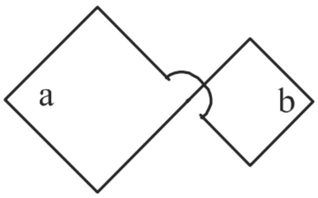
JEE 2023

Electromagnetic Induction

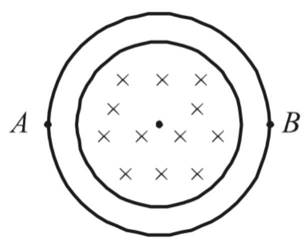
DPP-05

1. A plane loop, shaped as two squares of sides $a = 1\ m$ and $b = 0.4\ m$ is introduced into a uniform magnetic field $\perp$ to the plane of loop. The magnetic field varies as $B = 10^{-3}\sin(100t)T$. The amplitude of the current induced in the loop if its resistance per unit length is $r = 5 m\Omega m^{-1}$ is



(1) 2 A (2) 3 A
(3) 4 A (4) 5 A

2. A resistance less ring has 2 bulbs A and B rated at 2V, 10W and 2V, 20W respectively. The ring encloses an ideal solenoid whose magnetic field is as shown. The radius of solenoid is 1 m and the number of turns/length = 1000/m. The current changes at rate of 9 A/sec. Find the value of P if power dissipated in bulb B is $1.8P \times 10^{-4}$ watt.



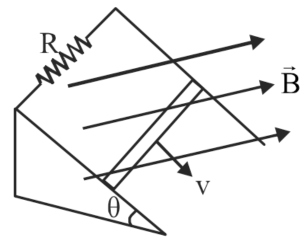
(1) 4 (2) 6
(3) 8 (4) 11

3. A rod PQ of length L moves with a uniform velocity v parallel to a long straight wire carrying a current i, the end P remaining at a distance r from the wire. The emf induced across the rod is

(1) $\frac{\mu_0 i v^2}{2\pi}\ell n\left(\frac{r+L}{r}\right)$ (2) $\frac{\mu_0 i^2 v^2}{2\pi}\ell n\left(\frac{r^2+L}{r}\right)$

(3) $\frac{\mu_0 i v}{2\pi}\ell n\left(\frac{r+L}{r}\right)$ (4) $\frac{\mu_0 i v}{2\pi}\ell n\left(\frac{r^2+L^2}{L^2}\right)$

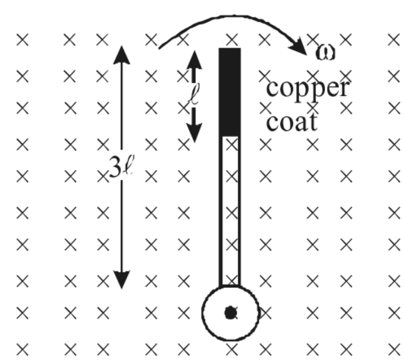
4. A conducting wire of mass m slides down two smooth conducting bars, set at an angle θ to the horizintal as shown in Fig. The separation between the bars is l. The system is located in the magnetic field B, perpendicular to the plane of the sliding wire and bars. The constant velocity of the wire is



(1) $\frac{mgR\sin\theta}{B^2 l^2}$ (2) $\frac{mgR\sin\theta}{Bl^3}$

(3) $\frac{mgR\sin\theta}{B^2 l^5}$ (4) $\frac{mgR\sin\theta}{Bl^4}$

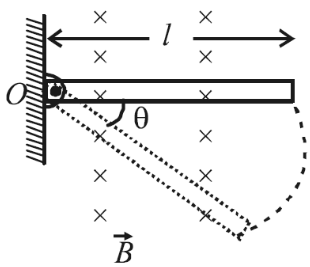
5. A wooden stick of length 3ℓ is rotated about an end with constant angular velocity ω in a uniform magnetic field B perpendicular to the plane of motion. If the upper one third of its length is coated with copper, the potential difference across the whole length of the stick is



(1) $\frac{9B\omega\ell^2}{2}$ (2) $\frac{4B\omega\ell^2}{2}$

(3) $\frac{5B\omega\ell^2}{2}$ (4) $\frac{B\omega\ell^2}{2}$

6. A conducting rod of length l is hinged at point O. It is free to rotate in vertical plane. There exists a uniform magnetic field $\vec{B}$ in horizontal direction. The rod is released from position shown in the figure. When rod makes an angle θ from released position then potential difference between two ends of the rod is proportional to:



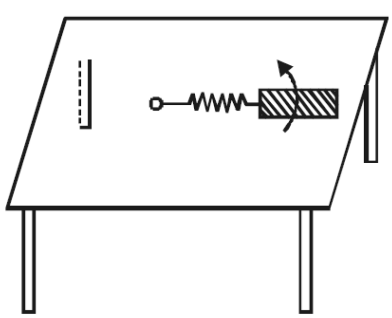
(1) $l^{1/2}$

(2) The lower end will be at a lower potential

(3) sin θ

(4) $(\sin\theta)^{1/2}$

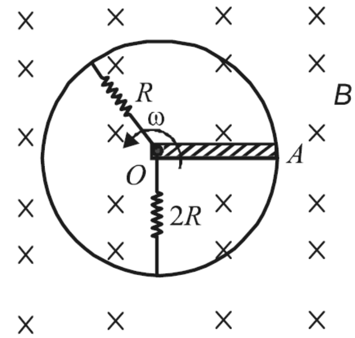
7. A metallic rod of length 'ℓ' is tied to a string of length 2ℓ and made to rotate with angular speed ω on a horizontal table with one end of the string fixed. If there is a vertical magnetic field 'B' in the region, the e.m.f. induced across the ends of the rod is



(1) $\frac{2B\omega\ell^2}{2}$ (2) $\frac{3B\omega\ell^2}{2}$

(3) $\frac{4B\omega\ell^2}{2}$ (4) $\frac{5B\omega\ell^2}{2}$

8. A rod OA of length l is rotating (about end O) over a conducting ring in crossed magnetic field B with constant angular velocity ω as shown in figure



(1) Current flowing through the rod is $\frac{B\omega\ell^2}{R}$

(2) Magnetic force acting on the rod is $\frac{3B^2\omega\ell^3}{4R}$

(3) Torque due to magnetic force acting on the rod is $\frac{3B^2\omega\ell^4}{8R}$

(4) Magnitude of external force that acts perpendicularly at the end of the rod to maintain the constant angular speed is $\frac{3B^2\omega\ell^3}{5R}$

9. Choose the correct statement about induced electric field.

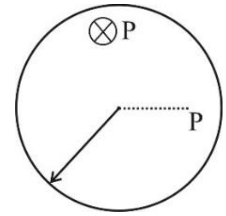
(1) One can define potential w.r.t. This induced field.

(2) The induced electric field is produced by only changing magnetic field & not by charges particles.

(3) The field lines can cross each other

(4) The field lines follow straight path.

10. A uniform magnetic field of induction B is confined in a cylindrical region of radius R. If the field is increasing at a constant rate of $\frac{dB}{Dt} = \alpha$ T/s , then intensity of electric field induced at point P, Distant r from axis as shown in figure is proportional to



(1) r^2 (2) r^3

(3) r (4) $r^{1/2}$

Answer Key

1. (2)
2. (1)
3. (3)
4. (1)
5. (3)
6. (4)
7. (4)
8. (2,3)
9. (2)
10. (3)