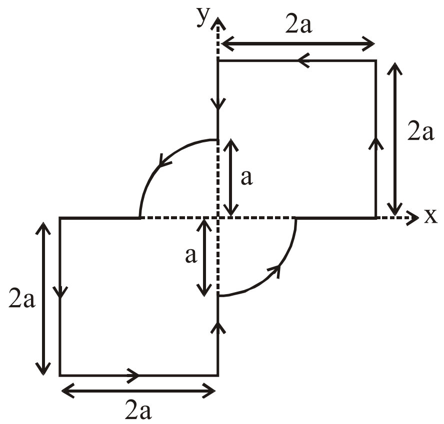
# CLASS TEST

PHYSICS | CLASS TEST # 51

## SECTION-I

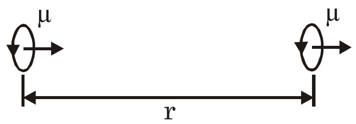
**Single Correct Answer Type** **7 Q. [3 M (–1)]**

**1.** A current 'I' flows through a thin wire as shown in the figure. If there exists an external magnetic field B in the same plane of the wire. The torque acting on the coil is :-




(A) $I\left(\frac{\pi a^2}{2}+8a^2\right)B$ (B) $I\left(\frac{\pi a^2}{2}+4a^2\right)B$ (C) $I\left(\pi a^2+8a^2\right)B$ (D) 0

**2.** Two-small magnetic dipole with the same magnetic moments $\mu$ are located at a distance r from each other. Determine force of their interaction.

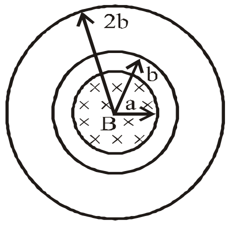



(A) $F=\frac{3\mu_o\mu^2}{2\pi r^4}$ (B) $F=\frac{\mu_o\mu^2}{\pi r^4}$ (C) $F=\frac{1\mu_o\mu^2}{2\pi r^4}$ (D) $F=\frac{\mu_o\mu^2}{2\pi r^4}$

**3.** A wire of radius R, carries current uniformly distributed over its cross section. The total current carried by the wire is I. The magnetic energy per unit length inside the wire is

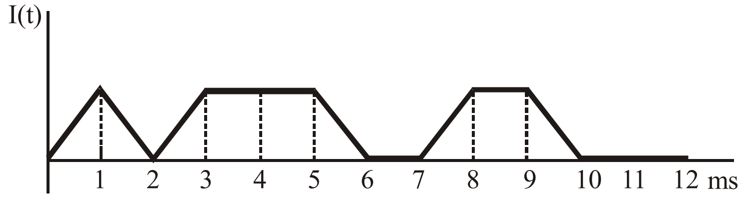
(A) $\frac{\mu_0 I^2}{4\pi}$ (B) $\frac{\mu_0 I^2}{8\pi}$ (C) $\frac{\mu_0 I^2}{2\pi}$ (D) $\frac{\mu_0 I^2}{16\pi}$

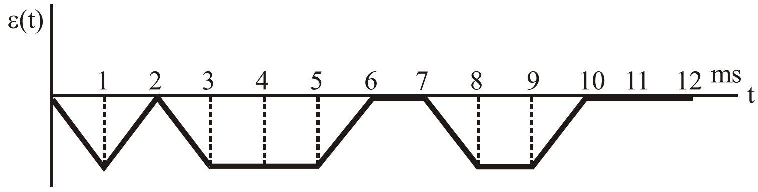
**4.** A uniform magnetic field B that is perpendicular to the plane of the page now passes through the loops, as shown. The field is confined to a region of radius a, where a < b, and is changing at a constant rate. The induced emf in the wire loop of radius b is ε. What is the induced emf in the wire loop of radius 2b :-

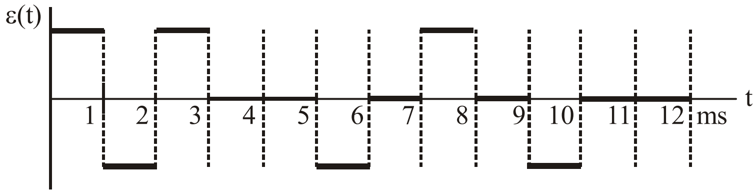


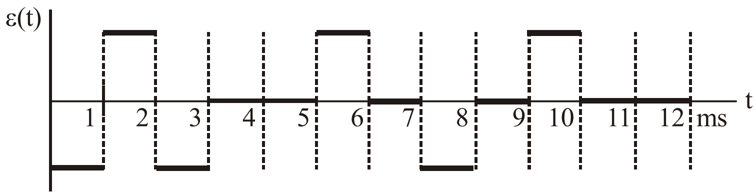

(A) 0 (B) ε/2 (C) ε (D) 2ε

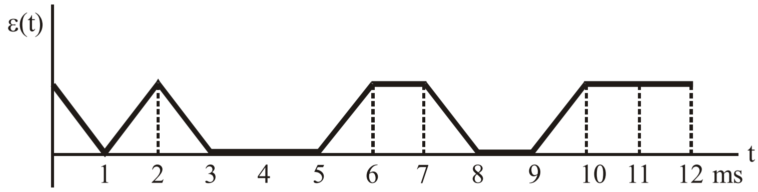
**5.** A spy taps the serial link between two computers by wrapping a small coil around the current-carrying wire connecting the computers. The current versus time for the transmission between the two computers is a signal as shown in figure. Then the sketch of the induced emf in the coil versus time as detected by the spy will be :-




(A)



(B)


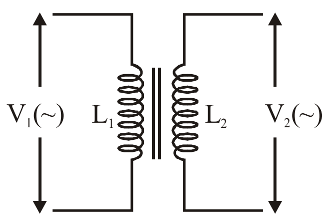

(C)



(D)



**6.** Consider a toroid of circular cross-section of radius b, major radius R much greater than minor radius b. Find the total energy stored in toroid. (I is current, N is total number of turns) :-

(A) $\dfrac{\mu_0 N^2 I^2 b^2}{2R}$ (B) $\dfrac{\mu_0 N^2 I^2 b^2}{3R}$ (C) $\dfrac{\mu_0 N^2 I^2 b^2}{6R}$ (D) $\dfrac{\mu_0 N^2 I^2 b^2}{4R}$

**7.** For an ideal transformer, ratio of $V_1$ & $V_2$ is equal to

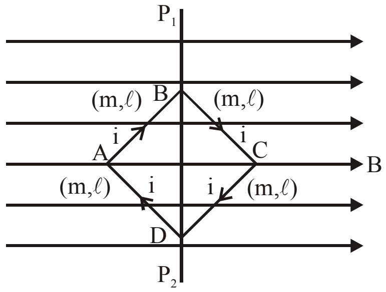



Where $L_1$ & $L_2$ are self inductances of primary and secondary windings. (For an ideal transformer coefficient of mutual induction for pair of coils is $M = \sqrt{L_1 L_2}$ ) :-

(A) $\dfrac{L_1}{L_2}$ (B) $\sqrt{\dfrac{L_1}{L_2}}$ (C) $\dfrac{L_2}{L_1}$ (D) $\sqrt{\dfrac{L_2}{L_1}}$

## Multiple Correct Answer Type 3 Q. [4 M (–1)]

**8.** Rod AB, BC, CD & DA form a square loop having current i, mass and length of each rod is m and $\ell$ respectively, is situated in a uniform magnetic field B as shown in the figure and it can rotate about axis $P_1P_2$, then



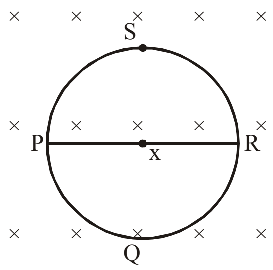

(A) Angular accelerati on of the square loop at t = 0, is $\frac{3}{2}\frac{Bi}{m}$

(B) Angular velocity when square loop rotated by 30°, is $\sqrt{\frac{3iB}{2m}}$

(C) Torque on the loop when it rotated by 60°, is $\frac{iB\ell^2}{2}$

(D) Angular acceleration of the square loop when it is rotated from starting to 90°, decreases

**9.** The radius of the circular loop is 'a'. Magnetic field is increasing at the constant rate $\alpha$. Magnetic field is confined to a cylindrical region and axis of magnetic field coincides with the axis of the loop. Resistance per unit length of the wire of loop is $\rho$. Choose the **CORRECT** option(s) :-



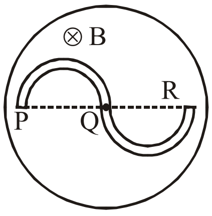

(A) Current in the loop PQRS is $\frac{a\alpha}{2\rho}$ anticlockwise

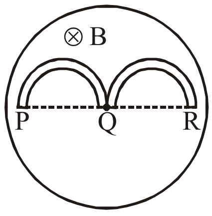
(B) Current in the loop PQRS in $\frac{a\alpha}{\rho}$ clockwise

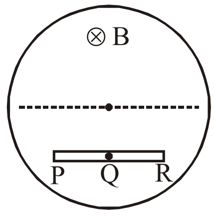
(C) Current in the wire PR is zero

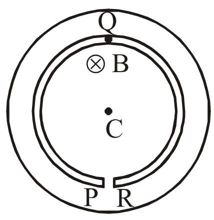
(D) Current in the wire PR is $\frac{\pi a\alpha}{2\rho}$

**10.** In each of the following diagrams, the magnetic field in the circular region is inside the plane of the paper and is increasing with time. Four different shaped metallic conductors 'PQR' are placed as shown. The end P will be more positively charged compared to R in : (Q is the centre in options AB).

(A) 

(B) 

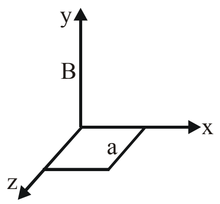
(C) 

(D) 

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

**Paragraph for Question 11 and 12**

A massless square loop of side a is kept in xz plane as shown. Magnetic field in space is non uniform given by $B = \frac{B_0 y}{a}\hat{k}$ . The loop is rotated about x-axis with constant angular velocity ω.




**11.** e.m.f. induced in the loop as function of time is equal to :-

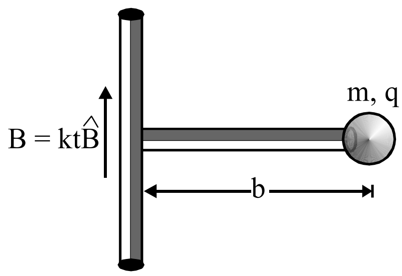
(A) $\frac{B_0 a^2}{2}\omega \sin 2\omega t$
(B) $\frac{B_0 a^2 \omega}{2}(1+\sin 2\omega t)$
(C) $2B_0 a^2 \omega \cos \omega t$
(D) $B_0 a^2 \omega \cos^2 \omega t$

**12.** Torque required to rotate the loop with constant angular velocity (as a function of time). Take resistance of loop = R.

(A) $\frac{B_0^2 a^4 \omega}{4R}(1+\sin 2\omega t)^2$
(B) $\frac{B_0^2 a^4 \omega}{4R}\sin^2 2\omega t$
(C) $\frac{4B_0^2 a^4 \omega}{R}\cos^2 \omega t$
(D) $\frac{B_0^2 a^4 \omega}{R}\cos^4 \omega t$

**Paragraph for Question Nos. 13 & 14**

In the figure a small dielectric body of mass m carries charge q. The body lies at the end of a rod of length b, having negligible mass. The other end of the rod is connected to a vertical shaft mounted on frictonless bearings so that the rod is perpendicular to the shaft and thus free to swing in a horizontal plane. At time t = 0, the rod is at rest, and a uniform magnetic field is turned on whose magnitude increases linearly with time : B = kt, where k is a constant. The direction of the field is parallel to the shaft.




**13.** What is the angular acceleration of the body about the shaft.

(A) $\alpha = \frac{qk}{2m}$ (B) $\alpha = \frac{2qk}{m}$ (C) $\alpha = \frac{qk}{m}$ (D) $\alpha = \frac{2qk}{3m}$

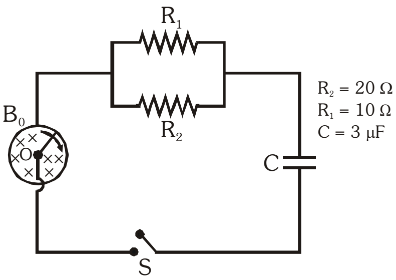
**14.** What is the speed v of the body as a function of time ?

(A) $v = \frac{2qkbt}{2m}$ (B) $v = \frac{qkbt}{2m}$ (C) $v = \frac{2qkbt}{m}$ (D) $v = \frac{2qkbt}{3m}$

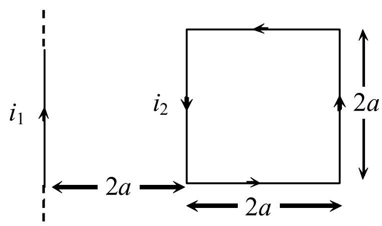
## SECTION-III

**Numerical Grid Type (Ranging from 0 to 9)** **6 Q. [4 M (0)]**

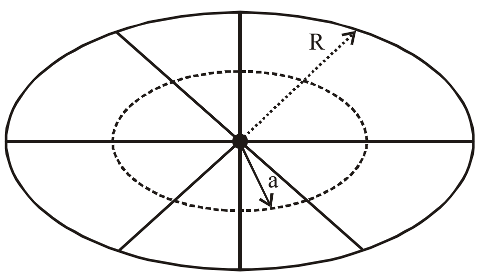
**1.** There is a metallic ring of radius 1m and having negligible resistance placed perpendicular to a constant magnetic field of magnitude 1T as shown in figure. One end of a resistanceless rod is hinged at the centre of ring O and other end is placed on the ring. Now rod is rotated with constant angular velocity 4 rad/s by some external agent and circuit is connected as shown in the figure, initially switch is open and capacitor is uncharged. If switch S is closed at t = 0, then calculate heat loss (in μJ) from the resistor $R_1$ from t = 0 to the instant when voltage across the capacitor becomes half of steady state voltage. (Assume plane of ring to be horizontal and friction to be absent at all the contacts).



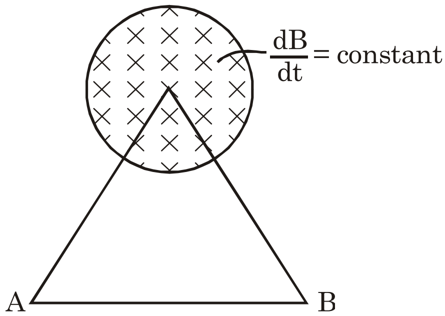

**2.** An infinitely long straight wire carries a current $i_1 = 1$ amp. A rectangular current loop placed in the same plane of shown dimensions carries a current $i_2 = 1$ amp anticlockwise. Magnitude of net force on the loop is found to be $\beta \frac{\mu_0}{4\pi}$. Find value of β.



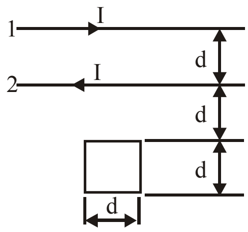

**3.** A line charge λ = $10^{-6}$ C/m is fixed on the rim of a wheel of radius 'R' = 1m which is then suspended horizontally, so that it is free to rotate (the spokes are made of wood). In the central region up to radius $a = \frac{1}{2}$ m there is uniform magnetic field, $|\vec{B}_0| = 1\text{T}$ pointing up. Now suddenly the field is turned off. If the moment of inertia (I) is = 0.25 kg/m², the final angular velocity 'ω' of the wheel is $n\pi \times 10^{-6}$ rad/s. Find n.



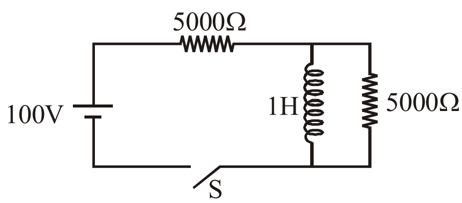
4. An uniform magnetic field is present in a cylindrical region as shown. This field is increasing uniformly with time. An equilateral loop is placed in such a way that its vertex coincide with centre of cylinderical region. Resistances of sides BC and CA are negligible whereas that of AB is $2\Omega$. If a current of magnitude 2A ampere flows int he triangular loop, due to induced emf, find potential difference between points A and B (in volt).




5. Two infinite parallel wires separated by a distance d carry equal currents I in opposite directions, with I increasing at the rate $\frac{dI}{dt} = 2A/s$. A square loop of wire of length d on a side lies in the plane of the wires at a distance $d = 2\pi$(m) from one of the parallel wires, as illustrated in figure. Find the emf induced (in V) in the square loop. If your answer is $n\mu_0 \ell n\frac{2}{3}$ write value of n.




6. Find the value of instantaneous power (in W) supplied by battery at the moment after the switch is closed.



**CLASS TEST # 51** **ANSWER KEY**

## SECTION-I

**Single Correct Answer Type** **7 Q. [3 M (–1)]**

| | | | |
|---|---|---|---|
| 1. Ans. (A) | 2. Ans. (A) | 3. Ans. (D) | 4. Ans. (C) |
| 5. Ans. (C) | 6. Ans. (D) | 7. Ans. (B) | |

**Multiple Correct Answer Type** **3 Q. [4 M (–1)]**

| | | |
|---|---|---|
| 8. Ans. (A,B,C,D) | 9. Ans. (A,C) | 10. Ans. (B, D) |

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

| | | | |
|---|---|---|---|
| 11. Ans. (A) | 12. Ans. (B) | 13. Ans. (A) | 14. Ans. (B) |

## SECTION-III

**Numerical Grid Type (Ranging from 0 to 9)** **6 Q. [4 M (0)]**

| | | | |
|---|---|---|---|
| 1. Ans. 3 | 2. Ans. 1 | 3. Ans. 1 | 4. Ans. 0 |
| 5. Ans. 4 | 6. Ans. 1 | | |