Question Bank

CHAPTER 14-OSCILLATIONS

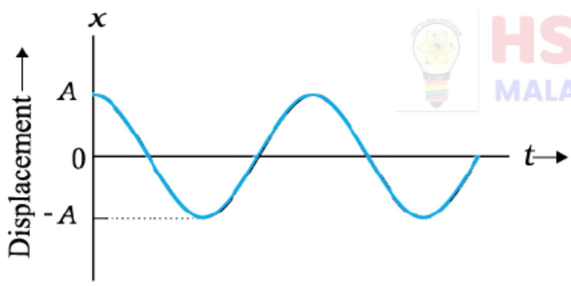
Each question scores One

1	What is the time period of a second's pendulum? Ans: 2 second.
2	The time period of a simple pendulum of length *l* as measured in a lift descending with the acceleration g/3 m/s ^{2} is .... Ans: $T=2\pi\sqrt{\frac{3l}{2g}}$
3	A particle executing SHM is an example of .... i) acceleration of constant magnitude and direction. ii) acceleration of changing magnitude and direction. iii) acceleration of changing magnitude but constant direction. iv) acceleration of constant magnitude but changing direction. Ans: iii) acceleration of changing magnitude but constant direction.
4	What is a seconds pendulum? Ans: Pendulum with time period = 2 second.
5	Under what conditions for the amplitude, are the oscillations of the pendulum simple harmonic? Ans : For small amplitude.
6	What is the frequency of a simple pendulum mounted in a cabin that is freely falling under gravity? Ans: Frequency become zero.
7	A vibrating simple pendulum of period T is placed in a lift which is accelerating downwards. What is the effect of this on the time period of the pendulum? Ans; Time period increases.
8	L-T^2 graph of motion of a simple pendulum will be...... Ans: Straight line with a slope
9	Two simple pendulum, one with a copper bob and the other with an iron bob with same length are oscillating. Which one will have more time period? Ans: Both have same time period.
10	L-T graph of motion of a simple pendulum will be..... Ans: Parabolic.

11	Give an example for periodic motion which is not oscillatory? Ans: Rotation of earth.
12	Equation for wave number k=....... Ans: $\frac{2\pi}{\lambda}$
13	The relation connecting ω and v is..... Ans: $v=\frac{\omega}{k}$
14	A simple pendulum is taken from the equator to the pole,its period a) Decreases b) Increases c) Remains same c) Becomes infinity Ans: a) Decrease
15	Which of the following is correct? a) A periodic motion is an SHM b) A periodic motion is not SHM c) A SHM is not a periodic motion d) A periodic motion may be an SHM Ans: d) A periodic motion may be an SHM

Each question scores Two

1	In a simple pendulum made of a metallic wire, what will happen to the period when the temperature increases? Give a reason. Ans: Time period increases. When the temperature increases , due to thermal expansion, the length of pendulum will increase and hence time period increases.
2	Define Simple Harmonic motion (SHM). Ans: Simple harmonic motion (SHM) is defined as such an oscillatory motion about a fixed point (mean position) in which the restoring force is always proportional to the displacement from that point and is always directed towards that point.
3	The acceleration due to gravity on the surface of the moon is 1.7 m/s ^{2} .What is the time period of a simple pendulum on the moon, if its time period on the earth is 3.5 second? Ans: We have , $T^2 \alpha \frac{1}{g}$ for a fixed length. Therefore, $T^2_{moon} \alpha \frac{1}{g_{moon}}$ and $T^2_{earth} \alpha \frac{1}{g_{earth}}$ Dividing, $\frac{T^2_{moon}}{T^2_{earth}} = \frac{g_{earth}}{g_{moon}}$

	$T^2_{moon} = T^2_{earth} \frac{g_{earth}}{g_{moon}} = 3.5^2 \, x \frac{9.8}{1.7} = 70.62$ therefore , Time period on the moon, T_{moon} = 8.4 second.
4	List any two conditions for a motion of a body to be simple harmonic. Ans; i. The restoring force is always proportional to the displacement from the mean position. ii. The restoring force is always directed towards the mean position.
5	A man with wristwatch on his hand falls from the top of a tower. Does the watch give the correct time during the free fall? Why? Ans: Yes, the motion in the wristwatch depends on spring action and has nothing to do with acceleration due to gravity.
6	Name two examples for simple harmonic motion. Ans: i. Oscillation of a loaded spring. ii. Oscillation of a simple pendulum.
7	A girl is swinging on a swing in the sitting position. How will the period of swing be affected if she stands up? Ans; Time period decreases, as the length of the pendulum decreases when she stands up.
8	Represent Simple Harmonic Motion graphically. Ans; 
9	What is periodic motion? Give examples. Ans:- Any motion which repeats itself at regular intervals of time is called periodic motion. Example : 1) Motion of a swing 2) Motion of a simple pendulum 3) Rotation of the earth about its own axis
10	Define oscillatory motion. Give examples. Ans:- Oscillatory motion is a periodic motion in which the particle moves to and fro on either side of the mean position between two limits. One to and fro motion is an oscillation or vibration. Eg : 1) Oscillations of the simple pendulum 2) Vibrations of the prongs of the tuning fork
11	A girl is swinging in a swing in a sitting position with a period T. What will happen to the period, if

	she starts swinging in a standing position? Ans:- $T = 2\pi\sqrt{\frac{l}{g}}$ l is the distance upto the centre of gravity. Centre of gravity of the human body is in the pelvic cavity. When she stands up the centre of gravity will get raised. Therefore l decreases and T decreases.

Each question scores Three

1	A simple pendulum has a bob of mass m is suspended from the ceiling of a lift which is lying at the ground floor of a multi storied building. a) Find the period of oscillation of pendulum when the lift is stationary. b)What is the tension of the string of the pendulum when it is ascending with an acceleration 'a'? c) What is the period of oscillation of the pendulum while the lift is ascending? Ans: a) $T=2\pi\sqrt{\frac{l}{g}}$ b) Tension T = m(g+a) c) $T=2\pi\sqrt{\frac{l}{g+a}}$
2	The bob of a simple pendulum is a hollow sphere filled with mercury. It oscillates with a period T. As it is oscillating mercury flows out through a hole at the bottom. What happens to the period? Ans:- The centre of gravity is originally at the centre. When mercury flows out the centre of gravity gets lowered, reaches the lowermost point and then rises to the original place when all the mercury flows out. Therefore *l* will first increase, reach a maximum and then decrease to the original value. Therefore period will first increase, reach a maximum and then decrease to the original value.
3	Show that length of seconds pendulum is 1m. Ans: $T = 2\pi\sqrt{\frac{l}{g}}$ Here T=2 sec $2 = 2\pi\sqrt{\frac{l}{g}}$ $1 = \pi\sqrt{\frac{l}{g}}$ on squaring $1= \pi^2 \frac{l}{g}$ Since π=3.14 $\pi^2 \approx 9.8$ $g = 9.8 m/s^2$ so l = 1m.
4	Find the value of velocity of SHM at points 1) at the origin.

2)at the amplitude.
3) at half of the amplitude.
Ans:
v = ω $\sqrt{A^2 - y^2}$

1) at y=0
v= Aω
2) at y = A
v = 0
3) at y = A/2
v = ω $\sqrt{A^2 - A^2/4}$
v = $\sqrt{3}$ Aω/2.

Each question scores Four

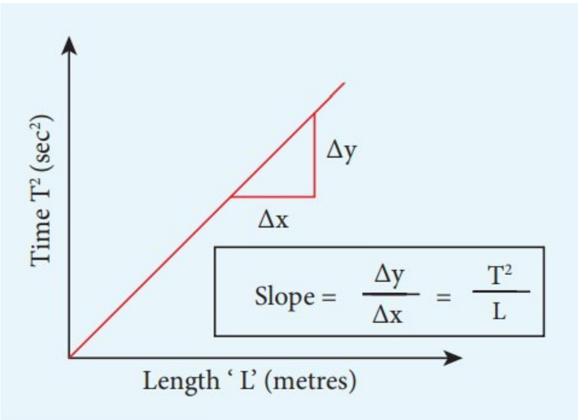
1 a) Among the following, which are examples of simple harmonic motion?
i. The rotation of the earth about its axis. ii. Vertical oscillations of a loaded spring.
iii. Oscillations of a simple pendulum. iv. Uniform circular motion.
b) The displacement in simple harmonic motion can be represented as x(t) = A Cos(ωt+ Φ), where 'Φ'is the phase constant. Identify and define 'A' and 'ω' in the equation.

Ans;
a) ii. Vertical oscillations of a loaded spring.
iii. Oscillations of a simple pendulum.
b) 'A' is the amplitude.
It is the magnitude of maximum displacement of particle from the mean position
'ω' is the angular frequency.
It is the rate of change of angular displacement.

$$\omega = \frac{2\pi}{T} \quad \text{OR} \quad \omega = 2\pi f$$

2 A student is advised to study the variation of period of oscillation with the length of a simple pendulum in the laboratory. Accordingly he recorded the period of oscillation for different lengths of the pendulum.
a) If he plots an L – T^2 graph,draw the shape of the graph?
b) How would you determine the value of acceleration due to gravity using l – T^2 graph?

Ans: a)



b) We have $T=2\pi\sqrt{\frac{l}{g}}$

Therefore $g=4\pi^2(\frac{l}{T^2})$

From the graph slope = $\frac{T^2}{l}$

Therefore $g=4\pi^2 x\frac{1}{slope}$

3 A particle executes simple harmonic motion according to the equation x = 5 sin$\left(\frac{2\pi}{3}t\right)$

a)Find the period of the oscillation

b)What is the minimum time required for the particle to move between two points 2.5cm on either side of the mean position?

Ans: a)We have x= a sin ωt

Given x=5 sin ($\frac{2\pi}{3}$ t)

Comparing $\omega=\frac{2\pi}{3}$ But $\omega=\frac{2\pi}{T}$

Therefore , Time period T=3 s

b)We have x= 5 sin ($\frac{2\pi}{3}$ t)

When the particle moves 2.5 cm from the mean position,

2.5=5 sin ($\frac{2\pi}{3}$ t)

sin ($\frac{2\pi}{3}$ t)= $\frac{1}{2}$ =sin ($\frac{\pi}{6}$)

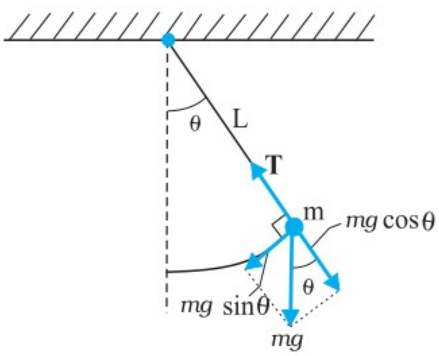
Therefore , t=0.25 s

Time taken to travel 2.5 from the mean position is 0.25 sec. Hence time taken to travel 2.5 cm on either side of the mean position is 0.5 sec.

Each question scores Five

1 a) Prove that the oscillations of a simple pendulum are simple harmonic and hence derive an expression for the time period of a simple pendulum.

b) What is the length of a simple pendulum, which ticks seconds?



Ans: a)Simple pendulum consists of a bob of mass ‘m’, suspended from one end of an inextensible string of length ‘L’. The other end is fixed to a rigid support.

The length of the pendulum is the distance between the rigid support and the centre of the bob.

When the bob is pulled to one side and released the pendulum executes oscillations.

At any instant ‘θ’ be the angular displacement.

The weight of the bob ‘mg’ can be resolved into two components,

mgsin θ→ directed towards mean position,

mgcos θ→ in the direction of string.

Here, ‘mgsin θ’ gives the restoring force.

$$ie \quad F=-mg\sin\theta=-mg\,\theta \qquad (as \quad \theta<<)$$

$$But \qquad \theta=\frac{x}{L}$$

$$\therefore \qquad F=-\left(\frac{mg}{L}\right)x$$

Thus for small amplitude oscillations, the force is proportional to the displacement and directed towards mean position. Hence oscillations of simple pendulum is SHM.

Period of oscillation of a simple pendulum:

For a simple pendulum,

$$F=-\left(\frac{mg}{L}\right)x \qquad and$$

$$F=ma$$

$$\therefore \quad ma=-\left(\frac{mg}{L}\right)x$$

$$a=-\frac{gx}{L}$$

$$But \qquad a=-\omega^2 x$$

$$\therefore \quad -\omega^2 x=-\frac{gx}{L}$$

$$\omega^2=\frac{g}{L}$$

$$\omega=\sqrt{\frac{g}{L}}$$

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

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

This is the period of oscillation of a simple pendulum.

b)The length of a seconds pendulum (which ticks seconds) L=1m.