DPP

DAILY PRACTICE PROBLEMS

CLASS : XITH
DATE :

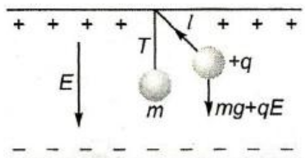
Solutions

SUBJECT : PHYSICS
DPP NO. : 1

Topic :- OSCILLATIONS

1 **(c)**

The motion of sphere is simple harmonic. It's time period (T_0) is given by



$$T_0 = 2\pi\sqrt{\frac{l}{g}} \quad \text{...(i)}$$

where l is length of string, g the acceleration due to gravity.

When sphere is placed in electric field. (E) force due to electric field acts on the sphere-1

$$F_E = qE = mg$$

where q is charge on sphere.

Hence, resultant acceleration is

$$g' = g + \frac{qE}{m}$$

$$\therefore \quad T = 2\pi\sqrt{\frac{l}{g + \frac{qE}{m}}} \quad \text{...(ii)}$$

[Time period decreases]

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

$$\frac{T}{T_0} = \sqrt{\frac{g}{g + \frac{qE}{m}}}$$

2 **(c)**

The time period of simple pendulum in air

$$T = t_0 = 2\pi\sqrt{\left(\frac{l}{g}\right)} \quad \text{...(i)}$$

l, being the length of simple pendulum.

In water, effective weight of bob

$w' =$ weight of bob in air – upthrust

$\Rightarrow \quad \rho V g_{eff} = mg - m'g$

$$= \rho V g - \rho' V g = (\rho - \rho')V g$$

where $\rho' =$ density of bob,

$\rho =$ density of water

$\therefore \quad g_{\text{eff}} = \left(\frac{\rho - \rho'}{\rho}\right)g = \left(1 - \frac{\rho'}{\rho}\right)g$

$\therefore \quad t = 2\pi\sqrt{\left[\frac{l}{\left(1 - \frac{\rho'}{\rho}\right)g}\right]}$ ...(ii)

Thus, $\frac{t}{t_0} = \sqrt{\left[\frac{1}{\left(1 - \frac{\rho'}{\rho}\right)}\right]}$

$$= \sqrt{\left(\frac{1}{1 - \frac{1000}{(4/3 \times 1000)}}\right)} = \sqrt{\left(\frac{4}{4 - 3}\right)} = 2$$

$\Rightarrow \quad t = 2t_0$

3 **(b)**

PE varies from zero to maximum. It is always positive sinusoidal function

4 **(a)**

Let T_1, T_2 be the time period of shorter length and longer length pendulums respectively.

Ads per question, $nT_1 = (n - 1)T_2$;

So $n2\pi\sqrt{\frac{0.5}{g}} = (n - 1)2\pi\sqrt{\frac{20}{g}}$

or $n = (n - 1)\sqrt{40} \approx (n - 1)6$

Hence, $5n = 6$

Hence, after 5 oscillations they will be in same phase

5 **(c)**

At centre $v_{\max} \Rightarrow a\omega = a.\frac{2\pi}{T} = \frac{0.2 \times 2\pi}{0.01} = 40\pi$

6 **(d)**

$F_1 = \frac{m4\pi^2 a}{\pi^2}$ and $F_2 = \frac{m4\pi^2 a}{T_2^2}$

$$F = F_1 + F_2 = \frac{4\pi^2 ma}{T_1^2} + \frac{4\pi^2 ma}{T_2^2}$$

$$= 4\pi^2 ma\left(\frac{1}{T_1^2} + \frac{1}{T_2^2}\right)$$

Or $\frac{4\pi^2 ma}{T^2} = 4\pi^2 ma\left(\frac{1}{T_1^2} + \frac{1}{T_2^2}\right)$

Or $\frac{1}{T^2} = \frac{1}{T_1^2} + \frac{1}{T_2^2}$

Or $\frac{1}{T^2} = \frac{T_1^2 + T_2^2}{T_1^2 T_2^2}$ or $T^2 = \frac{T_1^2 T_2^2}{T_1^2 + T_2^2}$

7 **(b)**

$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow l \propto T^2$ [Equation of parabola]

8 **(d)**

Here, $m = 4kg; k = 800Nm^{-1}; E = 4J$

In SHM, total energy is $E = \frac{1}{2}kA^2$

where A is the amplitude of oscillation

$\therefore 4 = \frac{1}{2} \times 800 \times A^2$

$A^2 = \frac{8}{800} = \frac{1}{100}$

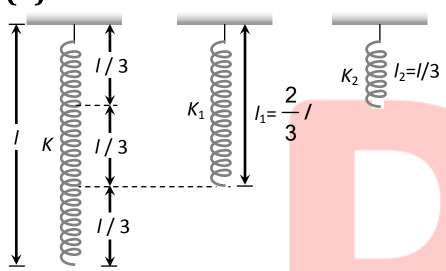
$\Rightarrow A = \frac{1}{10}m = 0.1m$

Maximum acceleration, $a_{\max} = \omega^2 A$

$= \frac{k}{m}A \qquad \left[\because \omega = \sqrt{\frac{k}{m}}\right]$

$= \frac{800Nm^{-1}}{4kg} \times 0.1m = 20ms^{-2}$

9 **(b)**



Force constant $(k) \propto \frac{1}{\text{Length of spring}}$

$\Rightarrow \frac{K}{K_1} = \frac{l_1}{l} = \frac{\frac{2}{3}l}{l} \Rightarrow K_1 = \frac{3}{2}K$

10 **(b)**

Total energy $U = \frac{1}{2}Ka^2$

11 **(b)**

$\omega = \sqrt{k/m} = \sqrt{\frac{4.84}{0.98}} = 2.22\ rad/s$

12 **(a)**

For resonance amplitude must be maximum which is possible only when the denominator of expansion is zero

$i.e.\ a\omega^2 - b\omega + c = 0 \Rightarrow \omega = \frac{+b \pm \sqrt{b^2 - 4ac}}{2a}$

For a single resonant frequency, $b^2 = 4ac$

13 **(a)**

Inside the mine g decreases

Hence from $T = 2\pi\sqrt{\frac{l}{g}}$; T increase

14 **(c)**

$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow \frac{l}{T^2} = \frac{g}{4\pi^2} = \text{constant}$

15 **(a)**

KE of a body undergoing SHM is given by

$\text{KE} = \frac{1}{2}m\omega^2A^2\cos^2\omega t$ and $\text{KE}_{\text{max}} = \frac{m\omega^2A^2}{2}$

[symbols represent standard quantities]

From given information

$$\text{KE}=(\text{KE}_{\text{max}}) \times \frac{75}{100}$$

$\Rightarrow \quad \frac{m\omega^2A^2}{2}\cos^2\omega t = \frac{m\omega^2A^2}{2} \times \frac{3}{4}$

$\Rightarrow \quad \cos\omega t = \pm\frac{\sqrt{3}}{2}$

$\Rightarrow \quad \omega t = \frac{\pi}{6}$

$\Rightarrow \quad \frac{2\pi}{T} \times t = \frac{\pi}{6}$

$\Rightarrow \quad t = \frac{T}{12} = \frac{1}{6}\text{ s}$

16 **(d)**

When spring is cut into two equal parts then spring constant of each part will be $2K$ and so using $n \propto \sqrt{K}$, new frequency will be $\sqrt{2}$ times, *i.e.* $f_2 = \sqrt{2}\, f_1$

17 **(a)**

Time period of pendulum $T = 2\pi\sqrt{\frac{l}{\text{g}}}$

$\therefore \quad T \propto \sqrt{l}$

18 **(d)**

Let x be the point where K.E. = P.E.

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

$\Rightarrow 2x^2 = a^2 \Rightarrow \frac{\text{a}}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}\ cm$

19 **(d)**

The periodic time of a simple pendulum is given by,

$$T = 2\pi\sqrt{\frac{l}{\text{g}}}$$

When taken to height $2R$.

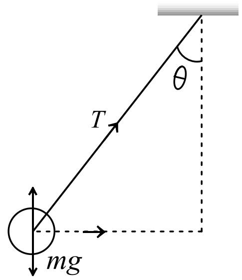
$$\text{g}' = \text{g}\left(1 + \frac{\text{h}}{R_e}\right)^2$$

$$= \text{g}\left(1 + \frac{2R}{R}\right)^{-2} = \text{g}(3)^{-2}$$

$\therefore \quad \frac{T_1}{T_2} = \sqrt{\frac{1}{3^2}}$

$\Longrightarrow \quad T_2 = 3T_1 \Rightarrow \frac{T_1}{T_2} = \frac{1}{3}$

20 **(d)**



$T \sin\theta = mL \sin\theta \omega^2$

$324 = 0.5 \times 0.5 \times \omega^2$

$\Rightarrow \omega^2 = \frac{324}{0.5 \times 0.5}$

$\Rightarrow \omega = \sqrt{\frac{324}{0.5 \times 0.5}}$

$\Rightarrow \omega = \frac{18}{0.5} = 36\, rad/sec$

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