JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 12th **PAPER CODE :- CWT-6**
CHAPTER :- ALTERNATING CURRENT

ANSWER KEY

1.	(B)	**2.**	(D)	**3.**	(C)	**4.**	(B)	**5.**	(C)	**6.**	(A)	**7.**	(A)
8.	(D)	**9.**	(D)	**10.**	(A)	**11.**	(D)	**12.**	(A)	**13.**	(A)	**14.**	(C)
15.	(B)	**16.**	(B)	**17.**	(C)	**18.**	(A)	**19.**	(B)	**20.**	(B)	**21.**	75
22.	0.36	**23.**	400	**24.**	4	**25.**	0.1	**26.**	119	**27.**	3	**28.**	125
29.	3	**30.**	25										

SOLUTIONS

1. (B)

Sol. $E = 10\cos\left(2\pi \times 50 \times \frac{1}{600}\right) = 5\sqrt{3}$

2. (D)

Sol. D.C. Voltmeter measures Average value only

3. (C)

Sol. $(2)^2R = P_2$ ....(i)

$I_{rms}^2 \times R = 3P_2$ ....(ii)

4. (B)

Sol. $I_{rms} = \frac{V_{rms}}{Z} = \frac{100}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$

P.d. across resistance = R I_{rms} .

5. (C)

Sol. $\tan\phi = \tan 45^\circ = \frac{\omega L}{R}$

$X_L = \omega L = R.$

6. (A)

Sol. At resonance ($V_C = V_L$)

$V = I_{rms} \times R$

$= \frac{V_{rms}}{Z} \times R$ (here z = R)

$V = V_{rms} = 100$ volt &

$I_{rms} = \frac{100}{50} = 2$ Amp.

7. (A)

Sol. $I_{rms} = \frac{60}{120} = \frac{1}{2}$ Amp. $V_L = I_{rms} \times (\omega L)$

$40 = \frac{1}{2} \times (40 \times 10^3) \times L$, $L = 20$ mH

At resonance $V_C = I_{rms}\left(\frac{1}{\omega C}\right) = V_L$

$C = \frac{1}{2} \times \frac{1}{4 \times 10^3} \times \frac{1}{40}$

$C = \frac{25}{8}\ \mu F.$

8. (D)

Sol. $\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{8}{1}$

$V_2 = 8 \times 120 = 960$ volt

$I = \frac{960}{10^4} = 96$ mA.

9. (D)

Sol. $V_{rms}^{\ 2} = \frac{\int_0^T (e_1\sin\omega t + e_2\cos\omega t)^2 dt}{T}$

$= \sqrt{\frac{e_1^2 + e_2^2}{2}}$

where $\omega = \frac{2\pi}{T}$.

10. (A)

Sol. $P_{av} = v_{rms} I_{rms} \cos\phi$

Here $\phi = 90^\circ$ so $P_{av} = 0$

11. (D)

Sol. $I_0 = \frac{V_0}{X_C} = \frac{200\sqrt{2}}{1/\omega C}$; $I_{RMS} = \frac{I_0}{\sqrt{2}} = 200$ mA

12. (A)

Sol. Power factor $= \frac{R}{Z} = \frac{30}{50} = \frac{3}{5}$

here $Z = \sqrt{R^2 + (x_L - y_c)^2}$

$= \sqrt{(30)^2 + (60-20)^2}$

Z = 50

$I = \frac{V}{Z} = \frac{100}{50} =$ **2 Amp.**

13. (A)

Sol. Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

14. (C)

Sol. Given : L = 10 H, f = 50 Hz.

For maximum power $X_C = X_L$

$\frac{1}{\omega C} = \frac{1}{\omega L}$, $C = \frac{1}{\omega^2 L}$

$C = \frac{1}{4\pi^2 \times 50 \times 50 \times 10}$

$\therefore$ $C = 0.1 \times 10^{-5}$ F = 1 μF

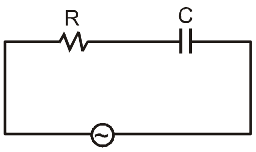
15. (B)

Sol. $i_{rms} = \frac{V_{rms}}{\sqrt{R^2 + \frac{1}{\omega^2 c^2}}}$

when ω increases, i_{rms} increases so the bulb glows brighter

16. (B)

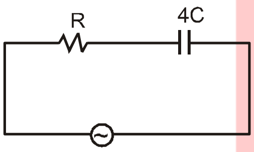
Sol. Case I



Z

$= \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$

Case II



$I_R^A = \frac{V}{Z}$ $\qquad Z' < Z$

$I_R^B = \frac{V}{Z'}$ $\qquad I_R^A < I_R^B$

$V_R^A < V_R^B$

So. $V_C^A > V_C^B$

$\because$ $V_R^2 + V_C^2 = V_0^2$

17. (C)

Sol. The current lags the EMF by π/2, so the circuit should contain only an inductor.

18. (A)

Sol. Initially at resonance: $X_L = X_E \Rightarrow Z = R$.

$\therefore i_0 = \frac{\varepsilon_0}{R} = 10\sqrt{2}$ A

After increasing frequency : $X_L > X_c$

$\omega L > 1/\omega C$

$\omega > \frac{1}{\sqrt{LC}} \Rightarrow \omega > \omega_0$ (i.e frequency increases)

and $i' = \frac{\varepsilon_0}{\sqrt{R^2 + X^2}} = \frac{\varepsilon_0}{\sqrt{2}R} = i_0 / \sqrt{2} = 10$ amp.

19. (B)

Sol. Wattless current = $I_{rms} \sin\phi$

Where $\tan\phi = \frac{\omega L}{R} = \frac{2\pi f L}{R}$

and $I_{rms} = \frac{V_{rms}}{z} = \frac{V_{rms}}{\sqrt{R^2 + (\omega L)^2}}$

20. (B)

Sol. Resonance occurs in a series LCR circuit to an AC source at a specific frequency when the inductive reactance equals the capacitive reactance, resulting in the circuit's lowest impedance. At this frequency. the circuit draws maximum current from the source: thus, the maximum power is dissipated in the circuit. Therefore, Statement I is true.

In a circuit containing only a resistor, the power dissipated is given by.

$P = VI = I^2R$

The voltage an current are in phase in a purely resistive circuit, which maximizes the power. Therefore, Statement II is also true.

Therefor, the currect answer is Both Statement I and Statement II are true.

21. 75

Sol. $P = V_{rms} I_{rms} \cos\phi$

$550 = 220 \times I_{rms} \times 0.8$

$\frac{2.5}{0.8} = I_{rms} = \frac{V_{rms}}{z} = \frac{220}{z}$

$z = \frac{220 \times 8}{25}$

$\cos\phi = 0.8 = \frac{R}{z}$

$\Rightarrow R = 0.8 \times \frac{44 \times 8}{5}$

$\sqrt{R^2 + x_L^2} = z = 1.25$ R

$R_2 + X_L^2 = \frac{25}{16} R^2$

$X_L^2 = \frac{9}{16} R^2$

$X_L = \frac{3R}{4} = \frac{1}{\omega c}$

$C = \frac{4}{3\omega R} = \frac{4}{3 \times 2\pi \times 50 \times 0.8 \times 44 \times 8}$

$= \frac{1}{3 \times 4 \times 44 \times 8 \times \pi} = 75.39$ μF

22. 0.36

Sol. C = C' × 200 = 0.014 × 200 = 2.8 μS

$L = \frac{1}{\omega^2 c} = \frac{1}{4\pi^2 f^2 c}$

$= \frac{1}{4\pi^2 \times (50\times10^3)^2 \times 22.8\times10^{-6}}$

$= 0.36\times10^{-3}H$

= 0.36 mH

23. 400

Sol. The circuit is in resonance

$i = \frac{200}{R}$ = 2A

P = i^2R = 4 × 100

= 400 W

24. 4

Sol. R.M.S value of supply voltage, V = 200 volts

Across resistance, rms voltage, V_R = $\sqrt{(200)^2-(120)^2}$ = 160 Volts

∴ Current, i = $\frac{160}{40}$ = 4 Amperes

25. 0.1

Sol. $\frac{24}{10\times10^{-3}} = z = \sqrt{(\omega L)^2 + R^2}$

$\sqrt{R^2+(\omega L)^2} = \sqrt{R^2+\left(\omega L - \frac{1}{\omega C}\right)^2}$

$(\omega L) = -\omega L + \frac{1}{\omega C}$

$L = \frac{1}{2\omega^2 C} = \frac{1}{2\times100\pi\times100\pi\times10^{-6}}$ = 5H

$(2400)^2 = (500\pi)^2 + R^2$

$R = \sqrt{(2400)^2-(5\pi\times100)^2}$

$= 100\sqrt{(24)^2-25\pi^2}$

$= 10 \times \sqrt{326} \cong 1800$

I = 0.1A

26. 119

Sol. $\tan\phi = \frac{wL_1}{R_1} = \frac{3}{4}$

$wL_1 = \frac{3}{4}R_1$

$1 = \frac{100}{\sqrt{\frac{9}{16}R_1^2 + R_1^2}}$

$R_1 = 80\Omega$ $\quad \omega L_1 = 60\Omega$

$\frac{wL_2}{R_2} = \frac{4}{3} \Rightarrow wL_2 = \frac{4}{3}R_2$

$5 = \frac{100}{\sqrt{\frac{16}{9}R_2^2 + R_2^2}} \Rightarrow R_2 = 12\Omega\ ;\ WL_2 = 16\Omega$

$z = \sqrt{(wL_1+wL_2)^2+(R_1+R_2)^2} = 119\Omega$

27. 3

Sol. $V_R \cos\theta = 4\sqrt{3}$ $\quad \theta = 30°$

$8\cos\theta = 4\sqrt{3}$ $\quad V_L^1 = V_L$

= cos (30° – 30°) = 3

28. 125

Sol. $P_r = \frac{V_{rms}^2}{R}$ as at resonance = Z = R

$= \frac{250\times250}{5} = 125\times10^2\,W$

29. 3

Sol. $\tan\phi \frac{|x_L - X_C|}{R}$

$\Rightarrow X_C = X_L + R = 9 + 1 = 10\Omega$

$C = \frac{1}{\omega X_C}$

$= \frac{1}{300\times10} = \frac{1}{3}\times10^{-3}F$

30. 25

Sol. The total impedance is given by.

$Z = \sqrt{R^2(X_L - X_C)^2} = \sqrt{80^2+(100-40)^2} = 100\Omega$

Therefore, the current in the circuit is given by.

$\Rightarrow i_0 = \frac{V_0}{Z} = \frac{2500}{100}A = 25A$