SPECTRUM INTERACTIVE LIVE CLASSES

# CPT-6 SOLUTIONS

## PHYSICS : ELECTROMAGNETIC INDUCTION & ALTERNATING CURRENT

**1.** (c) Potential difference between $B$ and $A$

$V_B - V_A = \frac{1}{2} B\omega l^2$ and between $B$ and $C$

$V_B - V_C = \frac{1}{2} B\omega l^2$ so, $V_A - V_C = 0$

**2.** (c) Magnetic flux associated with triangular loop is constant.

**3.** (c) $U = 1KWH = 3.6 \times 10^5 J$ and $U = \frac{1}{2} Li^2$

$\Rightarrow L = \frac{2U}{i^2} = \frac{2 \times 3.6 \times 10^6}{200 \times 200} = \frac{2 \times 360}{2 \times 2} = 180\ H$

**4.** (d) When rod moves along $N$-$S$ direction it will not cut horizontal as well as vertical component of earth magnetic field, so $e_1 = 0$. When it moves along $E - W$, it will cut horizontal component of earth magnetic field, so $e_2 > 0$ and similarly $e_3 = 0$

$\Rightarrow$ So, $e_2 > (e_1 = e_3)$

**5.** (c) $i = i_0(1 - e^{-\frac{R}{L}t}) \Rightarrow \frac{di}{dt} = i_0 \frac{R}{L} e^{-\frac{R}{L}t}$

$\Rightarrow \left(\frac{di}{dt}\right)_{at\ t=0} = i_0 \frac{R}{L} = \frac{E}{R}.\frac{R}{L} = \frac{E}{L}$

**6.** (b) At resonance, voltage across $L$ and $C$ are same in magnitude but in opposite phase. So net voltage across $L - C$ will be zero.

**7.** (b) With the increase of frequency, capacitive reactance $\left(X_c = \frac{1}{2\pi fC}\right)$ will decrease and current through it will increase *i.e.* its glow will increase.

**8.** (d)

**9.** (c) When the switch is opened, an induced emf is produced in the circuit, which is in the direction of applied emf. Therefore, current through circuit increases and bulb glow more brightly.

**10.** (c) When the rod moves with a velocity $v$ in a uniform magnetic field, then force on the free electrons in the rod is $F_e = (-e)vB$ and its direction according to Fleming's left hand rule will be along $B$ to $A$. So free electrons will be accumulated at end $A$. Thus end $A$ will be negative and $B$ will be positively charged.

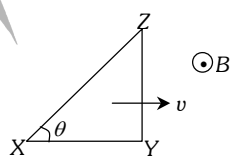
**11.** (c) When loop is translated or rotated about its axis there is no change in flux associated with the loop. So induced emf is zero. But when loop is rotated about its diameter flux associated with the loop will change and there will be induced emf in the loop.

**12.** (d) Emf induced in side $XZ$ is

$e_{XZ} = BV(XZ)\sin\theta$

putting $\sin\theta = \frac{ZY}{XZ}$

$\Rightarrow e_{XZ} = BV\,(ZY)$ with $X$-positive.




**13.** (c)

**14.** (d) Using Lenz's law

**15.** (b) At location (1) dots (.) associated with loop are increasing so according to Lenz's Law direction of induced current will be clockwise, at location (2) Magnetic flux links to loop is constant, so induced current is zero, at location 3, dots (.) associated with loop is decreasing so according to Lenz's law direction of induced current will be anti-clockwise.

**16.** (c) $dQ = \frac{d\phi}{R}$ *i.e.* $dQ$ is independent of $t$.

**17.** (d) Transformer doesn't work on dc

**18.** (b) Effective length between $A$ and $B$ remains same.

**19.** (c) $e = -L\frac{di}{dt} = -0.5\left(\frac{10-0}{2}\right) = -2.5V$

**20.** (d) In secondary *emf* induces only when current through primary changes.

**21.** (c) Peak value of $emf = e_0 = \omega NBA = 2\pi\nu NBA$

$= 2\pi \times 50 \times 300 \times 4 \times 10^{-2} \times (25 \times 10^{-2} \times 10 \times 10^{-2})$

$= 30\ \pi\ volt$

**22.** (a) $e = Bvl = 5 \times 10^{-5} \times \frac{360 \times 1000}{3600} \times 20 = 0.1V$

**23.** (b) $\Delta Q = \frac{\Delta\phi}{R} = \frac{n \times BA}{R}$

$\Rightarrow B = \frac{\Delta Q.R}{nA} = \frac{2 \times 10^{-4} \times 80}{40 \times 4 \times 10^{-4}} = 1\ Wb/m^2$

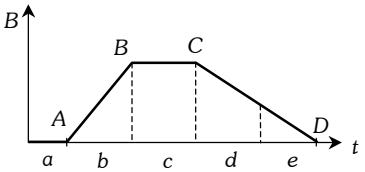
**24.** (c) $|e| = \frac{d\phi}{dt} = \frac{d}{dt}(5t^2 + 3t + 16) = (10t + 3)$

at $t = 3$ sec $e_3 = (10 \times 3 + 3) = 33\ V$

**25.** (b) When the magnet is allowed to fall vertically along the axis of loop with its north pole towards the ring. The upper face of the ring 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 $g$.

**26.** (b) Induced emf $e = A\frac{dB}{dt}$

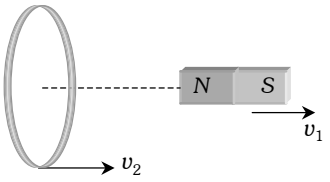
*i.e.* $e \propto \frac{dB}{dt}$ (= slope of $B - t$ graph)




In the given graph slope of $AB$ > slope of $CD$, slope in the '$a$' region = slope in the '$c$' region = 0, slope in the '$d$' region = slope in the '$e$' region $\neq 0$. That's why $b > (d = e) > (a = c)$

**27.** (a) Speed of the magnet

$v_1 = \frac{240}{120} = 2 m/s$




Speed of the coil

$v_2 = \frac{2}{1} = 2 m/s$

Relative speed between coil and magnet is zero, so there is no induced emf in the coil.

**28.** (d) Rod is moving towards east, so induced emf across it's end will be $e = B_V vl = (B_H \tan\phi) vl$

$\therefore\ e = 3\times10^{-4} \times \frac{4}{3} \times (20\times10^{-2}) \times 2 = 16\times10^{-5} V = 160\,\mu V$

**29.** (d) Induced charge $Q = -\frac{NBA}{R}(\cos\theta_2 - \cos\theta_1)$

$= -\frac{NBA}{R}(\cos 180^o - \cos 0^o) \Rightarrow B = \frac{QR}{2NA}$

**30.** (c) $2\pi\nu = 377 \Rightarrow \nu = 60.03\ Hz$

**31.** (c) Resonance frequency in *radian/second* is

$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{8\times0.5\times10^{-6}}} = 500\ rad/sec$

**32.** (c) $i_{WL} = i_{rms} \sin\phi \Rightarrow \sqrt{3} = 2\sin\phi \Rightarrow \sin\phi = \frac{\sqrt{3}}{2}$

$\Rightarrow \phi = 60^o$ so p.f. $= \cos\phi = \cos 60^o = \frac{1}{2}$.

**33.** (c) With dc : $P = \frac{V^2}{R} \Rightarrow R = \frac{(10)^2}{20} = 5\,\Omega$ ;

With ac : $P = \frac{V_{rms}^2 R}{Z^2} \Rightarrow Z^2 = \frac{(10)^2 \times 5}{10} = 50\,\Omega^2$

Also $Z^2 = R^2 + 4\pi^2\nu^2L^2$

$\Rightarrow 50 = (5)^2 + 4(3.14)^2\nu^2(10\times10^{-3})^2 \Rightarrow \nu = 80\,Hz.$

**34.** (d) The current will lag behind the voltage when reactance of inductance is more than the reactance of condenser.

Thus, $\omega L > \frac{1}{\omega C}$ or $\omega > \frac{1}{\sqrt{LC}}$

or $n > \frac{1}{2\pi\sqrt{LC}}$ or $n > n_r$ where $n_r$ = resonant frequency.

**35.** (b) $V_0 = i_0 Z \Rightarrow 200 = 100\,Z \Rightarrow Z = 2\Omega$

Also $Z^2 = R^2 + X_L^2 \Rightarrow (2)^2 = (1)^2 + X_L^2 \Rightarrow X_L = \sqrt{3}\Omega$

**36.** (b) With the increasing speed, $\omega$ increases. Thus current reduces due to increase in the back *emf*

Moreover $i = \frac{V - K\omega}{R}$. More $\omega$ will lead to the lesser current.

**37.** (a) $\phi = NBA\cos\theta = 100\times0.2\times5\times10^{-4}\cos 60^o$

$= 5\times10^{-3} Wb$

**38.** (c) $L = \mu_0 \frac{N^2}{l} A$. When $N$ and $l$ are doubled. $L$ is also doubled.

**39.** (c)

**40.** (d) $N\phi = Li \Rightarrow 100\times10^{-5} = L\times5 \Rightarrow L = 0.2\,mH.$

**41.** (b) In *dc* ammeter, a coil is free to rotate in the magnetic field of a fixed magnet.

If an alternating current is passed through such a coil, the torque will reverse it's direction each time the current changes direction and the average value of the torque will be zero.

**42.** (c) Hot wire ammeter reads *rms* value of current. Hence its peak value $= i_{rms} \times \sqrt{2} = 14.14\ amp$

**43.** (d) Brightness $\propto P_{consumed} \propto \frac{1}{R}$ for Bulb, $R_{ac} = R_{dc}$, so brightness will be equal in both the cases

**44.** (b) Reading of ammeter $= i_{rms} = \frac{V_{rms}}{X_C} = \frac{V_0\omega C}{\sqrt{2}}$

$= \frac{200\sqrt{2}\times100\times(1\times10^{-6})}{\sqrt{2}} = 2\times10^{-2} A = 20\ mA$

**45.** (d)

**46.** (a) At resonant frequency, $X_L = X_C \ \therefore\ Z = R$ (minimum) there for current in the circuit is maximum.

**47.** (d) On introducing soft iron core, the bulb will glow dimmer. This is because on introducing soft iron core in the solenoid, its inductance $L$ increases, the inductive reactance, $X_L = \omega L$ increases and hence the current through the bulb decreases.

**48.** (c) According to Faraday's laws, the conversion of mechanical energy into electrical energy. This is in accordance with the law of conservation of energy. It is also clearly known that in pure resistance, the emf is in phase with the current.

**49.** (c) Presence of magnetic flux cannot produce current.

**50.** (a)