DPP

DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

Solutions

SUBJECT : PHYSICS
DPP NO. : 5

Topic :- OSCILLATIONS

1 **(c)**

When the bob falls through a vertical height of 1m, the velocity acquired at the lowest point,

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 1} = \sqrt{20}$ ms^{-1}

Centrifugal force $= \frac{mv^2}{r} = \frac{0.01 \times 20}{1} = 0.20$ N

Net tension=weight+centrifugal force

$= (0.01 \times 10 + 0.20) = 0.30$ N

2 **(c)**

Mass (m)=20 g=0.02 kg

Frequency (f)=$\frac{5}{\pi}$ Hz

Time period of a loaded spring

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

Frequency $(f) = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$$\frac{5}{\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{0.02}}$$

or $10 = \sqrt{\frac{k}{0.02}}$

or $100 = \frac{k}{0.02}$

$\therefore$ $k = 2$ Nm^{-1}

3 **(c)**

$y_1 = a\sin(\omega t - kx)$;

$y_2 = b\cos\left(\omega t - \frac{k}{x}\right) = b\sin\left(\omega t - \frac{k}{x} + \pi/2\right)$

$\therefore$ Phase difference $= \left(\omega t - \frac{k}{x} + \pi/2\right) - (\omega t - kx)$

$= \pi/2$

4 **(c)**

When a mass m is placed on mass M, the new system is of mass $= (M + m)$, attached to the spring. New time period of oscillation,

$T' = 2\pi\sqrt{\frac{M+m}{k}}$

$T = 2\pi\sqrt{\frac{M}{k}}$

Let $v =$ velocity of the mass M while passing through the mean position.

$v' =$ Velocity of the mass$(M+m)$, while passing through the mean position.

According to law of conservation of linear momentum $Mv = (M+m)v'$

At mean position, $v = A\,\omega$ and $v' = A'\omega'$

$\therefore \quad MA\omega = (m+m)A'\omega$

or $A' = \left(\frac{M}{M+m}\right)\frac{\omega}{\omega'}A = \frac{M}{M+m} \times \frac{T'}{T} \times A$

$= \left(\frac{M}{M+m}\right) \times \sqrt{\frac{M+m}{M}} \times A$

$= A\sqrt{\frac{M}{M+m}}$

5 **(c)**

$T = 2\pi\sqrt{\frac{M}{k}}$ when mass is increased by m then ...(i)

$$T = 2\pi\sqrt{\frac{M+m}{k}}$$

$\Rightarrow \quad \frac{5T}{3} = 2\pi\sqrt{\frac{M+m}{k}}$ ...(ii)

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{3}{5} = \sqrt{\frac{M}{M+m}}$$

$$\frac{9}{25} = \frac{M}{M+m}$$

$\Rightarrow \quad 9M + 9m = 25M$

$\Rightarrow \quad 16M = 9m$

$$\frac{m}{M} = \frac{16}{9}$$

6 **(a)**

$T \propto \frac{1}{\sqrt{k}} \Rightarrow T_1 : T_2 : T_3 = \frac{1}{\sqrt{k}} : \frac{1}{\sqrt{k/2}} : \frac{1}{\sqrt{2k}} = 1 : \sqrt{2} : \frac{1}{\sqrt{2}}$

7 **(a)**

$y_1 = 4\sin\left(4\pi t + \frac{\pi}{2}\right) = 4\cos 4\pi t$

$y_2 = 3\cos(4\pi t) = 3\cos 4\pi t$

The phase difference $= 0$, both are along the same line

$\therefore A^2 = 4^2 + 3^2 + 2 \times 4 \times 3\cos 0°$

$A^2 = (4+3)^2 \Rightarrow A = 7$

The resultant amplitude is 7 units

8 **(b)**

$$n=\frac{1}{2\pi}\sqrt{\frac{g}{l}}\Rightarrow n\propto\frac{1}{\sqrt{l}}\Rightarrow\frac{n_1}{n_2}=\sqrt{\frac{l_2}{l_1}}=\sqrt{\frac{L_2}{2L_2}}$$

$$\Rightarrow\frac{n_1}{n_2}=\frac{1}{\sqrt{2}}\Rightarrow n_2=\sqrt{2}n_1\Rightarrow n_2>n_1$$

Energy $E=\frac{1}{2}m\omega^2a^2=2\pi^2mn^2a^2$

$$\Rightarrow\frac{a_1^2}{a_2^2}=\frac{m_2n_2^2}{m_1n_1^2}\qquad[\because E \text{ is same}]$$

Given $n_2>n_1$ and $m_1=m_2\Rightarrow a_1>a_2$

9 **(b)**

The two spring on left side having spring constant of $2k$ each are in series, equivalent constant is $\frac{1}{\left(\frac{1}{2k}+\frac{1}{2k}\right)}=k$. The two springs on right hand side of mass M are in parallel. Their effective spring constant is $(k+2k)=3k$

Equivalent spring constants of value k and $3k$ are in parallel and their net value of spring constant of all the four springs is $k+3k=4k$

$\therefore$ Frequency of mass is $n=\frac{1}{2\pi}\sqrt{\frac{4k}{M}}$

10 **(a)**

For S.H.M. $F=-kx$

$\therefore$ Force $=$ Mass $\times$ Acceleration $\propto -x$

$\Rightarrow F=-Akx$; where A and k are positive constants

11 **(c)**

When lift accelerates upwards, then effective acceleration on the pendulum

$$g_{eff}=g+\frac{g}{3}=\frac{4g}{3}$$

$$\therefore \text{ Time period } T'=2\pi\sqrt{\frac{l}{g_{eff}}}=2\pi\sqrt{\frac{l}{4g/3}}$$

$$=\frac{\sqrt{3}}{2}.2\pi\sqrt{\frac{l}{g}}$$

$$=\frac{\sqrt{3}}{2}T$$

12 **(a)**

When particle is at$x=2$, the displacement is $y=4{\sim}2=2$ cm. If r is the time taken by the particle to go from $x=4$ cm to $x=2$ cm, then

$$y=a\cos\omega t=a\cos\frac{2\pi t}{T}=a\cos\frac{2\pi t}{1.2}$$

or $\cos\frac{2\pi t}{1.2}=\frac{y}{a}=\frac{2}{4}=\frac{1}{2}=\cos\frac{\pi}{3}$

or $\frac{2t}{1.2}=\frac{1}{3}$ or $t=\frac{1.2}{6}=0.26$

time taken to move from $x=+2$ cm to $x=+4$ cm and back again

$=2t=2\times0.2\text{ s}=0.4\text{ s}$

13 **(a)**

Under forced oscillations, the body will vibrate with the frequency of the driving force

14 **(c)**

$E = \frac{1}{2} m\omega^2 a^2 \Rightarrow \frac{E'}{E} = \frac{a'^2}{a^2} \Rightarrow \frac{E'}{E} = \frac{\left(\frac{3}{4}a\right)^2}{a^2} \left(\because a' = \frac{3}{4}a\right)$

$\Rightarrow E' = \frac{9}{16} E$

15 **(b)**

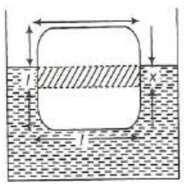
Let at any instant, cube is at a depth x from the equilibrium position then net force acting on the cube = upthrust on the portion of length x

$F = -\rho l^2 x g = -\rho l^2 g x$ ...(i)

Negative sign shows that, force is opposite to x. Hence equation of SHM

$F = -kx$ ...(ii)

Comparing Eqs. (i) and (ii)



$k = \rho l^2 g$

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

$= 2\pi\sqrt{\frac{l^3 d}{\rho l^2 g}} = 2\pi\sqrt{\frac{ld}{\rho g}}$

16 **(a)**

We know that during SHM, the restoring force is proportional to the displacement from equilibrium position. Hence restoring force is maximum when the displacement is maximum at its extreme position

17 **(b)**

Kinetic energy in SHM

$\text{KE} = \frac{1}{2}m\omega^2(A^2 - x^2)$

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

$\text{KE} = \frac{1}{2}m\omega^2\left(A^2 - \frac{A^2}{4}\right) = \frac{3}{4}\left(\frac{1}{2}m\omega^2 A^2\right)$

$= \frac{3}{4} \times$ Total energy of the particle

18 **(c)**

Displacement equation

$y = A\sin\omega t - B\cos\omega t$

Let $A = a\cos\theta$ and $B = a\sin\theta$

So, $A^2 + B^2 = a^2$

$\Rightarrow a = \sqrt{A^2 + B^2}$

Then, $y = a\cos\theta\sin\omega t - a\sin\theta\cos\omega t$

$y = a\sin(\omega t - \theta)$

which is the equation of simple harmonic oscillator

The amplitude of the oscillator

$$= a = \sqrt{A^2 + B^2}$$

19 **(d)**

$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow T \propto \sqrt{\frac{l}{g}}$, it is does not depend upon mass

20 **(c)**

When $t = 1\ s, y_1 = r\sin\omega \times 1 = r\sin\omega$

When $t = 2\ s,\ y_2 = r\sin\omega \times 2 = r\sin 2\omega$

$\therefore \quad \frac{y_1}{y_2} = \frac{r\sin\omega}{r\sin 2\omega}$

$= \frac{1}{2\cos\omega} = \frac{1}{2\cos 2\pi/T}$

$= \frac{1}{2\cos 2\pi/8}$

$= \frac{1}{2\cos\pi/4}$

$= \frac{1}{2(1/\sqrt{2})} = \frac{1}{\sqrt{2}}$

$\therefore \quad y_2 = \sqrt{2}y_1$

Distance converted in 2nd second

$= y_2 - y_1 = (\sqrt{2} - 1)y_1$

$\therefore \quad$ Ratio $= 1:(\sqrt{2} - 1)$

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