

ANSWER KEY

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|---------|---------|---------|---------|---------|---------|
| 1. [B] | 2. [A] | 3. [C] | 4. [A] | 5. [D] | 6. [B] |
| 7. [D] | 8. [C] | 9. [D] | 10. [A] | 11. [C] | 12. [B] |
| 13. [B] | 14. [D] | 15. [A] | 16. [C] | 17. [A] | 18. [B] |
| 19. [C] | 20. [D] | 21. [B] | 22. [A] | 23. [D] | 24. [C] |
| 25. [A] | 26. [D] | 27. [D] | 28. [B] | 29. [A] | 30. [D] |
| 31. [A] | 32. [B] | 33. [B] | 34. [C] | 35. [B] | 36. [A] |
| 37. [C] | 38. [B] | 39. [A] | 40. [D] | 41. [B] | 42. [B] |
| 43. [A] | 44. [A] | 45. [C] | 46. [C] | 47. [A] | 48. [A] |
| 49. [A] | 50. [D] | | | | |

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

$$\omega_{\min} = \frac{2\pi}{60 \times 60} \text{ rad/s}$$

$$\omega_{\text{second}} = \frac{2\pi}{60} \text{ rad/s}$$

$$\omega_{\min} - \omega_{\text{sec}} = \frac{2\pi}{60} \left(\frac{1}{60} - 1 \right)$$

$$\frac{59\pi}{1800} \text{ rad/s}$$

2. $F_{\text{cp}} = m\omega^2 r$ & $\omega = \frac{2\pi}{T}$

T, ω & masses are same

$$\therefore F_{\text{cp}} \propto r$$

$$\text{Hence } \frac{(F_{\text{cp}})_1}{(F_{\text{cp}})_2} = \frac{r_1}{r_2}$$

3. From Newton's law of gravitation

$$F = \frac{GM_1 M_2}{r^2}$$

If $M_1 = M_2 = 1$ unit of mass &

$r = 1$ unit of distance then

$F = G =$ universal gravitational constant.

4. Change in potential energy in displacing a body from r_1 to r_2 is given by

$$\Delta U = GMm \left(\frac{1}{r_1} - \frac{1}{r_2} \right)$$

$$= GMm \left(\frac{1}{2R} - \frac{1}{3R} \right)$$

$$= \frac{GMm}{6R}$$

5. As angular momentum is conserved

$$I_1 \omega_1 = I_2 \omega_2$$

$$\frac{2}{5} MR^2 \times \left[\frac{2\pi}{24} \right] = \frac{2}{5} \left[\frac{M}{3} \right] \times \left[\frac{R}{2} \right]^2 \times \left[\frac{2\pi}{T} \right]$$

$$\therefore T = 2 \text{ hrs.}$$

6. Linear K.E. = $\frac{1}{2} MV^2 = \frac{1}{2} Mr^2\omega^2$

Angular K.E. = $\frac{1}{2} I\omega^2 = \frac{1}{2} Mr^2\omega^2$

\therefore Ratio = 1:1

7. $x = a \sin \omega t \implies 2.5 = 5 \sin \left(\frac{2\pi}{6} t \right)$

$$\frac{2\pi t}{6} = \frac{\pi}{6}$$

$\therefore t = \frac{1}{2}$ sec

phase difference corresponding to 6s is 2π so phase difference corresponding to $\frac{1}{2}$ s is $\frac{\pi}{6}$

8. Given P.E. = $\frac{25}{100}$ T.E.

$\therefore \frac{1}{2} M\omega^2 x^2 = \frac{1}{4} (\frac{1}{2} M \omega^2 A^2)$

$$x^2 = \frac{A^2}{4}$$

$\therefore x = \frac{A}{2}$

9. $Y = \frac{FL}{Al}$

$\therefore F = YA \frac{l}{L}$

$$F \propto \frac{r^2}{L}$$

$$\frac{F_1}{F_2} = \left(\frac{r_1}{r_2} \right)^2 \times \left(\frac{L_2}{L_1} \right) = \left(\frac{2}{1} \right)^2 \cdot \left(\frac{1}{4} \right) = 1:1$$

10. Poisson's ratio = $\frac{\text{lateral strain}}{\text{longitudinal strain}}$

$$= 0.4 \times \frac{0.05}{100}$$

= is reduced by 0.02 %.

11. Work done = change in area x T
 = (96 - 24) x 2 x 30
 = 4320 erg

12. Volume of big drop = 10^6 x volume of each droplet

$$\frac{4}{3} \pi R^3 = 10^6 \times \frac{4}{3} \pi r^3$$

$$R = 10^2 r$$

$$r = \frac{R}{10^2} = \frac{10^{-3}}{10^2} = 10^{-5} \text{ m}$$

13. Distance between a compression and the nearest rarefaction is $\frac{\lambda}{2} = 1 \text{ m}$. Hence

$$n = \frac{v}{\lambda} = \frac{360}{2} = 180 \text{ Hz.}$$

14. $y = 0.01 \sin 4\pi (100 t - x)$
 $= 0.01 \sin 2\pi (200 t - 2x)$

equation of the standard simple harmonic wave is

$$y = A \sin 2\pi \left[nt - \frac{x}{\lambda} \right]$$

comparing both equations we get

$$n = 200 \text{ Hz.}$$

15. $y = 4 \cos \left[\frac{2\pi x}{50} \right] \sin (100\pi t)$

Amplitude $A = 4 \cos \left[\frac{2\pi x}{50} \right]$ At node $A = 0$

$$\therefore \cos \left[\frac{2\pi x}{50} \right] = 0$$

$$\therefore \left[\frac{2\pi x}{50} \right] = \frac{\pi}{2}, \frac{3\pi}{2}, \dots$$

$$\therefore x = \frac{50}{4}, \frac{150}{4}$$

$$\therefore x = 12.5, 37.5, \dots$$

Thus node will occur at a distance of 12.5 cm from the origin.

16. Fundamental frequency of closed pipe $n = \frac{v}{4l} = 220 \text{ Hz}$

$\therefore v = 220 \times 4l$

If $\left(\frac{1}{4}\right)^{\text{th}}$ of the pipe is filled with water, then the remaining length of air column is $\frac{3l}{4}$

Now the fundamental frequency $= \frac{v}{4\left(\frac{3l}{4}\right)} = \frac{v}{3l}$ and

First overtone $= 3 \times \text{fundamental frequency} = 3 \times \frac{v}{3l} = \frac{220 \times 4l}{l} = 880 \text{ Hz.}$

17. By Newton's law of cooling

$$\frac{\theta_2 - \theta_1}{t} = k \left[\frac{\theta_1 + \theta_2}{2} - \theta_0 \right] \quad \dots\dots\dots 1.$$

$$\frac{70 - 60}{5} = k (65 - \theta_0) \quad \dots\dots\dots 2.$$

$$\frac{60 - 54}{5} = k (57 - \theta_0) \quad \dots\dots\dots 3.$$

Dividing eqⁿ 1 by eqⁿ 2

$$\frac{5}{3} = \frac{65 - \theta_0}{57 - \theta_0}$$

$\therefore \theta_0 = 45^{\circ} \text{ C}$

18. $E = \sigma T^4$
 $\therefore T = \left[\frac{E}{\sigma} \right]^{1/4}$
 $= \left[\frac{5.67 \times 10^4}{5.67 \times 10^{-8}} \right]^{1/4} = 10^3 \text{ k}$

19. $\frac{E_2}{E_1} = \frac{T_2}{T_1}$ Given $E_2 = 3 E_1$

$\therefore \frac{3E_1}{E_1} = \frac{T_2}{T_1}$

$\therefore T_2 = 3T_1 = 3(227 + 273) = 1500 \text{ k}$

$T_2 = 1500 - 273 = 1227^{\circ} \text{ C}$

20. Free Path.

21. $V = \frac{4}{3} \pi r^3$

\therefore Percentage error in volume = 3 x percentage error in radius

$$= 3 \times \frac{0.1}{5.3} \times 100$$

22. Strain

23. Velocity

24. Kinetic energy

25. By principle of dimensional homogeneity

$$\left[\frac{a}{v^2} \right] = [P]$$

$$[a] = [p] [v^2]$$

$$= [M^1 L^{-1} T^{-2}] [L^6]$$

$$= [M^1 L^5 T^{-2}]$$

26. $F \propto \frac{q_1 q_2}{r^2}$ colum's law

$$F_{AB} \propto \frac{8}{x^2}$$

$$F_{AD} \propto \frac{8}{y^2}$$

$$F_{BD} \propto \frac{16}{x^2 + y^2}$$

$$F_{AC} \propto \frac{4}{x^2 + y^2}$$

Therefore from all equations the electric force will be least between A and C.

27. Resistance of each part will be R/n such 'n' parts are joined in parallel.

So, $R_{eq} = \frac{R}{n^2}$

28. Formula.

$$\begin{aligned}
 29. \quad P = p_1 + p_2 &= \frac{1}{f_1 \text{ (m)}} + \frac{1}{f_2 \text{ (m)}} \\
 &= \frac{1}{0.4} + \frac{1}{-0.25} \quad (\text{focal length of concave lens } -ve) \\
 &= \frac{1}{0.4} - \frac{1}{0.25} = -1.5 \text{ D}
 \end{aligned}$$

30. Explanation not required.

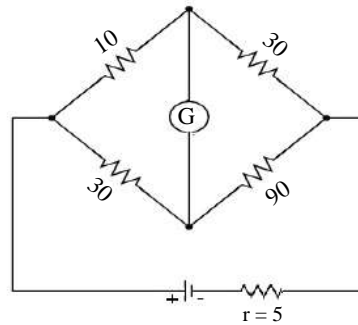
$$\begin{aligned}
 31. \quad V = V_1 + V_2 &= E_1 t_1 + E_2 t_2 = \frac{\sigma}{K_1 \epsilon_0} t_1 + \frac{\sigma}{K_2 \epsilon_0} t_2 \\
 &= \frac{\sigma}{\epsilon_0} \left(\frac{t_1}{K_1} + \frac{t_2}{K_2} \right) \\
 &= \frac{Q}{A \epsilon_0} \left(\frac{t_1}{K_1} + \frac{t_2}{K_2} \right) \quad (\sigma = Q/A)
 \end{aligned}$$

32. For a balanced wheatstone's network $\frac{P}{Q} = \frac{R}{S}$,

As the bridge is balanced, no current will flow through galvanometer.

Thus equivalent resistance is

$$\begin{aligned}
 R_{eq} &= \frac{(10+30)(30+90)}{(10+30+30+90)} \\
 &= \frac{40 \times 120}{160} \\
 &= 30 \text{ Ohm}
 \end{aligned}$$

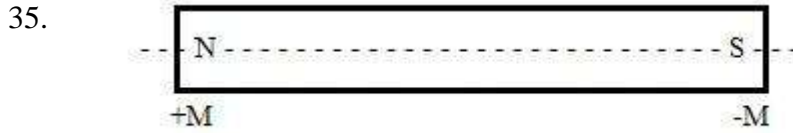


\therefore Reffective = 30 + 5 = 35 Ohm.

$$\text{Now } I = \frac{V}{R_{eff}} = \frac{7}{35} = \frac{1}{5} = 0.2 \text{ A}$$

$$\begin{aligned}
 33. \quad \text{K.E.} &= \frac{q^2 B^2 R^2}{2M_p} = \frac{(1.6 \times 10^{-19})^2 (0.5)^2 (4 \times 10^{-1})^2}{2 \times 1.67 \times 10^{-27}} \\
 &= 3.06 \times 10^{-13} \text{ J} \\
 &= \frac{3.06 \times 10^{-13}}{1.6 \times 10^{-19}} \text{ eV} \\
 &= 1.9 \times 10^6 \text{ eV} \\
 &= 1.9 \text{ MeV}
 \end{aligned}$$

34. $M = NIA$
 $\therefore M \propto A$



New Length $L^1 = L$

New pole strength $M^1 = M/2$

\therefore New Magnitude dipole moment $M^1 = 2 M^1 L$
 $= 2 M/2 L$
 $= M/2$

36. $Y = kt^2 \Rightarrow \frac{dy}{dt} = 2kt$
 $= \frac{d^2y}{dt^2} = 2k$
 $= a_y = 2 \text{ m/s}^2 \quad \dots\dots\dots (k = 1)$

$T_1 = 2\pi\sqrt{\frac{l}{g}}, \quad T_2 = 2\pi\sqrt{\frac{l}{g+a_y}}$
 $\frac{T_1^2}{T_2^2} = \frac{g+a_y}{g} = \frac{10+2}{10} = \frac{12}{10} = \frac{6}{5}$

37. The potential on each of them can be zero, if
 $q_{\text{net}} = 0$
 $\therefore q_1 \pm q_2 = 0$
 $\therefore C_1 V_1 \pm C_2 V_2 = 0$
 $\therefore 120 C_1 \pm 200 C_2 = 0$
 $\therefore 3 C_1 \pm 5 C_2 = 0$

38. $I = I_{\text{max}} \cdot \cos^2 \frac{\theta}{2} \quad \dots\dots\dots 1$
 Given $I = \frac{I_{\text{max}}}{2} \quad \dots\dots\dots 2$
 From 1 & 2

$$\theta = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \dots$$

$$\therefore \text{path difference, } \Delta x = \left(\frac{\lambda}{2\pi} \right) \theta$$

$$\therefore \Delta x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}, \dots \left(\frac{2n+1}{4} \right) \lambda$$

39. Explanation not required.

$$40. \quad \alpha = \frac{\Delta I_C}{\Delta I_E}, \quad \beta = \frac{\Delta I_C}{\Delta I_B}$$

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.95}{1-0.95} = 19$$

$$\therefore \Delta I_C = \beta \cdot \Delta I_B = 19 \times 0.4 = 7.6 \text{ mA}$$

$$41. \quad E = mc^2$$

$$E^1 = m \left(\frac{c}{2} \right)^2 \quad (C^1 = C/2)$$

$$= \frac{mc^2}{4}$$

$$= \frac{E}{4}$$

$$\therefore \text{Percentage decrease} = \frac{E-E^1}{E} \times 100$$

$$= \frac{E-E/4}{E} \times 100$$

$$= \frac{3}{4} \times 100$$

$$= 75 \%$$

$$42. \quad \frac{I_{\max}}{I_{\min}} = 9 = \left(\frac{a_1+a_2}{a_1-a_2} \right)^2 = 9$$

$$\frac{a_1+a_2}{a_1-a_2} = 3 \Rightarrow \frac{a_1}{a_2} = \frac{3+1}{3-1} = 2$$

$$\therefore I_1 : I_2 = 4:1 \quad \dots \dots \dots (I \propto a^2)$$

43. $K.E. = \frac{nc}{\lambda} - \phi$

$$\frac{nc}{\lambda_1} - \phi = k_1 \quad \dots\dots\dots 1$$

$$nc - \phi \lambda_1 = k_1 \lambda_1$$

$$\frac{nc}{\lambda_2} - \phi = k_2 \quad \dots\dots\dots 2$$

$$nc - \phi \lambda_2 = k_2 \lambda_2$$

From eqⁿ 1 & 2

$$(\lambda_2 - \lambda_1) \phi = k_1 \lambda_1 - k_2 \lambda_2$$

$$\phi = \frac{k_1 \lambda_1 - k_2 \lambda_2}{\lambda_2 - \lambda_1}$$

44. P.E. $\propto \frac{-1}{r}$ and K.E. $\propto \frac{1}{r}$

\therefore As r increases, K.E. decreases but P.E. increases.

45. The majority carriers in n - type semiconductors are electrons.

46. Explanation not required.

47. Explanation not required.

48. i) Emission of α particles mass no decreases by 4 and atomic no decreases by 2.
 ii) Emission of β particles mass no remains same but atomic no increases by 1.
 iii) Emission of γ particles remains same.

49. Explanation not required.

50. Explanation not required.