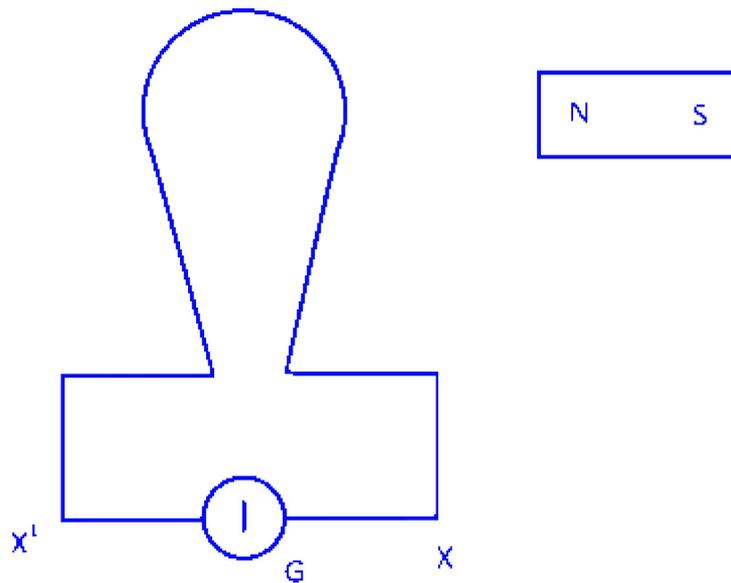


Electromagnetic Induction

Question1

When a bar magnet is pushed towards the coil, along its axis, as shown in the figure, the galvanometer pointer deflects towards X . When this magnet is pulled away from the coil, the galvanometer pointer



KCET 2025

Options:

- A. Deflects towards X^1
- B. Does not deflect
- C. Oscillates
- D. Deflects towards X

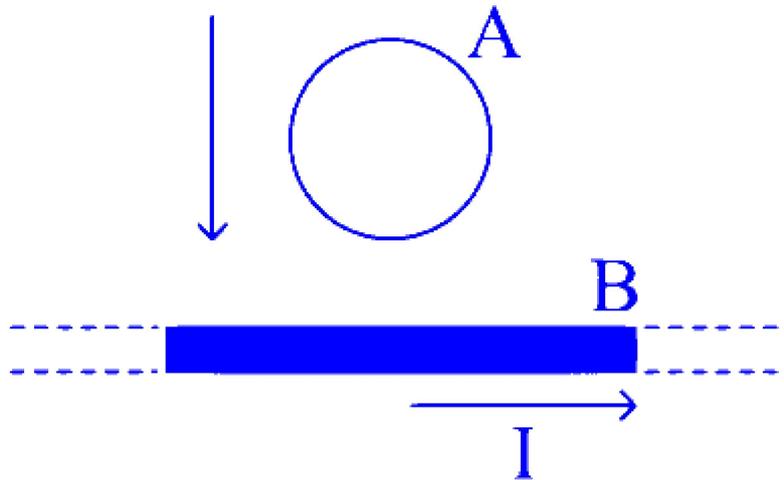
Answer: A

Solution:



According to Lenz's Law, a changing magnetic flux through a coil induces an electromotive force (EMF) that opposes the change in flux. When a bar magnet is pushed towards the coil, the change in magnetic flux through the coil causes the galvanometer pointer to deflect in one direction (towards X, in this case). Conversely, when the bar magnet is pulled away from the coil, the change in magnetic flux is in the opposite direction. Thus, the galvanometer pointer will deflect in the opposite direction, which is towards X^1 . This occurs as the system attempts to oppose the change in magnetic flux by inducing a current that produces a magnetic field opposing the original direction.

Question2



In the figure, a conducting ring of certain resistance is falling towards a current carrying straight long conductor. The ring and conductor are in the same plane. Then, the

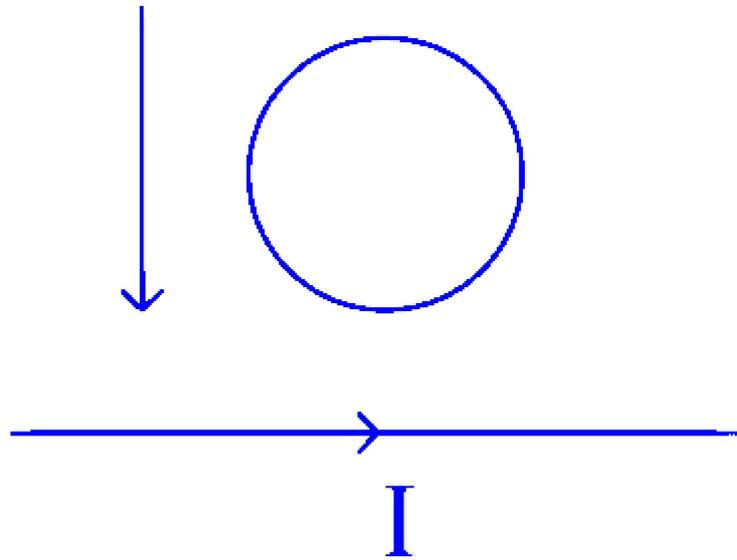
KCET 2024

Options:

- A. induced electric current is zero
- B. induced electric current is anti-clockwise
- C. induced electric current is clockwise
- D. ring will come to rest

Answer: C

Solution:



Magnetic field around the current carrying straight long conductor.

$$B = \frac{\mu_0 I}{2\pi r}$$

where, r is distance from the conductor.

Hence, magnetic field increases on moving towards the conductor.

Since, metal ring is moving towards the conducting wire, hence flux linked with ring, increases continuously in the out of plane direction. Hence, the induced current produces a magnetic field into the plane of paper. Thus, induced current will produce in the clockwise direction.

Question3

An induced current of 2 A flows through a coil. The resistance of the coil is 10Ω . What is the change in magnetic flux associated with the coil in 1 ms ?

KCET 2024

Options:

- A. 0.2×10^{-2} Wb
- B. 2×10^{-2} Wb
- C. 22×10^{-2} Wb
- D. 0.22×10^{-2} Wb



Answer: B

Solution:

Given, $I = 2 \text{ A}$, $R = 10\Omega$

$$t = 1 \text{ ms} = 10^{-3} \text{ s}$$

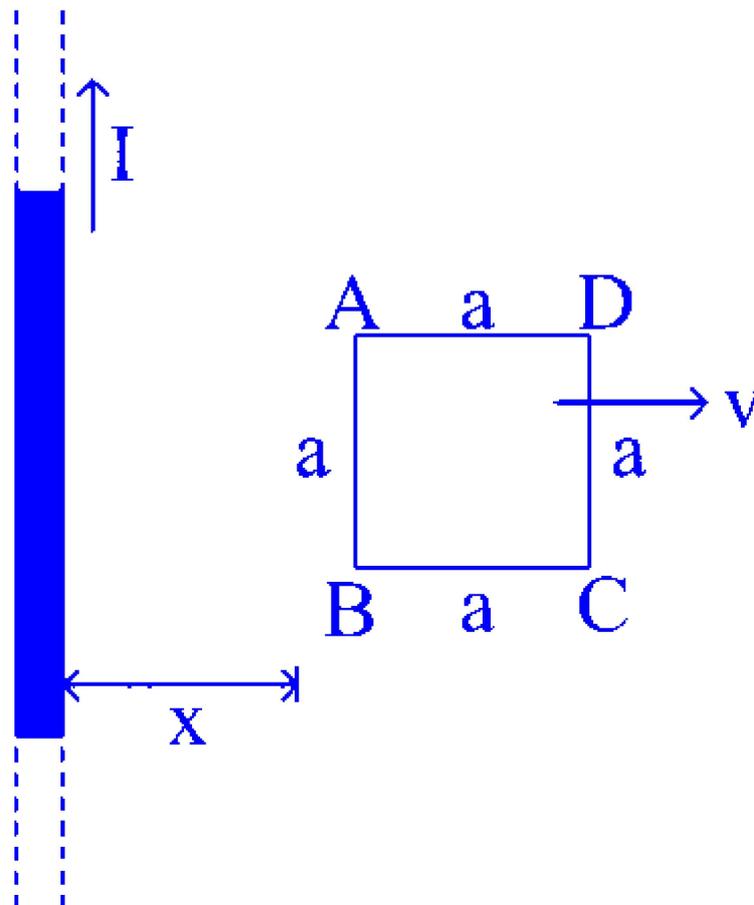
We know that,

$$|\varepsilon| = \frac{\Delta\phi}{\Delta t} \Rightarrow IR = \frac{\Delta\phi}{\Delta t}$$

$$\begin{aligned} \Rightarrow \Delta\phi &= IR\Delta t = 2 \times 10 \times 10^{-3} \\ &= 0.02 \text{ Wb} = 2 \times 10^{-2} \text{ Wb} \end{aligned}$$

Question4

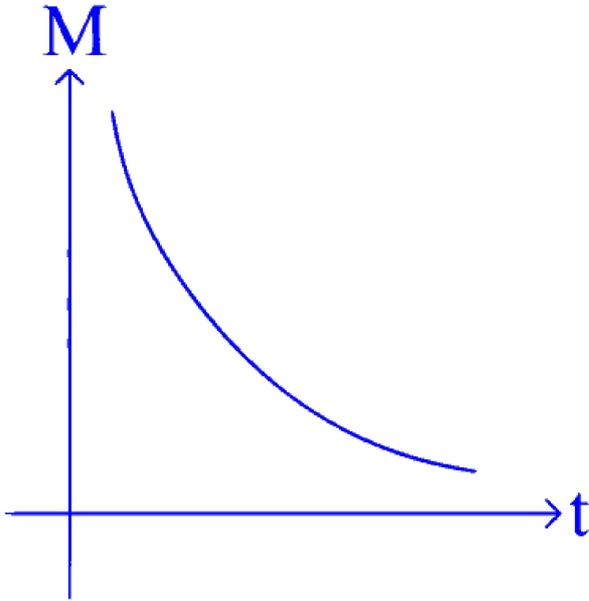
A square loop of side length a is moving away from an infinitely long current carrying conductor at a constant speed v as shown. Let x be the instantaneous distance between the long conductor and side AB . The mutual inductance M of the square loop-long conductor pair changes with time t according to which of the following graphs?



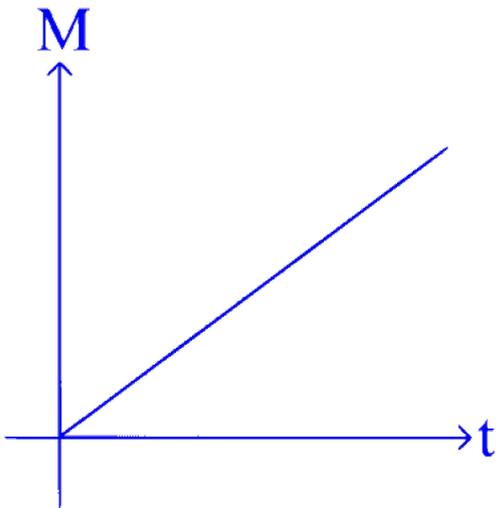
KCET 2024

Options:

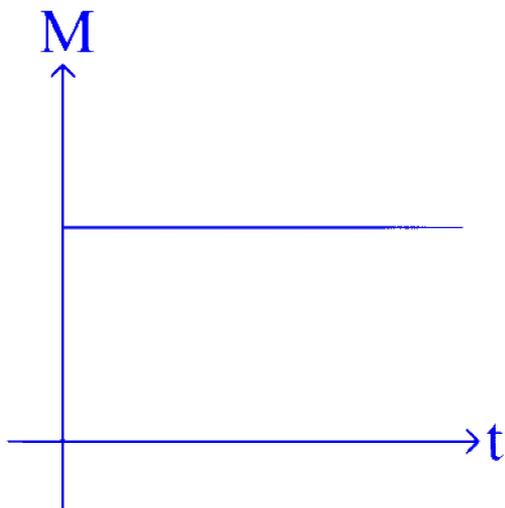
A.

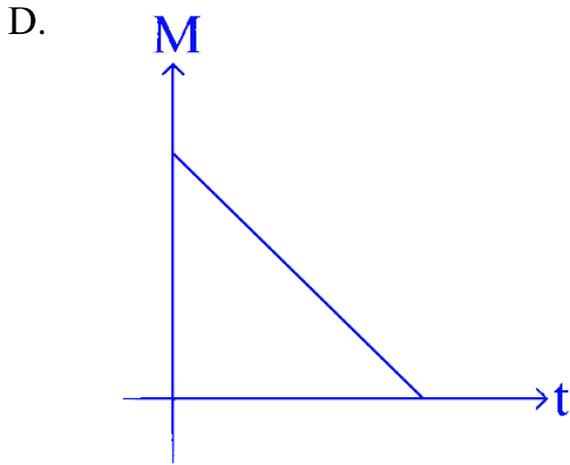


B.



C.





Answer: C

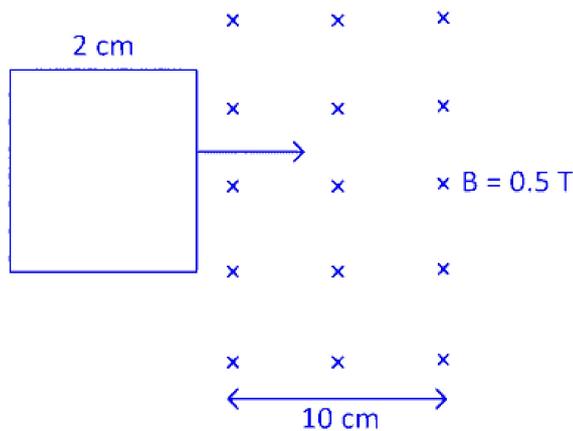
Solution:

As the mutual inductance is independent with time, hence graph shown in option (c) is correct.

Question5

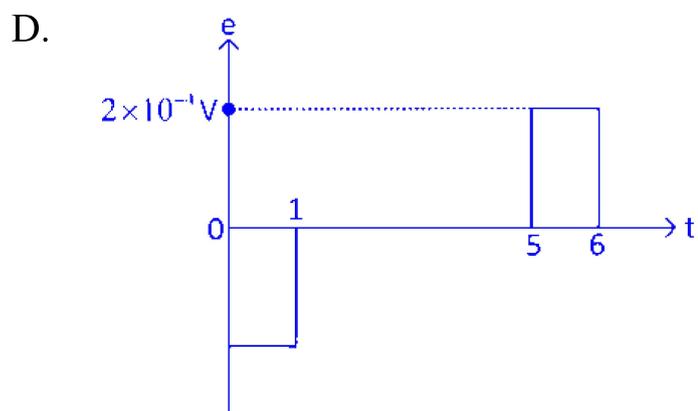
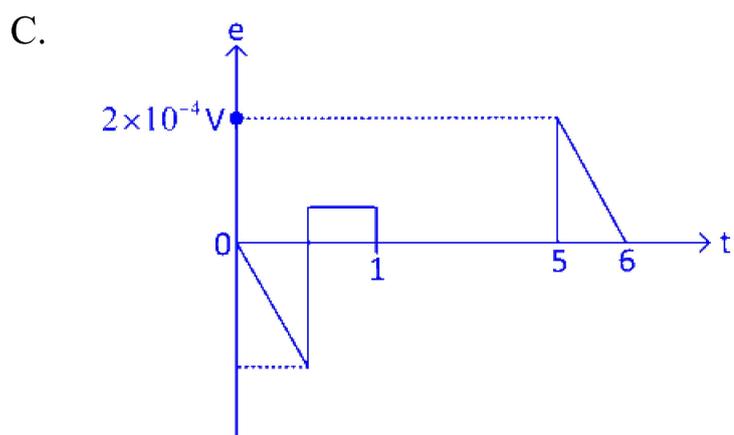
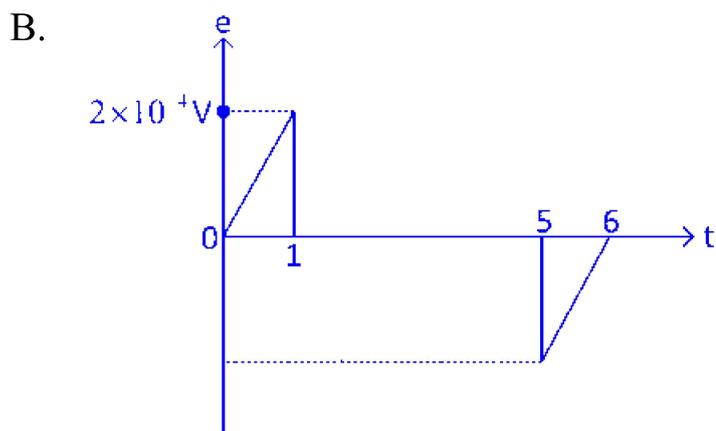
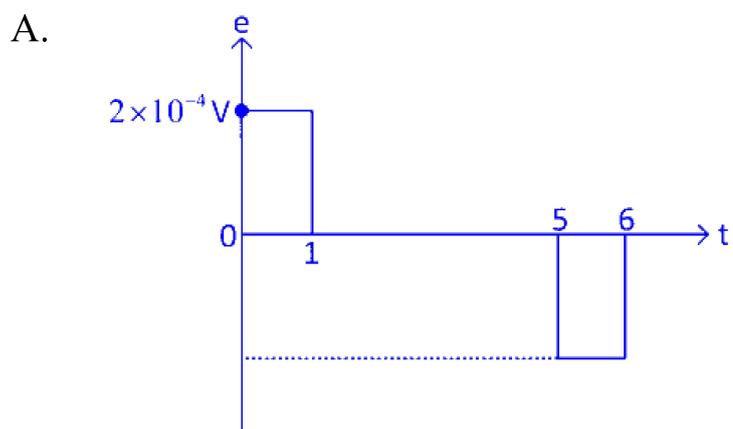
A square loop of side 2 cm enters a magnetic field with a constant speed of 2 cm s^{-1} as shown. The front edge enters the field at $t = 0 \text{ s}$. Which of the following graph correctly depicts the induced emf in the loop?

(Take clockwise direction positive)



KCET 2023

Options:



Answer: D

Solution:

As the loop moves, there are three cases.

(i) When the loop moves fully outside the magnetic field, there is no change in flux.

$$\therefore \varepsilon = \frac{d\phi}{dt} = 0$$

(ii) When the loop is entering/leaving the area of magnetic field.

$$\begin{aligned}\varepsilon &= BLV = (0.5) (2 \times 10^{-2}) (2 \times 10^{-2}) \\ &= 2 \times 10^{-4} \text{ V}\end{aligned}$$

As flux is in opposite direction to magnetic field.

$$\varepsilon \text{ when loop enters the field} = -2 \times 10^{-4} \text{ V}$$

$$\begin{aligned}\varepsilon \text{ when loop exits the field} &= -(-2 \times 10^{-4} \text{ V}) \\ &= 2 \times 10^{-4} \text{ V}\end{aligned}$$

(iii) When moving inside the magnetic field.

$$\frac{d\phi}{dt} = 0$$

\therefore No emf is induced.

Question6

The current in a coil changes from 2 A to 5 A in 0.3 s. The magnitude of emf induced in the coil is 1.0 V. The value of self-inductance of the coil is

KCET 2023

Options:

A. 1.0 mH

B. 100 mH

C. 0.1 mH

D. 10 mH

Answer: B

Solution:



$$\Delta I = 5 - 2 = 3 \text{ A}$$

$$\Delta t = 0.3 \text{ s}$$

Induced emf, $e = 1 \text{ V}$

We know that, $e = \frac{L \Delta I}{\Delta t}$

$$\Rightarrow e = \frac{L \Delta I}{\Delta t}$$

$$\Rightarrow L = \frac{e}{\frac{\Delta I}{\Delta t}} = \frac{1}{\frac{3}{0.3}} = 0.1 \text{ H} = 100 \text{ mH}$$

Question 7

A metallic rod of length 1 m held along east-west direction is allowed to fall down freely. Given horizontal component of earth's magnetic field $B_H = 3 \times 10^{-5} \text{ T}$. the emf induced in the rod at an instant $t = 2 \text{ s}$ after it is released is

(Take, $g = 10 \text{ ms}^{-2}$)

KCET 2023

Options:

A. $6 \times 10^{-4} \text{ V}$

B. $3 \times 10^{-3} \text{ V}$

C. $3 \times 10^{-4} \text{ V}$

D. $6 \times 10^{-3} \text{ V}$

Answer: C

Solution:

Given, $B_H = 3 \times 10^{-5} \text{ T}$

$l = 1 \text{ m}$

Height travelled by rod in $t = 2 \text{ s}$

$$h = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times 2^2 = 20 \text{ m}$$

$$\therefore \text{Speed of rod, } v = \frac{h}{t} = \frac{20}{2} = 10 \text{ m/s}$$

Hence, induced emf

$$\begin{aligned} e &= B_H v l = 3 \times 10^{-5} \times 10 \times 1 \\ &= 3 \times 10^{-4} \text{ V} \end{aligned}$$

Question8

A long solenoid has 500 turns, when a current of 2 A is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb, then self induction of the solenoid is

KCET 2022

Options:

A. 2.5 H

B. 2.0 H

C. 1.0 H

D. 4.0 H

Answer: C

Solution:

Given, number of turns in the solenoid,

$$N = 500$$

Current, $I = 2$ A

Magnetic flux, $\phi = 4 \times 10^{-3}$ Wb

Self-inductance of coil,

$$L = \frac{N\phi}{I} = \frac{500 \times 4 \times 10^{-3}}{2} = 1 \text{ H}$$



Question9

A magnetic field of flux density 1.0 Wb m^{-2} acts normal to a 80 turn coil of 0.01 m^2 area. If this coil is removed from the field in 0.2 s, then the emf induced in it is

KCET 2022

Options:

- A. 8 V
- B. 0.8 V
- C. 5 V
- D. 4 V

Answer: D

Solution:

Given, magnetic flux density,

$$B = 1 \text{ Wb/m}^2$$

Number of turns, $N = 80$

Area of coil, $A = 0.01 \text{ m}^2$

$$\Delta t = 0.2 \text{ s}$$

According to Faraday's law of electromagnetic induction, induced emf

$$\begin{aligned} |e| &= \frac{N\Delta\phi}{\Delta t} = N \cdot \frac{BA}{\Delta t} \quad [\because \Delta\phi = BA] \\ &= \frac{80 \times 1 \times 0.01}{0.2} = 4 \text{ V} \end{aligned}$$

Question10

The physical quantity which is measure in the unit of wb A^{-1} is

KCET 2021

Options:

- A. self-inductance
- B. magnetic flux
- C. mutual inductance
- D. Both (a) and (b)

Answer: D

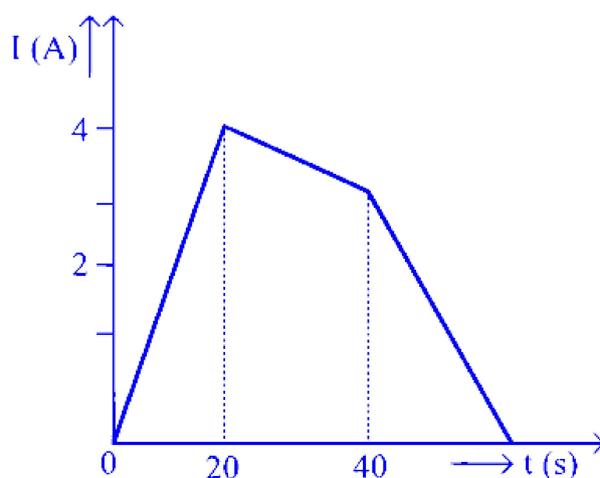
Solution:

The self-inductance (L) and mutual inductance (M), both has the same unit as, both are equal to magnetic flux per unit current i.e.

$$M = L = \frac{\phi}{I} = \left(\text{in wb A}^{-1} \right)$$

Question11

The current following through an inductance coil of self-inductance 6 mH at different time instants is as shown. The emf induced between $t = 20$ s and $t = 40$ s is nearly



KCET 2021

Options:

A. 2×10^{-2} V

B. 3×10^{-2} V

C. 4×10^{-3} V

D. 30×10^2 V

Answer: A

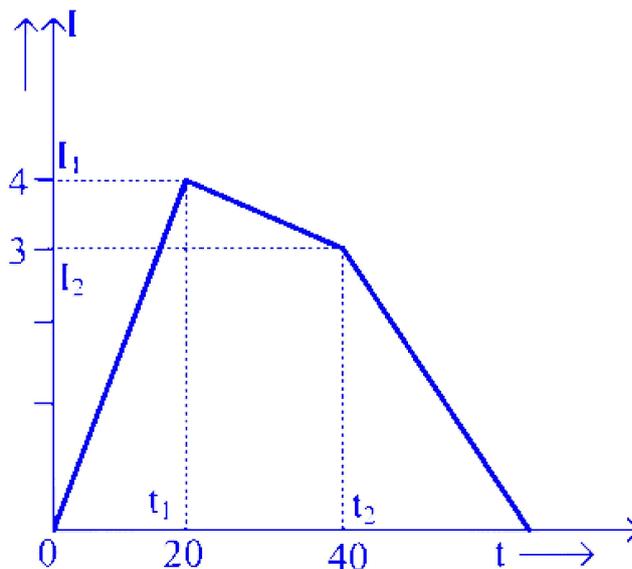
Solution:

As we know,

$$\text{Induced emf, } |e| = L \frac{dI}{dt}$$

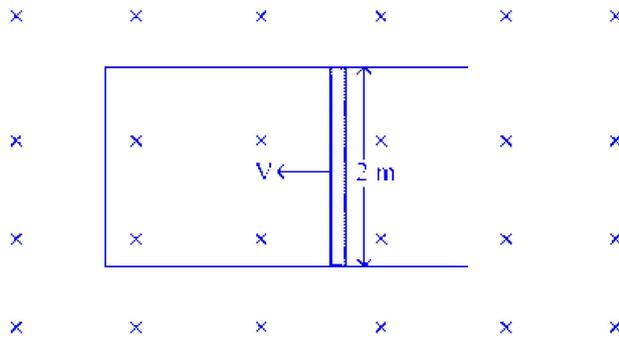
Here, $L = 6 \text{ mH} = 6 \times 10^{-3} \text{ H}$

From the given graph,



Question12

A rod of length 2 m slides with a speed of 5 ms^{-1} on a rectangular conducting frame as shown in figure. There exists a uniform magnetic field of 0.04 T perpendicular to the plane of the figure. If the resistance of the rod is 3Ω . The current through the rod is



KCET 2020

Options:

- A. 75 mA
- B. 133 mA
- C. 0.75 A
- D. 1.33 A

Answer: B

Solution:

Given, $l = 2 \text{ m}$, $v = 5 \text{ m/s}$, $B = 0.04 \text{ T}$ and $R = 3\Omega$

The current induced in a conducting coil, when moved in a uniform magnetic field is

$$I = \frac{Blv}{R} = \frac{0.04 \times 2 \times 5}{3} = 0.133 \text{ A} = 133 \text{ mA}$$



Question13

The current in a coil of inductance 0.2H changes from 5 A to 2 A in 0.5 s. The magnitude of the average induced emf in the coil is

KCET 2020

Options:

A. 0.6 V

B. 1.2 V

C. 30 V

D. 0.3 V

Answer: B

Solution:

Given, $L = 0.2\text{H}$, $I_1 = 5\text{ A}$, $I_2 = 2\text{ A}$ and $\Delta t = 0.5\text{ s}$

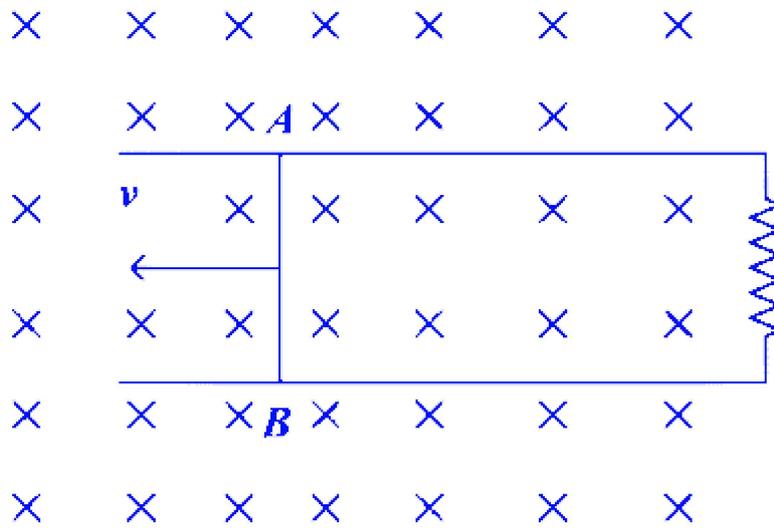
The magnitude of induced emf, $|e| = L \frac{dI}{dt}$

$$= L \frac{\Delta I}{\Delta t} = \frac{0.2 \times (5-2)}{0.5} = 1.2\text{ V}$$

Question14

Consider the situation given in figure. The wire AB is slid on the fixed rails with a constant velocity. If the wire AB is replaced by a semicircular wire, the magnitude of the induced current will





KCET 2019

Options:

- A. increase
- B. remain same
- C. decrease
- D. increase or decrease depending on whether the semicircle bulges towards the resistance or away from it.

Answer: B

Solution:

Magnitude of the induced current depends the rate of change of magnetic flux linked with coil. When wire AB is replaced by semicircular wire, change in magnetic flux is same, hence induced current remains same.

Question15

The magnetic flux linked with a coil varies as $\phi = 3t^2 + 4t + 9$. The magnitude of the emf induced at $t = 2$ s is

KCET 2018

Options:

- A. 8 V
- B. 32 V
- C. 16 V
- D. 64 V

Answer: C

Solution:

To find the induced emf, we use Faraday's law of electromagnetic induction, which states that the induced emf (ε) in a coil is given by:

$$\varepsilon = -\frac{d\phi}{dt}$$

Here, the flux is given by:

$$\phi(t) = 3t^2 + 4t + 9$$

Step-by-step calculation:

Differentiate the flux with respect to time:

$$\frac{d\phi}{dt} = \frac{d}{dt}(3t^2 + 4t + 9) = 6t + 4$$

Substitute $t = 2$ seconds:

$$\left. \frac{d\phi}{dt} \right|_{t=2} = 6(2) + 4 = 12 + 4 = 16$$

The induced emf is the negative of this derivative, but we are asked for the magnitude. Therefore:

$$|\varepsilon| = |-16| = 16 \text{ V}$$

So, the magnitude of the induced emf at $t = 2$ s is 16 V.

Answer: Option C 16 V.

Question16

A step-up transformer operates on a 230 V "ne and a load current of 2 A . The ratio of primary and secondary windings is 1 : 25. Then, the current in the primary is

KCET 2018

Options:

- A. 25 A
- B. 50 A
- C. 15 A
- D. 12.5 A

Answer: B

Solution:

Let's break down the solution step by step:

Since the transformer is a step-up type with a ratio of primary to secondary windings of 1 : 25, the secondary voltage is:

$$V_s = 25 \times 230 \text{ V} = 5750 \text{ V}$$

Assuming the transformer is ideal (no energy losses), the input power equals the output power:

$$V_p I_p = V_s I_s$$

Rearranging to solve for the primary current I_p :

$$I_p = \frac{V_s I_s}{V_p}$$

Substitute the known values:

$$I_p = \frac{5750 \text{ V} \times 2 \text{ A}}{230 \text{ V}} = \frac{11500}{230} = 50 \text{ A}$$

Therefore, the current in the primary is 50 A, which corresponds to Option B.

Question17

The working of magnetic braking of trains is based on

KCET 2017

Options:

- A. eddy current
- B. pulsating current
- C. alternating current
- D. steady current



Answer: A

Solution:

Magnetic braking in trains works on the principle of eddy currents. Here's a quick breakdown:

When a magnet moves relative to a conductive material (like aluminum), it induces circular currents (eddy currents) in that conductor.

According to Lenz's law, these eddy currents create their own magnetic fields that oppose the motion causing them.

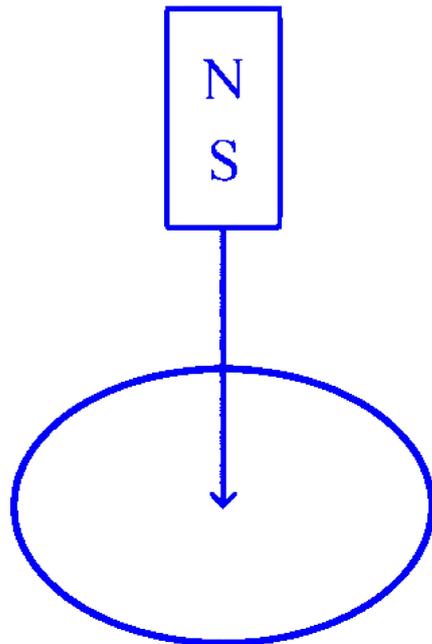
This opposition produces a braking force, which helps in slowing down the train without physical friction.

So, the correct answer is:

Option A: eddy current.

Question18

A bar magnet is allowed to fall vertically through a copper coil placed in a horizontal plane. The magnet falls with a net acceleration, is



KCET 2017

Options:

- A. Zero
- B. $= g$
- C. $\$$
- D. $> g$

Answer: C

Solution:

When the magnet is allowed to fall vertically along the axis of loop with its north pole towards the coil. The upper face of the coil will become north pole in an attempt to oppose the approaching north pole of the magnet. Therefore, the acceleration in the magnet is less than g .

Question19

A jet plane of wing span 20 m is travelling towards west at a speed of 400 ms^{-1} . If the earth's total magnetic field is $4 \times 10^{-4} \text{ T}$ and the dip angle is 30° , at that place, then the voltage differences developed across the ends of the wing is

KCET 2017

Options:

- A. 0.8 V
- B. 6.4 V
- C. 3.2 V
- D. 1.6 V

Answer: D

Solution:

Given:

Speed $v = 400 \text{ m/s}$

Magnetic field $B = 4 \times 10^{-4} \text{ T}$

Dip angle $\theta = 30^\circ$

To find the voltage difference developed across the ends of the wing, we use the formula:

Voltage difference = $B \cdot l \cdot v \cdot \sin \theta$

Substituting the given values:

$$\begin{aligned}\text{Voltage difference} &= 4 \times 10^{-4} \cdot 20 \cdot 400 \cdot \sin 30^\circ \\ &= 32000 \times 10^{-4} \times \sin 30^\circ \\ &= 32000 \times 10^{-4} \cdot \frac{1}{2} \\ &= 1.6 \text{ V}\end{aligned}$$

Thus, the voltage difference across the ends of the wing is 1.6 V.

