DPP – 3 (EMI)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/79

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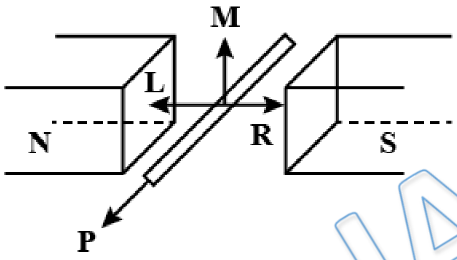
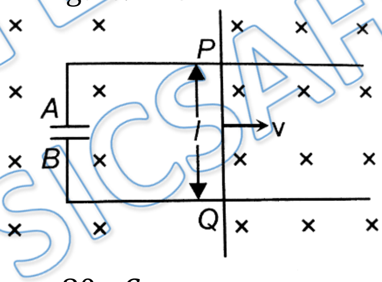
Q 1. An electric potential difference will be induced between the ends of the conductor shown in the diagram, when the conductor moves in the direction



(a) P (b) R
(c) L (d) M

Q 2. A conducting rod PQ of length $l = 1m$ is moving with a uniform speed v = 2m/s in a uniform magnetic field B = 4T directed into the paper. A capacitor of capacity C = 10 μF is connected as shown in figure. Then



(a) $q_A = +80\ \mu C$ and $q_B = -80\ \mu C$
(b) $q_A = -80\ \mu C$ and $q_B = +80\ \mu C$
(c) $q_A = 0 = q_B$
(d) Charge stored in the capacitor increase exponentially with time

Q 3. A coil of area $0.1m^2$has 500 turns. After placing the coil in a magnetic field (initially plane of coil is perpendicular to field) of strength $4 \times 10^{-4}\ Wb/m^2$ it is rotated through 90^0 in 0.1 s. The average emf induced in the coil is
(a) 0.2 Volt (b) 0.1 Volt
(c) 0.05 Volt (d) 0.012 Volt

Q 4. A coil of 1200 turns and mean area of 500 cm^2 is held its plane perpendicular to a uniform magnetic field of induction $4 \times 10^{-4}T$. The resistance of the coil is 20Ω. When the coil is rotated through 180^0 in the magnetic field in 0.1 seconds the average electric current (in mA) induced is:
(a) 12 (b) 24

(c) 36 (d) 48

Q 5. The e.m.f. induced in a coil of wire, which is rotating in a magnetic field, does not depend on
(a) the angular speed of rotation
(b) the area of the coil
(c) the number of turns on the coil
(d) the resistance of the coil

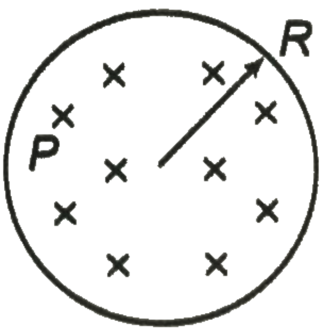
Q 6. The phase difference between the flux linkage and the induced e.m.f. in a rotating coil in a uniform magnetic field
(a) π (b) $\frac{\pi}{2}$
(c) $\frac{\pi}{4}$ (d) $\frac{\pi}{6}$

Q 7. The number of turns in the coil of an ac generator is 5000 and the area of the coil is 0.25 m^2. The coil is rotated at the rate of 100 cycles/sec in a magnetic field of 0.2 Wb/m^2. The peak value of the emf generated is nearly
(a) 786 kV (b) 440 kV
(c) 220 kV (d) 157.1 KV

Q 8. In a region of uniform magnetic induction B = 10^{-2}T, a circular coil of radius 30 cm and resistance π^2 ohm is rotated about an axis which is perpendicular to the direction of B and which forms a diameter of the coil. If the coil rotates at 200 rpm the amplitude of the alternating current induced in the coil
(a) $4\pi^2$ mA (b) 30 mA
(c) 6 mA (d) 200 mA

Q 9. Is induced electric field non conservative ?
(a) Yes (b) No
(c) May be sometimes (d) cannot say anything

Q 10. The figure shows as circular region of radius R occupied by a time varying magnetic field B(t) such that $\frac{dB}{dt} < 0$. The magnitude of induced electric field at the point P at a distance $r < R$ is:



(a) Directly proportional to r
(b) Inversely proportional to r
(c) Not varying with r

(d) varying as inversely proportional to r^2

Q 11. A uniform but time varying magnetic field B = $(2t^3 + 24t)\ T$ is present in a cylindrical region of radius R = 2.5 cm as shown in figure. The force on an electron at P at t = 2.0 s is

(a) 96×10^{-21}N (b) 48×10^{-21}N

(c) 24×10^{-21}N (d) zero

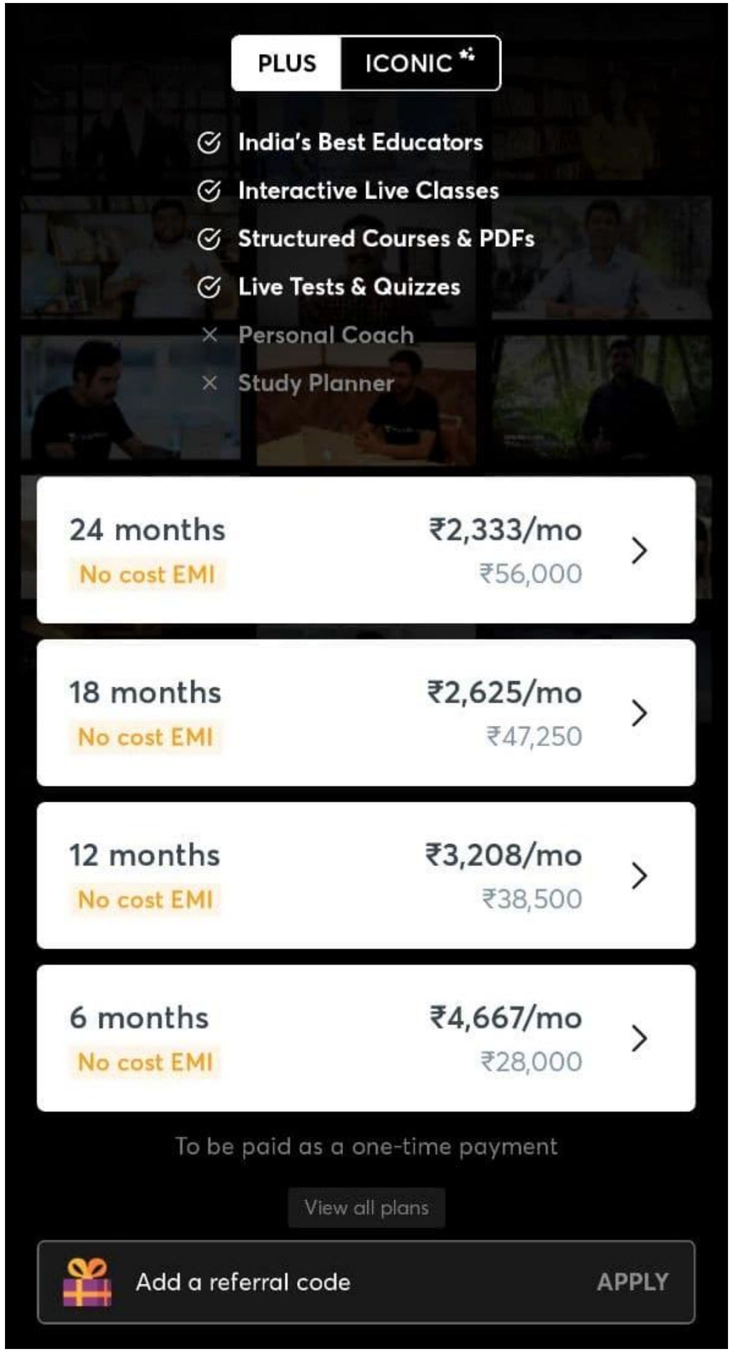
Q 12. A circular ring of radius 20cm has a resistance 0.01Ω. How much charge will flow through the ring if it is rotated from position perpendicular to the uniform magnetic field of B = 2T to a position parallel to field?

(a) 4 C (b) 6.28 C

(c) 3.14 C (d) 25.12 C

Answer Key

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



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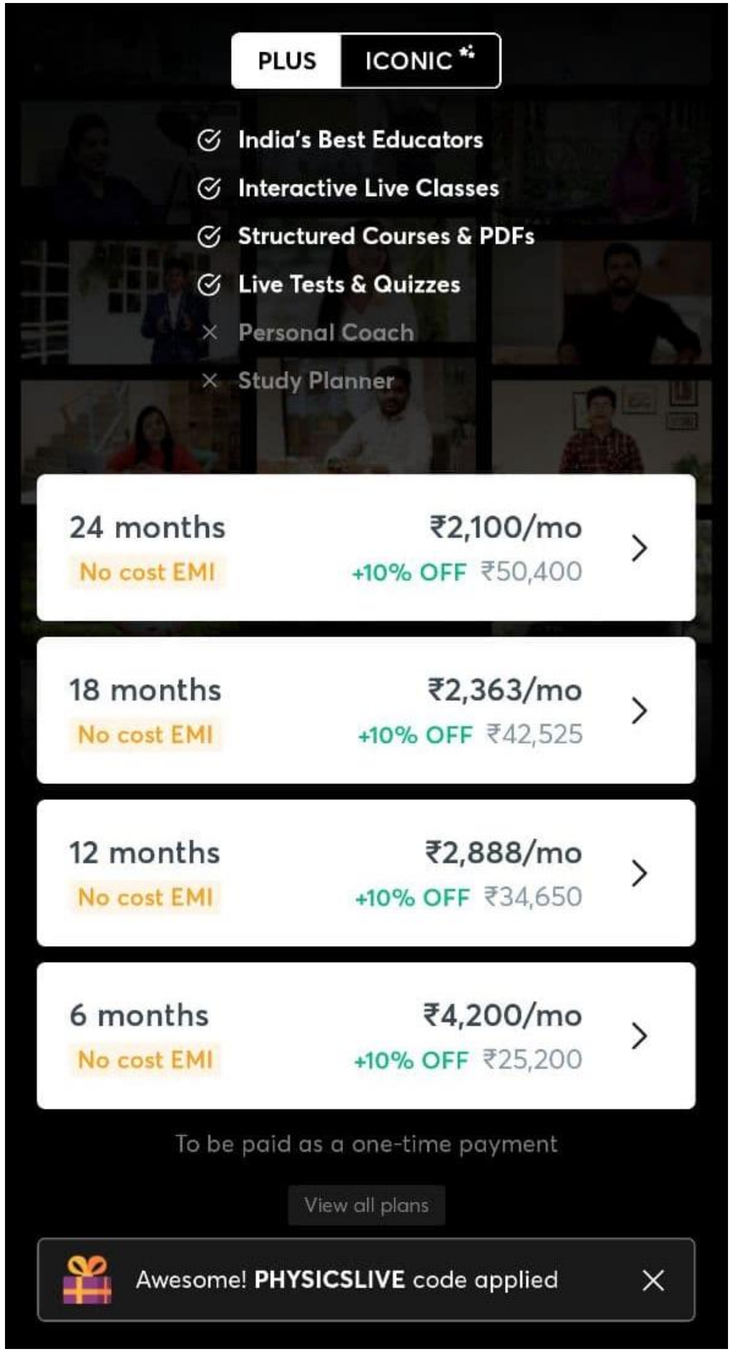

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Written Solution

DPP- 3 EMI: Principle of AC Generator, induced electric field due to varying magnetic field and induced current in loop

By Physicsaholics Team

Solution: 1

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

$\varepsilon = 0$; when $\vec{v} \parallel \vec{B}$ (or) $\vec{B} \parallel \vec{l}$ (or) $\vec{v} \parallel \vec{l}$

$\varepsilon = Blv$; when $v \perp B \perp l$

So; conductor should move along M to induce emf. Because conductor cuts magnetic flux only when, if it moves in the direction of M.

Ans. d

Solution: 2

$\varepsilon = B l v$

$\varepsilon = 4 \times 1 \times 2$

$\boxed{\varepsilon = 8 \text{ Volt}}$ (constant) $\because v = \text{constant}$.

For capacitor

$q = CV$

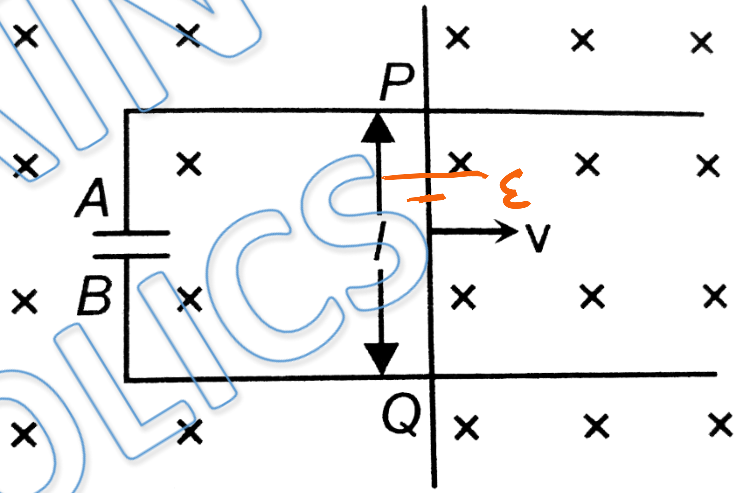
$q = 10\,\mu F \times 8 \text{ Volt}$

$\boxed{q = 80\,\mu C}$

$\because q_A = +ve$ & $q_B = -ve$

$\therefore$ end P is at heigher potential and Q is at lower potential

$\therefore \boxed{q_A = +80\,\mu C;\ q_B = -80\,\mu C}$ Ans.



Ans. a

Solution: 3

$\phi_i = nBA \quad [\theta = 0^\circ]$

$\phi_f = 0 \quad [\theta = 90^\circ]$

$\Delta\phi = nBA$

$\varepsilon = \frac{\Delta\phi}{\Delta t}$

$\varepsilon = \frac{nBA}{t}$

$\varepsilon = \frac{500 \times 4 \times 10^{-4} \times 0.1}{0.1}$

$\varepsilon = 2000 \times 10^{-4}$ Volt

$\boxed{\varepsilon = 0.2 \text{ Volt}}$ Ans.

Ans. a

Solution: 4

when rotated through 180°

$\Delta\phi = 2nBA = 2 \times 4 \times 10^{-4} \times 500 \times 10^{-4} \times 1200$

$\Delta\phi = 48 \times 10^{5} \times 10^{-8}$

$\Delta\phi = 48 \times 10^{-3}$ wb

$E_{avg} = \frac{\Delta\phi}{\Delta t} = \frac{48 \times 10^{-3}}{0.1}$

$E_{avg} = 48 \times 10^{-2}$ Volt

$I_{avg} = \frac{E_{avg}}{R}$

$I_{avg} = \frac{48 \times 10^{-2}}{20}$

$I_{avg} = 24 \times 10^{-3}$ Amp or $I_{avg} = 24$ mA Ans.

Ans. b

Solution: 5

Induced Emf in a rotating coil

$$\varepsilon = nBA\omega \sin\omega t$$

So; ε does not depend on the resistance of the coil.

Ans. d

Solution: 6

flux in a rotating coil

$$\phi = NBA\cos\omega t = NBA\sin(\omega t + \pi/2)$$

Induced emf :

$$\varepsilon = NBA\omega\sin\omega t$$

$$\therefore \boxed{\Delta\phi = \frac{\pi}{2}}$$ Ans.

Ans. b

Solution: 7

Induced emf

$\varepsilon = NBA\omega \sin \omega t$

for E_{max}; $\sin \omega t = 1$

$\therefore E_{max} = NBA\omega$

$= 5000 \times 0.2 \times 0.25 \times 200\pi$

$=$

$E_{max} = 157.1 \times 10^3$ Volt

or

$E_{max} = 157.1$ k Volt

Ans.

$f = 100$ cycle/s

$\omega = 2\pi f$

$\omega = 200\pi$ rad/s.

Ans. d

Solution: 8

$\omega = 2\pi f$

$\omega = 2\pi \times \frac{200}{60}$

$\boxed{\omega = \frac{20\pi}{3} \text{ rad/s}}$

Amplitude of AC = I_{max}

$I_{max} = \frac{E_{max}}{R}$

$E_{max} = NBA\omega = 1 \times 10^{-2} \times \pi \times (30 \times 10^{-2})^2 \times \frac{20\pi}{3}$

$E_{max} = \frac{18 \times 10^{3} \times 10^{-6} \times \pi^2}{3}$

$I_{max} = \frac{E_{max}}{R} = \frac{18 \times 10^{-3} \times \pi^2}{3 \times \pi^2} = 6 \times 10^{-3}$ Amp

$\boxed{I_{max} = 6 \text{ mA}}$ Ans.

Ans. c

Solution: 9

$$\int \vec{E}_{in} \cdot \vec{dl} = -\frac{d\phi}{dt}$$

E_{in} = induced Electric field

work done in close loop

$$W = \oint \vec{E}_{in} \cdot \vec{ds} \neq 0$$

Induced Electric field lines form closed loop.

$\therefore \vec{E}_{in}$ is Non-conservative always.

Ans. a

Solution: 10

$$\oint \vec{E}_{in} \cdot \vec{dl} = -\frac{d\phi}{dt}$$

$$\phi = BA$$

$$\frac{d\phi}{dt} = A\frac{dB}{dt}$$

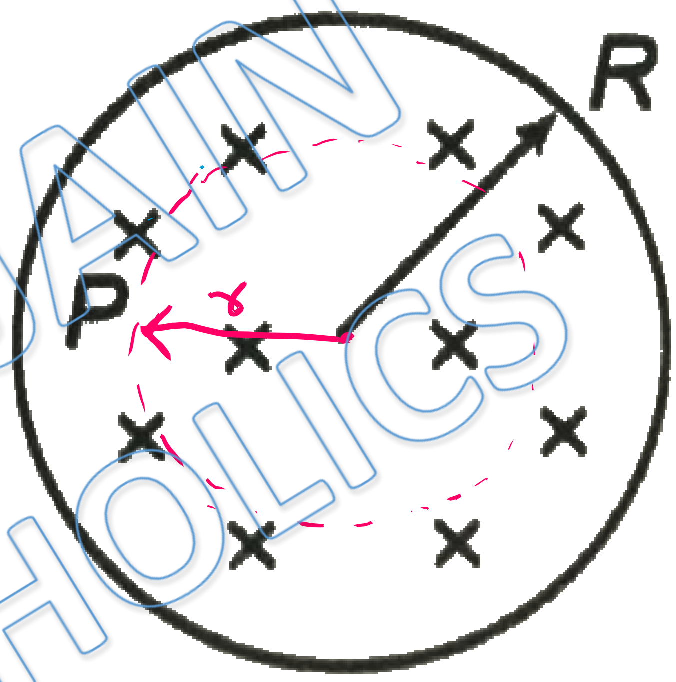
$$\frac{d\phi}{dt} = (\pi r^2)\frac{dB}{dt}$$

let $\frac{dB}{dt} = -K$

so, $-\frac{d\phi}{dt} = K(\pi r^2)$

$$\oint \vec{E} \cdot \vec{dl} = K(\pi r^2)$$

$$E(2\pi r) = K(\pi r^2)$$



$$E = \frac{K \pi r^2}{2\pi \cdot r}$$

$$\boxed{E = \frac{Kr}{2}}$$

$\Rightarrow$ $\boxed{E \propto r}$ Ans.

Ans. a

Solution: 11

$$B = 2t^3 + 24t$$

$$\phi = BA \Rightarrow \frac{d\phi}{dt} = A\frac{dB}{dt}$$

$$\frac{d\phi}{dt} = \pi \times (2.5\times10^{-2})^2 \times [6t^2 + 24]$$

at $t = 2$ sec

$$\frac{d\phi}{dt} = \pi \times 6.25 \times 10^{-4} \times [6\times2^2 + 24]$$

$$= \pi \times 6.25 \times 10^{-4} \times 48 = 942 \times 10^{-4}$$

$$\oint \vec{E}\cdot d\vec{l} = -\frac{d\phi}{dt} \Rightarrow E \times 2\pi(2.5\times10^{-2}) = -942\times10^{-4}$$

$$\boxed{E = 0.6 \text{ V/m}}$$

$$F = qE = 1.6\times10^{-19} \times 0.6$$

$$F = 0.96 \times 10^{-19}\ N \Rightarrow \boxed{F = 96\times10^{-21}\ N}$$ Ans.

Ans. a

Solution: 12

$$q = \frac{\Delta\phi}{R}$$

$$\Delta\phi = BA = 2 \times \pi \times (20\times10^{-2})^2$$

$$\Delta\phi = 800 \times \pi \times 10^{-4}$$

$$\Delta\phi = 8\pi \times 10^{-2} \text{ Wb}$$

$$q = \frac{\Delta\phi}{R}$$

$$q = \frac{8\pi\times10^{-2}}{0.01} = \frac{8\pi\times10^{-2}}{10^{-2}}$$

$$\boxed{q = 8\pi \text{ Coulomb}}$$ Ans.

Ans. d

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Chalo Niklo