DPP – 2 (EMI)

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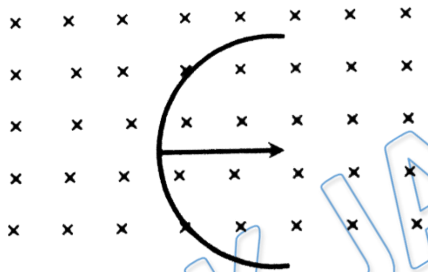
Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/61

Q 1. A straight wire of length L is bent into a semicircle. It is moved in a uniform magnetic field with speed V with diameter perpendicular to the field. The induced emf between the ends of the wire is



(a) BLV (b) 2BLV

(c) 2πBLV (d) $\frac{2BLV}{\pi}$

Q 2. A straight copper wire of length 2m is perpendicular to a uniform magnetic field of induction 0.7T. It is moved at right angles to its length and magnetic field at a speed of 2m/s. Find the induced emf between the ends of the wire

(a) 2V (b) 2.8V

(c) 1V (d) 1.4V

Q 3. A straight copper wire of length 2m is perpendicular to a uniform magnetic field of induction 0.7T. It is moved at right angles to its length and magnetic field at a speed of 2m/s. If the ends of wire are joined by completing a circuit through a 4-ohm resistor (stationary), at what rate must the work be done to keep the wire moving at the constant speed of 2m/s ?

(a) 1.56 W (b) 3.12 W

(c) 0.49 W (d) 1.96 W

Q 4. A 10 meter wire kept in east-west falling with velocity 5 m/sec perpendicular to the field $0.3 \times 10^{-4}\ Wb/m^2$. The induced e.m.f. across the terminal will be

(a) 0.15 V (b) 1.5 mV

(c) 1.5 V (d) 15.0 V

Q 5. Two rails of a railway track insulated from each other and the ground are connected to a milli voltmeter. What is the reading of voltmeter, when a train travels with a speed of 180 km/hr along the track. Given that the vertical component of earth's magnetic field is $0.2 \times 10^{-4}\ Wb/m^2$ and the rails are separated by 1 metre

(a) 10^{-2} Volt (b) 10^{-4} Volt

(c) 10^{-3} Volt (d) 1 Volt

Q 6. A thin wire of length 2m is perpendicular to the x−y plane. It is moved with velocity $\vec{V} = (2\hat{i} + 3\hat{j} + \hat{k})\ m/s$ through a region of magnetic induction $\vec{B} = (\hat{i} + 2\hat{j})\ Wb/m^2$. Then potential difference induced between the ends of the wire is

(a) 2V (b) 4V

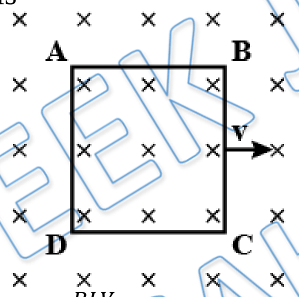
(c) 0V (d) none of these

Q 7. A copper disc of radius 0.1 m is rotated about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 Tesla with its plane perpendicular to the field. The e.m.f. induced across the radius of disc is

(a) $\frac{\pi}{10}$ V (b) $\frac{2\pi}{10}$ V

(c) $\pi \times 10^{-2}$ V (d) $2\pi \times 10^{-2}$ V

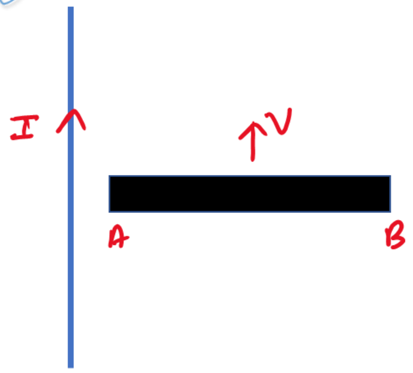
Q 8. A conducting square loop of side L and resistance R moves in its plane with a uniform velocity v perpendicular to one of its sides. A magnetic induction B constant in time and space, pointing perpendicular and into the plane of the loop exists everywhere. The current induced in the loop is



(a) $\frac{BLV}{R}$ clockwise (b) $\frac{BLV}{R}$ anticlockwise

(c) $\frac{2BLV}{R}$ anticlockwise (d) zero

Q 9. The current carrying wire and the rod AB are in same plane. The rod moves parallel to the wire with a velocity v. Which on of the following statement is true about induced emf in the rod?



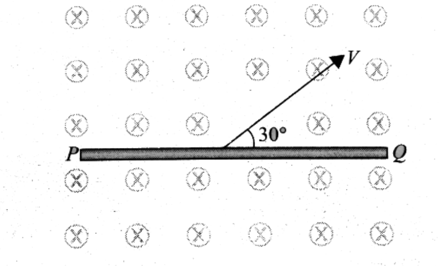
(a) End A will be at lower potential with respect to B

(b) A and B will be at the same potential

(c) There will be no induced e.m.f. in the rod

(d) Potential at A will be higher than that at B

Q 10. A conducting rod PQ of length l = 2m is moving at a speed of 2 m/s making an angle of $30^0$with its length. A uniform magnetic field B = 2T exists in a direction perpendicular to the plane of motin. Then

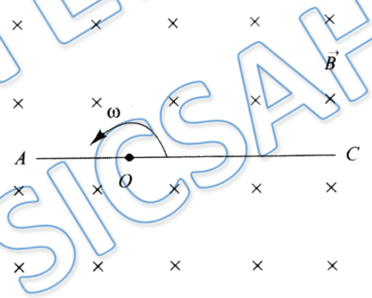


(a) $V_P - V_Q = 8V$
(b) $V_P - V_Q = 4V$
(c) $V_Q - V_P = 8V$
(d) $V_Q - V_P = 4V$

Q 11. A rod of length 20 cm is rotating with angular speed of 100 rps in a magnetic field of strength 0.5 T about its one end. What is the potential difference between two ends of the rod

(a) 2.28 V
(b) 4.28 V
(c) 6.28 V
(d) 2.5 V

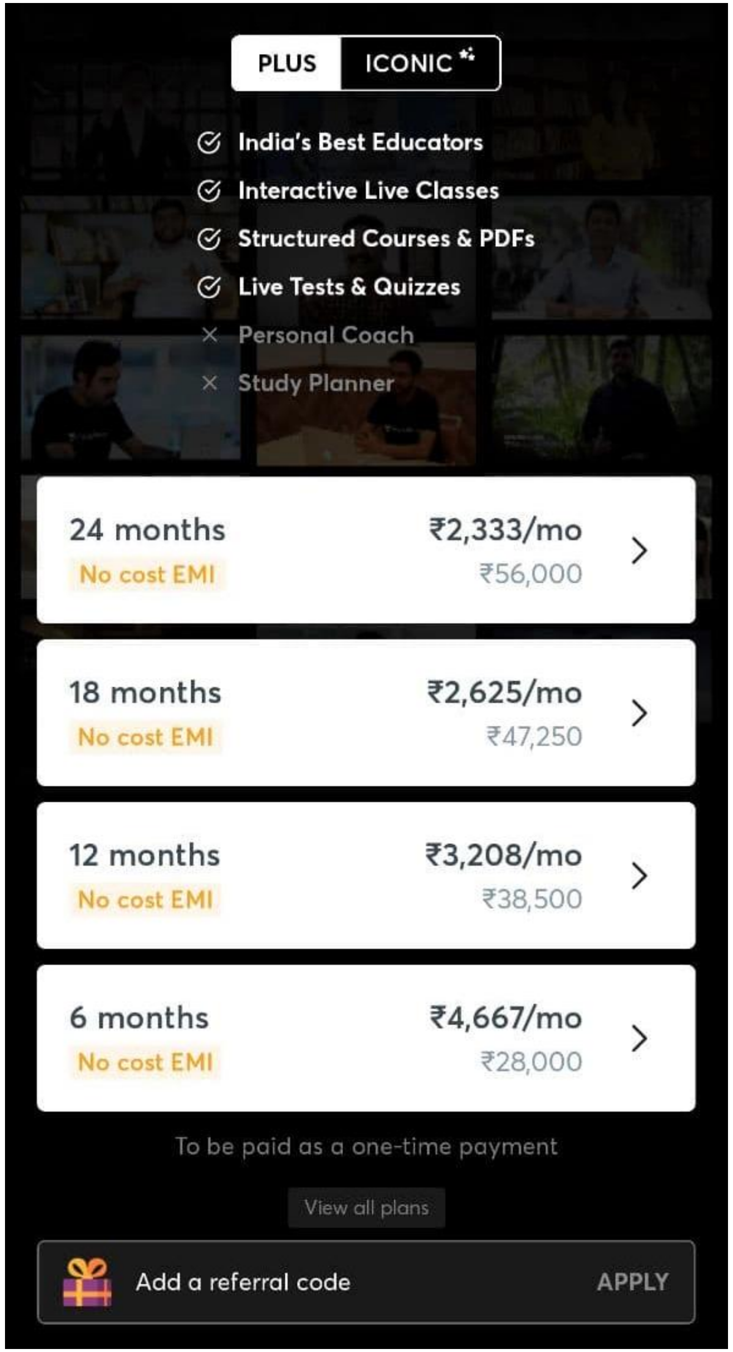
Q 12. A conducting rod AC of length $4l$ is rotated about point O in a uniform magnetic field $\vec{B}$ directed into the plane of the paper. AO = l and OC = $3l$. Find $V_A - V_C$



(a) $4B\omega l^2$
(b) $\frac{1}{4}B\omega l^2$
(c) zero
(d) $2B\omega l^2$

Answer Key

Q.1 d	**Q.2 b**	**Q.3 d**	**Q.4 b**	**Q.5 c**
Q.6 a	**Q.7 c**	**Q.8 d**	**Q.9 d**	**Q.10 b**
Q.11 c	**Q.12 a**			



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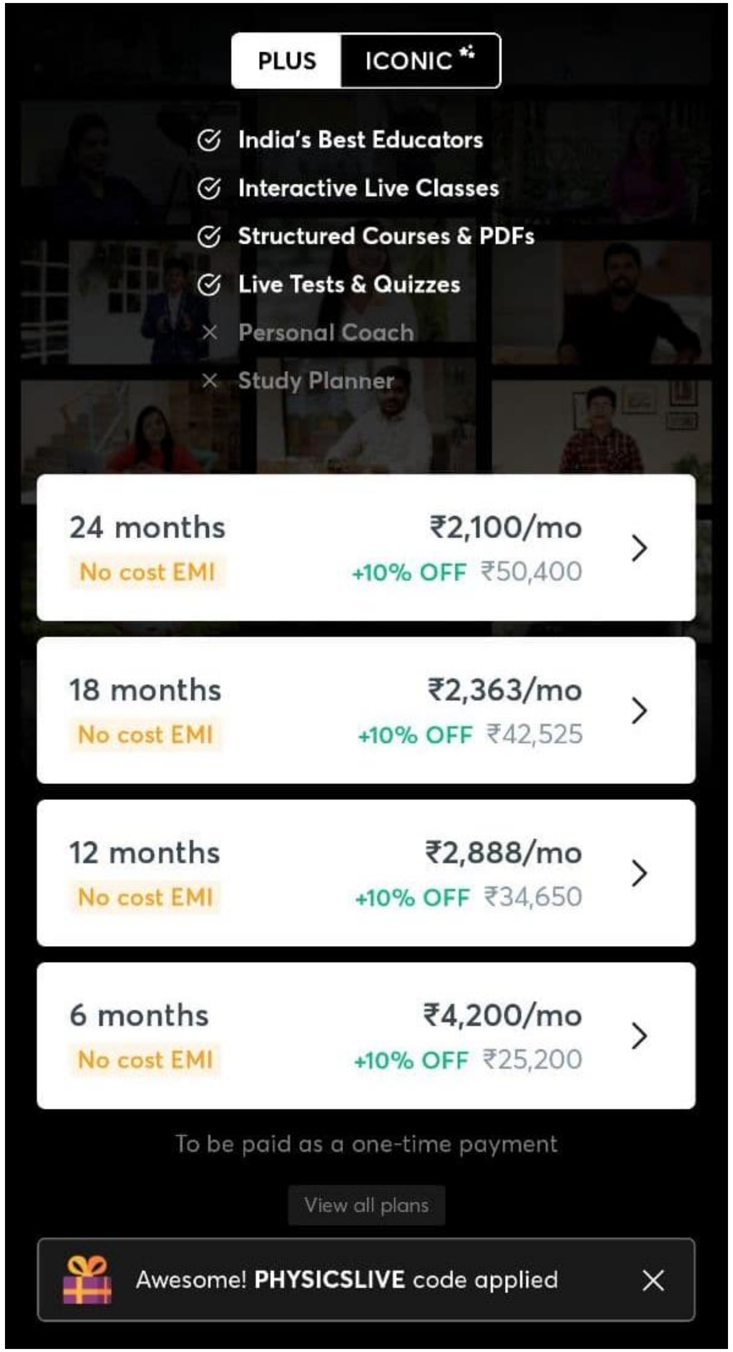

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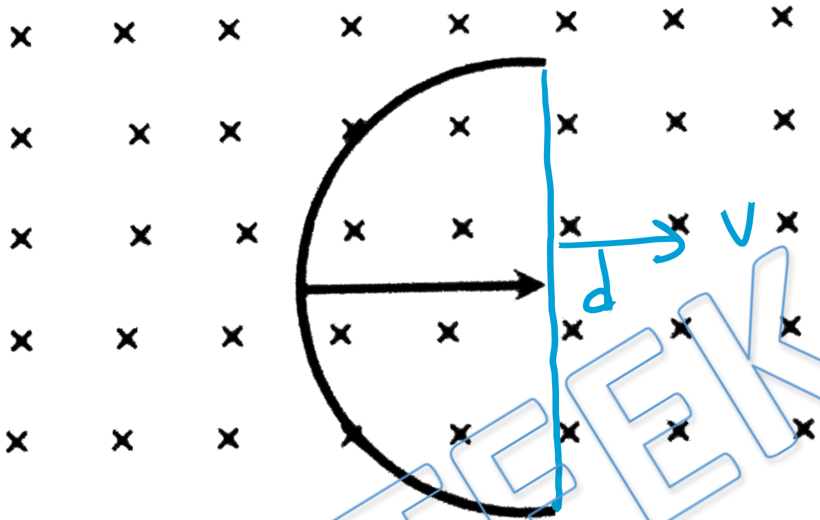
Written Solution

DPP- 2 EMI: Motional EMF (in rod and loop) and force on moving rod and loop, induced emf due to rotation of rod in field

By Physicsaholics Team

Solution: 1



$$n r = L$$

$$r = \frac{L}{n}$$

$$d = \frac{2L}{n}$$

$$l = d = \frac{2L}{n}$$

$$\varepsilon = Blv$$

$$\varepsilon = B\left(\frac{2L}{n}\right)v$$

$$\varepsilon = \frac{2BLv}{n}$$ Ans.

Ans. d

Solution: 2

$\varepsilon = Blv$

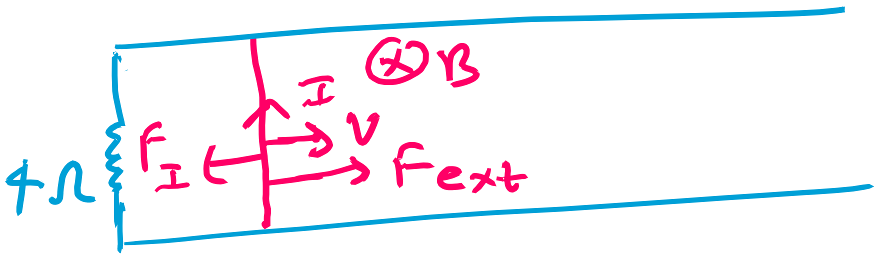
$\varepsilon = 0.7 \times 2 \times 2$

$\varepsilon = 1.4 \times 2$

$\boxed{\varepsilon = 2.8\ V}$ Ans.

Ans. b

Solution: 3



$\varepsilon = Bl$

$\varepsilon = 0.7 \times 2 \times 2$

$\boxed{\varepsilon = 2.8\ V}$

F_I = Force on wire due to induced current in magnetic field

F_{ext} = external force

If wire is moving at constant speed

$\Rightarrow \quad F_{ext} = F_I$

$F_{ext} = BIl$

$= 0.7 \times \frac{2.8}{4} \times 2$

$\boxed{F_{ext} = 0.98\ N}$

Rate of work = Power

$P = F_{ext} V$

$P = 0.98 \times 2$

$\boxed{P = 1.96\ W}$

or

The rate of work = power = Electric power dissipated through the resistor.

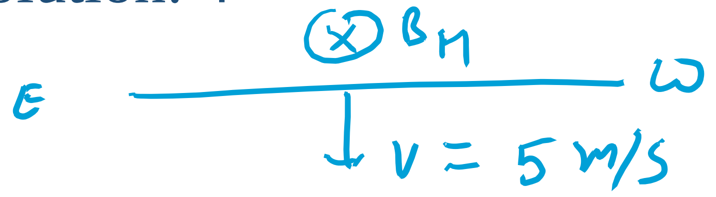
$P = IV$

$P = \left(\frac{2.8}{4}\right) \times 2.8$

$\boxed{P = 1.96\ W}$ Ans.

Ans. d

Solution: 4



$$\varepsilon = B l v$$

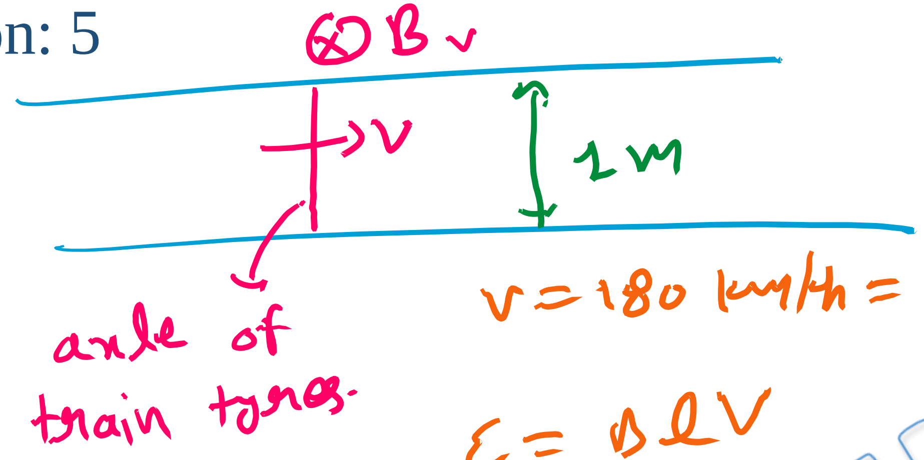
$$\varepsilon = 0.3 \times 10^{-4} \times 10 \times 5$$

$$\varepsilon = 1.5 \times 10^{-3}$$

$$\boxed{\varepsilon = 1.5 \text{ mV}}$$ Ans.

Ans. b

Solution: 5



$v = 180\ \text{km/h} = 50\ \text{m/s}$

$\varepsilon = B l v$

$\varepsilon = 0.2 \times 10^{-4} \times 1 \times 50$

$\varepsilon = 10 \times 10^{-4}\ V$

$\boxed{\varepsilon = 10^{-3}\ V}$ Ans.

or

$\boxed{\varepsilon = 1\ mV}$

Ans. c

Solution: 6

$$\varepsilon = (\vec{v} \times \vec{B}) \cdot \vec{l}$$

$$\vec{l} = 2\hat{k} \ (m)$$

$$\vec{v} = 2\hat{i} + 3\hat{j} + \hat{k} \ (m/s)$$

$$\vec{B} = \hat{i} + 2\hat{j} \ (wb/m^2)$$

$$\varepsilon = [(2\hat{i} + 3\hat{j} + \hat{k}) \times (\hat{i} + 2\hat{j})] \cdot (2\hat{k})$$

$$\varepsilon = [4\hat{k} - 3\hat{k} + \hat{j} - 2\hat{i}] \cdot (2\hat{k})$$

$$\varepsilon = [-2\hat{i} + \hat{j} + \hat{k}] \cdot [2\hat{k}]$$

$$\boxed{\varepsilon = 2 \text{ Volt}} \text{ Ans.}$$

Ans. a

Solution: 7

$f = 10\ Hz$

$\omega = 2\pi f = 2\pi \times 10$

$\omega = 20\pi\ rad/s$

$\varepsilon = \frac{1}{2} B \omega R^2$

$\varepsilon = \frac{1}{2} \times (0.1) \times (20\pi) \times (0.1)^2$

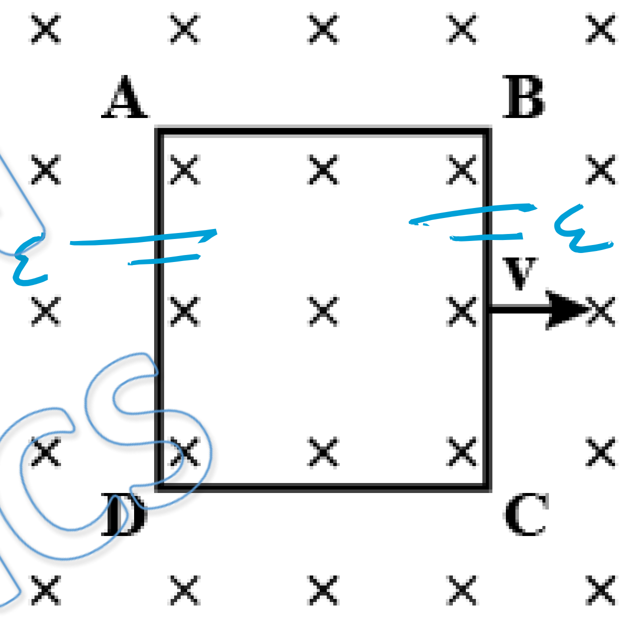
$\varepsilon = \frac{1}{2} \times 10^{-1} \times 20\pi \times 10^{-2}$

$\varepsilon = \pi \times 10^{-2}\ Volt$

$\boxed{\varepsilon = \pi \times 10^{-2}\ Volt}$ Ans.

Ans. c

Solution: 8



$\varepsilon_{AB} = 0$

$\varepsilon_{BC} = Blv$

$\varepsilon_{DC} = 0$

$\varepsilon_{AD} = Blv$

$\varepsilon_{net} = 0 + Blv + 0 - Blv$

$\boxed{\varepsilon_{net} = 0} \Rightarrow \boxed{I = 0}$ Ans.

(or)

in the given situation

$\Rightarrow B =$ constant

$A =$ constant

And loop is moving inside the magnetic field region.

so; $\phi = BA =$ constant

& $\dfrac{d\phi}{dt} = 0$

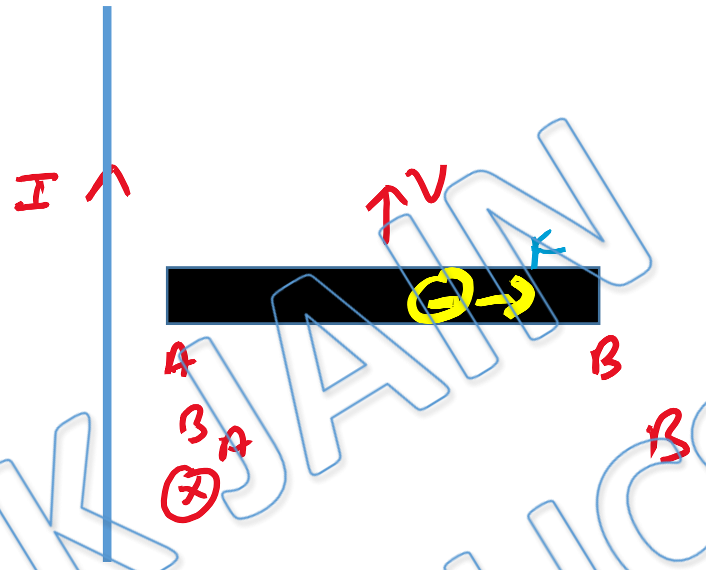
$\therefore \boxed{\varepsilon = -\dfrac{d\phi}{dt} = 0}$ Ans.

Ans. d

OR → for loop $\vec{l} = 0 \Rightarrow \varepsilon_{ind} = 0$.

Solution: 9

And magnetic field is inside the plane.



Force on -ve change = towards B

$\therefore$ $V_A > V_B$

Ans. d

Solution: 10

$\varepsilon = Blv \sin\theta$

$\theta = 30^\circ$

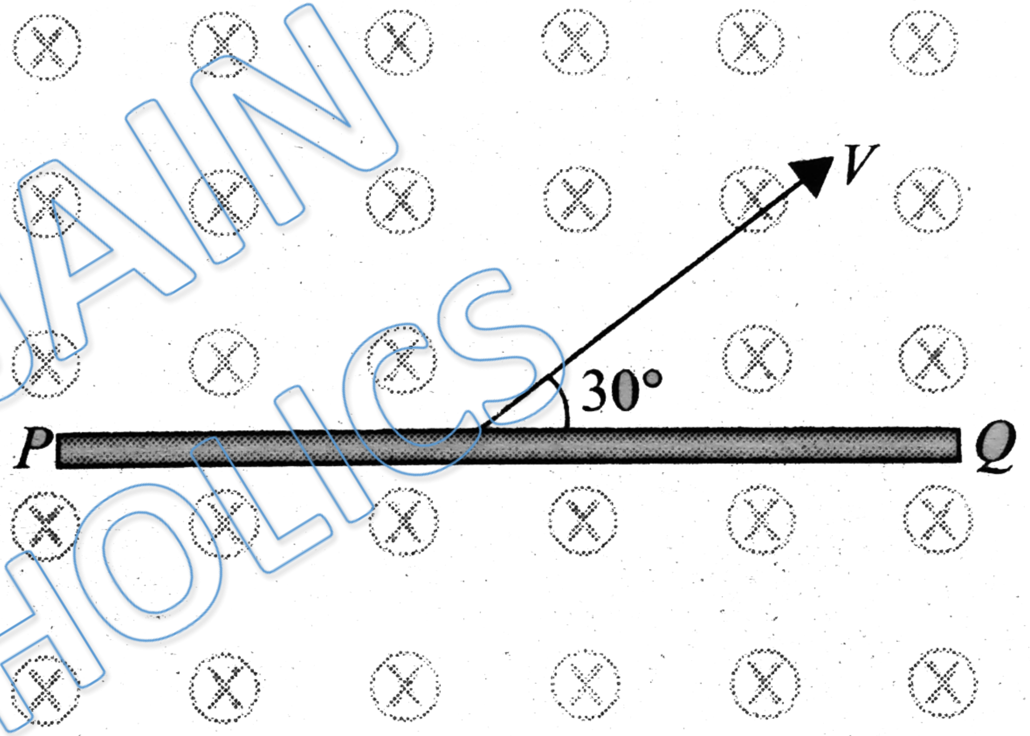
$\varepsilon = 2\times2\times2 \times \sin 30^\circ$

$\varepsilon = 8 \times 1/2$

$\varepsilon = 4$ Volt

$4 \Rightarrow V_P > V_Q$

$\therefore$ $V_P - V_Q = 4$ Volt Ans.



Ans. b

Solution: 11

$f = 100$ rps

$\omega = 2\pi f$

$\omega = 2\pi \times 100$

$\omega = 200\pi$ rad/sec

$\varepsilon = \frac{1}{2} B \omega l^2$

$\varepsilon = \frac{1}{2} \times 0.5 \times (200\pi) \times (20 \times 10^{-2})^2$

$\varepsilon = \frac{5}{2} \times 10^{-1} \times 2\pi \times 10^{2} \times 4 \times 10^{-2}$

$\varepsilon = 20\pi \times 10^{-1}$

$\boxed{\varepsilon = 2\pi \text{ Volt}}$ Ans.

or

$\varepsilon = 2 \times 3.14$

$\boxed{\varepsilon = 6.28 \text{ Volt}}$ Ans.

Ans. c

Solution: 12

$V_O - V_C = \frac{1}{2} B\omega (OC)^2$

$= \frac{1}{2} \times B\omega (3l)^2$

$V_O - V_C = \frac{9}{2} B\omega l^2$ —— (1)

And

$V_O - V_A = \frac{1}{2} B\omega (OA)^2$

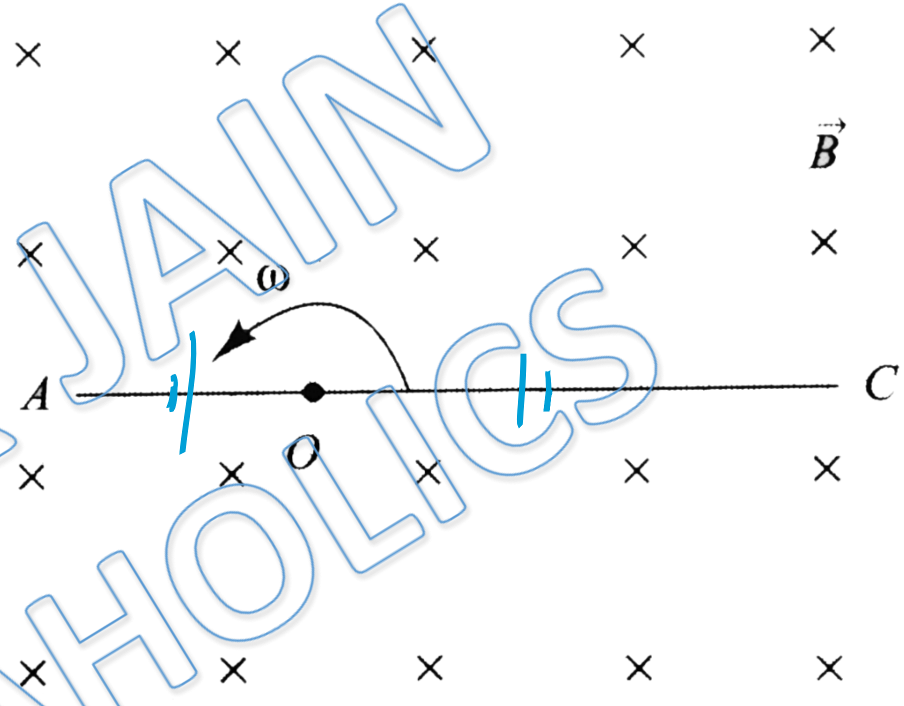
$= \frac{1}{2} \times B\omega (l)^2$

$V_O - V_A = \frac{1}{2} B\omega l^2$ —— (2)

(1) − (2) $\Rightarrow (V_O - V_C) - (V_O - V_A) = \frac{9}{2} B\omega l^2 - \frac{1}{2} B\omega l^2$

$-V_C + V_A = \frac{8}{2} B\omega l^2$

$\boxed{V_A - V_C = 4 B\omega l^2}$ Ans



Ans. a

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Chalo Niklo