Electromagnetic Induction JEE Main PYQ - 3

Total Time: 1 Hour **Total Marks:** 100

Instructions

Instructions

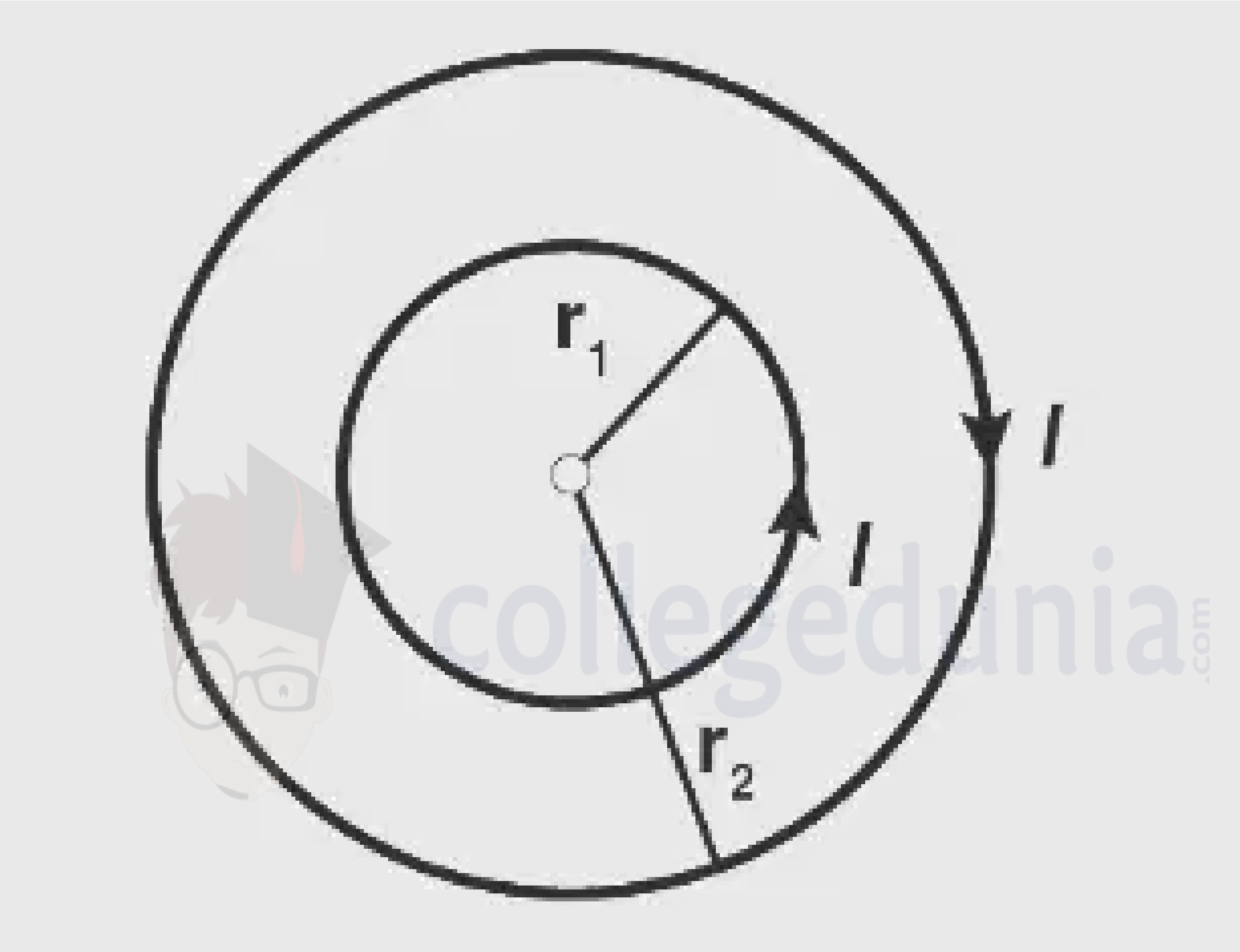
1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Electromagnetic Induction

1. Two concentric circular loops of radii $r_1 = 30$ cm and $r_2 = 50$ cm are placed in $X–Y$ plane as shown in the figure. A current $I = 7\ A$ is flowing through them in the direction as shown in figure. The net magnetic moment of this system of two circular loops is approximately **(+4, -1)**



a. $\frac{7}{2}\hat{k}\ Am^2$

b. $-\frac{7}{2}\hat{k}\ Am^2$

c. $7\hat{k}\ Am^2$

d. $-7\hat{k}\ Am^2$

---

2. The current in a coil of self inductance $2.0\ H$ is increasing according to $I = 2\ sin(t^2)\ A$. The amount of energy spent during the period when current changes from 0 to $2\ A$ is _______ J. **(+4, -1)**

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3. The magnetic moment of an electron (e) revolving in an orbit around nucleus with an orbital angular momentum is given by: **(+4, -1)**

a. $\vec{\mu L} = \frac{e\vec{L}}{2m}$

b. $\vec{\mu L} = -\frac{e\vec{L}}{2m}$

c. $\vec{\mu L} = -\frac{e\vec{L}}{m}$

d. $\vec{\mu L} = \frac{2e\vec{L}}{m}$

---

4. A metallic conductor of length 1 m rotates in a vertical plane parallel to east-west direction about one of its end with angular velocity 5 rad s^{-1}. If the horizontal component of earth's magnetic field is 0.2 × 10^{-4} T, then emf induced between the two ends of the conductor is: **(+4, -1)**

a. 5 μV

b. 50 μV

c. 5 mV

d. 50 mV

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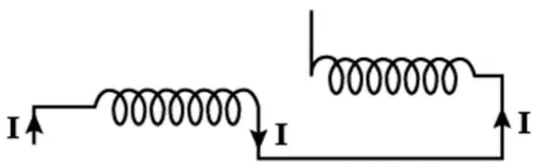
5. Two coils of self-inductance L_1 and L_2 are connected in series combination having mutual inductance of the coils as M. The equivalent self-inductance of the combination will be: **(+4, -1)**



a. $\frac{1}{L1} + \frac{1}{L2} + \frac{1}{M}$

b. $L_1 + L_2 + M$

c. $L_1 + L_2 + 2M$

d. $L_1 + L_2 - 2M$

6. The dimension of mutual inductance is : **(+4, -1)**

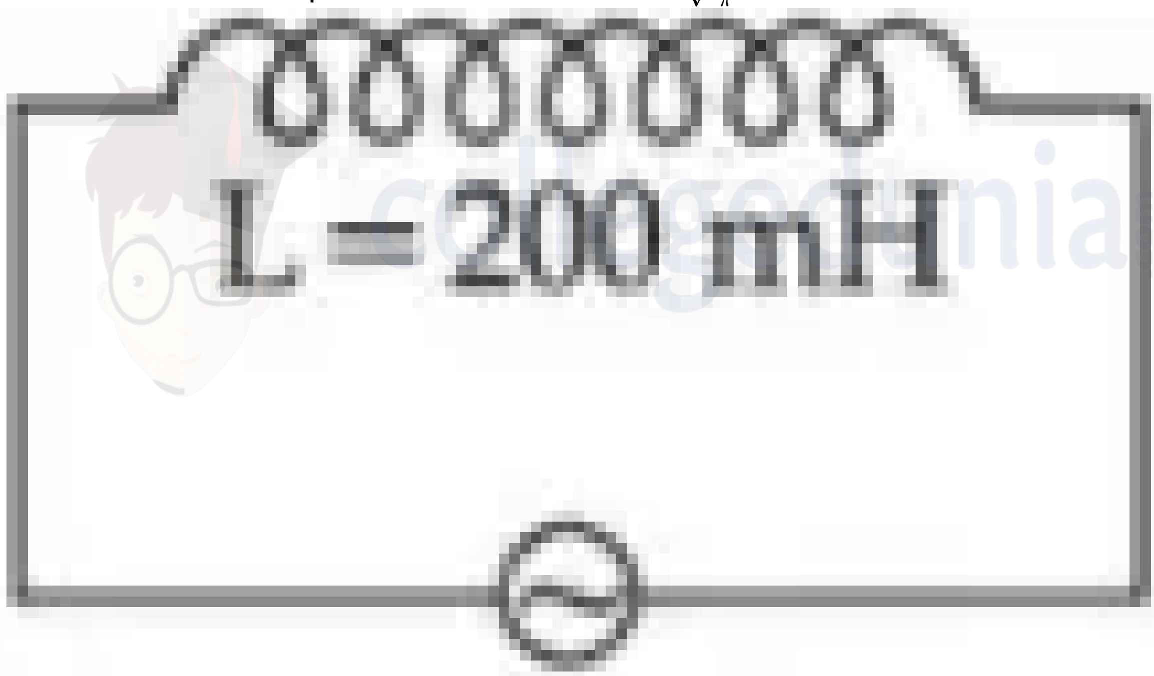
a. $[ML^2T^{-2}A^{-1}]$

b. $[ML^2T^{-3}A^{-1}]$

c. $[ML^2T^{-2}A^{-2}]$

d. $[ML^2T^{-3}A^{-2}]$

7. As shown in the figure an inductor of inductance 200 mH is connected to an AC source of emf 220 V and frequency 50 Hz. The instantaneous voltage of the source is 0 V when the peak value of current is $\sqrt{\frac{a}{\pi}}$.The value of a is ___ **(+4, -1)**



8. A resistance of 40 Ω is connected to a source of alternating current rated 220 V, 50 Hz. Find the time taken by the current to change from its maximum value to the rms value : **(+4, -1)**

a. 2.5 ms

b. 1.25 ms

c. 2.5 s

d. 0.25 s

---

9. The soft-iron is a suitable material for making an electromagnet. This is because soft-iron has (+4, -1)

a. Low coercivity and high retentivity

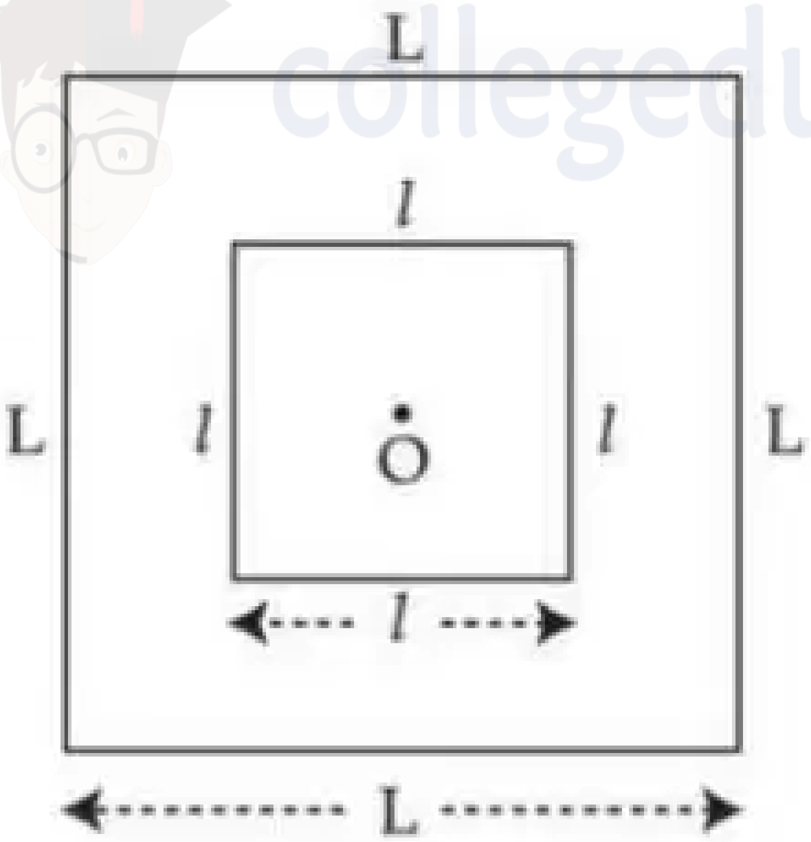
b. Low coercivity and low permeability

c. High permeability and low retentivity

d. High permeability and high retentivity

---

10. A small square loop of wire of side l is placed inside a large square loop of wire $L(L >> l)$ Both loops are coplanar and their centers coincide at point O as shown in figure The mutual inductance of the system is : (+4, -1)



a. $\frac{2\sqrt{2}\mu_0 L^2}{\pi \ell}$

b. $\frac{\mu_0 \ell^2}{2\sqrt{2}\pi L}$

c. $\frac{2\sqrt{2}\mu_0\ell^2}{\pi L}$

d. $\frac{\mu_0 L^2}{2\sqrt{2}\pi\ell}$

---

11. Variation of magnetic field through a coil of area 4 m^2 is shown in figure. What is the EMF induced in the coil (in mV)? **(+4, -1)**

a. 8

b. 16

c. 4

d. 2

---

12. A wire of length $1m$ moving with velocity $8m/s$ at right angles to a magnetic field of $2T$ The magnitude of induced emf, between the ends of wire will be ______ **(+4, -1)**

a. $20V$

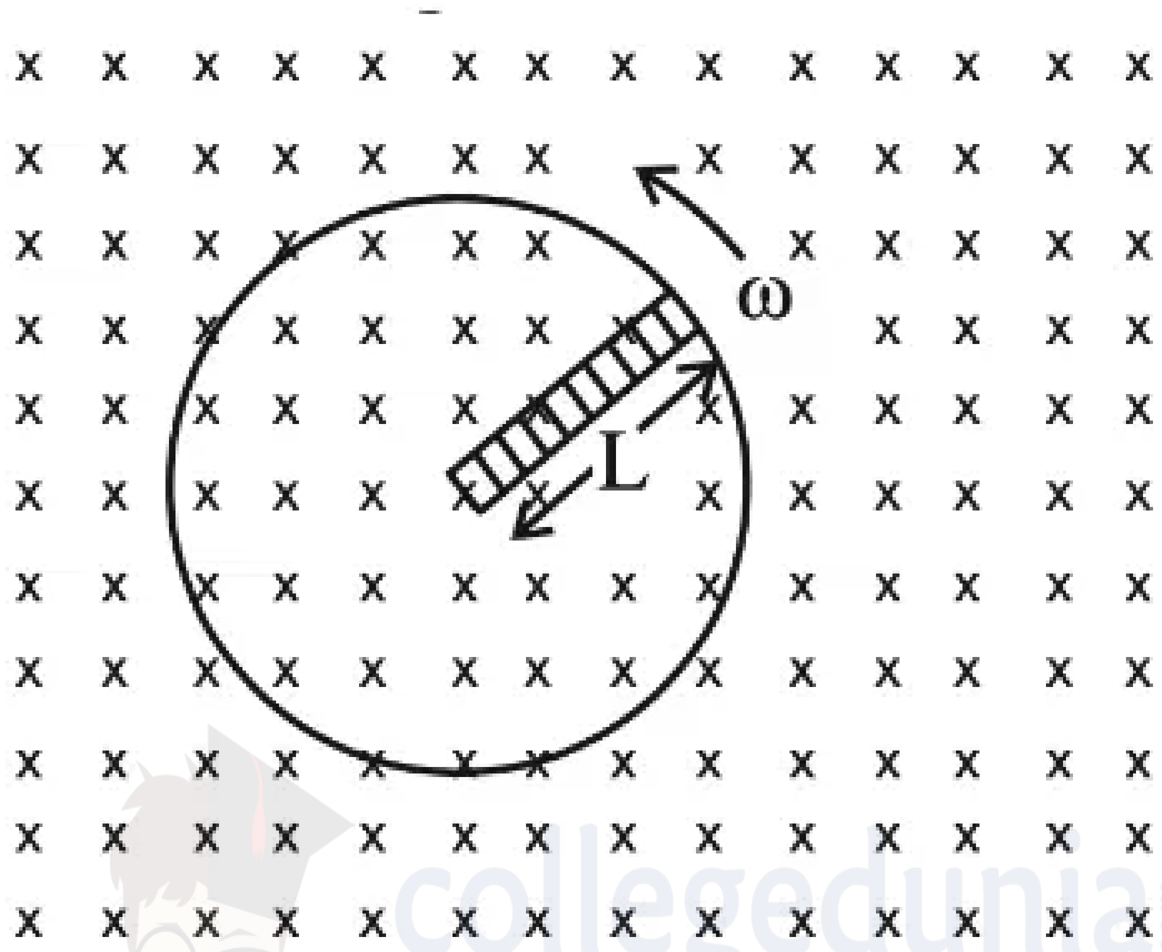
b. $16V$

c. $8V$

d. $12V$

---

13. A metallic rod of length ' L ' is rotated with an angular speed of ' ω ' normal to a uniform magnetic field ' B ' about an axis passing through one end of rod as shown in figure. The induced emf will be : **(+4, -1)**



a. $\frac{1}{2}B^2L^2\omega$

b. $\frac{1}{4}BL^2\omega$

c. $\frac{1}{2}BL^2\omega$

d. $\frac{1}{4}B^2L\omega$

---

14. Magnetic flux (in weber) in a closed circuit of resistance $20\,\Omega$ varies with time $t(s)$ as $\phi = 8t^2 - 9t + 5$. The magnitude of the induced current at $t = 0.25\,s$ will be ______ mA **(+4, -1)**

---

15. A square-shaped coil of area $70\,\text{cm}^2$ having 600 turns rotates in a magnetic field of $0.4\,\text{wbm}^{-2}$, about an axis which is parallel to one of the sides of the coil and perpendicular to the direction of the field. If the coil completes 500 revolutions **(+4, -1)**

in a minute, the instantaneous emf when the plane of the coil is inclined at 60° with the field, will be ________ V. (Take $\pi = \frac{22}{7}$)

16. A conducting circular loop of radius $\frac{10}{\sqrt{\pi}} cm$ is placed perpendicular to a uniform magnetic field of $0.5T$ The magnetic field is decreased to zero in $0.5s$ at a steady rate The induced emf in the circular loop at $0.25s$ is: **(+4, -1)**

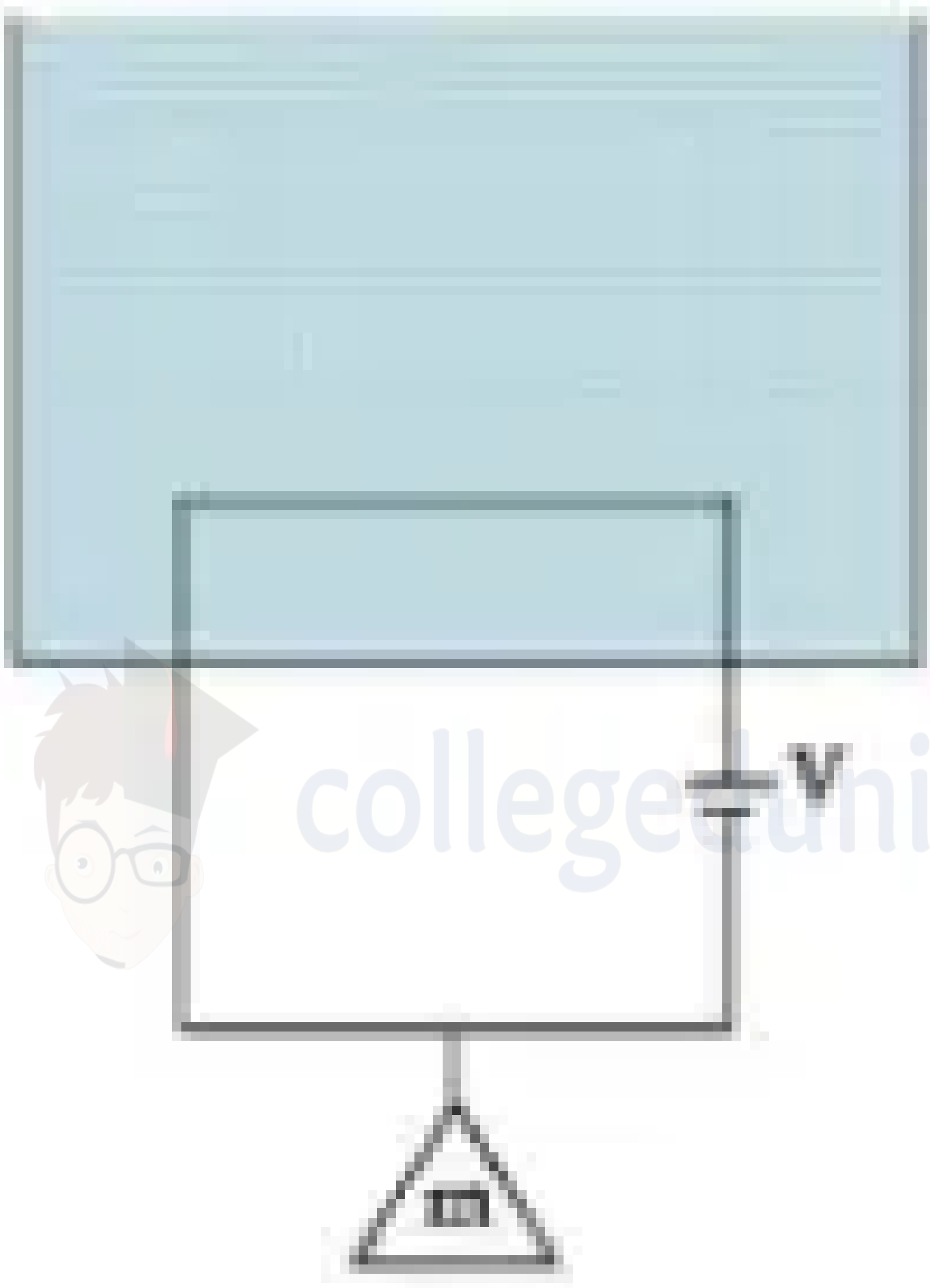
a. $emf = 1mV$

b. $emf = 100mV$

c. $emf = 5mV$

d. $emf = 10mV$

17. A massless square loop, of wire of resistance $10\,\Omega$, supporting a mass of $1\,g$, hangs vertically with one of its sides in a uniform magnetic field of $10^3 G$, directed outwards in the shaded region A de voltage V is applied to the loop For what value of V, the magnetic force will exactly balance the weight of the supporting mass of $1g$?(If sides of the loop $= 10\,cm, g = 10\,ms^{-2}$) **(+4, -1)**



a. $\frac{1}{10}V$

b. $1V$

c. $100V$ $

d. 10 V$

18. A rod with circular cross-section area $2\,cm^2$ and length $40cm$ is wound uniformly with 400 turns of an insulated wire If a current of 0.4 A flows in the wire windings, the total magnetic flux produced inside windings is $4\pi \times 10^{-6}\,Wb$ The relative permeability of the rod is(Given : Permeability of vacuum $\mu_0 = 4\pi \times 10^{-7}\,NA^{-2}$) **(+4, -1)**

a. 125

b. 12.5

c. $\frac{5}{16}$

d. $\frac{32}{5}$

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19. A coil of inductance 8.4 mH and resistance 6 Ω is connected to a 12 V battery. The current in coil is 1 A at approximately the time **(+4, -1)**

a. (A) 500 s

b. (B) 20 s

c. (C) 35 ms

d. (D) 1 ms

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20. The figure shows a square loop L of side $5\,cm$ which is connected to a network of resistances. The whole setup is moving towards right with a constant speed of $1\,cms^{-1}$. At some instant, a part of L is in a uniform magnetic field of $1T$, perpendicular to the plane of the loop. If the resistance of L is $1.7\,\Omega$, the current in the loop at that instant will be close to : **(+4, -1)**

a. $115\,\mu A$

b. $170\,\mu A$

c. $60\,\mu A$

d. $150\,\mu A$

---

21. When current in a coil changes from $5\,A$ to $2\,A$ in $0.1\,s$, an average voltage of $50\,V$ is produced. The self - inductance of the coil is : **(+4, -1)**

a. 0.67 H

b. 1.67 H

c. 3 H

d. 6 H

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22. In a coil of resistance $100\,\Omega$, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is : **(+4, -1)**

a. 200 Wb

b. 225 Wb

c. 250 Wb

d. 275 Wb

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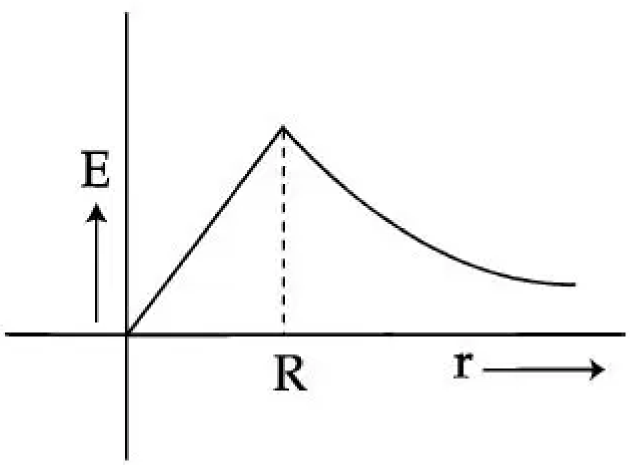
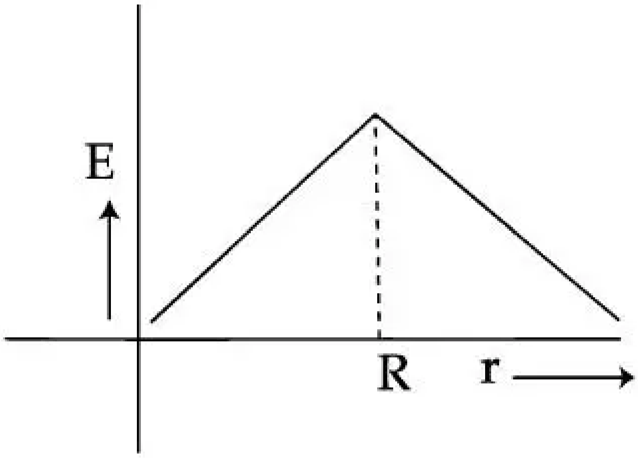
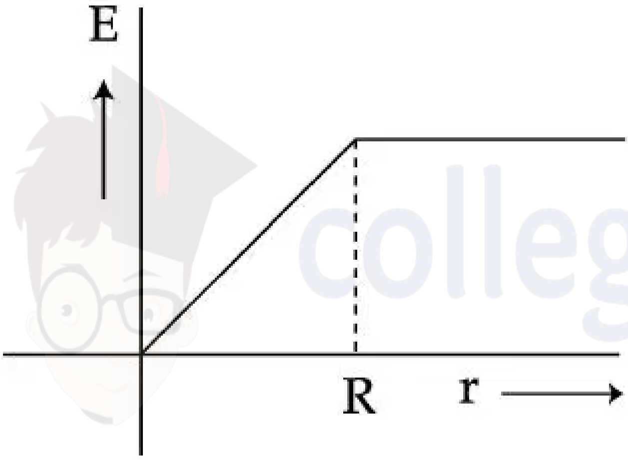
23. Figure shows a circular area of radius R where a uniform magnetic field $\vec{B}$ is going into the plane of paper and increasing in magnitude at a constant rate. In that case, which of the following graphs, drawn schematically, correctly shows the variation of the induced electric field E(r)? **(+4, -1)**



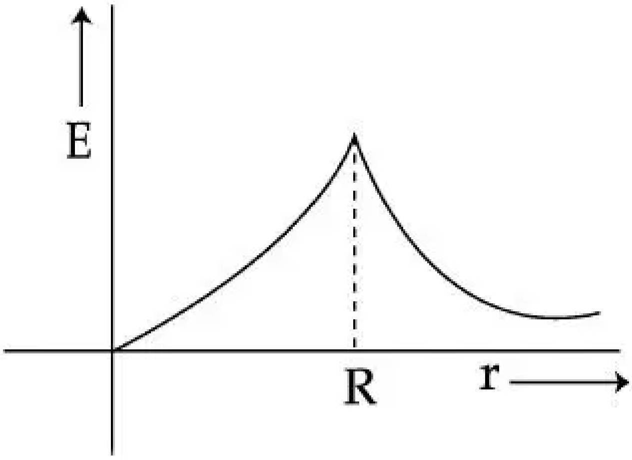
a.



b.



c.



d.

24. An insulating thin rod of length ℓ has a x linear charge density $p(x) = \rho_0 \frac{x}{\ell}$ on it . The rod is rotated about an axis passing through the origin $(x = 0)$ and perpendicular to the rod. If the rod makes n rotations per second, then the time averaged magnetic moment of the rod is : **(+4, -1)**

a. $\frac{\pi}{4} n\rho\ell^3$

b. $n\rho\ell^3$

c. $\pi n\rho\ell^3$

d. $\frac{\pi}{3} n\rho\ell^3$

---

25. A square frame of side 10 cm and a long straight wire carrying current 1 A are in the plane of the paper. Starting from close to the wire, the frame moves towards the right with a constant speed of 10 ms (see figure). The e.m.f induced at the time the left arm of the frame is at x = 10 cm from the wire is : **(+4, -1)**

a. $2\,\mu V$

b. $1\,\mu V$

c. $0.75\,\mu V$

d. $0.5\,\mu V$

Answers

1. **Answer: b**

Explanation:

The net magnetic moment of this system of two circular loops is :

$\mu_1 = \pi r_1^2 \times I_1$

$\mu_2 = \pi r_2^2 \times I_2$

Hence, $\mu_{net} = (\mu_2 - \mu_1)(-\hat{k})$

= $\pi(r_2^2 - r_1^2)I(-\hat{k})$

= $3.142 \times (0.5^2 - 03^2) \times 7(-\hat{k})$

= $-\frac{7}{2}\hat{}k\ Am^2$

Concepts:

1. Electromagnetic Induction:

Electromagnetic Induction is a current produced by the voltage production due to a changing magnetic field. This happens in one of the two conditions:-

1. When we place the conductor in a changing magnetic field.
2. When the conductor constantly moves in a stationary field.

Formula:

The electromagnetic induction is mathematically represented as:-

e=N × dØ.dt

Where

- e = induced voltage
- N = number of turns in the coil
- Φ = Magnetic flux (This is the amount of magnetic field present on the surface)
- t = time

Applications of Electromagnetic Induction

1. Electromagnetic induction in AC generator
2. Electrical Transformers
3. Magnetic Flow Meter

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2. Answer: 4 - 4

Explanation:

The amount of energy,
$U = \frac{1}{2}LI^2$

$U = \frac{1}{2} \times 2 \times 2^2$
$U = 4\ J$

So, the answer is $4\ J$.

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3. **Answer: b**

Explanation:

$\because \ \vec{\mu} = \frac{q\vec{L}}{2m}$

$\vec{\mu} = -\frac{e\vec{L}}{2m}$

Concepts:

1. **Magnetic Field:**

The magnetic field is a field created by moving electric charges. It is a force field that exerts a force on materials such as iron when they are placed in its vicinity. Magnetic fields do not require a medium to propagate; they can even propagate in a vacuum. Magnetic field also referred to as a vector field, describes the magnetic influence on moving electric charges, magnetic materials, and electric currents.

A magnetic field can be presented in two ways.

- **Magnetic Field Vector:** The magnetic field is described mathematically as a *vector field*. This vector field can be plotted directly as a set of many vectors drawn on a grid. Each vector points in the direction that a compass would point and has length dependent on the strength of the magnetic force.
- **Magnetic Field Lines:** An alternative way to represent the information contained within a vector field is with the use of *field lines*. Here we dispense with the grid pattern and connect the vectors with smooth lines.

Properties of Magnetic Field Lines

- Magnetic field lines never cross each other
- The density of the field lines indicates the strength of the field
- Magnetic field lines always make closed-loops

- Magnetic field lines always emerge or start from the north pole and terminate at the south pole.

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4. **Answer: b**

Explanation:

Emf = $(\frac{1}{2}) B\omega l^2$
= $(\frac{1}{2}) \times 0.2 \times 10^{-4} \times 5 \times 1^2$ V
= 0.5×10^{-4} V
= 50 μV

∴, The correct answer is (B): 50 μV

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Applications of Electromagnetic Induction

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---

5. **Answer: d**

Explanation:

Self-inductances are in series but their mutual inductances are linked oppositely so equivalent self-inductance

$L = L_1 + L_2 - M - M$

$L = L_1 + L_2 - 2M$

∴, The correct option is (D): $L_1 + L_2 - 2M$

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Applications of Electromagnetic Induction

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6. **Answer: c**

Explanation:

The correct answer is (C) : $[ML^2T^{-2}A^{-2}]$

$\because U = \frac{1}{2} Mi^2$

$\Rightarrow [M] = \frac{[U]}{[i^2]} = \frac{ML^2T^{-2}}{A^2}$
$= [ML^2T^{-2}A^{-2}]$

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Applications of Electromagnetic Induction

1. Electromagnetic induction in AC generator
2. Electrical Transformers
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---

7. **Answer: 242 - 242**

Explanation:

$$f = 50\text{Hz}$$

$$X_L = 2\pi f L$$

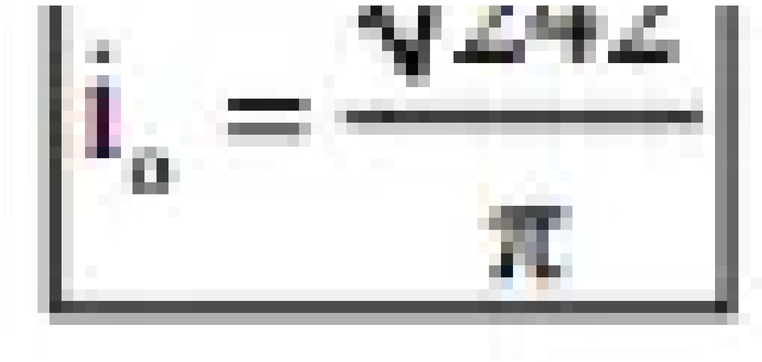
$$= 2\pi(50)(200 \times 10^{-3})$$

$$= 20\pi\Omega$$

$$i_0 = \frac{V_0}{X_L} \Rightarrow \frac{V_{rms}\sqrt{2}}{X_L}$$

$$= \frac{(220)\sqrt{2}}{20\pi} = \frac{11\sqrt{2}}{\pi}$$

$$= \sqrt{242}$$



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Applications of Electromagnetic Induction

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8. Answer: a

Explanation:

$I = I_0 \cos(\omega t)$ say

$\Rightarrow$ At maximum $\omega t_1 = 0$ or $t_1 = 0$

Then at rms value

$I = I_0 / \sqrt{2}$

$\Rightarrow \omega t_2 = \frac{\pi}{4}$

$\Rightarrow \omega(t_2 - t_1) = \frac{\pi}{4}$

$\Delta t = \frac{\pi}{4} \omega = \frac{\pi T}{4} \times 2\pi$

$= \frac{1}{400}$ s or 2.5 ms

The correct option is (A) : 2.5 ms

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Applications of Electromagnetic Induction

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9. **Answer: c**

Explanation:

Electromagnet requires high permeability and low retentivity.

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Applications of Electromagnetic Induction

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10. **Answer: c**

Explanation:

The correct option is (C)

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Applications of Electromagnetic Induction

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11. Answer: a

Explanation:

The correct option is (A): 8

Concepts:

1. Faradays Laws of Induction:

There are two laws, given by Faraday which explain the phenomena of electromagnetic induction:

Faraday's First Law:

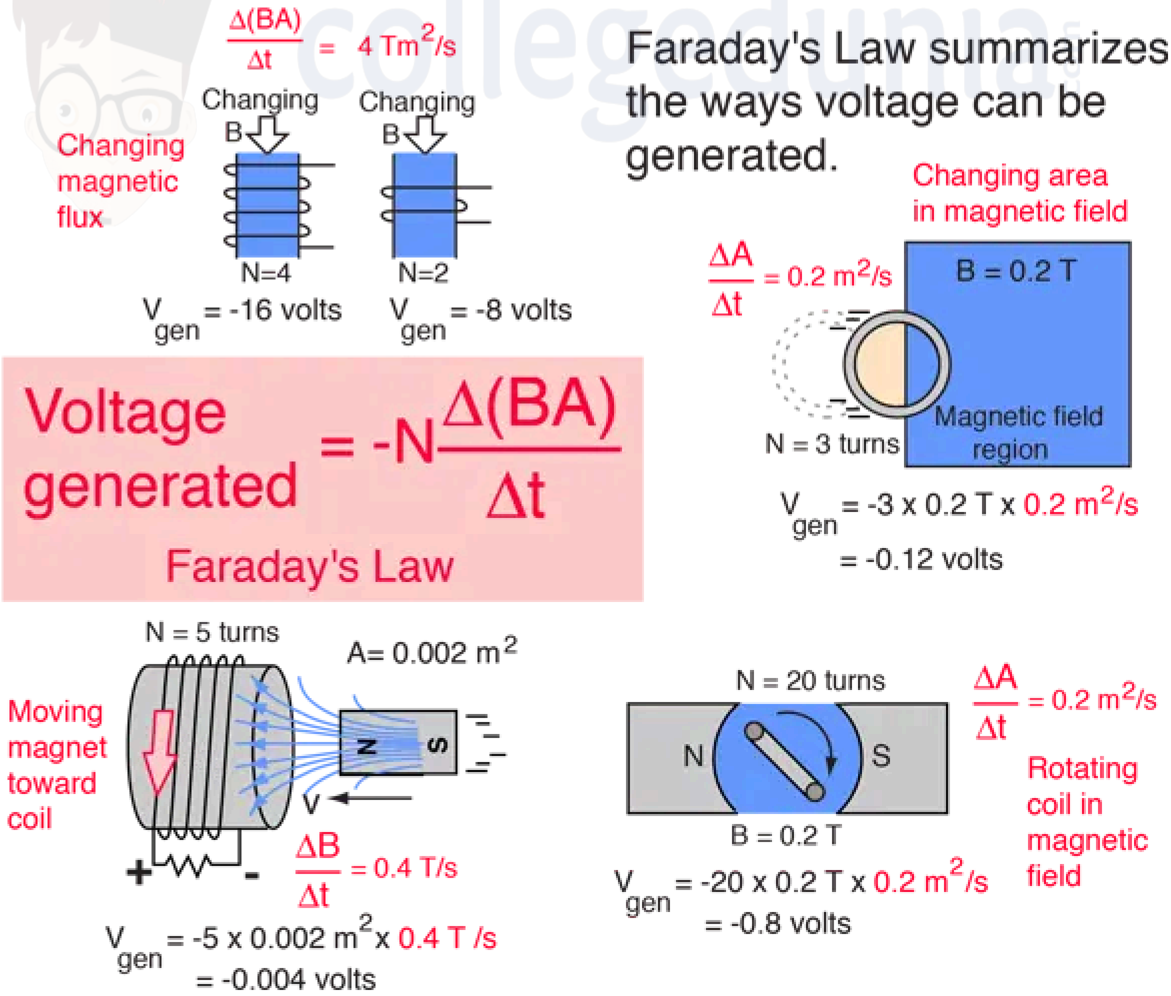
Whenever a conductor is placed in a varying magnetic field, an emf is induced. If the conductor circuit is closed, a current is induced, known as the induced current.

Faraday's Second Law:

The **Emf induced** inside a coil is equal to the **rate of change of associated magnetic flux.**

This law can be mathematically written as:

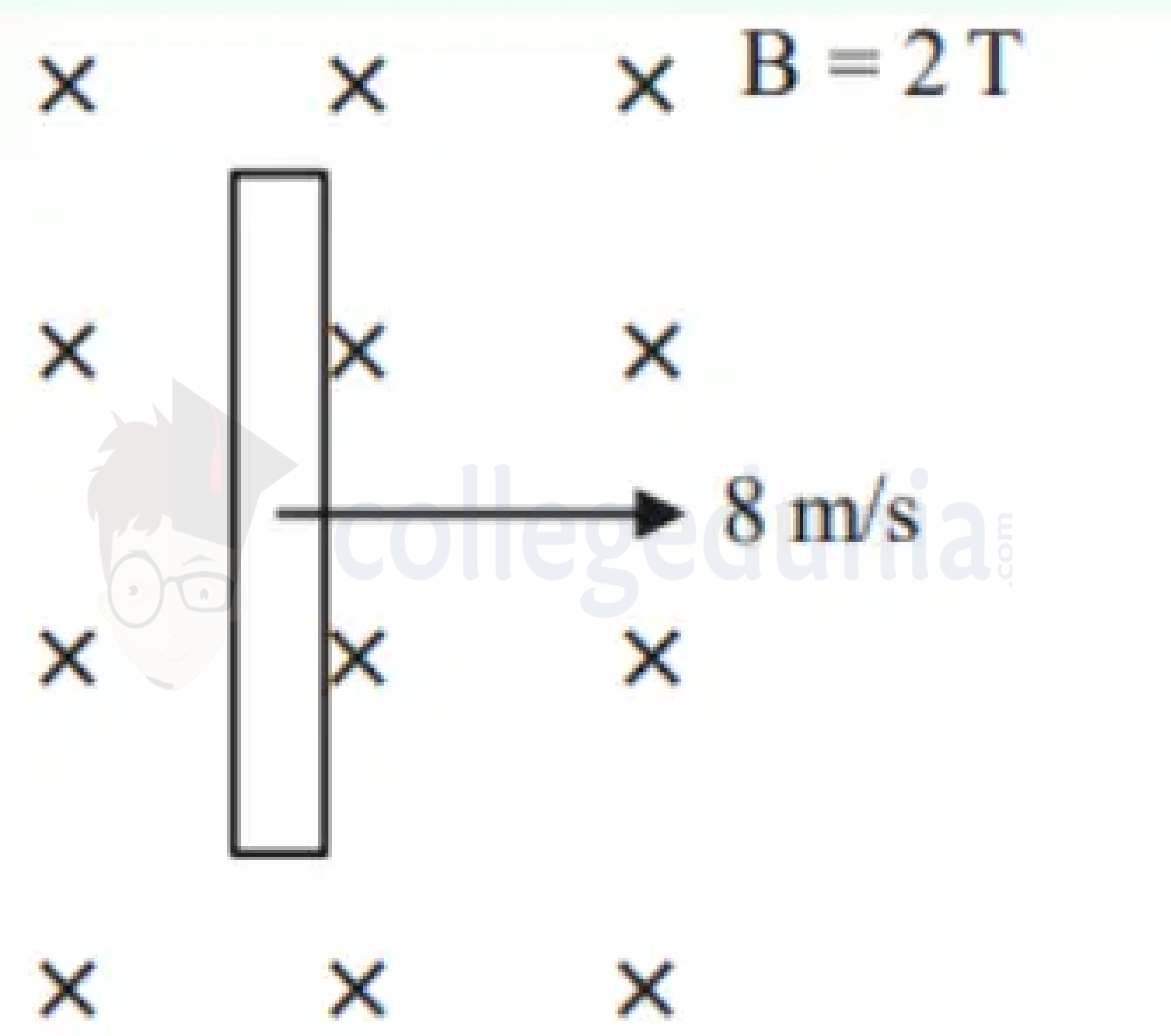
$\in -N\frac{\Delta\phi}{\Delta t}$



12. **Answer: b**

Explanation:

The correct answer is (B) : $16V$



Induced emf across the ends $= Bv\ell$

$= 2 \times 8 \times 1 = 16V$

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Applications of Electromagnetic Induction

1. Electromagnetic induction in AC generator
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13. Answer: c

Explanation:

When the rod rotates about one end in a uniform magnetic field, the induced EMF is calculated using Faraday's law. The differential EMF generated across an infinitesimal length dx of the rod is:

$$d\epsilon = Bv\,dx$$

where:

- $v = \omega x$ is the linear velocity of the element at a distance x from the axis of rotation,
- B is the uniform magnetic field.

Substitute $v = \omega x$:

$$d\epsilon = B(\omega x)\,dx = B\omega x\,dx$$

The total EMF is obtained by integrating $d\epsilon$ along the length of the rod:

$$\epsilon = \int_0^L B\omega x\,dx$$

$$\epsilon = B\omega \int_0^L x\,dx$$

$$\epsilon = B\omega \left[\frac{x^2}{2}\right]_0^L = B\omega \frac{L^2}{2}$$

Thus, the total induced EMF is:

$$\epsilon = \frac{1}{2} B L^2 \omega$$

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14. Answer: 250 - 250

Explanation:

The correct answer is 250

$\phi = 8t^2 - 9t + 5$

$emf = -\frac{d\phi}{dt} = -(16t - 9)$

At $t = 0.25s$

$Emf = -[(16 \times 0.25) - 9] = 5\,V$

Current $= \frac{\text{Emf}}{\text{Resistance}} = \frac{5V}{20\Omega}$

$= \frac{1}{4}A = \frac{1000}{4}mA = 250\,mA$

Concepts:

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Applications of Electromagnetic Induction

1. Electromagnetic induction in AC generator
2. Electrical Transformers
3. Magnetic Flow Meter

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15. Answer: 44 - 44

Explanation:

Step 1: Convert Area to m^2

Given area $A = 70\,\text{cm}^2$. Convert to m^2:

$$A = 70 \times 10^{-4}\,\text{m}^2$$

Step 2: Calculate Angular Velocity

The coil completes 500 revolutions in a minute (60 seconds). The angular velocity (ω) is:

$$\omega = \frac{500 \times 2\pi}{60} = \frac{1000\pi}{60} = \frac{50\pi}{3}\,\text{rad/s}.$$

Given $\pi = \frac{22}{7}$:

$$\omega = \frac{50}{3} \times \frac{22}{7} = \frac{1100}{21}\,\text{rad/s}.$$

Step 3: Calculate Instantaneous EMF

The instantaneous emf (E) induced in a rotating coil is given by:

$$E = NAB\omega \sin\theta$$

where N is the number of turns, A is the area of the coil, B is the magnetic field strength, ω is the angular velocity, and θ is the angle between the plane of the coil and the magnetic field.

Given $N = 600$, $A = 70 \times 10^{-4}\,\text{m}^2$, $B = 0.4\,\text{T}$ (since $1\,\text{wb/m}^2 = 1\,\text{T}$), $\omega = \frac{50\pi}{3}\,\text{rad/s}$, and $\theta = 60^\circ$:

$$E = 600 \times 70 \times 10^{-4} \times 0.4 \times \frac{50\pi}{3} \sin 60^\circ$$

$$E = 600 \times 70 \times 10^{-4} \times 0.4 \times \frac{50 \times 22}{3 \times 7} \times \frac{\sqrt{3}}{2} \approx 43.99\,\text{V}.$$

Since ωt is the angle between the area vector and the magnetic field vector, and we are given that the plane of the coil makes 60 degrees with the field, this means that the area vector makes 30 degrees with the field. Therefore, we should use $\sin(30)$ instead of $\sin(60)$:

$$E = 600 \times 70 \times 10^{-4} \times 0.4 \times \frac{100\pi}{6} \times \frac{1}{2} \approx 44\,\text{V}.$$

Conclusion: The instantaneous emf is approximately $44\,\text{V}$.

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Applications of Electromagnetic Induction

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3. Magnetic Flow Meter

16. **Answer: d**

Explanation:

The area of the loop is:

$$A = \pi r^2 = \pi \left(\frac{10}{\sqrt{\pi}}\right)^2 = 100\,\text{cm}^2 = 10^{-2}\,\text{m}^2.$$

The magnetic flux through the loop is:

$$\Phi = B \cdot A = 0.5 \cdot 10^{-2} = 5 \cdot 10^{-3}\,\text{Wb}.$$

The emf induced is:

$$\mathcal{E} = \left|\frac{\Delta\Phi}{\Delta t}\right| = \frac{5 \cdot 10^{-3}}{0.5} = 10\,\text{mV}.$$

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Applications of Electromagnetic Induction

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17. Answer: d

Explanation:

The relationship between the charges and radii is given by:

$$\frac{1}{4\pi\epsilon_0}\cdot\frac{Q_1'}{R}=\frac{1}{4\pi\epsilon_0}\cdot\frac{Q_2'}{2R}$$

Simplifying, we find:

$$Q_2'=2Q_1'$$

Using the charge conservation equation:

$$Q_1'+Q_2'=Q_1+Q_2$$

Substitute $Q_2'=2Q_1'$:

$$Q_1'+2Q_1'=20\pi R^2\sigma$$

$$3Q_1'=20\pi R^2\sigma$$

$$Q_1'=\frac{20\pi R^2\sigma}{3}$$

Substitute $Q_2'=2Q_1'$:

$$Q_2'=\frac{40\pi R^2\sigma}{3}$$

The surface charge densities are related by:

$$\sigma'=\frac{Q_2'}{4\pi(2R)^2}$$

$$\sigma'=\frac{\frac{40\pi R^2\sigma}{3}}{16\pi R^2}$$

$$\sigma'=\frac{40}{3}\cdot\frac{1}{16}\cdot\sigma$$

$$\sigma' = \frac{5}{6} \cdot \sigma$$

Electromagnetic Force and Voltage:

The force on a current-carrying conductor in a magnetic field is given by:

$$F_m = ILB$$

Equating with gravitational force $F_m = mg$:

$$ILB = mg$$

Substitute $I = \frac{V}{R}$:

$$\left(\frac{V}{R}\right) LB = mg$$

Solve for V:

$$V = \frac{mgR}{LB}$$

Substitute the given values $m = 1 \times 10^{-3}\ \mathrm{kg}$, $g = 10\ \mathrm{m/s}^2$, $R = 10\ \Omega$, $L = 0.1\ \mathrm{m}$, and $B = 10^{-3}\ \mathrm{T}$:

$$V = \frac{(1 \times 10^{-3})(10)(10)}{(0.1)(10^{-3})}$$

$$V = 10\ \mathrm{V}$$

Final Answer:

Voltage $V = 10\ \mathrm{V}$

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Applications of Electromagnetic Induction

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18. Answer: a

Explanation:

$\phi = \mu_r \mu_0 \frac{n}{l} I \times A$

$\phi = 4\pi \times 10-^{6} \times 4\pi \times 10^{-7} \frac{400}{0.40} \times 0.4 \times 2 \times 10^{-4}$
μ_r=125

So, the correct answer is (A): 125

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Applications of Electromagnetic Induction

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19. Answer: d

Explanation:

Explanation:

Given:Inductance , L = 8.4 mH = 8.4×10^{-3} HResistance , R = 6 ΩVoltage of the battery, = 12 VWe have to find the time when current in the coil is 1 A.Time constant of the L-R circuit is = – = $\frac{8.4\times10^{-3}}{6\Omega}$ = 1.4×10^{-3} sUsing Ohm's law, maximum current flowing through the circuit is $_0$ = – $_0$ = $\frac{12}{6\Omega}$ $_0$ = 2 Current at any instant of time t in the circuit is = $_0$(1 – $^{--}$)We are given that current = 1 at time . Thus, we have 1 = 2[$_{1\,-}$ – $\frac{}{1.4\times10^{-3}}$] $^{-}\frac{}{1.4\times10^{-3}}$ = $\frac{1}{2}$ $\frac{}{1.4\times10^{-3}s}$ = 2Taking log on both the sides, we get$\frac{}{1.4\times10^{-3}}$ = In2 $\frac{}{1.4\times10^{-3}s}$ = 0.693 = 0.97×10^{-3} ≈ 1×10^{-3} ≈ 1 So, the current in the coil is 1 A at time t = 1 ms.Hence, the correct option is (D).

---

20. Answer: b

Explanation:

Since it is a balanced wheatstone bridge, its equivalent resistance $= \frac{4}{3}\Omega$ $\varepsilon = B\ell v = 5 \times 10^{-4}V$ So total resistance $R = \frac{4}{3} + 1.7 \approx 3\Omega$ $\therefore$ $i\frac{\varepsilon}{R} \approx 166\mu A$ $\approx$ $170\mu A$

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Applications of Electromagnetic Induction

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21. Answer: b

Explanation:

According to Faraday?s law of electromagnetic induction,
Induced emf, $e = \frac{Ldi}{dt}$

$$50 = L\left(\frac{5-2}{0.1\,sec}\right)$$
$$\Rightarrow L = \frac{50\times0.1}{3} = \frac{5}{3} = 1.67\,H$$

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22. Answer: c

Explanation:

$$\varepsilon = \frac{d\phi}{dt}$$
$$iR = \frac{d\phi}{dt}$$
$$\int d\phi = R\int idt$$

Magnitude of change in flux = R $\times$ area under current vs time graph

$= 100 \times \frac{1}{2} \times \frac{1}{2} \times 10$

$= 250\,Wb$

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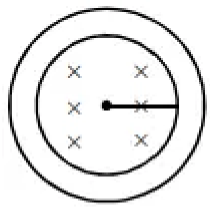
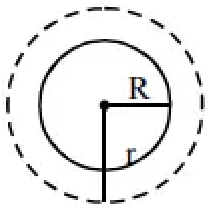
23. Answer: d

Explanation:



$B = B_0 t$
$r > R$
$\phi \bar{\varepsilon} \cdot de = \frac{d\phi}{dt}$
$\Rightarrow \varepsilon(2\pi r) = B\pi r^2$



$e \propto r$
$r > R$
$\varepsilon(2\pi r) = B\pi R^2$
$\varepsilon \propto \frac{1}{r}$

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---

24. **Answer: a**

Explanation:

$\because M = NIA$

$dq = \lambda dx \& A = \pi x^2$

$\int dm = \int (x) \frac{\rho_0 x}{\ell} dx . \pi x^2$

$M = \frac{n\rho_0\pi}{\ell} . \int_0^\ell x^3 . dx = \frac{n\rho_0\pi}{\ell} . \left[\frac{L^4}{4}\right]$

$M = \frac{n\rho_0\pi\ell^3}{4}$ or $\frac{\pi}{4} n\rho\ell^3$

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---

25. **Answer: b**

Explanation:

In given $fig_x = 15$ because left arm of the frame is at $10cm$ from the wire. and $a = 10cm$. emf in
$AD \implies e_1 \implies \frac{a\mu_o iv}{2\pi(x-a/2)}$

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