	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	**Department: SCIENCE 2025 – 26** **SUBJECT: PHYSICS**	**Date: 25/01/2026**
Worksheet No: 13 **WITH ANSWERS**	**CHAPTER / UNIT: OSCILLATIONS**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT:	**CLASS & SEC:**	**ROLL NO.:**

OBJECTIVE TYPE OF QUESTIONS (1 MARK):

1) Which of the following relationship between the acceleration a and the displacement x of a particle involves simple harmonic motion:
   a) a=0.7x
   b) a=-10x
   c) $a=-100x^2$
   d) $a=200x^2$

2) What is the primary characteristic of oscillatory motion?
   a) It always follows a circular path continuously.
   b) It moves to and fro about a mean position.
   c) It occurs only in the absence of any force.
   d) It is a non-repetitive type of movement.

3) If a particle P moves uniformly on a circle of radius A with angular speed w, and its initial angular position is φ , what is the x-projection of its position at time t?
   a) $x = Asin(\omega t + \varphi)$
   b) $x = Acos(\omega t + \varphi)$
   c) $x = Atan(\omega t + \varphi)$
   d) $x = \omega Acos(\omega t + \varphi)$

4) Consider the following statements about simple harmonic motion:
   1. The displacement is a sinusoidal function of time.
   2. The velocity is maximum at the extreme positions.
   3. The acceleration is always directed towards the equilibrium position.
   4. The total energy of the particle is proportional to the square of the amplitude.
   Which of the above statements are correct?
   a) 1, 2, and 3
   b) 1, 3, and 4
   c) 2, 3, and 4
   d) 1, 2, and 4

5) Identify the incorrect pair of physical quantity in SHM and its characteristic at an extreme position ($x=\pm A$).
   a) Displacement : $\pm A$
   b) Velocity : Zero
   c) Acceleration : Zero
   d) Potential Energy : Maximum

6) For a simple pendulum executing SHM, the tension in the string is maximum when the bob is:
   a) At its highest point (extreme position).
   b) At its mean position (lowest point).
   c) Midway between mean and extreme.
   d) Tension is always constant in SHM.

7) When the potential energy of a particle executive S.H.M. is one-fourth of the maximum value during the oscillation, its displacement from the equilibrium position in terms of its amplitude a is:
   a) a/4
   b) a/3
   c) a/2
   d) a

8) A particle executing SHM. The phase difference between acceleration and displacement is
   a) 0
   b) Π
   c) Π/2
   d) 2 Π

9) A simple harmonic wave having amplitude A and time period T is represented by the equation $y = 5 \sin \pi(t + 4)$ metres. Then the value of A (in metres) and T (in seconds) are
   a) A = 5, T = 2
   b) A = 10, T = 1
   c) A = 5, T = 1
   d) A = 5, T = 3

10) The total energy of a simple harmonic oscillator is proportional to
   a) Amplitude
   b) Square of amplitude
   c) Frequency
   d) Velocity

ASSERTION AND REASONING TYPE OF QUESTIONS (1 MARK):

DIRECTION: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
c) If Assertion is true but Reason is false.
d) If both Assertion and Reason are false.

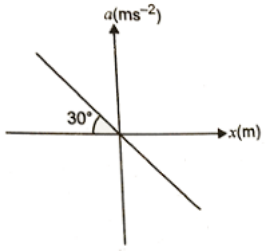
11) **Assertion:** In SHM, acceleration is always directed towards the mean position.
Reason: In SHM, the body has to stop momentary at the extreme position and move back to mean position.

12) **Assertion**: The graph between velocity and displacement for a simple harmonic motion is a parabola.
Reason: Velocity does change uniformly with displacement in simple harmonic motion.

13) **Assertion:** If a hole were drilled through the centre of earth and ball dropped into the hole at one end, it will not oscillate.
Reason: The ball will comes out of other and if passed through centre hole in earth.

VERY SHORT ANSWER TYPE OF QUESTIONS: (2 MARK)

14) Figure shows the acceleration displacement graph of a particle in SHM. Find the time period (in second).



15) Find the period of vibrating particle (SHM) which has acceleration of 45 cms^{-1}, when displacement from mean position is 5cm.
16) A point particle of mass 0.1kg is executing SHM of amplitude 0.1m. When the particle passes through the mean position, its kinetic energy is 0.008J. If each is 45°, then what is the equation of motion of this particle?
17) A 0.2 kg of mass hangs at the end of a spring. When 0.02 kg more mass is added to the end of the spring, it stretches 7cm more. If the 0.02kg mass is removed, what will be the period of vibration of the system?
18) The amplitude of a simple harmonic oscillator is doubled. How does this affect: (a) the period (b) the total energy (c) the maximum velocity of the oscillator?

SHORT ANSWER TYPE OF QUESTIONS (3 MARK):

19) A particle executes simple harmonic oscillation with an amplitude a. The period of oscillation is T. What will be the minimum time taken by the particle to travel half of the amplitude from the equilibrium position?
20) A man of mass 60kg is standing on a platform executing SHM in vertical direction. The displacement from mean position of platform varies as $y = 0.5 \sin(2\pi\upsilon t)$. What will be the minimum value of υ, for which the man will feel weightlessness at the highest point?
21) A body is describing SHM has a maximum acceleration of 8π m/s2 and maximum speed of 1.6m/s. Find the time period and the amplitude.

LONG ANSWER TYPE OF QUESTIONS (5 MARK):

22) A block is resting on a piston which is moving vertically with a SHM of period 1.0s. At what amplitude of vibration will the block and the piston separate? What is the maximum velocity of the piston at this amplitude?

23) What is Simple Harmonic Motion? What is phase difference between displacement and acceleration in SHM. A simple harmonic motion is described by a = -25x where a is acceleration (m/s) and x is displacement (m). What is the time period?

24) A body oscillates with SHM along the x-axis. Its displacement varies with time according to the equation $x = (4.00m)\cos(\pi t + \pi/4)$. Calculate (a) displacement (b) velocity (c) acceleration at t = 1.00 s (d) the maximum speed and maximum acceleration and (e) phase at t = 2.00 s.

CASE STUDY TYPE OF QUESTIONS (4 MARK):

25) Simple harmonic motion is the simplest form of oscillation. A particular type of periodic motion in which a particle moves to and fro repeatedly about a mean position under the influence of a restoring force is termed as simple harmonic motion (S.H.M).
A body is undergoing simple harmonic motion if it has an acceleration which is directed towards a fixed point, and proportional to the displacement of the body from that point.

$$\text{Acceleration } a \propto -x \Rightarrow a = -kx \quad \text{or} \quad \frac{d^2x}{dt^2} = -kx\,,$$

i) Which of the following is not a characteristic of simple harmonic motion?
   a) The motion is periodic.
   b) The motion is along a straight line about the mean position.
   c) The acceleration of the particle is directed towards the extreme position.
   d) The oscillations are responsible for the energy conversion.

ii) Which real-world system approximates SHM for small displacements due to a restoring force proportional to displacement?
   a) A car moving at constant velocity on a highway
   b) A mass attached to a spring oscillating vertically
   c) A ball thrown upward in projectile motion
   d) A rocket accelerating in free space

iii) Which of the following motions is not simple harmonic?
   a) Vertical oscillations of a spring
   b) Motion of a simple pendulum
   c) Motion of planet around the Sun
   d) Oscillation of liquid in a U-tube

iv) Which of the following expressions does not represent simple harmonic motion?
   a) $x = A\cos wt + B\sin wt$
   b) $x = A\cos(wt + a)$
   c) $x = B\sin(wt + b)$
   d) $x = A\sin wt\cos^2 wt$

ANSWER KEY

1	b) a=-10x
2	b) It moves to and fro about a mean position.
3	b) $x = Acos(\omega t + \varphi)$
4	b) 1, 3, and 4
5	c) Acceleration : Zero
6	b) At its mean position (lowest point).
7	c) a/2
8	b) Π
9	a) A = 5, T = 2
10	b)Square of amplitude
11	a)If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
12	d)If both Assertion and Reason are false.
13	d) If both Assertion and Reason are false.
14	The slope of given graph is $-\tan 30° = -1/\sqrt{3}$ $\therefore x/a = -1\sqrt{3}$ We know in SHM, $a = -\omega^2 x \Rightarrow x/a = -1/\omega^2$ $\frac{1}{\omega^2} = \frac{1}{\sqrt{3}} \Rightarrow \omega = 3^{1/4} \quad \therefore T = \frac{2\pi}{3^{1/4}}$
15	Here y = 5cm and acceleration a = 45cms^{-2}. We know that $a = \omega^2 y$ Therefore $45 = \omega^2 \times 5$ or $\omega = 3$ rad s^{-1} And $T = \frac{2\pi}{\omega} = \frac{2\pi}{3} = 2.0935$ s
16	At mean position, KE = 0.008J $\therefore \frac{1}{2} m v_{max}^2 = 0.008$ or $v_{max}^2 = \frac{0.008 \times 2}{m} = \frac{0.008 \times 2}{0.1} = 0.16$ $V_{rms} = 0.4$ ms^{-1}. Given A = 0.1m, $v_{max} = A\omega \Rightarrow \omega = \frac{v_{max}}{A} = \frac{0.4}{0.1} = 4$ rad s^{-1} $\delta = 45° = \pi/4$ (given) The equation of motion is $x = 0.0\sin\left[(4)t + \frac{\pi}{4}\right]$ $[\because x = A\sin(\omega t + \delta)]$
17	Mass added m = 0.02 Length stretched x = 7 cm = 0.07 m | Force due to weight| = | restoring force of spring| $\Rightarrow mg = kx$ $\Rightarrow k = \frac{0.02 \times 9.8}{0.07} = 2.86$ N/m Time period, $T = \mathbf{2\pi}\sqrt{\frac{L}{G}}$ $\Rightarrow T = \mathbf{2\pi}\sqrt{\frac{0.2}{2.86}} = 1.6$s.
18	(a) The time period of a simple harmonic oscillator is independent of its amplitude and

	as such remains unaffected. (b) The total energy (E) of the oscillator is given by $E = \frac{1}{2} m\omega^2 A^2$ where A is the amplitude. Obviously when A is doubled, E becomes four times its previous value. (c) As $v_{rnms} = \omega A \Rightarrow v_{max} = A$ i.e when A is doubled, v_{rms} is also doubled.
19	In simple harmonic motion, the displacement x(t) of a particle from equilibrium position at any time t is given by x(t) = a sinωt where a is the amplitude. At x(t) = a/2 a/2 = a sin ωt or ½ = sin ωt or sin 30° = sin ωt or $\sin\left(\frac{\pi}{6}\right) = \sin\omega t \Rightarrow \frac{\pi}{6} = \frac{2\pi}{T} t$ ($\because \omega = \frac{2\pi}{T}$, where T is the time period of oscillation) or t = T/12.
20	ω = 2πυ, A = 0.5, a = - ω^2 A For weightlessness we have a = g Thus g = - ω^2A ω^2 = g/0.5 = 2g Or $4\pi^2\upsilon^2 = 2g$ $\upsilon^2 = g/2\pi^2$ or $\upsilon = \frac{\sqrt{2g}}{2\pi}$
21	Maximum acceleration $a_{max} = \omega^2 A = 8\pi$ m/s² and maximum speed $v_{max} = \omega A = 1.6$ m Dividing gives $\omega = a_{max}/v_{max} = 8\pi/1.6 = 5\pi$ rad/s. Then $A = v_{max}/\omega = 1.6/(5\pi) \approx 0.102$ m and $T = 2\pi/\omega = 2\pi/(5\pi) = 0.4$
22	We are given that T = 1.0 s Further, the maximum acceleration in SHM, i.e., $a_{max} = \omega^2 A$ For the block and the piston to separate, $a_{max} \geq g$ or $\omega^2 A \geq g$ or $(2\pi/T)^2 A \geq g$ or $A \geq \frac{gT^2}{4\pi^2}$ or $A \geq \frac{(9.8\,m/s^2)(1.0\,s)^2}{39.48}$ (as $4\pi^2 = 39.48$) or $A \geq 0.248$ m Thus, the block and the piston separate, when A = 0.248 m Clearly. $v_{max} = \omega A = \left(\frac{2\pi}{T}\right)A = \left(\frac{2\times3.14}{1.0\,s}\right)(0.248\,m)$ $= 1.56$ m/s

23	Simple Harmonic Motion or SHM is defined as a motion in which the restoring force is directly proportional to the displacement of the body from its mean position. The direction of this restoring force is always towards the mean position. The acceleration of a particle executing simple harmonic motion is given by $a(t) = -\omega^2 x(t)$. Here, ω is the angular velocity of the particle. Displacement of the particle executing SHM x=Asinwt Acceleration of the particle a=dt2d2x $\Longrightarrow$ a=−Aw2sinwt=Aw2sin(π+wt) Thus phase difference between displacement and acceleration of the particle is π radian. Simple harmonic motion is defined by the equation: $a = (-x)\omega^2$ …(1) Where a and x have usual meanings as in question and ω = angular velocity. The relation between time period (t) ad angular frequency is: $t = 2\pi/\omega$,,,(2) By comparing a = - 25x in equation (1) we get ω = 5 From equation (2) time period, t = (2 × 3.14) /5 = 3.14/2.5 = 1.25 sec.
24	By comparing the given equation with the general equation for SHM along X axis i.e. x = A cos (ωt +ϕ_0) we get A = 4.00m, ω = π rad/s, $\phi_0 = \pi/4$ (a) Displacement at t = 1.00s, i.e x = (4.00m) cos (π × 1 × π/4) = (4.00)(- cos π/4) = (4.00)(- 0.707) = - 2.8m (b) Velocity at t = 1.00s i.e. v = - ωA sin (ωt + ϕ_0) Or $v = -(\pi)(4.00)\sin[\pi \times 1 + \pi/4]\text{m/s} = -(\pi)(4.00)\sin\left(\frac{5\pi}{4}\right)\text{m/s}$ = (4π) × 1/√2 = 8.87 m/s (c) $a = -\omega^2 A\cos(\omega t + \phi_0) = -\pi^2 \times 4.00\cos(\pi\times1+\pi/4)$ $= -(4.00\,\pi^2)(-\cos\pi/4)\ \text{m/s}^2 = 4.00 \times (3.14)^2 \times 0.707\ \text{m/s}^2 = 27.9\ \text{m/s}^2$ (d) Maximum velocity, $v_{max} = \omega A = \pi \times 4.00 = 12.56$m/s. Maximum acceleration, $a_{max} = \omega^2 A = \pi^2 \times 4.00 = 39.4\ \text{m/s}^2$ (e) Phase, $(\omega t + \phi_0) = (\pi/s) \times 2s + \frac{\pi}{4} = 2\pi + \frac{\pi}{4} = \frac{9\pi}{4}$
25	i) c)The acceleration of the particle is directed towards the extreme position. ii) b)A mass attached to a spring oscillating vertically iii) c)Motion of planet around the Sun iv) *d)x = A*sinw*t* cos^{2}w*t*

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