Electromagnetic Induction and Alternating Current

1. The work function of a metal is 1 eV. When the surface of this metal is illuminated with light of wavelength 64000 Å, then the maximum kinetic energy of emitted photoelectron will be

(a) $31 \times 19{-}19$ J
(b) $3.1 \times 10{-}19$ J
(c) $0.15 \times 10{-}19$ J
(d) $1.5 \times 10{-}19$ J

Answer: (d)

$\varphi 0=1w; h\nu=$energy of incident photon.

$\lambda= 64000$ Å; $c = 3 \times 108\ ms{-}1$; $h = 6.6 \times 10{-}34$ Js.

The $K_{max}=\frac{hc}{\lambda}-\varphi 0$, 1 ev. = $1.6 \times 10{-}19$ Joule.

2. The stopping potential for a certain photosensitive metal is V0 when the frequency of incident radiation is V0. When the frequency of the incident radiations is doubled, what will be the stopping potential?

(a) V0
(b) 2V0
(c) 4V0
(d) none of the above

Answer: (d)

$h\nu - h\nu o = evo$ (i)

If $h\nu' - h\nu o = ev'o$ (ii)

If $\nu' = 2\nu$ (iii)

From given information, we can't have $\nu'o$ in terms of νo.

3. The threshold frequency for a photosensitive metal is $v0$. When photons of frequency $2v0$ are incident on a photosensitive plate, the cut off potential is V0. What will be the cut off potential, when light of frequency $5v0$ is incident on it?

(a) V0 (b) 2V0 (c) 4V0 (d) 5V0

Answer: (c)

$h\nu - \varphi o = evo$ (i)

$\varphi o = h\nu o$

As when $\nu = 2\nu o$ Then $h(2\nu o) - h\nu o = evo$

$\Rightarrow h(2\nu) - h\nu o = evo$ (i)

Now, $e \cdot v'o = h \times 5\nu o - h\nu o = 4h\nu o$

$\therefore v'o = \frac{4h}{e} \times \frac{e}{h} \cdot vo = 4v.^{o}$

4. What is the de Broglie wavelength of an electron possessing 100 eV kinetic energy?

(a) 6.6260 nm (b) 1.60000 nm

(c) 12.2800 nm (d) 0.1228 nm

Answer: (d)

$\lambda = \frac{h}{p}$ (i)

As $P = \sqrt{2mqv}$

q = 1.6 × 10−19 coul. m = 9.1 × 10−31 kg.

v = P.D applied

qv = E = 100 ev = 100 × 1.6 × 10−19 Joule.

5. We wish to see inside an atom. Assuming the atom to have a diameter of 100 pm [1 picometer (pm), 10-12 m], this means that one must be able to resolve width of, say 10 pm. If an electron microscope is used, the minimum electron energy required is about

(a) 1.5 keV (b) 15 KeV (c) 150 keV (d) 1.5 MeV

Answer: (b)

$$\lambda = \frac{h}{\sqrt{2mK}}$$

$$\lambda^2 = \frac{h^2}{2mK}$$

$$K = \frac{h^2}{2m\lambda^2} = \frac{(6.6\times10^{-34})^2}{2\times9.1\times10^{-31}\times(10\times10^{-12})^2}\,J = \frac{6.6\times6.6\times10^{-15}}{2\times9.1\times1.6\times10^{-16}}\,keV = 15.1\,KeV$$

6. If K1 and K2 are maximum kinetic energies of photoelectrons emitted when lights of wavelength λ_1 and λ_2 respectively incident on a metallic surface and $\lambda_1 = 3\lambda_2$, then

(a) $K_1 > (K_2/3)$ (b) $K_1 < (K_2/3)$ (c) $K_1 = 2K_2$ (d) $K_2 = 2K_1$

Answer: (b)

$$K_1 = \frac{hc}{\lambda_1} - W_0$$

$$K_2 = \frac{hc}{\lambda_2} - W_0 \quad \text{or} \quad \frac{hc}{\lambda_2} = K_2 + W_0$$

Now, $K_1 - K_2 = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right) = hc\left(\frac{1}{3\lambda_2} - \frac{1}{\lambda_2}\right) = -\frac{2hc}{3\lambda_2} = -\frac{2}{3}(K_2 + W_0)$

or $K_1 = K_2 - \frac{2}{3}K_2 - \frac{2}{3}W_0 = \frac{K_2}{3} - \frac{2}{3}W_0$

$$\Rightarrow K_1 < \frac{K_2}{3}$$

7. If the kinetic energy of a particle is increased by 16 times, the percentage change in the de Broglie wavelength of the particle is (a) 25%

(b) 75% (c) 60% (d) 50%

Answer: (b)

$$\lambda = \frac{h}{\sqrt{2mK}}$$

$$\lambda' = \frac{h}{\sqrt{2m \times 16K}} = \frac{\lambda}{4}$$

% Change in de-Broglie wavelength,

$$\frac{\lambda - \lambda'}{\lambda} \times 100 = \left(1 - \frac{\lambda'}{\lambda}\right) \times 100 = \left(1 - \frac{1}{4}\right) 75\%$$

8. Two different coils have self-inductance $L1 = 8mH$, $L2 = 2mH$. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same rate. At a certain instant of time, the power given to the two coils is the same. At that time the current, the induced voltage and the energy stored in the first coil are $i1$, $V1$ and $W1$ respectively. Corresponding values for the second coil at the same instant are $i2$, $V2$ and $W2$ respectively. Then choose incorrect option

(a) $\frac{i1}{i2} = \frac{1}{4}$ (b) $\frac{i1}{i2} = 4$ (c) $\frac{W2}{W1} = 4$ (d) $\frac{V2}{V1} = \frac{1}{4}$

Answer: (b)

By $|e| = L\frac{di}{dt} \Rightarrow \frac{e_1}{e_2} = \frac{L_1}{L_2}\left(\frac{di}{dt} - \text{same}\right) \Rightarrow \frac{V_1}{V_2} = \frac{8}{2} = 4$

Power $P = ei \Rightarrow i \propto \frac{1}{e}$ $\{P - \text{same}\}$

$\Rightarrow \frac{i_1}{i_2} = \frac{e_2}{e_1} = \frac{V_2}{V_1} = \frac{L_2}{L_1} = \frac{2}{8} = \frac{1}{4}$

Energy stored $W = \frac{1}{2}Li^2$; $\frac{W_1}{W_2} = \frac{L_1}{L_2} \times \left(\frac{i_1}{i_2}\right)^2 = 4 \times \left(\frac{1}{4}\right)^2 = \frac{1}{4}$.

9. $\frac{2.5}{\pi}$ μF capacitor and 3000-*ohm* resistance are joined in series to an ac source of 200 *volt* and $50 \sec^{-1}$ frequency. The power factor of the circuit and the power dissipated in it will respectively

(a) 0.6, 0.06 *W* (b) 0.06, 0.6 *W*

(c) 0.6, 4.8 *W* (d) 4.8, 0.6 *W*

Answer: (c)

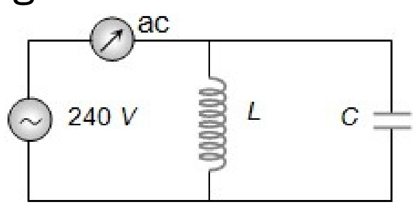
$$Z = \sqrt{R^2 + \left(\frac{1}{2\pi\nu C}\right)^2} = \sqrt{(1000)^2 + \frac{1}{\left(2\pi \times 50 \times \frac{2.5}{\pi} \times 10^{-6}\right)^2}}$$

$\Rightarrow Z = \sqrt{(3000)^2 + (4000)^2} = 5 \times 10^3 \,\Omega$

So power factor $\cos\phi = \frac{R}{Z} = \frac{3000}{5 \times 10^3} = 0.6$ and power

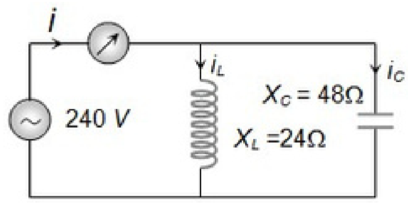
$P = V_{rms} i_{rms} \cos\phi = \frac{V_{rms}^2 \cos\phi}{Z} \Rightarrow P = \frac{(200)^2 \times 0.6}{5 \times 10^3} = 4.8\,W$

10. In the following circuit diagram inductive reactance of inductor is 24Ω and capacitive reactance of capacitor is 48Ω, then reading of ammeter will be



(a) 5 *A* (b) 2.4 *A* (c) 2.0 *A* (d) 10 *A*

Answer: (a)

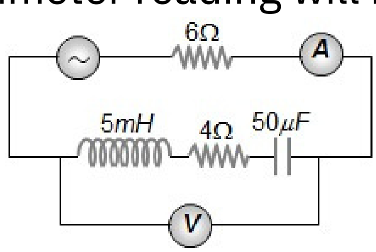


$i_L = \frac{240}{24} = 10A$

$i_C = \frac{240}{48} = 5A$

Hence, $i = i_L - i_C = 5A$

11. In the circuit shown in the figure the ac source gives a voltage V=20cos(2000t). Neglecting source resistance, the voltmeter and ammeter reading will be



(a) 0 V, 0.47 A (b) 1.68 V, 0.47 A (c) 0 V,1.4 A (d) 5.6V,1.4A

Answer: (d)

$X_L = \omega L$ = 2000 × 5 × 10−3 = 10 Ω and $X_C = \frac{1}{2000 \times 50 \times 10^{-6}} = 10\Omega$

Total impedance of the circuit

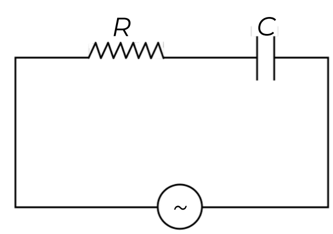
$= \sqrt{(R)^2 + (X_L - X_C)^2} = \sqrt{(4)^2 + 0} = 10\Omega$

Ammeter reads *r.m.s.* current so it's value

$i_{rms} = \frac{V_{rms}}{\text{Total impedance}} = \frac{20/\sqrt{2}}{10} = \sqrt{2} = 1.41A$

Since, $X_L = X_C$; this is the condition of resonance and in this condition $V = V_R = iR$ = 1.4 × 4 = 5.6 *V*.

12. A 50 Hz AC source of 20V is connected across *R* and *C* as shown in figure. The voltage across *R* is 12V. The voltage across *C* is



(a) 8V

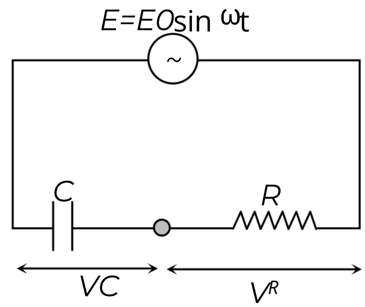
(b) 16V

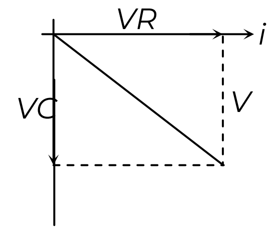
(c) 10V

(d) not possible to determine unless values of R and C are given

Answer: (b)

The given circuit is a C-R series circuit, V_R is in phase with *i*, while V_C lags behind *i* by 90⁰. Hence, resultant potential is $V = \sqrt{V_R^2 + V_C^2}$





$\therefore\ (20)^2 = (12)^2 + V_C^2$

$\Rightarrow\ V_C^2 = (20)^2 - (12)^2 = 400 - 144 = 256$

$\Rightarrow\ V_C = \sqrt{256} = 16V$

13. An *L–C–R* series circuit is connected to an external e.m.f. *e* = 200 sin 100 π*t*. The value of the capacitance and resistance in the circuit are 1μ*F* and 100Ω respectively. The amplitude of the current in the circuit will be maximum when the inductance is

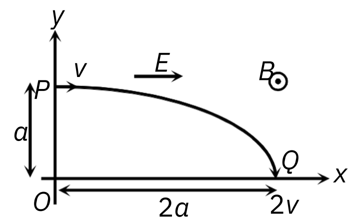
(a) 100 H (b) $\frac{100}{\pi^2}$H (c) 100π H (d) 100 π^2H

Answer: (b)

For maximum current $X_L = X_C \Rightarrow \omega L = \frac{1}{\omega C}$

$\therefore\ L = \frac{1}{\omega^2 C} = \frac{1}{(100\pi)^2 \times 1 \times 10^{-6}} = \frac{100}{\pi^2}\ H$

14. A particle of charge Q, mass m is moving under the influence of uniform electric field $E\hat{i}$ and a uniform magnetic field $B\hat{k}$ follows a trajectory from P to Q as shown in figure. The velocity at P and Q are $v\hat{i}$ and $2v\hat{j}$ respectively. Find the rate of work done by electric field at P.



(a) $\frac{3}{4}\left(\frac{mv^2}{qa}\right)$ (b) $\frac{3}{4}\left(\frac{mv^3}{a}\right)$

(c) $\frac{3}{4}\left(\frac{mv^3}{qa}\right)$ (d) none of these

Answer: (b)

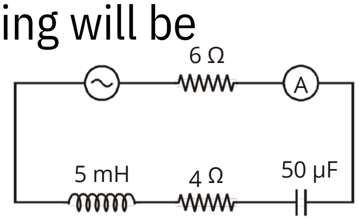
Work done = change in KE

$W_{PO} + W_{OQ} = \frac{1}{2}m(2v)^2 - \frac{1}{2}m(v)^2$, $qE(a\cos 90^\circ) + qE(2a\cos 0) = \frac{3}{2}mv^2$

$0 + qE(2a) = 3/2\, mv^2$, $E = \frac{3}{4}\left(\frac{mv^2}{qa}\right)$

Rate of work done $F.v = q.Ev = \frac{3}{4}\left(\frac{mv^3}{a}\right)$

15. In the circuit shown in the figure. The a.c. source gives a voltage $V = 20\sin(2000t)$. Neglecting source resistance ammeter reading will be



a) $\sqrt{2}$ A

b) 2 A
c) $2\sqrt{2}$A
d) $\frac{1}{\sqrt{2}}$A

Answer: (a)

Explanation:

$X_L = 2000 \times 5 \times 10^{-3} = 10$

$X_C = \frac{1}{\omega C} = \frac{1}{2000 \times 50 \times 10^{-6}} = 10\ \Omega$

$I_0 = \frac{20}{10} = 2, I_{rms} = \frac{2}{\sqrt{2}} = 1.4$

16. A small square loop of wire of side l is placed inside a large square loop of wire of side L(>>l). The loops are coplanar and their centres coincide. The mutual inductance of the system is:

(a) Directly proportional to l2

(b) Inversely proportional to l2

(c) Directly proportional L2

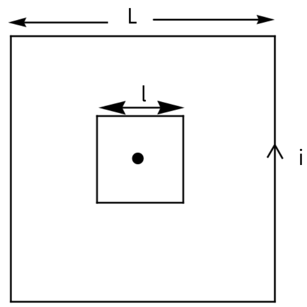
(d) Inversely proportional to L2

Answer: (a)

Because of larger loop, the field at the centre will be

$B = \frac{4 \times \mu_0 i}{4\pi(L/2)}(\sin 45^0 + \sin 45^0)$

$$B = \frac{\mu_0}{4\pi}\frac{8\sqrt{2}}{L}i$$



So, flux linked with the smaller loop $\varphi_2 = BS_2 = \frac{\mu_0}{4\pi}\frac{8\sqrt{2}}{L}il^2$

$$\varphi_2 = Mi_1$$

Or $Mi = \frac{\mu_0}{4\pi}\frac{8\sqrt{2}}{L}il^2$

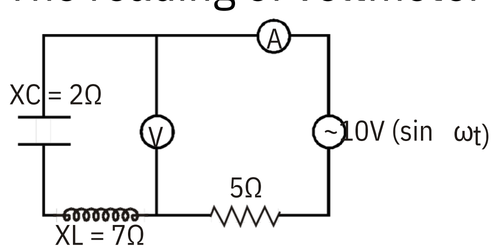
Or $M = \frac{\mu_0}{4\pi}\frac{8\sqrt{2}l^2}{L}$

Or $M \alpha l^2$

Hence, choice (D) is correct and choice (B) is wrong.

Also, $M \alpha \frac{1}{L}$

17. In the figure shown hot wire voltmeter and hot wire ammeter are ideal. The reading of voltmeter is



(a) $5\sqrt{2}$ V (b) 5V (c) 10V (d) None of these

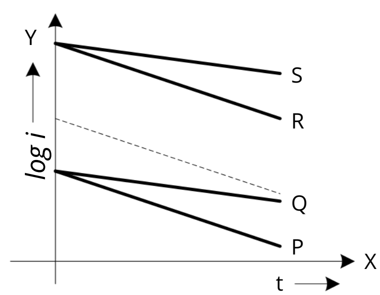
Answer: (b)

$$Z = \sqrt{(X_L - X_C)^2 + R^2} = \sqrt{25+25} = 5\sqrt{2}$$

$$I_{rms} = \frac{10/\sqrt{2}}{5\sqrt{2}} = 1$$

$$V = 1 \times (X_L - X_C) = 1 \times 5 = 5 \text{ volt}$$

18. In an RC circuit while charging, the graph of in i versus time is as shown by the dotted line in the diagram figure, where i is the current. When the value of the resistance is doubled, which of the solid curve best represents the variation of in i versus time?



(a) P (b) Q (c) R (d) S

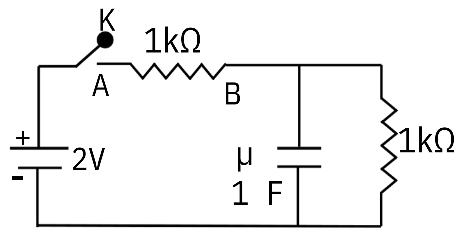
Answer: (b)

In case of RC circuit $i = \frac{E}{R} e^{-t/RC}$

$$\therefore \quad \log_e i = -\frac{t}{RC} + \log_e \frac{E}{R}$$

When R is doubled, the slope of the curve increases. Further at t = 0, the current will be less for an increased value of resistance.

19. When the key K is pressed at time t = 0, which of the following statements about the current I, in the resistor AB of the given circuit is true.



(a) 2mA at all time

(b) Oscillates between 1mA and 2mA

(c) 1mA at all time

(d) At t = 0, I = 2mA and with time it finally reduces to 1Ma.

Answer: (d)

Initially the capacitance acts as short circuited and at steady it acts as open circuit.

Hence, at t = 0, $i = \frac{2}{1\times10^{3}} = 2mA$

At steady state $i = \frac{2}{2\times10^{3}} = 1mA$

20. An AC source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of source is changed to ω/3 (but maintaining the same voltage), the current in the circuit is found to be halved. The ratio of reactance to ohmic resistance at the original frequency ω will be.

(a) $\sqrt{\frac{3}{5}}$ (b) $\sqrt{\frac{5}{3}}$

(c) $\frac{3}{5}$ (d) $\frac{5}{3}$

Answer: (a)

According to given problem,

$$I = \frac{V}{Z} = \frac{V}{\left[R^2 + (1/C\omega)^2\right]^{1/2}} \quad \text{.............................(1)}$$

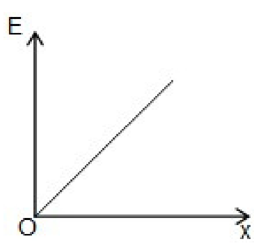
And $$\frac{I}{2} = \frac{V}{\left[R^2 + (3/C\omega)^2\right]^{1/2}} \quad \text{.............................(2)}$$

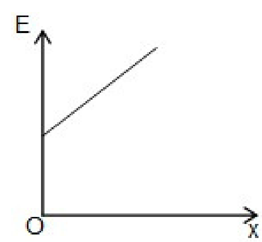
Substituting the value of I from equation (1) in (2),

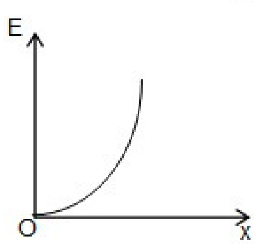
$$4\left[R^2 + \frac{1}{C^2\omega^2}\right] = R^2 + \frac{9}{C^2\omega^2}, \text{ i.e., } \frac{1}{C^2\omega^2} = \frac{3}{5}R^2$$

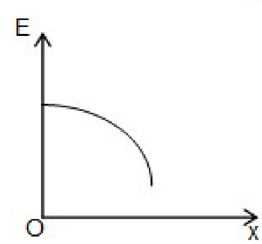
So that $$\frac{X}{R} = \frac{(1/C\omega)}{R} = \frac{\left[(3/5)R^2\right]^{1/2}}{R} = \sqrt{\frac{3}{5}}$$

21. A cylindrical conductor has uniform cross section. Resistivity of its material Increases linearly from left end to right end. If a constant current is flowing through it and at a section of distance x from left end, magnitude of electric field intensity is E, which of the following graphs is correct?

(a)


(b)


(c)


(d)


Answer: (b)

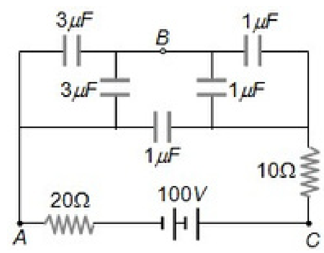
If you take resistivity at a distance ‘x’ from left end as

$\rho = (\rho 0 + \alpha x)$, then electric field intensity at this point will be $E = \frac{iP}{A}$, where i is the current flowing through the conductor.

Therefore, $E \propto P$ and $E(x) = \frac{i(\rho 0+\alpha x)}{A}$

Hence, choice (2).

22. In the figure below, what is the potential difference between the point *A* and *B* and between *B* and *C* respectively in steady state



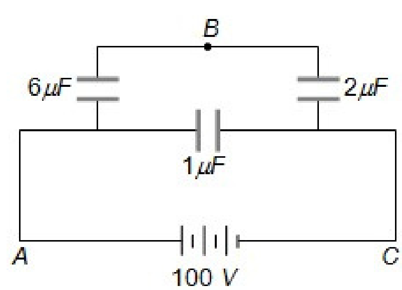
(a) VAB=VBC=100V

(b) VAB=75V,VBC=25V

(c) VAB=25V,VBC=75V

(d) VAB=VBC=50V

Answer: (c)



$$C_{eq} = \frac{(3+3)\times(1+1)}{(3+3)+(1+1)} + 1 = \left(\frac{6\times 2}{6+2}\right) + 1 = \frac{5}{2}\mu F$$

$$\therefore \quad Q = C \times V = \frac{5}{2}\times 100 = 250\mu C$$

Charge in 6μF branch

$$= VC = \left(\frac{6\times 2}{6+2}\right)100 = 150\mu C$$

$V_{AB} = \frac{150}{6}$ =25V and VBC=100 V AB=75V

23. A current I = 10 sin(100π t) amp. is passed in first coil, which induces a maximum e.m.f of 5π volt in second coil. The mutual inductance between the coils is -

(a) 10 mH (b) 15 mH (c) 25 mH (d) 5 mH

Answer: (d)

Let $I = I_0 \sin\omega t$,

where $I_0 = 10$, $\omega = 100\pi$

then $\varepsilon = M \frac{dI}{dt}$

$= M \frac{d}{dt} I_0 \sin \omega t$

$= M I_0 \omega \cos\omega t$

$\therefore \varepsilon_{max} = M I_0 \omega$

$5\pi = M \times 10 \times 100\pi$

M = 5mH

24. Assertion: After increasing the magnetic flux through induction the self-inductance also increases.

Reason: Because the self-inductance is directly proportional to the magnetic flux.

a) If both Assertion & Reason are true and the reason is the correct explanation of the assertion.

b) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion.

c) If Assertion is true statement but Reason is false.

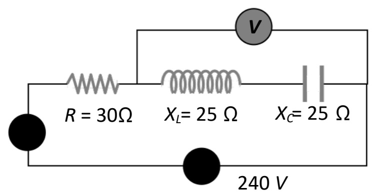
d) If both Assertion and Reason are false statements.

Answer: (d)

Explanation:

The value of the self-inductance will be high if the magnetic flux is stronger for the given value of current. Therefore After increasing the magnetic flux through induction the self-inductance also increases because the self-inductance is directly proportional to the magnetic flux.

25. In the circuit shown in figure neglecting source resistance the voltmeter and ammeter reading will respectively, will be



(a) 0V,3A (b) 150V, 3A (c) 150V, 6A (d) 0V, 8A

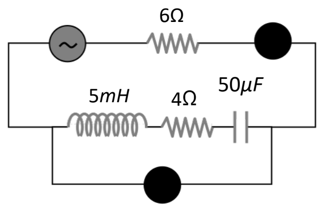
Answer: (d)

The voltage VL and VC are equal and opposite so voltmeter reading will be zero.

Also $R=30\Omega, X_L=X_C=25\Omega$

So $i=\frac{V}{\sqrt{R^2+(X_L-X_C)^2}}=\frac{V}{R}=\frac{240}{30}=8A$

26. In the circuit shown in the figure, the ac source gives a voltage $V=20\cos(2000t)$. Neglecting source resistance, the voltmeter and ammeter reading will be



(a) 0*V*, 0.47*A*
(b) 1.68*V*, 0.47*A*
(c) 0*V*, 1.4 *A*
(d) 5.6*V*, 1.4 *A*

Answer: (d)

$Z=\sqrt{(R)^2+(X_L-X_C)^2}$

$R=10\Omega, X_L=\omega L=2000\times5\times10^{-3}=10\Omega$

$X_C=\frac{1}{\omega C}=\frac{1}{2000\times50\times10^{-6}}=10\Omega$ i.e. $Z=10\Omega$

Maximum current $i_0=\frac{V_0}{Z}=\frac{20}{10}=2A$

Hence $i_{rms}=\frac{2}{\sqrt{2}}=1.4A$

and $V_{rms}=4\times1.41=5.64\ V$

27. A telephone wire of length 200 *km* has a capacitance of 0.014 *μF* per *km*. If it carries an ac of frequency 5 *kHz*, what should be the value of an inductor required to be connected in series so that the impedance of the circuit is minimum

(a) 0.35 *mH* (b) 35 *mH*

(c) 3.5 *mH* (d) Zero

Answer: (a)

Capacitance of wire

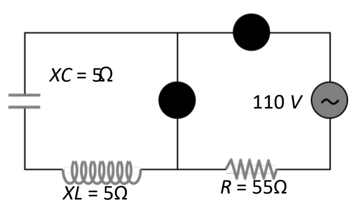
$C = 0.014 \times 10^{-6} \times 200 = 2.8 \times 10^{-6} F = 2.8 \mu F$

For impedance of the circuit to be minimum

$X_L = X_C \Rightarrow 2\pi\nu L = \frac{1}{2\pi\nu C}$

$\Rightarrow L = \frac{1}{4\pi^2\nu^2 C} = \frac{1}{4(3.14)^2 \times (5 \times 10^3)^2 \times 2.8 \times 10^{-6}} = 0.35 \times 10^{-3} H = 0.35 mH$

28. The reading of ammeter in the circuit shown will be



(a) 2*A* (b) 2.4 *A* (c) Zero (d) 1.7 *A*

Answer: (c)

Given $X_L = X_C = 5\Omega$, this is the condition of resonance. So $V_L = V_C$, so net voltage across *L* and *C* combination will be zero.

29. An *LCR* series circuit with a resistance of 100 *ohm* is connected to an ac source of 200 *V* (*r.m.s.*) and angular frequency 300 *rad*/*s*. When only the capacitor is removed, the current lags behind the voltage by 60°. When only the

inductor is removed the current leads the voltage by 60^o The average power dissipated is

(a) 50 *W* (b) 100 *W* (c) 200 *W* (d) 400 *W*

Answer: (d)

$\tan\phi = \frac{X_L}{R} = \frac{X_C}{R} \Rightarrow \tan 60^o = \frac{X_L}{R} = \frac{X_C}{R}$

$\Rightarrow X_L = X_C = \sqrt{3}R$

i.e. $Z = \sqrt{R^2 + (X_L - X_C)^2} = R$

So, average power $P = \frac{V^2}{R} = \frac{200 \times 200}{100} = 400\ W$

30. A virtual current of 4*A* and 50 *Hz* flows in an ac circuit containing a coil. The power consumed in the coil is 240 *W*. If the virtual voltage across the coil is 100 *V* its inductance will be

(a) $\frac{1}{3\pi}H$ (b) $\frac{1}{5\pi}H$ (c) $\frac{1}{7\pi}H$ (d) $\frac{1}{9\pi}H$

Answer: (b)

$R = \frac{P}{i_{rms}^2} = \frac{240}{16} = 15\Omega$

$Z = \frac{V}{i} = \frac{100}{4} = 25\Omega$

Now $X_L = \sqrt{Z^2 - R^2} = \sqrt{(25)^2 - (15)^2} = 20\Omega$

$\therefore 2\pi\nu L = 20 \Rightarrow L = \frac{20}{2\pi \times 50} = \frac{1}{5\pi}$ Hz

31. For a series *RLC* circuit $R = X_L = 2X_C$. The impedance of the circuit and phase difference (between) *V* and *i* will be

(a) $\frac{\sqrt{5}R}{2}, \tan^{-1}(2)$ (b) $\frac{\sqrt{5}R}{2}, \tan^{-1}\left(\frac{1}{2}\right)$

(c) $\sqrt{5}X_C, \tan^{-1}(2)$ (d) $\sqrt{5}R, \tan^{-1}\left(\frac{1}{2}\right)$

Answer: (b)

$X_L = R, X_C = R/2$

$\therefore \tan\phi = \frac{X_L - X_C}{R} = \frac{R - \frac{R}{2}}{R} = \frac{1}{2}$

$\Rightarrow \phi = \tan^{-1}(1/2)$

Also $Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \frac{R^2}{4}} = \frac{\sqrt{5}}{2}R$

32. A lamp emits monochromatic green light uniformly in all directions. The lamp is 3% efficient in converting electrical power to electromagnetic waves and consumes 100W of power. The amplitude of the electric field associated with the electromagnetic radiation at a distance of 10m from the lamp will be:

(a) 1.34 V/m (b) 2.68 V/m (c) 5.36 V/m (d) 9.37 V/m

Answer: (a)

$S_{av} = \frac{P}{4\pi R^2} = \frac{1}{2}\varepsilon_0 c E_0^2$

$\therefore E_0 = \sqrt{\frac{P}{2\pi R^2 \varepsilon_0 c}} = \sqrt{\frac{3}{2 \times 3.14 \times 100 \times 8.85 \times 10^{-12} \times 3 \times 10^8}} = 1.34$ V/m

33. In a series circuit $C = 2$ F, $L = 1$ mH and $R = X$ When the current in the circuit is maximum, at that time the ratio of the

energies stored in the capacitor and inductor is $\frac{W_C}{W_L} = \frac{1}{5}$. Find the values of *R*.

a) 5 □
b) 7 □
c) 1□□
d) 10□□

Answer: (d)

Explanation:

$W_C = \frac{1}{2} C E^2$

$W_L = \frac{1}{2} L \left(\frac{E}{R}\right)^2$ at resonance $I = \frac{E}{R}$

$\frac{CR^2}{L} = \frac{1}{5} \Rightarrow R = 10$

34. An alternating e.m.f. 100cos100*t* volt is connected in series to a resistance of 10 ohm and inductance 100 mH. What is the phase difference between the current in the circuit and the e.m.f.?

(a) $\frac{\pi}{4}$ (b) zero (c) π (d) $\frac{\pi}{2}$

Answer: (a)

$\cos\varphi = \frac{R}{Z} = \frac{R}{\sqrt{X_L^2 + R^2}}$, $R = 10\Omega$, $X_L = \omega L = 10\ \Omega$

$\therefore \cos\varphi = \frac{1}{\sqrt{2}}$ or $\varphi = \frac{\pi}{4}$

35. An alternating voltage $E = 200\sqrt{2}\sin(100\,t)$ V is connected to a 1μF capacitor through an ac ammeter. The reading of ammeter will be -

(a) 10 mA (b) 50 mA (c) 20 mA (d) 40 mA

Answer: (c)

$E_0 = 200\sqrt{2}$ V and ω = 100 rad./s

So $X_c = \frac{1}{\omega C} = \frac{1}{100\times10^{-6}} = 10^4\,\Omega$

As ammeter reads rms value of current

$\therefore I_{rms} = \frac{E_{rms}}{X_c} = \frac{E_0}{(\sqrt{2})X_c} = \frac{200\sqrt{2}}{\sqrt{2}\times10^4} = 20$ mA

36. At what time (From zero) the alternating voltage becomes $\frac{1}{\sqrt{2}}$ times of it's peak value, where T is the periodic time

(a) $\frac{T}{2}$ sec (b) $\frac{T}{4}$ sec (c) $\frac{T}{8}$ sec (d) $\frac{T}{12}$ sec

Answer: (c)

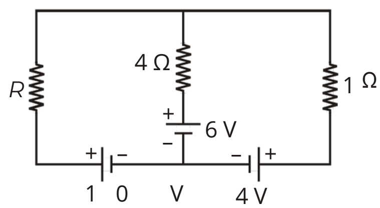
By using $V = V_0 \sin\omega t$

$\Rightarrow \frac{V_0}{\sqrt{2}} = V_0 \sin\frac{2\pi t}{T} \Rightarrow \frac{1}{\sqrt{2}} = \sin\left(\frac{2\pi}{T}t\right)$

$\Rightarrow \sin\frac{\pi}{4} = \sin\left(\frac{2\pi}{T}\right)t$

$\Rightarrow \frac{\pi}{4} = \frac{2\pi}{T}t \Rightarrow t = \frac{T}{8}$ sec.

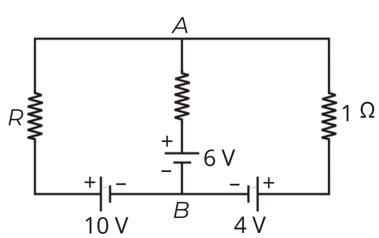
37. For the circuit shown in figure for what value of *R* current passing through 4 Ω resistance will be zero?



a) 4 Ω b) 1Ω c) 3 Ω d) 2 Ω

Answer: (d)

Explanation:



$V_A - V_B = 6$ V

Potential difference across 1 Ω resistance is 2 V.

Current is 2 A

$R(2) = 4$

$\therefore R = 2$

38. An A.C. source of frequency 50 Hz is connected in an A.C. circuit and at any instant the current rod by hot wire ammeter is 5 A. The current in circuit after $t = \frac{1}{200}$ s after the instantaneous current in circuit is zero, is equal to

a) $5\sqrt{2}$ A

b) 5 A

c) $\frac{5}{\sqrt{2}}$ A

d) $\frac{5\sqrt{3}}{2}$ A

Answer: (a)

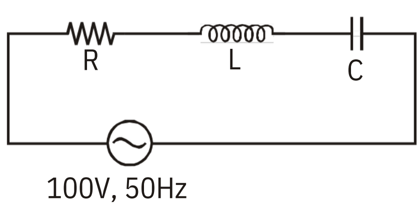
Explanation:

□ $T = \frac{1}{50}$ s

$t = \frac{T}{4} = \frac{1}{200}$ s

$\therefore\ t = \frac{T}{4} \Rightarrow i_0 = 5\sqrt{2}$

39. Consider the following AC Circuit where VL = 400 V, VC = 400 V, R = 50 Ω then the voltage across resistor and the current through it will be



a) 400 V, 3A

b) 300 V, 4 A

c) 600 V, 5 A

d) 100 V, 2 A

Answer: (a)

Explanation:

As $|V_L| = |V_C|$, So $V_R = 100$ V and $I = \frac{V_R}{R} = \frac{100V}{50\Omega} = 2A$.

40. Let frequency ν = 50 Hz, and capacitance C = 100μF in an ac circuit containing a capacitor only. If the peak value of the current in the circuit is 1.57 A. The expression for the instantaneous voltage across the capacitor will be

(a) $E = 50 \sin (100 \pi t - \frac{\pi}{2})$
(b) $E = 100 \sin (50 \pi t)$
(c) $E = 50 \sin (100 \pi t)$
(d) $E = 50 \sin (100 \pi t + \frac{\pi}{2})$

Answer: (a)

Peak value of voltage $V_0 = i_0 X_C = \frac{i_0}{2\pi\nu C} \Rightarrow \frac{1.57}{2\times3.14\times50\times100\times10^{-6}} = 50V$

Hence if equation of current $i = i_0 \sin\omega t$ then in capacitive circuit voltage is $V = V_0 \sin\left(\omega t - \frac{\pi}{2}\right)$

$$\Rightarrow V = 50 \sin\left(2\pi\times50t - \frac{\pi}{2}\right) = 50 \sin\left(100\pi t - \frac{\pi}{2}\right)$$

41. The current and voltage in an ac circuit are respectively given by i=sin314t and e=200sin(314t+π/3). If the resistance is 100Ω then the reactance of the circuit is

(a) $100/\sqrt{3}\,\Omega$ (b) $100\sqrt{3}\,\Omega$ (c) $200\,\Omega$ (d) $200\sqrt{3}\,\Omega$

Answer: (b)

From the given equation $i_0=1A$ and $V_0=200$volt. Hence

$Z = \frac{200}{1} = 200\Omega$ also $Z^2=R^2+X_L^2$

$\Rightarrow (200)^2=(100)^2+X_L^2 \Rightarrow X_L=100\sqrt{3}\,\Omega$.

42. The current is given by i = 3t here t is time in a second and i in ampere. The r.m.s. current for period t = 0 to t = 1 s is

(a) 3 A (b) 9 A

(c) $\sqrt{3}$A (d) [3]V3A.

Answer: (c)

i = 3t

$i^2 = 9t^2$

$i_{rms} = \sqrt{\frac{1}{3}\int_0^3 i^2\, dt}$

$= \sqrt{\frac{1}{2}\int_0^1 9t^2\, dt}$

$= \sqrt{3}$ A .

43. When in a coil the current changes from + 5A to – 5A in 0.04 second, then 4 V emf is induced in a coil. The coefficient of self-induction of the coil will be

a) 0.016 H b) 0.29 H

c) 0.4 H d) 0.80 H

Answer: (a)

Explanation:

$$e = L\frac{di}{dt} \Rightarrow 4 = L \times \frac{(5-(-5))}{0.04} \Rightarrow L = 0.016H$$

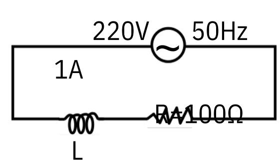
44. A bulb is rated at 100 V, 100 W, it can be treated as a resistor. Find out the inductance of an inductor (called choke coil) that should be connected in series with the bulb to operate the bulb at its rated power with the help of an ac source of 200V and 50 Hz.

(a) $\frac{\pi}{\sqrt{3}}$ H (b) 100 H (c) $\frac{\sqrt{2}}{\pi}$ H (d) $\frac{\sqrt{3}}{\pi}$ H

Answer: (d)

From the rating of the bulb, the resistance of the bulb can be calculated.

$$R = \frac{V_{rms}^2}{P} = 100\Omega$$

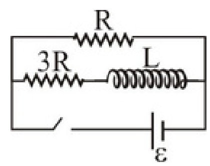


For the full to be operated at its rated value the rms current through it should be 1A

Also,

$$I_{rms} = \frac{V_{rms}}{Z} \therefore 1 = \frac{200}{\sqrt{100^2 + (2\pi 50L)^2}} \Rightarrow L = \frac{\sqrt{3}}{\pi} H$$

45. The ratio of time constant in charging and discharging in the circuit shown in figure is



a) 1 : 1 b) 3 : 16

c) 4 : 3 d) 3 : 4

Answer: (c)

Explanation:

During charging $\tau_{eq} = \frac{L_{eq}}{R_{eq}} = \frac{L}{3R}$

During discharging $\tau_{eq} = \frac{L_{eq}}{R_{eq}} = \frac{L}{4R}$