DPP
DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

Solutions

SUBJECT : PHYSICS
DPP NO. : 10

Topic :- OSCILLATIONS

1 **(b)**

$T \propto \sqrt{l}$, $\because$ effective length $l_{\text{sitting}} > l_{\text{standing}}$

2 **(a)**

Let the equations of two mutually perpendicular SHM's same frequency be

$x = a_1 \sin \omega t$ and $y = a_2 \sin(\omega t + \emptyset)$

Then, the general equation of Lissajous figure can be obtained

as $\frac{x^2}{a_1^2} + \frac{y^2}{a_2^2} - \frac{2xy}{a_1 a_2} \cos \emptyset = \sin^2 \emptyset$

For $\emptyset = 0°: \frac{x^2}{a_1^2} + \frac{y^2}{a_2^2} - \frac{2xy}{a_1 a_2} = 0$

$\Rightarrow \left[\frac{x}{a_1} - \frac{y}{a_2}\right]^2 = 0 \Rightarrow \frac{x}{a_1} = \frac{y}{a_2} \Rightarrow y = \frac{a_2}{a_1} x$

This is an equation of a straight line passing through origin.

3 **(a)**

In this case springs are in parallel, so $k_{eq} = k_1 + k_2$

and $\omega = \sqrt{\frac{k_{eq}}{m}} = \sqrt{\frac{k_1 + k_2}{m}}$

4 **(c)**

$x = A \sin(\omega + \pi/2) = A \cos \omega t$

$\therefore \cos \omega t = x/A$ and $\sin \omega t = \sqrt{1 - (x^2/A^2)}$

$y = A \sin 2\omega t = \sqrt{1 - (x^2/\Delta A^2)}$

$y = A \sin 2\omega t = 2A \sin \omega t \cos \omega t$

or $y^2 = 4A^2 \sin^2 \omega t \cos^2 \omega t$

$= 4A^2 \times \frac{x^2}{A^2} \times \left(\frac{A^2 - x^2}{A^2}\right) = 4x^2\left(1 - \frac{x^2}{A^2}\right)$

5 **(d)**

The time period of oscillation of a spring does not depend on gravity

6 **(a)**

The standard equation in SHM is

$$x = a\cos(\omega t + \emptyset) \qquad ...(i)$$

Where a is amplitude, ω the angular velocity and $(\emptyset)$ the phase difference.

Also, $\omega = \frac{2\pi}{T}$ where T is periodic time.

So, Eq. (i) becomes

$$x = a\cos\left(\frac{2\pi t}{T} + \emptyset\right) \qquad ...(ii)$$

Given, equation is

$$x = 0.01\cos\left(\frac{2\pi t}{2} + \frac{\pi}{4}\right) \qquad ...(iii)$$

Comparing Eq. (ii) with Eq. (iii), we get

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

$\Rightarrow \quad T = 2\text{s}$

So, frequency $n = \frac{1}{T} = \frac{1}{2} = 0.5$ Hz

7 **(a)**

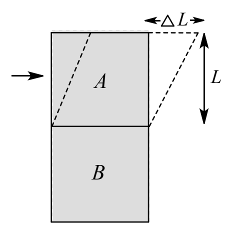
When lift falls freely effective acceleration and frequency of oscillations become zero

$g_{eff} = 0 \Rightarrow T' = \infty$, hence a frequency $= 0$

8 **(d)**

When the force F is applied to one side of block A, let the upper face of A be displaced through distance ΔL

Then



$\eta = \frac{F/L^2}{\Delta L/L}$ or $F = \eta L \Delta L \quad ...(i)$

So, $F \propto \Delta L$ and this force is restoring one. So, if the force is removed, the block will execute SHM

From Eq. (i) spring factor $= \eta L$

Here, inertia factor $= M$

$\therefore$ Time period, $T = 2\pi\sqrt{\frac{M}{\eta L}}$

9 **(d)**

$$\frac{T'}{T} = \sqrt{\frac{g}{g'}} = \sqrt{\left[\frac{g}{g\left(1 - \frac{1}{10}\right)}\right]} = \sqrt{\frac{10}{9}}$$

$\Rightarrow \quad T' = \sqrt{\frac{10}{9}}T$

10 **(b)**

$$\frac{d^2x}{dt^2} = -\alpha x \qquad ...(i)$$

We know,

$$a = \frac{d^2y}{dt^2} = -\omega^2 x \quad ...(ii)$$

From Eqs.(i) and (ii), we have

$$\omega^2 = \alpha$$

$$\omega = \sqrt{\alpha}$$

or $$\frac{2\pi}{T} = \sqrt{\alpha}$$

$\therefore$ $$T = \frac{2\pi}{\sqrt{\alpha}}$$

11 **(c)**

Time period $$T = 2\pi\sqrt{\frac{m}{k}}$$

$\because$ $$mg = kx$$

$\therefore$ $$T = 2\pi\sqrt{\frac{x}{g}}$$

$$(0.5)^2 = 4\pi^2 \times \sqrt{\frac{x}{10}}$$

$$\frac{(0.5)^2 \times 9.8}{4 \times 3.14 \times 3.14} = x$$

$$x = 0.0621 \text{ m}$$

$$x = 6.2 \text{ cm}$$

12 **(a)**

Given that, the time period of particle $A = T$ and the time period of particle $B = \frac{5T}{4}$

Hence, the time difference $(\Delta T) = \frac{5T}{4}$ - T

$\Rightarrow$ $$\Delta T = \frac{T}{4} \quad ...(i)$$

The relation between phase difference and time difference is

$$\Delta\emptyset = \frac{2\pi}{T}\Delta T$$

$$\Delta\emptyset = \frac{2\pi}{T} \times \frac{T}{4}$$

$\Rightarrow$ $$\Delta\emptyset = \frac{\pi}{2}$$

13 **(c)**

As X and Y have negligible mass, both the spring balances read the same force $8kg$ or $8kg$

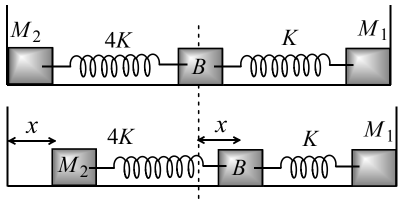
15 **(c)**

If a spring of spring constant k is divided into n equal parts, the spring constant of each part becomes nk. So, effective spring constant

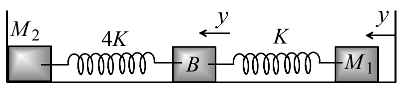
$$k = k_1 + k_2$$

$$= 4k + 4k = 8k$$

16 **(c)**



As springs and supports (M_1 and M_2) are having negligible mass. Whenever springs pull the massless supports, springs will be in natural length. At maximum compression, velocity of B will be zero



And by energy conservation

$$\frac{1}{2}(4K)y^2 = \frac{1}{2}Kx^2 \Rightarrow \frac{y}{x} = \frac{1}{2}$$

17 **(a)**

$A_{\max} = \omega^2 a$

19 **(c)**

Let displacement equation of particle executing SHM is

$y = a \sin \omega t$

As particle travels half of the amplitude from the equilibrium position, so $y = \frac{a}{2}$

Therefore, $\frac{a}{2} = a \sin \omega t \Rightarrow \sin \omega t = \frac{1}{2} = \sin \frac{\pi}{6}$

$$\Rightarrow \omega t = \frac{\pi}{6} \Rightarrow t = \frac{\pi}{6\omega} \Rightarrow t = \frac{\pi}{6\left(\frac{2\pi}{T}\right)} \left(\text{As } \omega = \frac{2\pi}{T}\right)$$

$$\Rightarrow t = \frac{T}{12}$$

Hence, the particle travels half of the amplitude from the equilibrium in $\frac{T}{12}s$

20 **(d)**

Let r be the amplitude of oscillation and T be the time period in SHM. Then total distance travelled in time $T = 4r$

$\therefore$ Average velocity, $v_{av} = \frac{4t}{T} = \frac{4r}{2\pi/\omega}$

$$= \frac{2r\omega}{\pi} = \frac{2v_{\max}}{\pi}$$

ANSWER-KEY										
Q.	1	2	3	4	5	6	7	8	9	10
A.	B	A	A	C	D	A	A	D	D	B
Q.	11	12	13	14	15	16	17	18	19	20
A.	C	A	C	B	C	C	A	A	C	D