

Answers and Solutions

PHYSICS

1) 3	2) 3	3) 2	4) 3	5) 4	6) 3	7) 2	8) 4	9) 4	10) 3
11) 4	12) 4	13) 4	14) 3	15) 4	16) 3	17) 1	18) 3	19) 2	20) 3
21) 4	22) 2	23) 3	24) 4	25) 2	26) 3	27) 1	28) 2	29) 2	30) 4
31) 1	32) 4	33) 3	34) 1	35) 2	36) 3	37) 3	38) 4	39) 3	40) 4
41) 2	42) 4	43) 1	44) 4	45) 3					

HINTS & SOLUTIONS

1. Answer (3)

$$1. a.m.u = 1u = 1.6 \times 10^{-27} \text{ kg}$$

$$40u = 40 \times 1.6 \times 10^{-27} \text{ kg}$$

Number of atoms in earth

$$= \frac{6.64 \times 10^{24}}{40 \times 1.6 \times 10^{-27}} = 10^{50}$$

2. Let V_1 be the initial velocity of 1 kg block and V_2 be the final velocity of 2kg block.
From law of conservation of momentum, we get

$$1(v_1) = 2(v_2) \Rightarrow v_2 = \frac{v_1}{2}$$

$$\Rightarrow v_2 = \frac{4}{2} = 2 \text{ ms}^{-1}$$

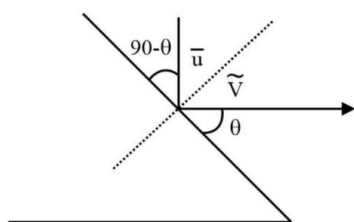
$$(\because v_1 = 4 \text{ ms}^{-1})$$

$$\Delta \text{ Kinetic energy} = \frac{1}{2} m_1 v_1^2 - \frac{1}{2} m_2 v_2^2$$

$$= \frac{1}{2} (1 \times 4^2 - 2 \times 2^2)$$

$$= \frac{1}{2} \times 8 = 4J$$

3.



$$\vec{u} = -\sqrt{2gh} \hat{j}$$

$$|\vec{v}| = |\vec{u}|$$

$$\Rightarrow \vec{v} = \sqrt{2gh} \hat{i}$$

$$\Rightarrow u \cos \theta = v \sin \theta$$

$$\tan \theta = 1$$

$$\Rightarrow \theta = 45^\circ$$

4. Since there is no resistance, the trajectory of motion will be parabolic, and as a result, the angle of projection will be equal to the angle of striking the ground.

Also, we know that the horizontal component of velocity remains unaffected throughout the motion. So it will not contribute to the change in momentum. The components contributing to the change in momentum will be the vertical components.

Initial vertical momentum component is $mv\sin 45^\circ$ and the final vertical momentum component is $-(mv\sin 45^\circ)$

Change in momentum,

$$\Delta p = mv\sin 45^\circ - (-mv\sin 45^\circ)$$

$$= 2mv\sin 45^\circ = 2mv \frac{1}{\sqrt{2}} = \sqrt{2}mv$$

5. $V = r\omega$

$$r = R \cos \theta$$

Where $R = 6400$ km is radius of the earth; $\theta = 60^\circ$ is the latitude angle.

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

$$(T = 24 \text{ hours} = 24.60.60\text{s})$$

$$\therefore V = R \cos \theta \frac{2\pi}{T} = 6400 \times 10^3 \times \frac{1}{2} \times \frac{2\pi}{24.60.60} = \frac{2000\pi}{27} \text{ ms}^{-1}$$

6. Curve C correctly depicts a high relative permeability ($\mu_r \gg 1$) that drops sharply as the temperature approaches and exceeds T_c

7. Current in the given circuit $i = \frac{50}{(5+8+10+3)} = 2\text{A}$

$$\text{Potential difference between A and B } V_A - V_B = 2 \times 12$$

$$\Rightarrow V_A - 0 = 24\text{V} \Rightarrow V_A = 24\text{V}$$

8. Since the cells are in parallel,

$$V = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}} = \frac{\frac{18}{2} + \frac{12}{1}}{\frac{1}{2} + \frac{1}{1}} = \frac{21}{1.5} = 14\text{V}$$

9. Given $\frac{v^2}{[9+r]^2} 9 = \frac{v^2}{[4+r]^2} 4$

$$\Rightarrow r = 6$$

$$\therefore H = \left(\frac{10}{11}\right)^2 \times 5 \times 1 = 4.13\text{J}$$

10. At $t = 0$, L behaves as open circuit and at $t = \infty$ as short circuit.

$$\text{So at, } t = 0, i = 10/10 = 1\text{A}$$

$$\left[\because R_{eq} = 10\Omega \right]$$

$$\text{And at } t = \infty, i = \frac{10}{\left(\frac{10}{3}\right)} = 3\text{A}$$

$$\left[\because R_{eq} = \frac{10}{3}\Omega \right]$$

11. On closing the switch, current begins flowing through coil 1. Hence, a magnetic field will be produced in this coil. The magnetic field varies from zero at a maximum value in a certain time. As a result, the field across coil 2 will change for that time. This change in field will cause current to be induced in coil 2 for that short time. This phenomenon of generation of current in coil 2, caused by the variation in the magnetic field of coil 1, is known as electromagnetic induction. The current induced in coil 2 will deflect the pointer of the galvanometer connected to it

Why alternative 1 is wrong : Coil 2 will not move toward coil 1 because so mechanical force is produced on closing the switch

Why alternative 2 is wrong : Coil 2 will not move away from coil 1 because there is no mechanical force that could repel it.

Why alternative 3 is wrong: Since current will be induced in coil 2, the pointer of the galvanometer will not remain at zero.

The correct answer is 4.

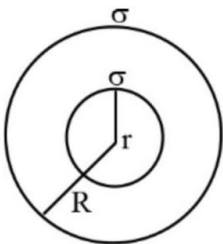
$$12. \quad \tan \phi = \frac{V_L - V_C}{V_R}$$

$$= \frac{30 - 30}{60} = 0$$

$$\text{Or } \phi = 0^\circ$$

$$13. \quad E_{\text{east-west}} = 0 \Rightarrow \left(\frac{dv}{dr} \right)_{\text{east-west}} = 0$$

14.



The potential at the centre is the same as that on the surface

$$\therefore v = \frac{\sigma r}{\epsilon_0} + \frac{\sigma R}{\epsilon_0}$$

$$15. \quad \text{Using } W_{i \rightarrow f} = q(V_f - V_i)$$

$$20 = (V - 10)$$

$$V = 5 + 10 = 15V$$

$$16. \quad \text{Pitch} = 0.5 \text{ mm}$$

$$\text{L.C} = \frac{0.5}{50} = 0.01 \text{ mm}$$

$$\text{M.S.R} = 2$$

$$\text{Neck reading} = 25$$

$$d = 2 \times (0.5) + 25 \times 0.01 = 1.25 \text{ mm}$$

Considering zero error

Here zero error is

$$= +5 \times 0.01$$

$$= +0.05 \text{ mm}$$

So actual diameter

$$= d - 0.05 = 1.20 \text{ mm}$$

$$17. \quad \text{For a satellite in a closed orbit, we know that T.E.} = \frac{P.E}{2} = -K.E$$

Hence, in order to make the body escape, we should make its total energy 0, which can be achieved by providing additional energy equal to the kinetic energy of the body itself as from the above relation we can clearly see that T.E = -K.E..

So, the energy given to the body so as to completely escape from its orbit is equal to its kinetic energy K.

$$18. \quad \text{Rate of loss of energy by unit area of the planet} = \sigma T^4, \text{ where } \sigma \text{ is the Stefan's constant. Let } Q \text{ be the total energy emitted by the sun every second. If } d \text{ is the distance of the planet from sun, then } Q \text{ falls uniformly over the inner surface of the sphere of radius } d. \text{ Rate of gain of heat by unit area of planet,}$$

$$= \frac{Q}{4\pi d^2}$$

For steady temperature of planet

$$\sigma T^4 = \frac{Q}{4\pi d^2}$$

$$T^4 = \frac{Q}{4\pi\sigma d^2} \text{ or } T = \left(\frac{Q}{4\pi\sigma d^2} \right)^{1/4}$$

$$T \propto \frac{1}{\sqrt{d}}$$

19. We have, the heat lost by water = $ms\theta$, heat gained by ice = $MS\theta + ML$.
From the principle of calorimetry, we have, the heat lost by water = heat gained by ice

$$\text{Hence, } ms\theta_1 = MS\theta_2 + ML$$

$$5 \times 1 \times (20 - 0) = 2 \times 0.5 \times 20 + x \times 80$$

$$x = 1\text{kg}$$

1kg of ice melts to form water.

Hence, final amount of water

$$5\text{kg} + 1\text{kg} = 6\text{kg}$$

Here, m , s and θ_1 are the mass, specific heat and temperature difference for water respectively. Similarly, M , S and θ_2 are the corresponding quantities for ice. Here, L is the latent heat of fusion

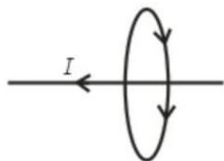
20. $W_{\text{total}} = W_{\text{isobaric}} + W_{\text{adiabatic}}$

$$W_{\text{total}} = nR\Delta T + \frac{nR\Delta T}{\gamma - 1}$$

$$W_{\text{total}} = 2 \times \frac{25}{3} \times 600 \left[1 + \frac{1}{\frac{9}{7} - 1} \right]$$

$$= 45\text{kJ}$$

- 21.



By Ampere's theorem $\vec{B} \cdot 2\pi d = \mu_0 i$

$$\vec{B} = \frac{\mu_0 i}{2\pi d} = \frac{4\pi \times 10^{-7} \times 100\text{A}}{2\pi \times 4\text{m}} = 50 \times 10^{-7} \text{ T}$$

$$\Rightarrow B = 5 \times 10^{-6} \text{ T southwards.}$$

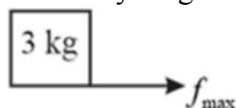
22. The current is same in both the wire, hence magnetic field induced will be same

23. Given $F=29\text{N}$, $M_A=7\text{kg}$, $M_B=3\text{kg}$, $\mu=?$

$$F = (3+7)a$$

$$\Rightarrow a = 4.9 \text{ ms}^{-2}$$

Free body diagram of B



$$f_{\text{max}} = \mu(3g) = 3a$$

$$\mu = \frac{3a}{3g} = \frac{4.9}{g} = \frac{4.9}{9.8} = 0.5$$

24. In fusion, two lighter nuclei combine to give a heavier nucleus and possibly other products

$$25. \lambda_{\text{photon}} = \frac{hc}{E}$$

$$\lambda_{\text{electron}} = \frac{h}{\sqrt{2mE}}$$

$$\Rightarrow \frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} = C \sqrt{\frac{2m}{E}}$$

$$\frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} \propto \frac{1}{\sqrt{E}}$$

$$26. \frac{\Delta V}{V} = \frac{P}{B}$$

$$\frac{\Delta V}{V} = \frac{\rho ph}{B} = \frac{1000 \times 10 \times 3000}{2.2 \times 10^9}$$

$$\Rightarrow \frac{\Delta V}{V} = 0.0136 = 1.36\%$$

$$27. \text{At } P, \delta = 0 = A(\mu - 1) \Rightarrow \mu = 1$$

$$\text{Also } \delta_m = (\mu - 1)A = A\mu_m - A$$

Comparing it with $y = mx + c$

Slope of the line = $m = A$

It means that medium 2 is denser medium. SO total internal reflection cannot occur.

28. For normal vision (related eye), the image is formed at infinity. Hence the magnifying power of Galilean

$$\text{telescope} = \frac{f_0}{f_e} = \frac{200}{2} = 100$$

$$29. F = \frac{dp}{dt} \Rightarrow Kt = \frac{dp}{dt}$$

$$\int_P^{3P} dP = \int_0^t Kt dt \Rightarrow 3P - P = \frac{Kt^2}{2} \Rightarrow t$$

$$= 2\sqrt{\frac{P}{K}}$$

$$30. t = \sqrt{\frac{2s}{g \sin \theta} \left(1 + \frac{K^2}{R^2} \right)}$$

$$\frac{t_1}{t_2} = \sqrt{\frac{1 + \frac{2}{5}}{1 + \frac{1}{2}}} = \sqrt{\frac{14}{15}}$$

31. From Boolean algebra we have

$$Y = A.(A + B) = A$$

32. The P-N junction will conduct only when it is forward biased i.e., when -5V is fed to it, so it will conduct only for 3rd quarter part of signal shown and when it conducts potential drop 5 volt will be across both the resistors, so output voltage across R_2 is 2.5V

33. Let m gram of water, whose temperature is θ be added to 20g of water at 30°C

$$\text{If } m \times 1(\theta - \theta_0) = 20 \times 1(\theta_0 - 30)$$

$$\Rightarrow (m+2)\theta_0 = 600 + m\theta$$

$$\Rightarrow \theta_0 = \frac{600 + m\theta}{20 + m}$$

For option 1

$$\theta_0 = \frac{600 + m\theta}{20 + m} = \frac{600 + 20 \times 40}{20 + 20} = 35^\circ C$$

For option 2

$$\theta_0 = \frac{600 + m\theta}{20 + m} = \frac{600 + 40 \times 35}{20 + 40} = 33.33^\circ C$$

For option 3

$$\theta_0 = \frac{600 + m\theta}{20 + m} = \frac{600 + 10 \times 50}{20 + 10} = 36.67^\circ C$$

For option 4

$$\theta_0 = \frac{600 + m\theta}{20 + m} = \frac{600 + 40 \times 18}{20 + 40} = 22^\circ C$$

We can see θ_0 is maximum for option 3

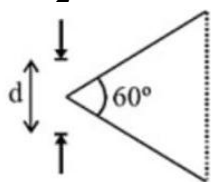
34. As $d \sin \theta = n\lambda$ when $n = 1$

$d \sin \theta = \lambda$ the phase difference is 2π and we get first minima

35. In diffraction

$$d \sin 30^\circ = \lambda$$

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



Young's fringe width [d' – the separation between with slits]

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

$$10^{-2} = \frac{d}{2} \times \frac{50 \times 10^{-2}}{d'}$$

$$10^{-2} = \frac{10^{-6} \times 50 \times 10^{-2}}{2 \times d'}$$

$$d' = 25 \mu m$$

36. $V_A = 18 kmh^{-1} = 5 ms^{-1}$

$$V_B = 27 kmh^{-1} = 7.5 ms^{-1}$$

Frequency received by A

$$f_A = f_0 \left(\frac{1500 - 5}{1500 - 7.5} \right)$$

Frequency of reflected wave as heard by B.

$$f'_B = f_A \left(\frac{1500 + 7.5}{1500 + 5} \right)$$

$$= 500 \left(\frac{1495}{1492.5} \right) \left(\frac{1500 + 7.5}{1500 + 5} \right)$$

$$= 501.67 Hz \approx 502 Hz$$

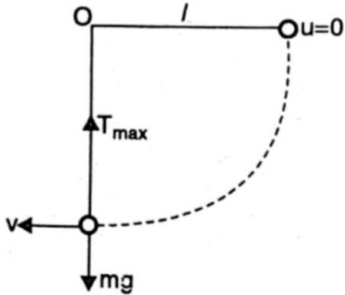
37. Intensity is proportional to (amplitude)² and also intensity is proportional to (frequency)². Therefore, intensity

$$\text{becomes } \frac{2^2}{4^2} = \frac{1}{4}$$

$$38. \quad OO' = \frac{2d}{3} - \frac{d}{2} = \frac{4d - 3d}{6}$$

$$OO' = \frac{d}{6} \Rightarrow x = \frac{d}{6}$$

39. The tension in string is maximum at the lowest position of the ball.



$$\therefore T_{\max} - mg = \frac{mv^2}{1}$$

$$\therefore T_{\max} - mg = \frac{mv^2}{1} \dots (i)$$

The loss in potential energy = gain in kinetic energy

$$\text{Or } mgl = \frac{1}{2}mv^2$$

$$\therefore v = \sqrt{2gl} \dots (ii)$$

$$\therefore \frac{mv^2}{1} = \frac{m}{1} 2gl = 2mg \dots (iii)$$

From equation (i), (ii) and (iii)

$$T_{\max} = mg + 2mg = 3mg$$

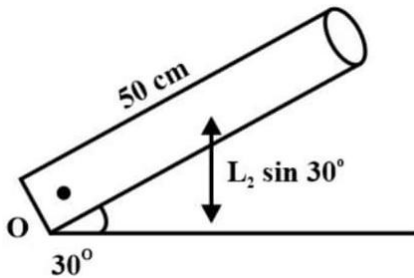
$$40. \quad \text{P.E} = \frac{1}{2} \times Y \times (\text{strain})^2 = \frac{1}{2} \times Y \times \frac{l^2}{L^2}$$

$$\text{Or P.E} \propto l^2$$

$$\therefore \frac{(P.E)_2}{(P.E)_1} = \frac{l_2^2}{l_1^2} = \frac{(6)^2}{(3)^2} = \frac{36}{9} = 4$$

$$\therefore (P.E)_2 = 4(P.E)_1 = 4V$$

41. From the conservation of mechanical energy



$$mg \frac{1}{2} \sin 30 = \frac{1}{2} I \omega^2$$

$$mg \frac{1}{2} \sin 30 = \frac{1}{2} \frac{ml^2}{3} \omega^2$$

$$\omega = \sqrt{\frac{3g}{2l}} = \sqrt{\frac{3 \times 10}{2 \times 50 \times 10^{-2}}} = \sqrt{30} \text{ rad s}^{-1}$$

42. $\Delta U =$ decrease in potential energy

$$= U_i - U_f$$

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

$$= \frac{1}{4} C (V_1 - V_2)^2$$

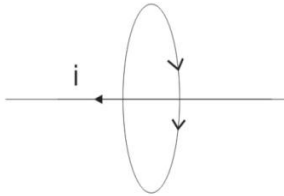
43. Potential difference between two points in a electric fields is,

$$V_A - V_B = \frac{W}{q_0}$$

Where W is work done by moving charge q_0 from point A to B.

$$\text{So, } V_A - V_B = \frac{2}{20} = 0.1V$$

(Here $W = 2J$, $q_0 = 20C$)



44.

By ampere's theorem, $\vec{B} \cdot 2\pi d = \mu_0 i$

$$\vec{B} = \frac{\mu_0 i}{2\pi d} = \frac{4\pi \times 10^{-7} \times 100A}{2\pi \times 4m}$$

$$= 5 \times 10^{-6} \text{ T southwards}$$

50. $\frac{dQ}{dt} = L \left(\frac{dm}{dt} \right)$

$$\text{Or } \frac{\text{Temperature difference}}{\text{Thermal difference}} = L \left(\frac{dm}{dt} \right)$$

$$\text{Or } \left(\frac{dm}{dt} \right) \propto \frac{1}{\text{Thermal resistance}}$$

$$q \propto \frac{1}{R}$$

In the first case, rods are in parallel and thermal resistance is $\frac{R}{2}$ while in second case rods are in series and

thermal resistance is $2R$

$$\frac{q_1}{q_2} = \frac{\frac{2R}{\frac{R}{2}}}{\frac{R}{2}} = 4.$$