Sample Paper-03

Class 12[th] NEET (2024)

PHYSICS

ANSWER KEY

1. (1)
2. (3)
3. (3)
4. (4)
5. (2)
6. (4)
7. (2)
8. (3)
9. (3)
10. (3)
11. (4)
12. (3)
13. (1)
14. (3)
15. (1)
16. (1)
17. (1)
18. (2)
19. (2)
20. (2)
21. (3)
22. (1)
23. (3)
24. (4)
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26. (1)
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40. (4)
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47. (3)
48. (3)
49. (3)
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HINTS AND SOLUTION

1. **(1)**

$$E=-\frac{dV}{dx}=-\frac{d}{dx}(5x^2+10x-9)=-10x-10$$

$\therefore$ $(E)_{x=1}=-10\times 1-10=-20\text{V/m}$

2. **(3)**

Initial energy of the system

$$U_i=\frac{1}{2}CV_1^2+\frac{1}{2}CV_2^2$$

When the capacitors are joined, common potential

$$V=\frac{CV_1+CV_2}{2C}=\frac{V_1+V_2}{2}$$

Final energy of the system

$$U_f=\frac{1}{2}(2C)V^2=\frac{1}{2}2C\left(\frac{V_1+V_2}{2}\right)^2=\frac{1}{4}C(V_1+V_2)^2$$

Decrease in energy $=U_i-U_f=\frac{1}{4}C(V_1-V_2)^2$

3. **(3)**

Let q_1, q_2 be the charges on two condensers

$\therefore$ $V=\frac{q_1}{6}=\frac{q_2}{14}\Rightarrow\frac{q_1}{q_2}=\frac{6}{14}$

Also, $q_1+q_2=600$ $\Rightarrow$ $q_1+\frac{14}{6}q_1=600$

$\Rightarrow$ $q_1=\frac{600}{20}\times 6$

$\therefore$ $V=\frac{q_1}{6}=\frac{600}{20}=30\,\text{volt}$

4. **(4)**

When metal sphere is placed inside a charged parallel plate capacitor, the electric lines of force will not enter the metallic conductor as $E=0$ inside a charged conductor. Moreover, the surface of a charged conductor is an equipotential surface and hence, electric lines of force are always perpendicular to equipotential surface.

5. **(2)**

$$C=\frac{A\varepsilon_0}{d}$$

After inserting the slab

$$C'=\frac{A\varepsilon_0}{(d-b)}=\frac{A\varepsilon_0}{d-\frac{d}{2}}$$

$$C'=\frac{2A\varepsilon_0}{d}\therefore\ \frac{C'}{C}=\frac{2}{1}$$

6. **(4)**

Net resultant flux $\phi=(\phi_2-\phi_1)$

From gauss Law, $\phi=\frac{q_{\text{in}}}{\epsilon_0}$

or, $q_{\text{in}}=\phi\epsilon_0=\epsilon_0(\phi_2-\phi_1)$

7. **(2)**

Capacitance of two capacitors each of area $\frac{A}{2}$, plate separation d but dielectric constants K_1 and K_2 respectively joined in parallel.

$$C_1=\frac{K_1\varepsilon_0\left(\frac{A}{2}\right)}{\frac{d}{2}}+\frac{K_2\varepsilon_0\left(\frac{A}{2}\right)}{\frac{d}{2}}=\frac{(K_1+K_2)\varepsilon_0A}{d}$$

It is in series with a capacitor of plate area A, plate separation $\frac{d}{2}$ and dielectric constant K_3 ie,

$$C_2=\frac{K_3\varepsilon_0A}{\frac{d}{2}}.$$

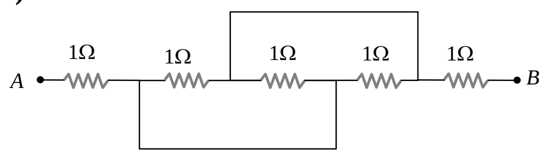
If resultant capacitance be taken as $C=\frac{K\varepsilon_0A}{d}$,

Then $\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}$

$$\therefore\ \frac{d}{K\varepsilon_0A}=\frac{d}{(K_1+K_2)\varepsilon_0A}+\frac{\frac{d}{2}}{K_3\varepsilon_0A}$$

$$\Rightarrow\ \frac{1}{K}=\frac{1}{K_1+K_2}+\frac{1}{2K_3}$$

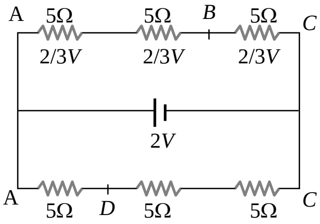
8. **(3)**



$$R_{AB}=2+\frac{1}{3}=2\frac{1}{3}\Omega$$

9. (3)

The given circuit can be redrawn as follows.



For identical resistance, potential difference distributes equally among all. Hence potential difference across each resistance is $\frac{2}{3}$ V, and potential difference between A and B is $\frac{4}{3}$ V.

10. (3)

For portion *CD* slope of the curve is negative i.e. resistance is negative

11. (4)

$T = \frac{2\pi}{\omega} = \frac{2\pi m}{qB}$ … (ii)

Given, $B = 3.534 \times 10^{-5}\ T$,

$q = 1.6 \times 10^{-19}\ C$, $m = 9.1 \times 10^{-31}$ kg, T = ?

From Eq. (ii), we get

$\therefore T = \frac{2 \times 3.14 \times 9.1 \times 10^{-31}}{3.534 \times 10^{-5} \times 1.6 \times 10^{-19}} = 1 \times 10^{-6}\text{ s} = 1\mu\text{s}$

12. (3)

Since, the magnetic field, due to current through wire *CD* at various locations on wire *AB* is not uniform, Therefore, the wire *AB*, carrying current i_1 is subjected to variable magnetic field. Due to which, neither the force nor the torque on the wire *AB* will be zero. As a result of which the wire *AB* will have both translation and rotational motion.

13. (1)

Magnetic dipole moment of current loop is

$M = NiA = 10 \times 0.5 \times 2 \times 10^{-4} = 10^{-3}\text{ Am}^2$

Magnetic field the solenoid carrying current

$B = \mu_0 ni = 4\pi \times 10^{-7} \times 10^{-2} \times 3$

$= 12\pi \times 10^{-4} T$

$\therefore$ Torque, $\tau = MB \sin\theta$

$= 10^{-3} \times 12\pi \times 10^{-4} \times \sin 90°$

$= 12\pi \times 10^{-7}$ Nm

14. (3)

$\text{Susceptibility}(\chi) = \frac{\text{intensity of magnetisation}(I)}{\text{magnetic field}(B)}$

or $I = \chi B$

$\therefore$ $I = 3 \times 10^{-4} \times 4 \times 10^{-4}$

or $I = 12 \times 10^{-8}\text{ Am}^{-1}$

15. (1)

Mass becomes $\frac{1}{2}$ and length becomes $\frac{1}{2}$.

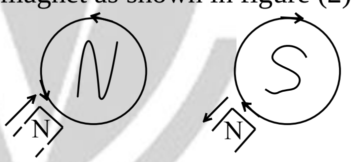
$\therefore$ Moment of inertia I becomes $\frac{1}{2}\left(\frac{1}{2}\right)^2 = \frac{1}{8}$ times.

Magnetic moment M becomes $\frac{1}{2}$th .

As $T = 2\pi\sqrt{\frac{I}{MH}}$, $\therefore$ T becomes $\frac{1}{2}$th .

16. (1)

When a north pole of a bar magnet moves towards the coil, the induced current in the coil flows in a direction such that the coil presents its north pole to the bar magnet as shown in figure (1). Therefore, the induced current flows in the coil in the anticlockwise direction. When a north pole of a bar magnet moves away from the coil, the induced current in the coil flows in a direction such that the coil presents its such pole to the bar magnet as shown in figure (2)



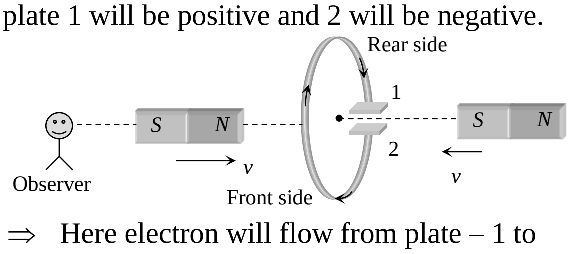
Therefore, induced current flows in the coil in the clockwise direction.

17. (1)

$|e| = L\frac{di}{dt} \Rightarrow 1 = \frac{L \times [10 - (-10)]}{0.5} \Rightarrow L = 25\,mH$

18. (2)

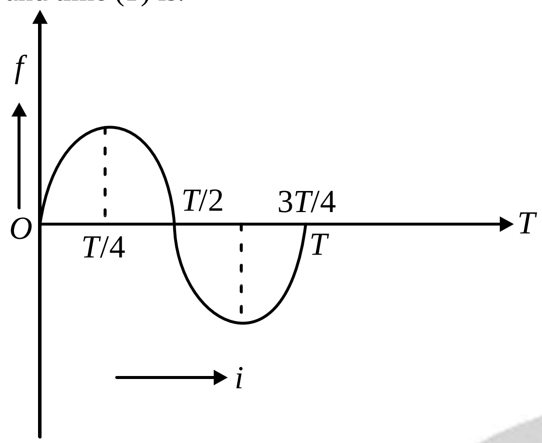
By the movement of both the magnets, current will be anticlockwise, as seen from left side, i.e., plate 1 will be positive and 2 will be negative.



$\Rightarrow$ Here electron will flow from plate – 1 to plate 2. Hence, 2nd plate will be negative.

19. **(2)**

An alternating current is one whose magnitude changes continuously with time between zero and a maximum value and whose direction reverses periodically. The relation between frequency (f) and time (T) is.



$$T = \frac{1}{f} = \frac{1}{50} = 0.02\text{s}$$

As is clear from the figure time taken to reach the maximum value is

$$\frac{T}{4} = \frac{0.02}{4} = 0.005\text{s}$$

20. **(2)**

For given circuit current is lagging the voltage by $\frac{\pi}{2}$, so circuit is purely inductive and there is no power consumption in the circuit. The work done by battery is stored as magnetic energy in the inductor.

21. **(3)**

We have $X_C = \frac{1}{C \times 2\pi f}$ and $X_L = L \times 2\pi f$

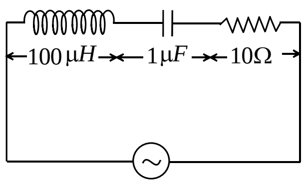
22. **(1)**

Impedance of LCR circuit will be minimum at resonant frequency so

$$V_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{1\times10^{-3}\times0.1\times10^{-6}}} = \frac{10^5}{2\pi}\text{Hz}$$

23. **(3)**

Impedance, $Z = \sqrt{(X_L \sim X_C)^2 + R^2}$



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

Inductive reaction

$X_L = \omega L = 70 \times 10^3 \times 100 \times 10^{-6} = 7\Omega$

Capacitance reactance

$$X_C = \frac{1}{\omega C} = \frac{1}{70\times10^3\times1\times10^{-6}} = \frac{100}{7}[X_C > X_L]$$

Hence, circuit behaves like an R-C circuit.

24. **(4)**

Intensity of electromagnetic wave is

$$I = \frac{P_{av}}{4\pi\times r^2} = \frac{E_0^2}{2\mu_0 c}$$

or $E_0 = \sqrt{\frac{\mu_0 c P_{av}}{2\pi r^2}}$

$$= \sqrt{\frac{(4\pi\times10^{-7})\times(3\times10^8)\times800}{2\pi\times(4)^2}} = 54.77\ \text{Vm}^{-1}$$

25. **(3)**

$$V_{ba} = L\frac{di}{dt} = -8.8\times10^{-3}\ \text{V}$$

Since, V_{ba} (= $V_b - V_a$) is negative. It implies that $Va > V_b$ or a is at higher potential.

So, $V_{ab} = 8.8 \times 10^{-3}$ V

= 8.8 mV

26. **(1)**

$\sqrt{\frac{\mu}{\varepsilon}}$ = has the dimensions of resistance, hence it is called the intrinsic impedance of the medium.

27. **(2)**

We know that, $\beta = \frac{\lambda D}{d}$

Now the changed values are $\lambda' = 3\lambda$

$d' = \frac{d}{2}$

$D' = 2D$

$$\beta' = \frac{(3\lambda)(2D)}{\left(\frac{d}{2}\right)} = 12\frac{\lambda D}{d} = 12\beta$$

The fringe width increases to 12 times of the original.

28. **(1)**

Here optical distance between fish and the bird is $s = y' + \mu y$

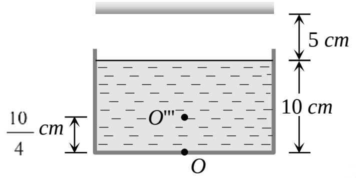
Differentiating w.r.t. we get $\frac{ds}{dt} = \frac{dy'}{dt} + \frac{\mu dy}{dt}$

$\Rightarrow \quad 9 = 3 + \frac{4}{3}\frac{dy}{dt} \Rightarrow \frac{dy}{dt} = 4.5 \text{ m/s}$

29. **(2)**

From figure it is clear object appears to be raised by $\frac{10}{4}$ cm (2.5 cm)

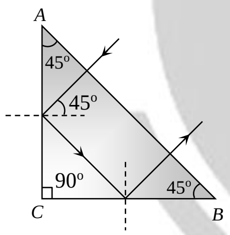
Hence distance between mirror and O'''''' = 5 + 7.5 = 12.5 cm



So final image will be formed at 12.5 cm behind the plane mirror.

30. **(1)**

From figure it is clear that *TIR* takes place at surface *AC* and *BC*



i.e.45° > C

$\Rightarrow \quad \sin 45 > \sin C$

$\Rightarrow \quad \frac{1}{\sqrt{2}} > \frac{1}{\mu} \Rightarrow \mu > \sqrt{2}$

Hence $\mu_{\text{least}} = \sqrt{2}$

31. **(3)**

In photoelectric effect, an electron absorbs a quantum of energy (hv) of radiation. If absorbed energy exceeds the minimum energy (work function ϕ_o of the metal), the most loosely bound electron will emerge with maximum kinetic energy, more tightly bound electron will emerge with kinetic energies less than the maximum value.

Einstein's photoelectric equation,

$K_{max} \sim hv - \phi_0$

K_{max} is independent of intensity of radiation but depends linearly on v.

32. **(1)**

If C is the equivalent capacitance,

Then $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{3} + \frac{1}{9} = \frac{4}{9}$

$\therefore \quad C = \frac{9}{4} = 2.25 \mu F$

Charge $q = CV = 2.25 \times 10^{-6} \times 300 = 6.75 \times 10^{-4} C$

Potential cross $C_1 = V_1 = \frac{6.75 \times 10^{-4}}{3 \times 10^{-6}} = 225V$

Potential across $C_2 = V_2 = \frac{q}{C_2} = 75 \text{ volt}$

Energy stored in

$C_1 = \frac{1}{2}C_1V_1^2 = \frac{1}{2} \times 3 \times 10^{-6} \times (225)^2$

$= 7.6 \times 10^{-2}$ J

Energy stored in

$C_2 = \frac{1}{2}C_2V_2^2 = \frac{1}{2} \times 9 \times 10^{-6} \times (75)^2$

$= 2.5 \times 10^{-2}$ J

33. **(1)**

The fringe width is given by:

$\beta = \frac{\lambda D}{d}$

The fringe width is directly proportional to the wavelength.

The wavelength of blue light is less than that of the red light. So, for blue light the fringe will be narrower.

34. **(1)**

Its kinetic energy will increase and its potential energy will decrease. So, its mechanical energy will remain constant.

35. **(2)**

Statement I and III is true but Statement II is wrong.

The work done in charging a capacitor is stored in the form of electronic potential energy given by expression $V_E = \frac{Q^2}{2C}$.

There is equal and opposite charge (Q) on the plates of a parallel plate capacitor. Therefore, there is no net charge on capacitor.

36. **(1)**
Electromagnets are magnets, which can be turned on and off by switching the current on and off. As the material in electromagnets is subjected to cyclic change (magnetisation and demagnetisation), the hysteresis loss of the material must be small. The material should attain high value of I and B with low value of magnetising field intensity H. As soft iron has small coercivity, so it is a best choice for this purpose.

37. **(4)**
In young's double slit the width of bright and dark fringe both will be same.
If we use white light in YDSE then central maxima will be white because for this position every colour of white light has maxima at this position. Fringes of different colours are observed clearly only after the central maxima.

38. **(3)**
According to Bohr, the wavelength emitted when an electron jumps from n_1th to n_2th orbit is.

$$E=\frac{hc}{\lambda}=E_1-E_2$$

$$\frac{1}{\lambda}=R\left(\frac{1}{n_2^2}-\frac{1}{n_1^2}\right)$$

For first line in Lyman series

$$\frac{1}{\lambda_L}=R\left(\frac{1}{1^2}-\frac{1}{2^2}\right)=\frac{3R}{4} \qquad \ldots\text{(i)}$$

For first line in Balmer series,

$$\frac{1}{\lambda_B}=R\left(\frac{1}{2^2}-\frac{1}{3^2}\right)=\frac{5R}{36} \qquad \ldots\text{(ii)}$$

From Eqs. (i) and (ii)

$$\therefore \quad \frac{\lambda_B}{\lambda_L}=\frac{3R}{4}\times\frac{36}{5R}=\frac{27}{5}$$

$$\therefore \quad \lambda_B=\frac{27}{5}\lambda \qquad (\because \lambda_L=\lambda)$$

39. **(3)**
Centripetal force=force of attraction of nucleus on electron.

$$\frac{mv^2}{a_0}=\frac{1}{4\pi\varepsilon_0}\frac{e^2}{a_0^2}, v=\frac{e}{\sqrt{4\pi\varepsilon_0 ma_0}}$$

40. **(4)**
Number of possible emission lines $=\frac{n(n-1)}{2}$

Where n = 4; Number $=\frac{4(4-1)}{2}=6$

41. **(2)**
Given, R =1250, R_0 = 5000 and t = 5 min

$R = R_0 e^{-\lambda t}$

$1250 = 5000\, e^{-\lambda \times 5}$

$\lambda = 0.4 \log_e 2$

42. **(1)**
The potential of P-side is more negative that of N-side, hence diode is in reverse biasing. In reverse biasing it acts as open circuit, hence no current flows.

43. **(4)**
At logic gate I, the Boolean expression is $\bar{B}\cdot C=Y'$

At logic gate II, the Boolean expression is $A+(\bar{B}\cdot C)=Y''$

At logic gate III, the Boolean expression is $\overline{A+(\bar{B}\cdot C)}=Y$

44. **(2)**

$$\phi=\frac{\pi}{3}, a_1=4, a_2=3$$

So, $A=\sqrt{a_1^2+a_2^2+2a_1.a_2\cos\phi} \Rightarrow A\simeq 6$

45. **(2)**
λ = 6000 Å = 6×10^{-7}m

Path difference for dark fringe $\Delta x=(2n+1)\frac{\lambda}{2}$

For third dark fringe n = 2

$$\therefore \quad \Delta x=(2\times2+1)\times\frac{6\times10^{-7}}{2}$$

$$=\frac{5\times6\times10^{-7}}{2}$$

$= 15\times10^{-7}$

$\Rightarrow \quad 1.5\times10^{-6}$ m = 1.5μ

46. **(3)**
In Youngs's double slit experiment half angular width is given by

$$\sin\theta=\frac{\lambda}{d}$$

$$=\frac{589\times10^{-9}}{0.589\times10^{-3}}=10^{-3}$$

$\Rightarrow \quad \theta = \sin^{-1}(0.001)$

47. (3)

$\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2m}} \cdot \frac{1}{\sqrt{E}}$. Taking log of both sides

$$\log\lambda = \log\frac{h}{\sqrt{2m}} + \log\frac{1}{\sqrt{E}} \Rightarrow \log\lambda = \log\frac{h}{\sqrt{2m}} - \frac{1}{2}\log E$$

$$\Rightarrow \quad \log\lambda = -\frac{1}{2}\log E + \log\frac{h}{\sqrt{2m}}$$

This is the equation of straight-line having slope (–1/2) and positive intercept on log λ axis.

48. (3)

$$\frac{1}{2}mv^2 = eV$$

$$v = \sqrt{\frac{2eV}{m}} = \sqrt{2V \times \frac{e}{m}}$$

$$v = \sqrt{2 \times 0.71 \times 1.76 \times 10^{11}}$$

$= 5 \times 10^5$ m/s = 500 km/s

49. (3)

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2m_\alpha Q_\alpha V}}$$

On putting $Q_\alpha = 2 \times 1.6 \times 10^{-19} C$

$m_\alpha = 4m_p = 4 \times 1.67 \times 10^{-27}$ kg

$$\Rightarrow \quad \lambda = \frac{0.101}{\sqrt{V}} \text{Å}$$

50. (3)

For K_α line $\nu \propto (z-1)^2 \Rightarrow \lambda \propto \frac{1}{(z-1)^2}$

i.e. the graph between λ and z will be (C)