DPP

DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

Solutions

SUBJECT : PHYSICS
DPP NO. : 7

Topic :- OSCILLATIONS

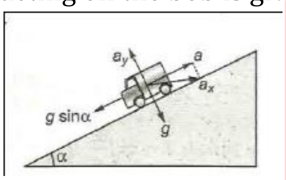
1 **(a)**

The acceleration of the vehicle down the plane = gsin α.

The reaction force acting on the bob of pendulum gives it an acceleration $a(= \mathrm{g}\sin\alpha)$ up the plane. This acceleration has two rectangular components,

$a_x = a\cos\alpha = \mathrm{g}\sin\alpha\cos\alpha$

And $a_y = a\sin\alpha = \mathrm{g}\sin^2\alpha$ as shown in figure. The effective acceleration due to gravity acting on the bob is given by



$\mathrm{g}_{\mathrm{eff}}^2 = a_x^2 + (\mathrm{g} - a_y)^2 = a_x^2\mathrm{g}^2 + a_y^2 - 2\mathrm{g}a_y$

$= \mathrm{g}^2\sin^2\alpha\cos^2\alpha + \mathrm{g}^2\sin^4\alpha - 2\mathrm{g}\times\mathrm{g}\sin^2\alpha$

$= \mathrm{g}^2\sin^2\alpha(\cos^2\alpha + \sin^2\alpha) + \mathrm{g}^2 - 2\mathrm{g}^2\sin^2\alpha$

$= \mathrm{g}^2\sin^2\alpha + \mathrm{g}^2 - 2\mathrm{g}^2\sin^2\alpha = \mathrm{g}^2(1 - \sin^2\alpha)$

$= \mathrm{g}^2\cos^2\alpha$

$\therefore \quad \mathrm{g}_{\mathrm{eff}} = \mathrm{g}\cos\alpha$

Now, $T' = 2\pi\sqrt{\frac{L}{e_{\mathrm{eff}}}}$

$= 2\pi\sqrt{\frac{L}{\mathrm{g}\cos\alpha}}$

2 **(d)**

For SHM, $\frac{d^2y}{dt^2} \propto -y$

3 **(b)**

Torque acting on the bob

$= I\alpha = -(mg)l\sin\theta$

Or $(m_i l^2)\alpha = -(m_g g)l\theta$

Or $\alpha = -\left(\frac{m_g g}{m_i l}\right)\theta = -\omega^2\theta;$

Where $\omega^2 = \frac{m_g g}{m_i l}$

$$\therefore\ T=\frac{2\pi}{\omega}=2\pi\sqrt{\frac{m_i l}{m_g g}}$$

4 **(d)**

The energy of simple harmonic oscillator

$$E=\frac{1}{2}m\omega^2A^2$$

or $E\propto A^2$

ie, energy is proportional to square of the amplitude.

5 **(c)**

$y=0.2\sin(10\pi\,t+1.5\pi)\cos(10\pi\,t+1.5\pi)$

$=0.1\sin 2(10\pi t+1.5\pi)\quad[\because \sin 2A=2\sin A\cos A]$

$=0.1\sin(20\pi\,t+3.0\pi)$

$\therefore$ Time period, $T=\dfrac{2\pi}{\omega}=\dfrac{2\pi}{20\pi}=\dfrac{1}{10}=0.1\ sec$

6 **(b)**

Two springs each of spring constant k_1 in parallel, given equailvalent spring constant of 2 k_1 and this is in series with spring of constant k_2, so equivalent spring constant,

$$k=\left(\frac{1}{k_2}+\frac{1}{2k_1}\right)^{-1}$$

7 **(b)**

For displacement $OQ=40$ cm; let t_1 be the time taken then

$40=41\sin\frac{2\pi}{24}t_1$, on solving $t_1=5.16$ s

For displacement $OQ=-9$ cm, let t_2 be the time taken then $9=41\sin\frac{2\pi}{12}t_2$,

On solving $t_2=0.84$ s

Total time $=5.16+0.84=6.00$ s

9 **(d)**

The time period (T) of a simple pendulum length l, is given by

$$T=2\pi\sqrt{\frac{l}{g}}=\frac{1}{\text{frequency}(n)}$$

where g is acceleration due to gravity.

$$\therefore\quad \frac{n_1}{n_2}=\sqrt{\frac{l_2}{l_1}}$$

$$\Rightarrow\quad \frac{l_1}{l_2}=\left(\frac{n_2}{n_1}\right)^2$$

Given, $\dfrac{n_2}{n_1}=\dfrac{3}{2}$

$$\therefore\quad \frac{l_1}{l_2}=\left(\frac{3}{2}\right)^2=\frac{9}{4}$$

10 **(a)**

It is a system of two springs in parallel. The restoring force on the body is due to springs and not due to gravity pull. Therefore slope is irrelevant. Here the effective spring constant $=k+k=2k$

Thus time period, $T = 2\pi\sqrt{M/2k}$

11 **(b)**

Here $a = 12$ cms^{-2}, $x = 3$ cm

In SHM, acceleration $a = -\omega^2 x$

$\therefore$ Magnitude of acceleration $a = \omega^2 x$

(discarding off –ve sign)

$\therefore \quad \omega^2 = \frac{a}{x}$

or $\quad \omega = \sqrt{\frac{a}{x}}$

or $\quad \frac{2\pi}{T} = \omega = \sqrt{\frac{a}{x}}$

or $\quad T = 2\pi\sqrt{\frac{a}{x}}$

$= 2\pi\sqrt{\frac{3}{12}}$

$= \pi s = 3.14$ s

12 **(d)**

In S.H.M. $v = \omega\sqrt{a^2 - y^2}$ and $a = -\omega^2 y$ when $y = 0$

$\Rightarrow v_{\max} = a\omega$ and $a_{\min} = 0$

13 **(b)**

Body collides elastically with walls of room. So, there will be no loss in its energy and it will remain colliding with walls of room after a regular time interval, so it's motion will be periodic. Since acceleration is not proportional to displacement, so it's motion is not SHM

14 **(d)**

$y = A\sin\left(\frac{2\pi}{T}\right)t$

$\Rightarrow \quad \frac{A}{2} = A\sin\left(\frac{2\pi}{T}\right)t$

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

$t = \frac{1}{3}$ s

15 **(b)**

Let k be the force constant of the shorter part of the spring of length$l/3$. In a complete spring, three springs are in series each of force constant k

$k_1 = k/2 = \frac{3k}{2}$

$\therefore \quad \frac{k}{k_1} = \frac{3K}{3K/2} = 2$ or $k{:}k_1 = 2{:}1$

16 **(c)**

In S.H.M. frequency of K.E. and P.E.

$= 2 \times$ (Frequency of oscillating particle)

17 **(a)**

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

and $2 + 1 = 2\pi\sqrt{\frac{M+4}{k}}$

or $3 = 2\pi\sqrt{\frac{k+4}{k}}$ so $\frac{4}{9} = \frac{M}{M+4}$

or $4M + 16 = 9M$ or $M = \frac{16}{5} = 3.2$ kg

18 **(a)**

Given $K.E. = P.E. \Rightarrow \frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\Rightarrow \frac{1}{2}m\omega^2(a^2 - x^2) = \frac{1}{2}m\omega^2x^2$

$\Rightarrow a^2 - x^2 = x^2 \Rightarrow x^2 = \frac{a^2}{2} \Rightarrow \frac{x}{a} = \frac{1}{\sqrt{2}}$

19 **(b)**

Acceleration in SHM is directly proportional to displacement and is always directed to its mean position

20 **(a)**

In S.H.M. when acceleration is negative maximum or positive maximum, the velocity is zero so kinetic energy is also zero. Similarly for zero acceleration, velocity is maximum so kinetic energy is also maximum

ANSWER-KEY

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