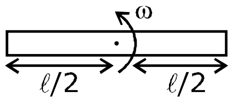
OBJECTIVE - I

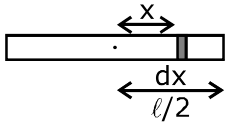
1. A rod a length l rotates with a small but uniform angular velocity w about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the centre of the rod and an end is

(A) zero (B*) $\frac{1}{8}$ wBl^2 (C) $\frac{1}{2}$ wBl^2 (D) Bwl^2

Sol. **B**



Take a small element dx at a distance of 'x' centre

Þ 

$$d \in \int_0^{\frac{l}{2}} B\omega x dx = \frac{Bwx^2}{2}\Big|_0^{\frac{l}{2}}$$

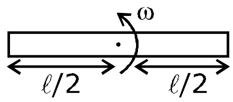
$$\in = \frac{1}{8}Bwl^2$$

2. A rod of length l rotates with a uniform angular velocity w about its perpendicualr bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the two ends of the rod is

(A*) zero (B) $\frac{1}{2}$ wBl^2 (C) Bwl^2 (D) 2Bwl^2

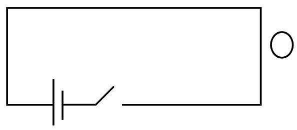
Sol. **D**

Emf at both end is same = $\frac{1}{8}Bwl^2$



So the potential difference between the two ends of therod is zero.

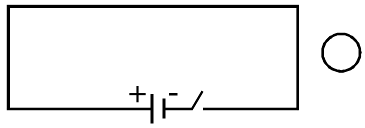
3. Consider the situation shown in fig. If the switch is closed and after some time it is opened again, the closed loop will show



(A) an anticlockwise current-pulse
(B) a clockwise current-pulse
(C) an anticlockwise current-pulse and then a clockwise current-pulse
(D*) a clockwise current-pulse and then an anticlockwise current-pulse

Sol. **D**

When the switch is closed than a clock wise current pulse generated (Because initially current flow the terminal to negative terminal).
Due to Mutual Induction, current is generated in the loop. If circuit is open after some time. Dut to loop an anticlock wise current pulse generated in the circuit.



4. Solve the previous question if the closed loop is completely enclosed in the circuit containing the switch.

(C*)

Sol. **C**

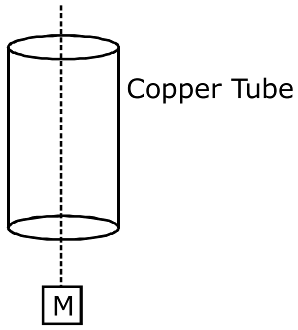
An anticlock wise current-pulse generated and then a clock-wise current pulse.

5. A bar magnet is relased from rest along the axis of a very long, vertical copper tube. After some time the magnet

(A) will stop in the tube (B*) will move with almost contant speed

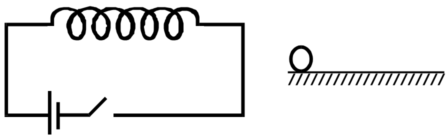
(C) will move with an acceleration g (D) will oscillate

Sol. **B**



After sometime the Magnet will move with almost contant speed.

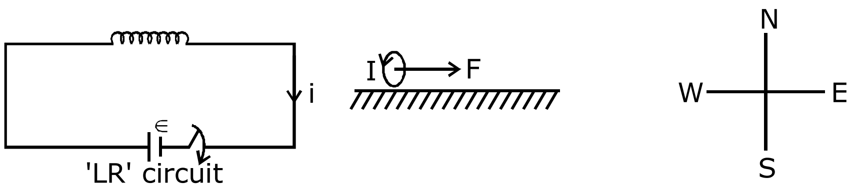
6. Fig. shown a horizontal solenoid connected to a battery and a switch. A copper ring is place on a frictionless track, the axis of the ring being along the axis of the solenoid. As the switch is closed, the ring will



(A) remain stationery (B) move towards the solenoid
(C*) move away from the sloenoid
(D) move towards the solenoid or away from it depending on

which terminal (positive or neagtive) of the battery is connected to the left end of the solenoid.

Sol. **C**



$$e = -L\frac{di}{dt}$$

Current flow in the CKt is clock wise direction, due to Mutual Induction current flow in the loop anti clockwise direction. The net force applied on the loop in east direction. So we can say that the ring will move away from the solenoid.

7. Consider the following statements:
(a) An emf can be induced by moving a conductor in a magnetic field
(b) An emf can be induced by changing the magnetic field.

(A*) Both A and B are true (B) A is true but B is false
(C) B is true but A is false (D) Both A and B are false

Sol. **A**

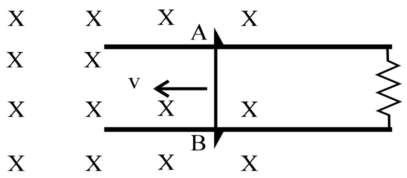
$\Rightarrow$ An emf con be induced by moving a condcutor in a magnetic field

$$\in = Bvl$$

$\Rightarrow$ An emf can be induced by charging the magnetic field.

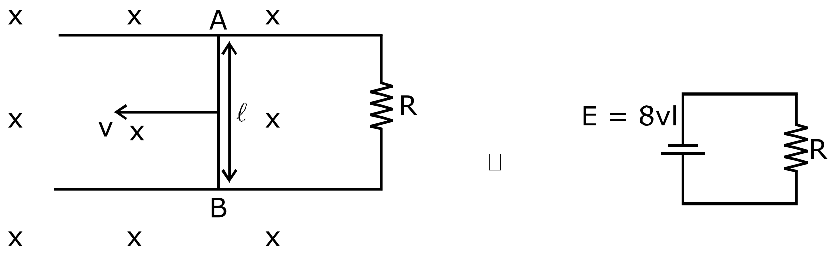
$$\in = \frac{-d\phi}{dt} \qquad \phi \rightarrow \text{flux}$$

8. Consider the situation shown in fig. The wire AB is slid on the fixed rails with a constant velocity. If the wire AB is rep;aced by a semicircular wire, the magnitude of the induced current will



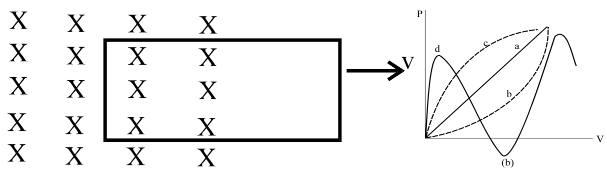
(A) increase (B*) remain the same
(C) decrease
(D) increase or decrease depending on whether the semicircle bulges towards the resistance or away from it.

Sol. **B**



E = Bvl
If the wire AB is replaced by a semicircular wire, the magnitude of the induced current will be same. Because it is depend on the velcoty & lenght of the wire.

9. Fig. shows a conducting loop being pulled out of a magnetic field with a speed u. Which of the four plots shown in fig. may represnet the power delovered by the pulling agent as a function of the speed u.



(B*)

Sol. **B**

$\in = Bvl$

$$\text{Power} = \frac{v^2}{R} = \frac{\in^2}{R} = \frac{B^2v^2l^2}{R}$$

Here $P \times v^2$

$P \rightarrow$ Power
$v \rightarrow$ velocity
$B \rightarrow$ Magnetic field

10. Two circular loops of equal radii are placed coaxially at some separation. The first is cut and a battery is inseted in between to dirve a current in it. The current changes slightly because of the variation in resistance with temperature. During the period, the two loops

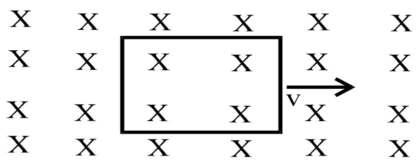
(A*) attract each other
(B) repel each other
(C) do not exert any force on each other
(D) attract or repel each other depending on the sense of the current

Sol. **A**
Due to Mutual induction, current is generated in second loop and that causes the two loops attract each other.

11. A small, conducting circular loop is placed inside a long solenoid carrying a current. The plane of the loop contains the axis of the solenoid. If the current in the solenoid is varied, the current induced in the loop is

(A) clockwise (B) anticlockwise (C*) zero
(D) clockwise or anticlockwise depending on whether the resistance in increased or decreased.
Sol. C

12. A conducting square loop of side l and resistance R moves in its plane with a uniform velocity u perpendicular to one of its sides. A uniform and constant magnetic field B exists along the perpendicular to the plane of the loop in fig. The current induced in the loop is



(A) Blu/R clockwise
(B) Blu/R anticlockwise
(C) 2Blu/R anticlockwise
(D*) zero

Sol. **D**

Induced emf is AB is Bvl and Induced emf is DC is also Bvl.
Net emf in the closed circuit (loop) is zero.
So induced current in the loop is zero.

OBJECTIVE - II

1. A bar magnet is moved along the axis of a copper ring placed far away from the magnet, an anticlockwise current is found to be induced in the ring. Which of the following may be true ?

(A) The south pole faces the ring and the magnet moves towards it
(B*) The north pole faces the ring asnd the magnet moves towards it
(C*) The south pole faces the ring and the magnet moves away from it.
(D) The north pole faces the ring and the manget moves away from it.

Sol. **BC**

Þ The north pole faces the ring and the magnet moves towards it
Þ The south Pole faces the ring and the Magnet moves away from it.

2. A conducting rod is moved with a constant velocity u in a magnetic field. A potential difference. A potential difference appears across the two ends

(A) if $\vec{\upsilon} || \vec{l}$ || (B) if $\vec{\upsilon} || \vec{B}$|| (C) if $\vec{l}$ || $\vec{B}$|| (D*) none of these

Sol. **D**

Potential difference appears across the two ends = Bvl
v ^ B , v ^ l , l ^ B

3. A conduction loop is placed in a uniform magnetic filed with its plane perpenducular to the field. An emf is induced in the loop if

(A) it is translated (B) it is rotated about its axis
(C*) it is rotated about a diameter (D*) it is deformed

Sol. **CD**

Þ An emf is induced in the loop is it is rotated about a diameter.
Þ An emf is induced in the loop if it is deformed.

4. A metal sheet is placed in front of a strong magnetic pole. A force needed to

(A*) hold the sheet there if the metal is magnetic
(B) hold the sheed there if the metal is nonmagnetic
(C*) move the sheet away from the pole with uniform velocity if the metal is magnetic
(D*) move the sheet away from the pole with uniform velocity if the metal is nonmagnetic.
Negative any effect if oaramagnetism, diamagnetism and gravity.

Sol. **ACD**

5. A constant current i is maintained in a solenoid. Which of the following quantities will increase if an iron rod is inserted in the soleniod along axis ?

(A*) magnetic field at the centre (B*) mangetic flux linked with the solenoid
(C*) self-inductance of the solenoid (D) rate of Joule heating

Sol. **ABC**

6. Two solenoids have identical geometrical construction but one is made of thick wire and the other of thin wire. Which of the following quantities are different for the two solenoids ?
(A) self-inductance (B*) rate of Joule heating if the same current goes through them
(C) magnetic field energy if the same current goes through them
(D*) time constant if one solenoid is connected to one battery and the other is connected to another battery

Sol. **BD**

$R = \frac{\rho l}{A}$ A - Crossectional Area

Thick wire "A" is large than thin wire.

R_{thick} wire < R_{thin} wire

Þ time constant Þ $\tau = \frac{L}{R}$

Þ Power dissipatedin Heating = I^2R

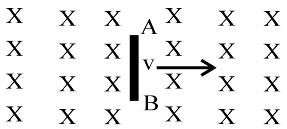
7. An LR circuit with a battery is connected at t =0. Which of the following quantities is not zero just after the connection ?

(A) current in the circuit (B) magnetic field energy in the inductor

(C) power delivered by the battery (D*) emf induced in the inductor

Sol. **D**

8. A rod AB moves with a uniform velocity v in a uniform magnetic field as shown in fig.



(A) The rod becomes electrically charged

(B*) The end A becomes positively charged

(C) The end B become positibely charged

(D) The rod becomes hot because of Joule heating

Sol. **B**

The end 'A' becomes, positively charged. Because magnetic field exerts an average Force $\vec{F_0} = q\vec{v} \times \vec{B}$ on each free electron where q = 1.6 ×10^{19}C is the charge on the electron. This Force is towards AB and hence the free electrons will move towareds B. Negative charge is accumulated at 'B' and positive charge appears at A.

9. L, C and R represent the physical quantities inductance, capacitance and resistance combinations have dimensions of frequency ?

(A*) $\frac{1}{RC}$ (B*) $\frac{R}{L}$ (C*) $\frac{1}{\sqrt{LC}}$ (D) C/L

Sol. **ABC**

Þ Time constant t = RC in RC circuit

$$\text{frequency} = \frac{1}{\tau} = \frac{1}{RC} \quad ....(i)$$

Þ Time constant in LR circuit is $\tau = \frac{L}{RC}$

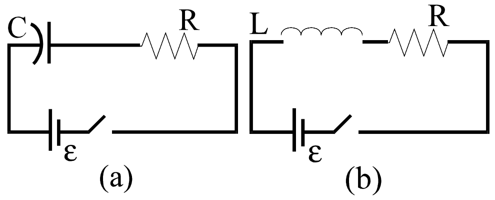
$$\text{frequency} = \frac{1}{\tau} = \frac{R}{L} \quad ....(i)$$

Þ eq. (i) & (ii) multiply Þ

$$\text{frequency} = \frac{1}{LC}$$

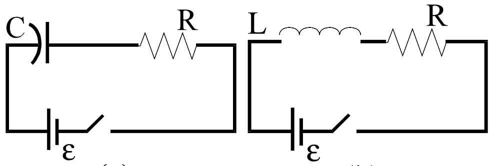
$$\text{frequency} = \frac{1}{\sqrt{2C}}$$

10. The switches in fig. and are closed at t = 0 and reopened after a long time at t = t_0.



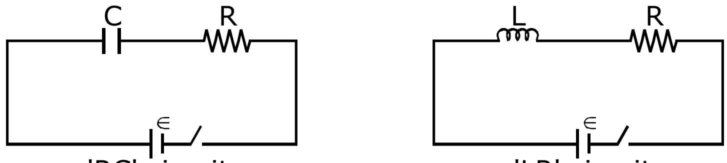
(A) The change on C just after t = 0 is XC. (B*)The change on C long after t = 0 is XC.

(C*) The current in L just before t = t_0 is X/R (D) The current in L long after t = t_0 is X/R



(a) (b)

Sol. **BC**



'RC' circuit 'LR' circuit

Þ A long time after capacitor is fully charged is equal to

$Q = CV = C\hat{I}$ Þ $Q = C\hat{I}\,(1-e^{-t/t})$

Þ The current in 'L' just before $t = t_0$ is

$i = \hat{I}/R\,(1-e^{-t/t}) = \hat{I}/R$