Octahedron institute, chandan nagar

office no 2, 1st floor chandan complex

Class 11 - Physics

WAVES

Maximum Marks: 83 **Time Allowed: 2 hours**

General Instructions:

ANSWER ALL QUESTIONS

Section A

1. An 8kg body performs S.H.M. of amplitude 30 cm. The restoring force is 60N when the displacement is 30cm. Find - a) Time period b) the acceleration c) potential and kinetic energy when the displacement is 12cm? **1**
2. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2 open at both the ends vibrating in its third overtone are in resonance with a given tuning fork. Find the ratio of length of P_1 and P_2? **1**
3. A particle is executing S.H.M of amplitude 4cm and T = 4sec. find the time taken by it to move from positive extreme position to half of its amplitude? **1**
4. There are two springs, one delicate and another hard or stout one. For which spring, the frequency of the oscillator will be more? **1**
5. A 40gm mass produces on extension of 4cm in a vertical spring. A mass of 200gm is suspended at its bottom and left pulling down. Calculate the frequency of its vibration. **1**
6. A person deep inside water cannot hear sound waves produces in air. Why? **1**
7. A point describes S.H.M. in a line 6 cm long. Its velocity, when passing through the centre of line is 18 cms. Find the time period. **1**
8. What is ratio of frequencies of the vertical oscillations when two springs of spring constant K are connected in series and then in parallel? **1**
9. A steel wire has a length of 12.0m and a mass of 2.10kg. What should be the tension in the wire so that speed of a transverse wave on the wire equals the speed of sound in dry air at 20 °C = 343 ms^{-1}? **1**
10. The acceleration due to gravity on the surface of moon is 1.7 m/s^2. What is the time **1**

period of simple pendulum on moon if its time period on the earth is 3.5s? (g on the surface of earth is 9.8 ms^{-2}).

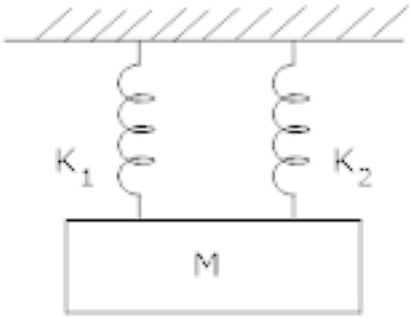
11. The equation of a plane progressive wave is given by the equation y = 10 sin 2π (t - 0.005x) where y and x are in cm and t in seconds. Calculate the amplitude, frequency, Wave length and Velocity of the Wave. **1**
12. A wire of density a g/cm^3 is stretched between two clamps 1m apart while subjected to an extension of 0.05 cm. What is the lowest frequency of transverse vibration in the wire? Let young's Modulus = $y = 9 \times 10^{10} \mathrm{N/m^2}$? **1**
13. Particle executes S.H.M. of amplitude 25cm and time period 3s. What is the minimum time required for the particle to move between two points 12.5cm on either side of the mean position? **1**
14. Springs with spring constant K, 2K, 4K, K ----- are connected in series. A mass M Kg is attached to the lower end of the last spring and system is allowed to vibrate. What is the time period of oscillation? **1**
15. Two sitar strings A and B playing the note 'Ga' are slightly out of tune and produce beats of frequency 6 Hz. The tension in the string A is slightly reduced and the beat frequency is found to reduce to 3 Hz. If the original frequency of A is 324 Hz, what is the frequency of B? **2**
16. If string wires of same material of length l and 2l vibrate with frequencies 100HZ and 150 HZ. Find the ratio of their frequencies? **2**
17. Earthquakes generate sound waves inside the earth. Unlike a gas, the earth can experience both transverse (S) and longitudinal (P) sound waves. Typically the speed of S wave is about 4.0 km s-1, and that of P wave is 8.0kms^{-1}. A seismograph records P and S waves from an earthquake. The first P wave arrives 4 min before the first S wave. Assuming the waves travel in straight line, at what distance does the earthquake occur? **2**
18. The length of a sonometer wire between two fixed ends is 110cm. Where the two bridges should be placed so as to divide the wire into three segments whose fundamental frequencies are in the ratio of 1:2:3? **2**
19. A circular disc of mass 10kg is suspended by a wire attached to its centre. The wire is twisted by rotating the disc and released. The period of torsional oscillations is **2**

found to be 1.5s. The radius of the disc is 15cm. Determine the torsional spring constant of the wire. (Torsional spring constant α is defined by the relation $J = -\alpha\theta$, where J is the restoring couple and θ, the angle of twist).

20. A mass attached to a spring is free to oscillate, with angular velocity, ω in a horizontal plane without friction or damping. It is pulled to a distance x_0 and pushed towards the centre with a velocity v_0 at time t = 0. Determine the amplitude of the resulting oscillations in terms of the parameters Ã"°, $x_0$and v_0. [Hint: Start with the equation x = a cos ($\omega t + \theta$) and note that the initial velocity is negative.] **2**

21. The acceleration due to gravity on the surface of moon is 1.7 ms^{-2}. What is the time period of a simple pendulum on the surface of moon if its time period on the surface of earth is 3.5s? (g on the surface of earth is 9.8 ms^{-2}) **2**

22. A mass = m suspend separately from two springs of spring constant k_1 and k_2 gives time period t_1 and t_2 respectively. If the same mass is connected to both the springs as shown in figure. Calculate the time period 't' of the combined system? **2**



23. Two similar sonometer wires of the same material produce 2 beats per second. The length of one is 50cm and that of the other is 50.1cm. Calculate the frequencies of two wires? **2**

24. A particle executing S.H.N. along a straight line has a velocity of um/s when its displacement from mean position is 3 m and 3 m / s when displacement is 4m. Find the time taken to travel 2.5m from the positive extremity of its oscillation? **2**

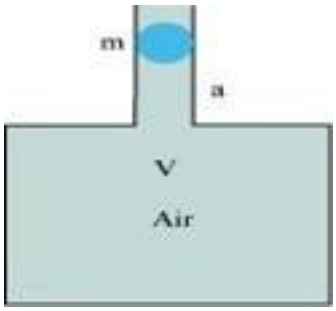
25. A simple pendulum of length l and having a bob of mass M is suspended in a car. The car is moving on a circular track of radius R with a uniform speed v. If the pendulum makes small oscillations in a radial direction about its equilibrium position, what will be its time period? **2**

26. A U-tube contains water and methylated spirit separated by mercury. The mercury columns in the two arms are in level with 10.0 cm of water in one arm and 12.5 cm **2**

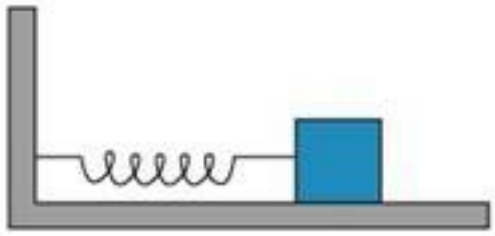
of spirit in the other. What is the specific gravity of spirit?

27. Cylindrical piece of cork of density of base area *A* and height *h* floats in a liquid of density ρ_l. The cork is depressed slightly and then released. Show that the cork oscillates up and down simple harmonically with a period $T = 2\pi\sqrt{\frac{h\rho}{\rho_l g}}$ Where ρ is the density of cork. (Ignore damping due to viscosity of the liquid). **5**

28. An air chamber of volume V has a neck area of cross section a into which a ball of mass m just fits and can move up and down without any friction (Figure). Show that when the ball is pressed down a little and released, it executes SHM. Obtain an expression for the time period of oscillations assuming pressure-volume variations of air to be isothermal. **5**



29. A spring having with a spring constant 1200 N m^{-1} is mounted on a horizontal table as shown in Fig. A mass of 3 kg is attached to the free end of the spring. The mass is then pulled sideways to a distance of 2.0 cm and released. **5**



Determine (i) the frequency of oscillations, (ii) maximum acceleration of the mass, and (iii) the maximum speed of the mass.

30. One end of a U-tube containing mercury is connected to a suction pump and the other end to atmosphere. A small pressure difference is maintained between the two columns. Show that, when the suction pump is removed, the column of mercury in the U-tube executes simple harmonic motion. **5**

31. The transverse displacement of a string (clamped at its both ends) is given by $y(x,t) = 0.06 \sin\frac{2}{3}x \cos(120\pi t)$ Where x and y are in m and t in s. The length of the string is 1.5 m and its mass is 3.0×10^{-2} kg. **5**

Answer the following:

a. Does the function represent a travelling wave or a stationary wave?
b. Interpret the wave as a superposition of two waves travelling in opposite directions. What is the wavelength, frequency, and speed of each wave?
c. Determine the tension in the string.

32. The motion of a particle executing simple harmonic motion is described by the displacement function, x (t) = A cos $(\omega_t + \omega)$. **5**

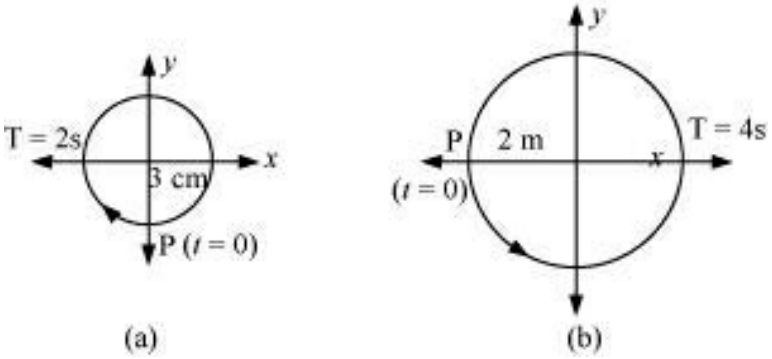
If the initial (t = 0) position of the particle is 1 cm and its initial velocity is ω cm/s, what are its amplitude and initial phase angle? The angular frequency of the particle is π s^{-1}. If instead of the cosine function, we choose the sine function to describe the SHM: x = B sin $(\omega t + a)$, what are the amplitude and initial phase of the particle with the above initial conditions.

33. Take the position of mass when the spring is unstreched as x = 0, and the direction from left to right as the positive direction of x-axis. Give x as a function of time t for the oscillating mass if at the moment we start the stopwatch (t = 0), the mass is **5**

a. at the mean position,
b. at the maximum stretched position, and
c. at the maximum compressed position.

In what way do these functions for SHM differ from each other, in frequency, in amplitude or the initial phase?

34. In figures correspond to two circular motions. The radius of the circle, the period of revolution, the initial position, and the sense of revolution (i.e. clockwise or anti-clockwise) are indicated on each figure. **5**



Obtain the corresponding simple harmonic motions of the *x*-projection of the radius vector of the revolving particle P, in each case.

35. Show that for a particle in linear SHM the average kinetic energy over a period of oscillation equals the average potential energy over the same period. **5**