Class XI

Oscillations and waves worksheet 2

1. Is the motion of a simple pendulum strictly simple harmonic? 1

Ans. It is not strictly simple harmonic because we make the assumption that $\sin\theta = \theta$, which is nearly valid only if θ is very small.

2. Can a simple pendulum experiment be done inside a satellite? 1

Ans. time period of a simple pendulum is $T = 2\pi\sqrt{\frac{l}{g}}$

Since, inside a satellite, effective value of g = 0 so, T = ∞.
i.e. inside the satellite, the pendulum does not oscillate at all.
So, it can't be preformed inside a satellite.

3. Give some practical examples of S. H. M? 1

Ans. 1) Motion of piston in a gas – filled cylinder.
2) Atoms vibrating in a crystal lattice.
3) Motion of helical spring.

4. The time period of a body suspended by a spring is T. What will be the new time period if the spring is cut into two equal parts and 1) the body is suspended by one part. 2) Suspended by both parts in parallel? 2

Ans. $T = 2\pi\sqrt{\frac{m}{k}}$ $[k - force\,const.]$

1) On cutting the spring in two equal parts, the length of one part is halved and the force constant of each part will be doubled (2k).

$$T_1 = 2\pi\sqrt{\frac{m}{2k}} = \frac{T}{\sqrt{2}}$$

2) If the body is suspended from both parts in parallel, then the effective force constant of parallel combination = 2k + 2k = 4k.

$$T_2 = 2\pi\sqrt{\frac{m}{4k}} = \frac{T}{2}$$

5. A simple pendulum is executing Simple harmonic motion with a time T. If the length of the pendulum is increased by 21 %. Find the increase in its time period? 2

Ans. $l_2 = l_1 + \frac{21}{100} l_1 = \frac{121}{100} l_1 = 1.21 l_1$

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

$T_1 = 2\pi \sqrt{\frac{l_1}{g}}$

$T_2 = 2\pi \sqrt{\frac{l_2}{g}}$

$\frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}}$

$= \sqrt{\frac{l_1}{1.21 l_1}}$

$T_2 = 1.1 T_1 = 1.1 T \qquad [\because T_1 = T]$

$\%\, increase\, in\, time\, period = \frac{T_2 - T_1}{T_1} \times 100\%$

$= \frac{1.1T - T}{T} \times 100\%$

$= 0.1 \times 100\%$

$= 10\%$

6. A particle is executing S H M of amplitude 4 cm and T = 4 sec. find the time taken by it to move from positive extreme position to half of its amplitude? 2

Ans. $a = 4m$

$y = \frac{a}{2} = 2m$

$T = 4 \sec$

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

$2 = 4 \cos \frac{2\pi}{4} t$

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

$60 = \frac{2\pi}{4} t$

$t = \frac{120}{\pi} s$

7. Two linear simple harmonic motions of equal amplitudes and angular frequency w and 2w are impressed on a particle along axis X and Y respectively. If the initial phase difference between them is π/2, find the resultant path followed by the particle? 2

Ans. $x = a\sin wt$

$$y = a\sin\left(2wt + \frac{\pi}{2}\right)$$

$$= a\cos 2wt$$

$$= a(1 - 2\sin^2 wt)$$

$$= a\left(1 - \frac{2x^2}{a^2}\right)$$

$$y = a - \frac{2x^2}{a}$$

$$\frac{2x^2}{a} = a - y$$

$$2x^2 = a^2 - ay$$

$$x^2 = \frac{a^2}{2} - \frac{a}{2}y$$

8. The acceleration due to gravity on the surface of moon is 1.7 m/s^2. What is the time period of simple pendulum on moon if its time period on the earth is 3.5s? 2

Ans. $g = 9.8ms^{-2}$

$g' = 1.7ms^{-2}$

$$T_E = 2\pi\sqrt{\frac{l}{g}}$$

$$T_M = 2\pi\sqrt{\frac{l}{g'}}$$

$$\frac{T_E}{T_M} = \sqrt{\frac{g'}{g}}$$

$$\frac{3.5}{T_M} = \sqrt{\frac{1.7}{9.8}}$$

$T_M = 8.4s$

9. Using the correspondence of S. H. M. and uniform circular motion, find displacement, velocity, amplitude, time period and frequency of a particle executing SH.M? 3

Ans.