Haldia Institute of Technology

Department of Applied Science

Assignment - I

Course: PH 101/PH 201

Module1: ***Vibration and Waves***

1) The displacement of a body of mass 2 gm executing SHM is indicated by

$y= 10 \sin \left(\frac{\pi}{3}t + \frac{\pi}{15}\right)$ cm. Calculate the (a) amplitude (b) angular velocity (c) time period (d) maximum and minimum velocity , maximum and minimum acceleration (e) kinetic energy and (f) potential energy. Is its energy conserved?

2) Two particles execute SHM with same amplitude and frequency along two parallel straight lines. They pass one another when going in opposite directions. Each time their displacement is half of their amplitude. What is the phase difference between them ?

3) Calculate the displacement to amplitude ratio for a SHM when the kinetic energy is 90 % of the total energy.

4) A particle oscillates with SHM of amplitude 4 cm and a time period of 5 sec. Find out the time taken by the particle to move from one end of its path to a position 2 cm from the equilibrium position on the same side.

5) An oscillator executing SHM has zero displacement at time t=0. If the displacements are 1 mm and 1.5 mm at instants 0.1 and 0.2 seconds, calculate the frequency and amplitude of oscillation.

6) A point mass m suspended at the end of a massless wire of length l and cross sectional area A. If the Young's modulus of elasticity of the wire be Y then obtain the frequency of oscillation for the simple harmonic motion along the vertical line.

7) The equation for displacement of a point of damped oscillator is given by x= 5 exp (-0.5t) sin (π/2)t. Find the velocity of oscillating point at t=T/5 and T, where T is the time period of oscillation.

8) An object of mass m = 1 g hangs from a spring of spring constant k= 106 dyne cm^{-1}. A resistive force k'v acts on it where v is the velocity in cm s^{-1} and k' = 10^4 g s^{-1}. If the object be subjected to a driving force, $F = F_p \cos \omega' t$ with $F_p = 2 * 10^6$ dyne and ω'=5000 rad s^{-1}, then calculate the amplitude of oscillation and phase, relative to the applied resistive force, in the steady state.

9) Show that at velocity resonance the velocity is in phase with the driving force.

10) Show that the motion of a body floating in a liquid is SHM. Hence find its time period.

or

A cubical block of side L cm and density ρ is floating in water of density ρ_0 ($\rho_0 > \rho$). The block is slightly depressed and released. Show that it will execute SHM. Determine the frequency and time period of oscillation.

11) A body of mass 10 g is acted upon by a restoring force /unit displacement of 10^7 dyne/cm, a frictional force /unit velocity of 4 * 10^3 dyne/cm s^{-1} and a driving force of 10^5 cos ωt dyne. Find the value of maximum amplitude.

12) If the relaxation time of a damped vibration is 50 sec. find the time in which (i) the amplitude falls to 1/e times the initial value (ii) the energy falls to $1/e^4$ times of the initial value.

13) Show that for a system of forced vibration, the ratio of two energy are as follows

$$\frac{average\,potential\,energy}{average\,kinetic\,energy} = \frac{\omega^2}{\omega'^2}$$

14) The amplitude of damped vibration of frequency 300/s decays to 1/10 of its initial value after 1800 cycles. Find it's a) damping constant, b) Q-factor, c) relaxation time, d) the time in which its energy is reduced to 1/e of its initial energy and reduced to ½ of its initial energy.

15) A particle of mass 0.2 kg. is acted on by a restoring force/unit displacement $10X10^{-3}$ N/m and a frictional force/unit velocity $2X10^{-3}$ N/ms-1 . Find whether the motion is oscillatory or non-oscillatory? For what value of frictional (resistive) force, the damping will be critical?

16) Establish the condition for Amplitude Resonance. What do you mean by Sharpness of Resonance? What is Q-factor?

17) What is Velocity Resonance? Find the condition for velocity resonance. Distinguish between Amplitude and Velocity Resonance. Prove that the maximum energy intake by an oscillator at Velocity Resonance.

18) Write down the equation of forced vibration and explain each term in the equation. Solve the equation of motion.