

WEEKLY TEST OYM TEST - 30 RAJPUR
 SOLUTION Date 01-12-2019

[PHYSICS]

1. We are given that a particle of mass m is located in a one dimensional potential field and the potential energy is given by $V(x) = A(1 - \cos px)$.

So, we can find the force experienced by the particle as

$$F = -\frac{dV}{dx} = -Ap \sin px$$

For small oscillations, we have

$$F \approx -Ap^2 x$$

Hence, the acceleration would be given by

$$a = \frac{F}{m} = -\frac{Ap^2}{m} x$$

Also we know that

$$a = \frac{F}{m} = -\omega^2 x$$

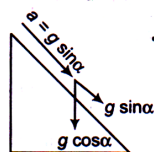
So,

$$\omega = \sqrt{\frac{Ap^2}{m}}$$

or

$$T = \frac{2\pi}{\omega} = 2\pi \sqrt{\frac{m}{Ap^2}}$$

2. We are given that the simple pendulum of length l is hanging from the roof of a vehicle which is moving down the frictionless inclined plane.



So, its acceleration is $g \sin \theta$. since vehicle is accelerating a pseudo force $m(g \sin \theta)$ will act on bob of pendulum which cancel the $\sin \theta$ component of weight of the bob. Hence we can say that the effective acceleration would be equal to

$$g_{\text{eff}} = g \cos \alpha$$

Now the time period of oscillation is given by

$$\begin{aligned}
 T &= 2\pi \sqrt{\frac{l}{g_{\text{eff}}}} \\
 &= 2\pi \sqrt{\frac{l}{g \cos \alpha}}
 \end{aligned}$$

3. The radius of particle is 3. Which is maximum, so the amplitude of simple harmonic motion is 3 cm.
4. The average acceleration of a particle performing SHM over one complete oscillation is zero.
5. Total energy in SHM

$$E = \frac{1}{2} m\omega^2 a^2, \text{ (where, } a = \text{amplitude)}$$

$$\begin{aligned} \text{Kinetic energy } K &= \frac{1}{2} m\omega^2 (a^2 - y^2) \\ &= E - \frac{1}{2} m\omega^2 y^2 \end{aligned}$$

$$\text{when } y = \frac{a}{2}$$

$$\begin{aligned} \Rightarrow K &= E - \frac{1}{2} m\omega^2 \left(\frac{a^2}{4} \right) = E - \frac{E}{4} \\ E &= \frac{3E}{4} \end{aligned}$$

6. For a body executing SHM, velocity,

$$v = \sqrt{\omega^2 (a^2 - y^2)}$$

$$\text{we have } 10^2 = \omega^2 (a^2 - 4^2)$$

$$\text{and } 8^2 = \omega^2 (a^2 - 5^2)$$

$$\text{So, } 10^2 - 8^2 = \omega^2 (5^2 - 4^2) = (3\omega)^2$$

$$\text{or } 6 = 3\omega$$

$$\text{or } \omega = 2$$

$$\therefore \text{ Time, } t = \frac{2\pi}{\omega}$$

$$\therefore t = \frac{2\pi}{2} = \pi \text{ second}$$

7. $\frac{d^2 x}{dt^2} + 16x = 0$

$$\therefore \omega^2 = 16 \Rightarrow \omega = 4$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{4} = \frac{\pi}{2}$$

8. The time period of the iron ball would be given by,

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

So, if mass of the ball is increased to 4 times of its initial mass, then the new period becomes

$$P' = 2\pi \sqrt{\frac{4M}{K}} = 2P$$

9.

10. Displacement-time equation of the particle will be,

$$x = A \cos \omega t$$

Given that;

$$x_1 = A \cos \omega$$

$$x_2 = A \cos 2\omega$$

and

$$x_3 = A \cos 3\omega$$

Now,

$$\begin{aligned} \frac{x_1 + x_3}{2x_2} &= \frac{A(\cos \omega + \cos 3\omega)}{2A \cos 2\omega} \\ &= \frac{2A \cos 2\omega \cos \omega}{2A \cos 2\omega} = \cos \omega. \end{aligned}$$

$$\therefore \omega = \cos^{-1} \left(\frac{x_1 + x_3}{2x_2} \right) = \frac{2\pi}{T}$$

$$\text{or } T = \frac{2\pi}{\omega}, \text{ where } \omega = \cos^{-1} \left(\frac{x_1 + x_3}{2x_2} \right).$$

11. A

12. For simple harmonic motion, $v = \omega \sqrt{a^2 - x^2}$

$$\text{When } x = \frac{a}{2}, v = \omega \sqrt{a^2 - \frac{a^2}{4}} = \omega \sqrt{\frac{3}{4}a^2}$$

$$\text{As } \omega = \frac{2\pi}{T},$$

$$\therefore v = \frac{2\pi}{T} \cdot \frac{\sqrt{3}}{2} a$$

$$\text{or } v = \frac{\pi\sqrt{3}a}{T}$$

13. A

14. C

15.

$$\begin{aligned} y &= 4 \cos^2(t/2) \sin(1000t) \\ &= 2[2 \cos^2(t/2) \sin(1000t)] \\ &= 2(1 + \cos t) \sin(1000t) \\ &= 2 \sin(1000t) + 2 \sin(1000t) \cos t \\ &= 2 \sin(1000t) + \sin(1001t) + \sin(999t) \end{aligned}$$

i.e., the given wave represents the superposition of three waves.

16. Resultant amplitude,

$$\begin{aligned} A_R &= \sqrt{A_1^2 + A_2^2 + 2A_1A_2 \cos \phi} \\ &= \sqrt{A^2 + A^2 + 2A^2 \cos \phi} \end{aligned}$$

But

$$A_R = A$$

 \therefore

$$\begin{aligned} A &= \sqrt{2A^2(1 + \cos \phi)} \\ &= \sqrt{4A^2 \cos^2 \frac{\phi}{2}} = 2A \cos \frac{\phi}{2} \end{aligned}$$

or

$$\cos \frac{\phi}{2} = \frac{1}{2} \quad \text{or} \quad \phi = \frac{2\pi}{3}.$$

17. (b) Let the line joining AB represents axis 'r'. By the conditions given 'r' coordinate of the particle at time t is

$$r = 2\sqrt{2} \cos \omega t$$

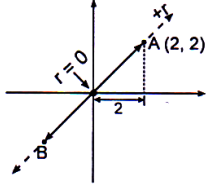


$$\omega = \frac{2\pi}{T} = \frac{2\pi}{2} \pi$$

$$\therefore r = 2\sqrt{2} \cos \pi t$$

$$x = r \cos 45^\circ = \frac{r}{\sqrt{2}} = 2 \cos \pi t$$

$$\therefore a_x = -\omega^2 x = -\pi^2 2 \cos \pi t \quad \therefore F_x = m a_x = -4\pi^2 \cos \pi t$$



18. (c) Both the spring are in series

$$\therefore K_{eq} = \frac{K(2K)}{K+2K} = \frac{2K}{3}$$

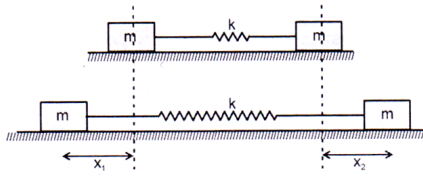
Time period

$$T = 2\pi \sqrt{\frac{\mu}{K_{eq}}} \quad \text{where } \mu = \frac{m_1 m_2}{m_1 + m_2}$$

$$\text{Here } \mu = \frac{m}{2} \quad \therefore T = 2\pi \sqrt{\frac{m}{2} \cdot \frac{3}{2K}}$$

$$= 2\pi \sqrt{\frac{3m}{4K}}$$

Method II



$$\therefore m x_1 = m x_2 \Rightarrow x_1 = x_2$$

force equation for first block;

$$\frac{2k}{3}(x_1 + x_2) = -m \frac{d^2 x_1}{dt^2}$$

$$\text{Put } x_1 = x_2 \Rightarrow \Rightarrow \frac{d^2 x_1}{dt^2} + \frac{4k}{3m} x_1 = 0 \quad \Rightarrow \omega^2 = \frac{4k}{3m}$$

$$\therefore T = 2\pi \sqrt{\frac{3m}{4k}}$$

$$19. (b) \frac{I_1}{I_2} = \frac{a_1^2 f_1^2}{a_2^2 f_2^2} = \frac{(3)^2 (8)^2}{(2)^2 (12)^2} = 1$$

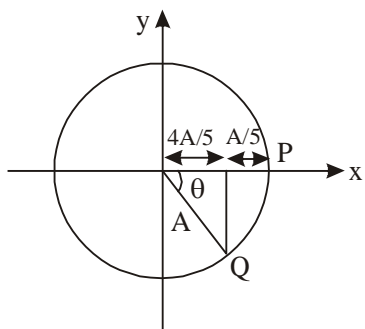
20. (b) Particle is starting from rest i.e., from one of its extreme position.

As particle moves a distance $A/5$, we can represent it on a circle as shown.

$$\cos \theta = \frac{4A/5}{A} = \frac{4}{5}$$

$$\theta = \cos^{-1} \left(\frac{4}{5} \right)$$

$$\omega t = \cos^{-1}\left(\frac{4}{5}\right)$$



$$t = \frac{1}{\omega} \cos^{-1}\left(\frac{4}{5}\right) = \frac{T}{2\pi} \cos^{-1}\left(\frac{4}{5}\right)$$

Alternatively

As starts from rest i.e., from extreme position $x = A \sin(\omega t + \phi)$

At $t = 0$; $x = A$

$$\Rightarrow \phi = \frac{\pi}{2}$$

$$\therefore A - \frac{A}{5} = A \cos \omega t$$

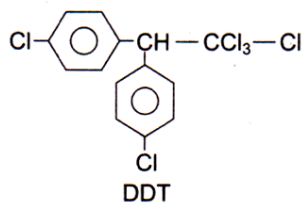
$$\frac{4}{5} = \cos \omega t$$

$$\Rightarrow \omega t = \cos^{-1} \frac{4}{5};$$

$$t = \frac{T}{2\pi} \cos^{-1}\left(\frac{4}{5}\right)$$

[CHEMISTRY]

21. (a)

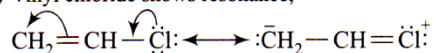


22. (d) Its vapours are non-inflammable (i.e. do not catch fire).
Hence used as fire extinguishers under the name pyren.

23. (d) S_N1 reaction gives racemic mixture with slight predominance of that isomer which corresponds to inversion because S_N1 also depends upon the degree of 'shielding' of the front side of the reacting carbon.

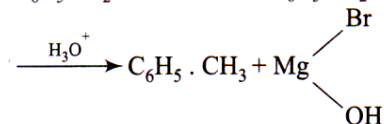
24. (b) Chloroform is oxidised to a poisonous gas, phosgene (COCl_2) by atmospheric gas.
 $\text{CHCl}_3 + \text{O} \longrightarrow \text{COCl}_2 + \text{HCl}$

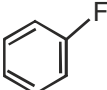
25. (b) Vinyl chloride shows resonance,



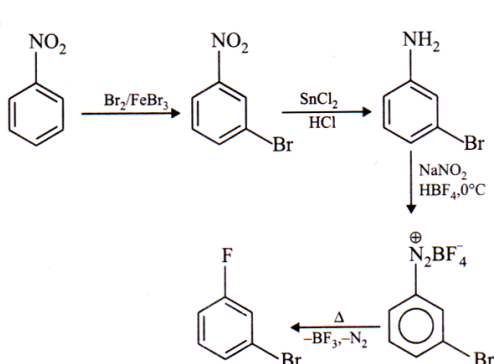
Due to resonance C—Cl bond has partial double bond character so bond is broken with difficulty.

26. (c) $\text{C}_6\text{H}_5\text{CH}_2\text{Br} \xrightarrow{\text{Mg/ether}} \text{C}_6\text{H}_5\text{CH}_2\text{MgBr}$

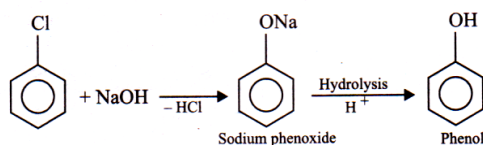


27. (A) Fluoro benzene 

28. (b) Sandmeyer's reaction.

29. (d) 

30. (c) Gammexane

31. (c) 

32. (d) Resonance stabilization and the hybridisation of C attached to halide is sp^2 .

33. (c) With ethoxide base, most substituted alkene (I) is formed as the major product. In the formation of (II), $\text{C}_2\text{H}_5\text{O}^-$ takes proton from less hindered β -carbon, hence less activation energy and greater rate of reaction although stability of product determines its content at equilibrium. Also, since E2 reaction is an elementary reaction in which halogen leaves in the rate determining step, iodide leaves most easily and fluoride with maximum difficulty.

34. (b) $\text{CH}_3-\underset{\text{Br}}{\text{CH}}-\text{CH}_2-\text{CH}_3 + \text{KOH} \xrightarrow[\text{(alc)}]{\text{Saytzeff's rule}}$

35. $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{\text{PBr}_3} \text{CH}_3\text{CH}_2\text{Br} \xrightarrow{\text{alc. KOH}} \text{CH}_2=\text{CH}_2$
 $\text{CH}_3\text{CH}_2\text{OH} \xleftarrow[\text{heat}]{\text{H}_2\text{O}} \text{CH}_3-\text{CH}_2-\text{HSO}_4$

36. Electron withdrawing $-\text{NO}_2$ group has very strong $-\text{I}$ and $-\text{R}$ effects so, compound 3 will be most acidic.



