	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	**Department: SCIENCE 2022 – 23** **SUBJECT : PHYSICS**	**Date of submission:** **09-02-2023**
Worksheet No:13 **WS WITH ANS.**	**Topic: OSCILLATIONS & WAVES**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT:	**CLASS & SECTION:**	**ROLL NO:**

OBJECTIVE TYPE QUESTIONS:

1) A particle executing SHM starts from mean position. The phase of that particle is π/2 when it has
   a) Maximum displacement
   b) Maximum velocity
   c) Maximum energy
   d) Maximum kinetic energy

2) The ratio of kinetic energy of mean position to the potential energy when the displacement is half of the amplitude is A constant
   a) 4/1
   b) 2/3
   c) ¼
   d) ½

3) Two simple pendulums of length 5 meter and 20 meter respectively are given small linear displacement in one direction at the same time. They will be again in the same phase when the pendulum of shorter length has completed oscillations
   a) 1
   b) 2
   c) 3
   d) 4

4) How will the time period of a simple pendulum change when its length is doubled?
   a) $\sqrt{3}$ times
   b) $\sqrt{2}$ times
   c) 2 times
   d) 3 times

5) How is the time period effected, if the amplitude of a simple pendulum is increased?
   a) Increases
   b) Decreases

c) Remains same
d) Becomes zero

6) 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

7) Which of the following statements is incorrect?
   a) Sound travels in a straight line
   b) Sound is a form of energy
   c) Sound travels faster in vacuum that then in air
   d) Sound needs a medium to travel.

8) The equation of a progressive wave traveling on a stretched string is $y = 10 \sin\left(\frac{t}{0.02} - \frac{x}{100}\right)$ where x and y are in cm and t is in sec. what is the speed of the wave?
   a) 500 cm/s
   b) 50 m/s
   c) 40 m/s
   d) 20 m/s

9) Which of the following relationships between the acceleration 'a' and the displacement 'x' of a particle involve simple harmonic motion?
   a) $a=0.7x$
   b) $a=-200x^2$
   c) $a = -10x$
   d) $a=100x^3$

10) Spring is pulled down by 2 cm. What is the amplitude of motion?
   a) 0 cm
   b) 2 cm
   c) 4 cm
   d) 1 cm

11) Time period of simple pendulum of length L and a place where acceleration to gravity g is T. What is the period of simple pendulum of the same length at place where the acceleration due to gravity is 1.02 g is:
   a) T
   b) 1.02 T
   c) 0.99 T
   d) 1.01 T

12) In SHM graph of which of the following is a straight line?
   a) Total energy against Displacement
   b) Potential energy against Displacement
   c) Acceleration against time
   d) Velocity against time

13) Length of a simple pendulum executing simple harmonic motion is increased by 21%. The percentage increase in the time period of the pendulum of increased length is
    a) 10%
    b) 1%
    c) 21%
    d) 42%

14) If a simple harmonic oscillator has got a displacement of 0.02 meter and acceleration equal to 2 m/s^2 at any time, the angular frequency of the oscillator is equal to
    a) 10 rad/s
    b) 1 rad/s
    c) 100 rad/s
    d) 0.1 rad/s

15) If a hole is bored along the diameter of the earth and a stone is dropped into the hole, then
    a) The stone reaches the centre of the earth and stops there.
    b) The stone reaches the other side of the earth and stops there.
    c) The stone executes simple harmonic motion about the centre of the earth
    d) The stone reaches the other side of the earth and escapes into space.

16) Energy is not carried by:
    a) Longitudinal progressive eaves
    b) Electromagnetic waves
    c) Transverse progressive waves
    d) Stationary waves

17) The equation of wave traveling along string is $y = 3\cos\pi (100t - x)$ in C.G.S. unit. The wavelength is
    a) 1 m
    b) 2 cm
    c) 2m
    d) 5 cm

18) The standing waves can be produced
    a) on a string clamped at both the ends
    b) on a string clamped at one end and free at the other end.
    c) when the incident wave gets reflected from a wall.
    d) when two identical waves with a phase difference of K are moving in the same direction.

19) The velocity of sound is maximum in
    a) Water
    b) Air
    c) Metal
    d) Same in all

20) The length of second's pendulum on the surface of earth is 1 m. the length of same pendulum on the surface of moon, where acceleration due to gravity is (1/6)th of the g on the surface of earth is
    a) 36 m

b) 1/6 m
c) 1/36 m
d) 6 m

ASSERTION AND REASON TYPE QUESTIONS:

21) **Assertion**: The time period of a simple pendulum on a satellite orbiting the earth is infinite.
Reason: The time period of a satellite T α 1/g

22) **Assertion**: Energy of a particle executing simple harmonic motion is entirely potential energy at the extreme position.
Reason: Particle at extreme position is at rest.

23) **Assertion**: In S.H.M., the velocity is maximum when acceleration is minimum.
Reason: Displacement and velocity of S.H.M. differ in phase by π/2.

24) **Assertion**: In simple harmonic motion, the motion is 'to and fro' and periodic.
Reason: Velocity of particle is $v = w\sqrt{r^2 - x^2}$ where x is displacement and r is amplitude.

VERY SHORT ANSWER TYPE QUESTIONS:

25) The maximum velocity of a particle, executing S.H.M with amplitude of 7mm is 4.4 m/s. What is the period of oscillation?
26) At what points is the energy entirely kinetic and potential in S.H.M? What is the total distance travelled by a body executing S.H.M in a time equal to its time period, if its amplitude is A?
27) A particle executes SHM with amplitude A. At what distance from the mean position its KE is equal to PE?
28) An observer standing at the sea coast observes 54 waves reaching the coast per minute. If the wavelength of the eave is 10 m, what is wave velocity?
29) A girl is swinging in the sitting position. How will the period of the swing change if she stands up?
30) Write any three characteristics of stationary waves:

LONG ANSWER TYPE QUESTIONS:

31) Derive an expression to find the total energy of a particle executing simple harmonic motion. Represent graphically, the variations of energy with displacement.
32) Show that the oscillation of a simple pendulum is simple harmonic and deduce an expression for the time period of oscillation of the pendulum.
33) Discuss the formation of standing waves in a string fixed at both ends and the different modes of vibration.
34) A body of mass 1 kg executing SHM given by x = 6.0 cos (100 t + π/4) cm. Determine the maximum kinetic energy of the body.
35) A particle moves in a straight line with simple harmonic motion, making 7 complete oscillations in 11 seconds. The velocity of the particle is 1.2 m/s when its distance from the center of oscillation is 12.5 cm. Find the amplitude of motion, the maximum velocity and maximum acceleration.
36) A particle which is attached to a spring oscillates horizontally with simple harmonic motion, with a frequency of (1/ π) Hz and total energy 10 J. If the maximum speed of the particle is 0.4 m/s,

what is the force constant of the spring? What will be the maximum potential energy of the spring during the motion?

37) Write displacement equation respecting the following condition obtained in SHM.
Amplitude = 0.01m, Frequency = 600Hz, phase = $\varphi = \frac{\pi}{6}$

38) The equation of a plane progressive wave is, $y = 10 \sin 2\pi [t - 0.005x]$ where y & x are in cm & t in second. Calculate the amplitude, frequency, wavelength & velocity of the wave:

39) Write the equation of a progressive wave propagating along the positive x-direction, whose amplitude is 5 cm, frequency 250 Hz and velocity 500 m/s.

40) The mass of 1-meter-long steel wire is 20 grams. The wire is stretched under attention of 800 N. What are the frequencies of fundamental mode of vibration and next to higher modes?

41) A string vibrates with a frequency of 200 Hz. Its length is doubled and its tension is altered till it begins to vibrate with a frequency of 300 Hz. What is the ratio of new tension to the original tension?

42) A second's pendulum is taken from a place where $g=9.8\ m/s^2$ to a place where $g = 9.7\ m/s^2$. How would its length be changed in order its time period remains unaffected?

43) What is the percentage change in the time period, if the length of simple pendulum increases by 3%?

44) A second pendulum is taken in a carriage. Find the period of oscillation when the carriage moves with an acceleration of $4.2\ m/s^2$ (i) vertically upwards (ii) vertically downwards.

45) A particle executes SHM given by $y = 0.24 \sin (400\ t + 0.5)$ in SI units. Find amplitude, frequency and time period of vibration:

ANSWERS:

1	Maximum displacement
2	4/1
3	2
4	$\sqrt{2}$ times
5	Remains same
6	A = 5, T = 2
7	Sound travels faster in vacuum that then in air
8	50 m/s
9	$a=-200x^2$
10	2 cm
11	0.99 T
12	Total energy against Displacement
13	10%
14	10 rad/s
15	The stone executes simple harmonic motion about the centre of the earth
16	Stationary waves
17	2 cm
18	on a string clamped at both the ends and when the incident wave gets reflected from a wall.
19	Metal
20	1/6 m
21	Both Assertion and Reason are correct and Reason is the correct explanation for Assertion

22	Both Assertion and Reason are correct and Reason is the correct explanation for Assertion
23	Both Assertion and Reason are correct but Reason is not the correct explanation for Assertion
24	Both Assertion and Reason are correct but Reason is not the correct explanation for Assertion
25	So, $v_{max} = A\omega$ or $4.4 = 7 \times 10^{-3}(2\pi/T)$ or $T = 9.99 \times 10^{-3} = 10 \times 10^{-3} = 0.01s$
26	The energy is entirely kinetic at mean position i.e. at y=0. The energy is entirely potential at extreme positions i.e. $y = \pm A$. Total distance travelled in time period $T = 2A + 2A = 4A$.
27	$KE = PE$ $\frac{1}{2}m\omega^2(a^2 - x^2) = \frac{1}{2}m\omega^2x^2$ $(a^2 - x^2) = x^2$ $x = \frac{a}{\sqrt{2}}$
28	Total number of waves=54 wavelength of each wave=10 Total wavelength=540m Time taken=60sec $\text{velocity} = \frac{\lambda}{T}$ $= \frac{540}{60}$ $= 9m/s$
29	$T = 2\pi\sqrt{\frac{l}{g}}$ Where l is the length, Since length of the simple pendulum is equal to the distance from the point of suspension to CG of the oscillating body, when the girl stands up the distance of CG from the point of suspension will decrease. Therefore, time period of the oscillation also decreases.
30	1. A stationary wave does not move in any direction. 2. There is no flow of energy. 3. All particles in a loop are in the same phase & they are in opposite phase with respect to the adjacent loop. 4. Amplitude is different for different particle
31	As given in the notes

32	As given in the notes
33	As given in the notes
34	Here, m = 1 kg. The given equation of SHM is x = 6.0 cos (100 t + π/4) Comparing it with the equation of SHM x = a cos (ωt+ ϕ), we have, a = 6.0 cm = 6/100 m and ω = 100 rad s^{-1} Max. kinetic energy $= \frac{1}{2} m(V_{max})^2$ $= \frac{1}{2} m(a\omega)^2 = \frac{1}{2} \times 1 \times \left(\frac{6}{100} \times 100\right)^2 = 18$ J
35	Frequency, $f = 7/11$ Hz ; $\omega = 2\pi f = 2\pi \times 7/11 = 4$ rad/s If V is the velocity of the particle when at a distance y from the centre of oscillation, then, $V^2 = \omega (a^2 - y^2)$ or $(1.2)^2 = (4)^2 [a^2 - (0.125)^2]$ $\therefore$ Amplitude, $a = 0.325$ m = **32.5 cm** Maximum velocity of the particle occurs when $y = 0$. $\therefore$ $V_{max} = \omega a = 4 \times 0.325 =$ **1.3 ms^{-1}** The acceleration of the particle is maximum when $y = a$. $\therefore$ $A_{max} = \omega^2 y = \omega^2 a = (4)^2 \times 0.325 =$ **5.2 ms^{-2}**
36	Let m be the mass of the particle in SI units. The maximum speed of the particle is $V_{max} = 0.4$ ms^{-1}. Total energy = Maximum kinetic energy $= \frac{1}{2} m V_{max}^2$ or $10 = \frac{1}{2} m \times (0.4)^2$ or $m = \frac{10 \times 2}{(0.4)^2} = 125$ kg Angular frequency, $\omega = 2\pi f = 2\pi \times \frac{1}{\pi} = 2$ rad/s Force constant of the spring is given by; $k = m\omega^2 = 125 \times (2)^2 =$ **500 Nm^{-1}** Maximum P.E. = Total energy = Maximum K.E. = **10 joules**
37	$Y = A \sin[\omega t + \varphi] = 0.01 \sin[1200\omega t + \frac{\pi}{6}]$
38	We have $y = A\sin 2\pi[\frac{t}{T} - \frac{x}{\lambda}]$ Amplitude A = 10cm Frequency =1Hz Wavelength= 200cm Velocity v = = 1 x 200 = 200cm/s

39	$T = \frac{1}{\nu} = \frac{1}{250}$ s, $\lambda = \frac{v}{\nu} = \frac{500}{250} = 2$ m The equation of the wave is $y = r \sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$ **$y = 0{\cdot}05 \sin \pi (500\, t - x)$ metre**
40	Here, $m = 20g = 20 \times 10^{-3} kg$, $T = 800N, l = 1m$ $v_1 = \frac{1}{2l}\sqrt{\frac{T}{m}} = \frac{1}{2 \times 1}\sqrt{\frac{800}{20 \times 10^{-3}}} = \frac{200}{2} = 100Hz$ Frequencies of higher modes of vibration are $v_2 = 2v_1 = 200Hz, v_3 = 3v_1 = 300Hz$
41	Here, $200 = \frac{1}{2l}\sqrt{\frac{T_1}{m}}$ and $300 = \frac{1}{2(2l)}\sqrt{\frac{T_2}{m}}$ Divide $\frac{T_2}{4T_1} = \left(\frac{300}{200}\right)^2 = \frac{9}{4}$ or $\frac{T_2}{T_1} = \frac{9}{1}$
42	$T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{l'}{g'}}$ or $l' = \frac{lg'}{g} = \frac{l \times 9.7}{9.8}$ Decrease in length $= l - l' = l\left(1 - \frac{9.7}{9.8}\right) = \frac{0.1}{9.8}l$ Here, $l = \frac{T^2 g}{4\pi^2} = \frac{2^2 \times 9.8}{4 \times (22/7)^2} = 0.992$ $\therefore l - l' = \frac{0.1}{9.8} \times 0.992 = 0.0101m$
43	$T = 2\pi\sqrt{\frac{l}{g}}$ $T \alpha \sqrt{l}$ $\frac{T_2}{T_1} = \sqrt{\frac{l_2}{l_1}} = \sqrt{\frac{1.03l_1}{l_1}} = 1.014$ $T_2 = 1.014T_1$ % increase in time period $= \frac{T_2 - T_1}{T_1} \times 100 = 1.4\%$

44	For a second pendulum , $T = 2s.$ As $T = 2\pi\sqrt{\frac{l}{g}}, so 2 = s\pi\sqrt{\frac{l}{g}}$ or $l = \frac{g}{\pi^2} = \frac{9.8}{\pi^2}$ (i) When the carriage moves up with an accelceration $a = 4.2ms^{-2}$, the time period is $T_1 = 2\pi\sqrt{\frac{l}{g+a}} = 2\pi\sqrt{\frac{9.8/\pi^2}{9.8+4.2}}$ $= \frac{2\pi}{\pi}\sqrt{\frac{9.8}{14.0}} = 2 \times 0.863$ $= 1.73s$ (ii) When the carriage moves down with an acceleration $a = 4.2ms^{-2}$, the time period is $T_2 = 2\pi\sqrt{\frac{l}{g-a}} = 2\pi\sqrt{\frac{9.8/\pi^2}{9.8-4.2}}$ $= \frac{2\pi}{\pi}\sqrt{\frac{9.8}{5.6}} = 2.64s$
45	Given $y = 0.24\sin(400t + 0.5)$ Compare it with the standard equation of SHM $y = a\sin(\omega t + \theta)$ we have (i) amplitude, $a = 0.24m.$ (ii) $\omega = 400$ or $2\pi v = 400$ or $v = \frac{400}{2\pi} = \frac{200}{\pi} = \frac{200 \times 7}{22} = 63.6Hz$ (iii) Time period $T = \frac{1}{v} = \frac{\pi}{200} = \frac{22}{7 \times 200}$ $= 0.0157s.$

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