loop is $\frac{I\pi R^2}{2}\left(-\hat{i} - \hat{j}\right)$

(C) The angular acceleration of the loop is non zero.

(D) The magnetic moment of the loop is $\frac{I\pi R^2}{2}\left(-\hat{i} + \hat{j}\right)$



8. A uniform, thin, uniformly charged disk of mass m radius R and uniform surface charge density σ rotates with angular speed ω about an axis through its centre and perpendicular to disc. The disk is in region with a uniform magnetic field B that makes angle θ with rotation axis. Mark the **CORRECT** statement :-



(A) Torque exerted on the disk by magnetic field is $\frac{1}{4}\pi\sigma R^4\omega B\sin\theta$

(B) Ffrequency with which angular velocity vector rotates is given by $\frac{\pi\sigma R^2 B}{4m}\sin\theta$.

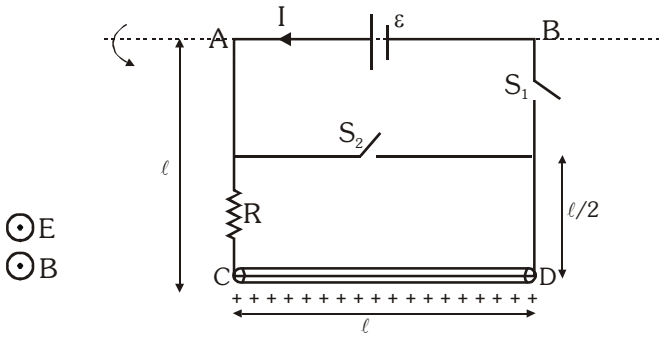
(C) For an observer looking from above the angular velocity vector begins to rotate anticlockwise sense.

(D) For an observer looking from above the angular velocity vector begins to rotate clockwise sense.

Linked Comprehension Type (1 Para × 3Q. & 1 Para × 2Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Questions no. 9 to 11

Consider the circuit shown with the two switches S_1 and S_2. The battery has an emf of e and the internal resistor has a resistance. The bottom wire is encased in an insulated wrapping of mass M which carries a positive static charge of Q. Assume that the masses of all other wires and components are very small as compared to this charge bearing wrapping. The dimensions of the circuit are ℓ. The bridge (or middle connecting) wire, with S_2 in it, is $\ell/2$ above the bottom wire. The device is suspended in such a way that it can rotate in vertical circle about axis AB. The circuit maintains its shape regardless of the switch configuration. A magnetic field B, and an electric field (E), both point out of the page, exist in the space. Magnetic interaction between wires of the circuit is negligible.



9. With both switches open, find the equilibrium angle θ that the plane of the circuit makes with the vertical as it swings upwards due to the presence of the electric field.

(A) $\tan^{-1}$ (QE/3Mg) (B) $\tan^{-1}$ (4QE/3Mg) (C) $\tan^{-1}$(QE/6Mg) (D) $\tan^{-1}$(QE/Mg)

10. With S_1 closed and S_2 open, find the equilibrium angle θ (assuming current through battery as I)

(A) $\tan^{-1}$ QE/(3Mg+ ILB) (B) $\tan^{-1}$ 4QE/(3Mg+ILB)

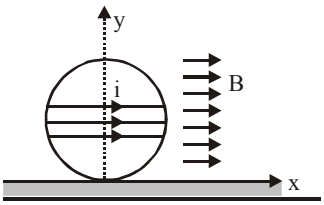
(C) $\tan^{-1}$ QE/(6Mg+ILB) (D) $\tan^{-1}$QE/(Mg+ILB)

11. With S_1 and S_2 both closed, magnetic force on the wire CD is (assuming current through battery as I)

(A) $IB\ell$ (B) $\frac{I}{2}B\ell$ (C) zero (D) $\frac{2}{3}IB\ell$

Paragraph for Question no. 12 and 13

A person wants to roll a solid non-conducting spherical ball of mass m and radius r on a surface whose coefficient of static friction is μ. He placed the ball on the surface wrapped with n turns of closely packed conducting coils of negligible mass at the diameter. By some arrangement he is able to pass a current i through the coils either in the clockwise direction or in the anticlockwise direction. A constant horizontal magnetic field $\vec{B}$ is present throughout the space as shown in the figure. (Assume μ is large enough to help rolling motion)



12. If current i is passed through the coils the maximum torque in the coil is :-

(A) $-\pi nir^2B\hat{k}$ (B) $\pi nir^2B\hat{j}$ (C) $-\pi nir^2B\hat{j}$ (D) $\pi nir^2B\hat{k}$

13. The angular velocity of the ball when it has rotated through an angle θ is ($\theta < 180°$) is :-

(A) $\sqrt{\frac{10}{7}\frac{\pi niB}{m}\sin\theta}$ (B) $\sqrt{\frac{5}{14}\frac{\pi niB}{m}\sin\theta}$ (C) $\sqrt{\frac{5}{14}\frac{\pi niB}{m}\cos\theta}$ (D) $\sqrt{\frac{5}{7}\frac{\pi niB}{m}\sin\theta}$

SECTION-II

Numerical Answer Type Question 1 Q. [3(0)]

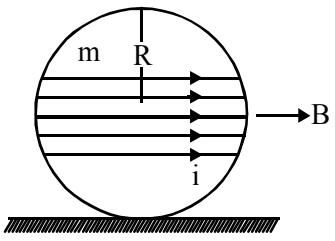
(upto second decimal place)

1. Two coaxial long solenoids having number of turns 3000 & 1500 per metre, radii 2.0 m & 1.0 m and carry current of 2A & 4A in opposite sense respectively. Find the magnetic energy stored per unit length (in J/m). [Take $\pi^2 = 10$]

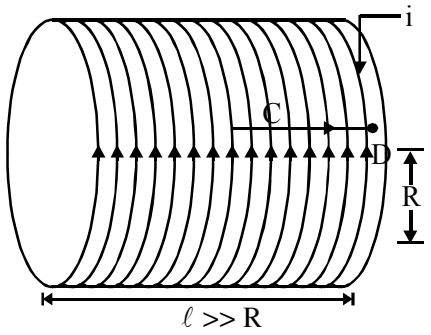
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 5 Q. [4 M (0)]

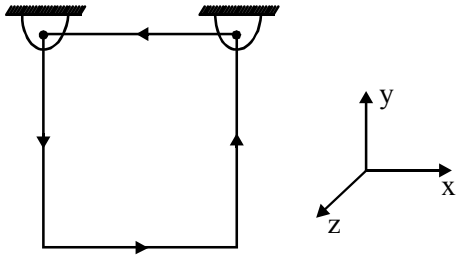
1. A wire is wrapped N = 10 times over a solid sphere of mass m = 5kg, current I = 2A, which is placed on a smooth horizontal surface. A horizontal magnetic field of induction $|\vec{B}| = 10T$ is present. Find the angular acceleration experienced by the sphere. Assume that the mass of the wire is negligible compared to the mass of the sphere. If answer is $20n\pi$. Write value of n.



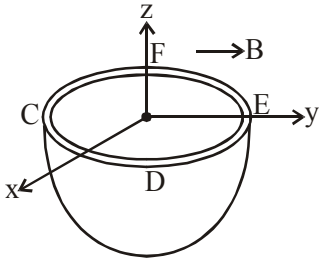
2. A small circular loop of radius a = 2cm carrying a current i_0 = 1A is placed co-axially with an ideal solenoid of radius R = 5cm, and current i = 1A flowing through its windings. Number of turns per unit length is n = 100. If the loop is displaced from the centre C of the solenoid to the end of the solenoid slowly by an external agent, find the magnitude of work done by the external agent. If answer is $x\left(\frac{\pi\mu_0 \times 10^{-2}}{3}\right)$ (in J) . Then the value of x is.



3. A current carrying uniform square frame is suspended from hinged supports as shown in the figure such that it can freely rotate about its upper side. The length and mass of each side of the frame is 2m and 4kg respectively. A uniform magnetic field $\vec{B} = \left(3\hat{i} + 4\hat{j}\right)$ is applied. When the wire frame is rotated to 45° from vertical and released it remains in equilibrium. If the magnitude of current (in A) in the wire frame is I then find $\left(\frac{3}{5}\right)$I .



4. A rigid circular massless frame carrying current of 6 A is fixed to a uniform nonconducting hemispherical shell of mass 3 kg and the system lies in a gravity free space. The wire frame lies in x-y plane and a uniform magnetic field (2 Tesla) is switched on along y-axis. If the angular acceleration (in rad/s^2) of the shell at this instant is x × π then find the value of x.

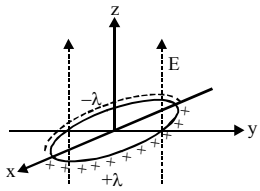
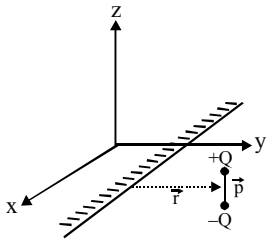
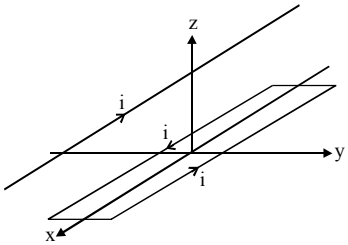
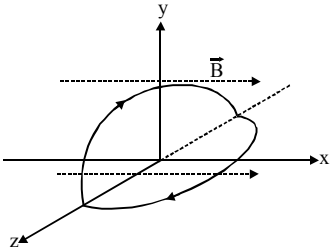


5. A long and thin metallic tube of radius $\frac{2}{\sqrt{\pi}}$ cm carries a current of 4000 A long its length. Calculate the magnetic pressure (in kPa) on the tube that tries to compress it.

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Column-I shows some charge distributions and current distributions accompanied by their descriptions. Column-II shows the instantaneous characteristics. Here **(S)** symbolizes the system on which results are to be obtained.

Column–I		**Column–II**	
(A)	 Circular ring (**S**) half positive and other half negative placed in a uniform electric field, with centre at origin.	(P)	Net force on **S** is zero
(B)	 Dipole (**S**) is placed infront of a long uniformly negatively charged wire parallel to x-axis, such that $\vec{p}$ is perpendicular to $\vec{r}$ and dipole is kept parallel to z-axis.	(Q)	Net force on **S** have no x-component
(C)	 A square current carrying coil (**S**) is placed in xy-plane with centre at origin and sides parallel to x-axis and y-axis, and a long wire placed parallel above square on z-axis and parallel to x-axis.	(R)	Net torque on **S** is along x-axis
(D)	 A circular current coil (**S**) with one half in yz-plane other half in xz-plane, placed in a uniform magnetic field in x-direction.	(S)	Net torque on **S** is zero
		(T)	Direction of magnetic dipole moment or electric dipole moment is in x-y plane.

CLASS TEST # 47 **ANSWER KEY**

SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

1. Ans. (A) **2. Ans. (A)** **3. Ans. (C)** **4. Ans. (A)**
5. Ans. (A) **6. Ans. (A)**

Multiple Correct Answer Type **2 Q. [4 M (–1)]**

7. Ans. (A,B) **8. Ans. (A, D)**

Linked Comprehension Type **(1 Para × 3Q. & 1 Para × 2Q.) [3 M (-1)]**
(Single Correct Answer Type)

9. Ans. (D) **10. Ans. (D)** **11. Ans. (C)** **12. Ans. (A)**
13. Ans. (A)

SECTION-II

Numerical Answer Type Question **1 Q. [3(0)]**
(upto second decimal place)

1. Ans. 216

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **5 Q. [4 M (0)]**

1. Ans. 5 **2. Ans. 6** **3. Ans. 6** **4. Ans. 6**
5. Ans. 2

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Ans. (A) → (P, Q, R, T) ; (B) → (Q, R) ; (C) → (Q, R) ; (D) → (P, Q, T)