JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 12th **PAPER CODE :- CWT-5**
CHAPTER :- ELECTROMAGNETIC INDUCTION

ANSWER KEY

1.	(A)	**2.**	(D)	**3.**	(A)	**4.**	(D)	**5.**	(D)	**6.**	(D)	**7.**	(C)
8.	(B)	**9.**	(B)	**10.**	(D)	**11.**	(A)	**12.**	(D)	**13.**	(C)	**14.**	(A)
15.	(A)	**16.**	(A)	**17.**	(A)	**18.**	(C)	**19.**	(C)	**20.**	(B)	**21.**	8
22.	58	**23.**	5	**24.**	5	**25.**	2	**26.**	500	**27.**	83	**28.**	50
29.	5	**30.**	2										

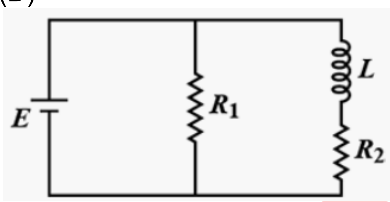
SOLUTIONS

1. (A)

2. (D)
Sol. Flux linked with the loop will first increase and then decrease as electron pass by.

3. (A)
Sol. $V_A - 5 + 15 + 5 = V_B$
$V_A - V_B = -15$ V, $V_B - V_A = 15$V

4. (D)



Sol. Potential drop = $E - I_2R_2$
$I_2 = I0\,(1 - e^{-t/tc})$
$$I_0 = \frac{E}{R_2} = \frac{12}{2} = 6$$
$$t_c = \frac{L}{R_2} = \frac{400\times10^{-3}}{2} = 0.2$$
$I_2 = 6(1 - e^{-t})$
$L = E - R_2I_2 = 12 - 2 \times 6(1 - e^{-5t})$
$= 12\,e^{-5t}$

5. (D)
Sol. $\phi = 10t^2 - 50t + 250$
$\therefore \frac{d\phi}{dt} = 20t - 50, \frac{-d\phi}{dt}$
$e = -(20t - 50) = -[20 \times 3 - 50]$
$= -10$ Volt

6. (D)
Sol. $M = k\sqrt{L_1L_2}$
considering ideal coupling
$M = \sqrt{L_1L_2} = \frac{\mu_0 A}{\ell} N_1N_2 = 2.4\,\pi \times 10^{-4}$ H

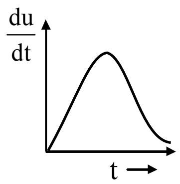
7. (C)
Sol. $X_C = X_L$
$\frac{1}{we} = WL$ or $= \frac{1}{w^2L}$
$$c = \frac{1}{4\pi^2 \times 50\times50\times10} = 1\mu F$$

8. (B)
Sol. $\varepsilon = \frac{1}{2}B\omega L^2 = \frac{1}{2}\times0.2\times15^4\times5\times1^2$
$= 0.5 \times 10^{-5}$V
$= 50\ \mu$V

9. (B)
Sol. $I = I_0\,(1 - e^{Rt/L})$
$$\frac{I_0}{2} = I_0\left(1 - e^{rt/L}\right)$$
$$e^{-Rt/L} = \frac{1}{2} \Rightarrow \frac{Rt}{L} = \ln 2 \Rightarrow t = \frac{L}{R}\ln 2$$
$$t = \frac{300\times10^{-3}}{2}\times0.693 = 0.1\,\text{sec}$$

10. (D)
Sol. $I_0 = V/R = 2$ A
$I = I_0\,(1 - e^{-(Rt/L)})$
Here,
$I_0 = V/R = 12/6 = 2$A, is the steady-state current through the circuit.
$\tau = L/R = 8.4m/6 = 1.4$ ms, is the time constant.
So, $I(t) = 1A \Rightarrow 2(1 - e^{-t/1.4ms}) = 1$
$\Rightarrow$ e–t/1.4m = 0.5
Taking logarithm of both sides,
$-t/1.4$ m $= -0.693 \Rightarrow t = 0.97$ms $\approx$ 1ms

11. (A)
Sol. Rate of increment of energy in inductor
$$= \frac{du}{dt} = \frac{d}{dt}\left(\frac{1}{2}Li^2\right) = Li\frac{di}{dt}$$
Current in the inductor at time t is :
$$i = i_0\left(1 - e^{-\frac{t}{\tau}}\right) \text{ and } \frac{di}{di} = \frac{i_0}{\tau}e^{-\frac{t}{\tau}}$$
$$\frac{du}{dt} = \frac{Li_0^2}{\tau}e^{-\frac{t}{\tau}}\left(1 - e^{-\frac{t}{\tau}}\right)$$
$\frac{du}{dt} = 0$ at $t = 0$ and $t = \infty$
Hence E is best represented by :



12. (D)

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

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

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

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

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

$\therefore \varepsilon_{max} = MI_0\omega$

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

M = 5mH

13. (C)

Sol. Flux cannot change in a superconduction loop.

$\Delta\phi = 2\pi R^2 .B$

Initially current was zero, so self flux was zero.

$\therefore$ Finally $Li = 2\pi R^2 \times B$.

$i = \frac{2\pi R^2 \times B}{L}$

14. (A)

Sol. By Lenz law as induced current is such that it always opposes the cause of its genration.

15. (A)

Sol. $d\phi = NBA(\cos 180° - \cos 0°)$

$(d\phi) = 2$ NBA

$e = \frac{\Delta\phi}{dt} = \frac{2NBA}{dt} = 84V$

16. (A)

Sol. QV because induced electric field so generated is non conservative i.e. $\oint E.d\ell = V$.

17. (A)

Sol. L will decrease as Bi is diamagnetic

$\therefore I = \frac{V}{X_L}$ will increase

18. (C)

Sol. $I_0 = \frac{V_0}{R}$ divide the current in L_1 and L_2 like resistors $I_1 = I_0 \frac{L_2}{L_1 + L_2}$

19. (C)

Sol. $i = \frac{1}{R}\left[\frac{d\phi}{dt} + L\frac{di}{dt}\right]$

$q = \int i dt = \frac{1}{R}[\Delta\phi + 0] = \frac{\Delta\phi}{R} = \frac{1}{R}\int_{b-a}^{b+a} Badx$

$= \frac{1}{R}\int_{b-a}^{b+a} \frac{\mu_0 ia}{2\pi x} dx = \frac{\mu_0 ia}{2\pi R} \log_e \frac{b+a}{b-a}$

20. (B)

Sol. As power dissipated $P = \frac{e^2}{R}$

Here, e = induced e.m.f. $= -\left(\frac{d\phi}{dt}\right)$ and ϕ

$= NBA \quad \therefore e = -NA\left(\frac{dB}{dt}\right)$

Also, we know that $R \propto \frac{\ell}{a} \propto \frac{\ell}{r^2}$

$\therefore P = \frac{e^2}{R} \propto \frac{N^2A^2r^2}{\ell} \propto \frac{N^2r^4}{\ell}$

According to the question

r, radius is halved and N, number of turns is quadrupled.

$\therefore$ P remains the same.

21. 8

Sol. $\phi = B\pi r^2 \qquad \varepsilon = \frac{d\phi}{dt} = N\pi r^2 \frac{dB}{dt}$

$= N\pi r^2 \mu_0 n \frac{di}{dt}$

$I = \frac{\varepsilon}{R}$ and $\Delta Q = I\Delta t = \frac{N\pi r^2 \mu_0 n}{R} \Delta t$

$\Delta Q = \frac{100 \times \pi \times (2\times10^{-2})^2 \times 10^4 \times 4\pi\times10^{-7} \times 10}{20}$

$= 8 \times 10^{-4}$c = 800 μC $\Rightarrow$ n = 8

22. 58

Sol. $B = \frac{\phi}{a\cos(90° - 60°)}$

$= \frac{\phi}{a\cos 30°} = \frac{10^{-3}}{2\times10^{-2} \times \cos\sqrt{3}/2}$

= 0.058 T = 0.058 T × 1000 = 58 T

23. 5

Sol. Emf induced between centre and circum

$\varepsilon = \frac{B\omega a^2}{2}$, a $\to$ radius

$\therefore i = \frac{\varepsilon}{R} = \frac{B\omega a^2}{2R} = \frac{0.4\times10\times(5\times10^{-2})^2}{2\times10}$

= 0.5A × 10 = 5A

24. 5

Sol. Magnetic field of solenoid, $B_1 = \frac{\mu_0 N_1 i_1}{\ell}$

Magnet flux of coil, $\phi_2 = N_2 B_1 A_2 = N_2 \left(\frac{\mu_0 N_1 i_1}{\ell}\right) A_2$

As $\phi_2 = M i_1$, so $M = \frac{\phi_2}{i_1} = \frac{\mu_0 N_1 N_2 A_2}{\ell}$

$\therefore$ induced emf, $|e| = M\frac{di_1}{dt}$

or $|e| = \frac{\mu_0 N_1 N_2 A_2}{\ell} \times \frac{di_1}{dt}$

$= \frac{4\pi\times10^{-7}\times2000\times300\times1.2\times10^{-3}}{0.30} \times \frac{4}{0.25}$

$= 4.8 \times 10^{-2}$ Volt

$= 4.8$

25. 2

Sol. $e = -L\frac{di}{dt} = -L\frac{d}{dt}\left(t^2e^{-t}\right)$

$\therefore \frac{di}{dt} = 2t.e^{-t} - t^2e^{-t} = 0$

t = 2 second

26. 500

Sol. $\frac{V_s}{V_p} = \frac{N_s}{N_p} \Rightarrow N_s = \frac{220}{2200}\times5000 = 500$

27. 83

Sol. $P_{in} = 240 \times 1.7 = 168$

$P_{out} = 140W$

$\eta = \frac{P_{out}}{P_{in}} = \frac{140}{168} = 83.3\%$

28. 50

Sol. $\frac{I_p}{I_s} = \frac{N_s}{N_p}$

$I_p = \frac{N_s}{N_p}\times T_s = \frac{25}{1}\times2 = 50 \text{ amp}$

29. 5

Sol. $\phi = BAN$

$= 5 \times 10^{-3} \times 2 \times 10^{-3} \times 500$

$\Rightarrow 5 \times 10^{-3} \times 1000 \times 10^{-3}$

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

30. 2

Sol. $\phi = 6t^2 - 5t + 1$

$e = \frac{d\phi}{dt} = 12t - 5$

at t = 0.25sec

$|e| = (12/4 - 5) = |3 - 5| = 2$

$i = e/R = 2/10 = 0.2A$