

### Assignment-1 [For PHY-2105]

1. An object undergoing simple harmonic motion takes 0.25 s to travel from one point of zero velocity to the next such point. The distance between those points is 36 cm. Calculate the (i) period, (ii) frequency, and (iii) amplitude of the motion.
2. A block whose mass  $m$  is 680 gm is fastened to a spring whose spring constant  $k$  is 65 N/m. The block is pulled maximum 11 cm generating cosine form on a frictionless surface and released from rest at  $t=0$ . Find out (i) time period, (ii) angular frequency, (iii) phase constant, (iv)  $V$  (4 sec),  $V_{\max}$ , (v)  $a$  (4 sec),  $a_{\max}$ , (vi) displacement at  $t=0$  sec,  $t=7$  sec, and (vii) velocity at a displacement  $x=0.11$  m,  $x=0.04$  m.
3. A 0.12 kg body undergoes simple harmonic motion of amplitude 8.5 cm and period 0.20 s. (i) What is the magnitude of the maximum force acting on it? (ii) If the oscillations are produced by a spring, what is the spring constant?
4. In an electric shaver, the blade moves back and forth over a distance of 2.0mm in simple harmonic motion, with a frequency 120Hz. Find (i) the amplitude, (ii) the maximum blade speed and (iii) the magnitude of the maximum acceleration of blade.
5. An oscillator consists of a block attached to a spring ( $k = 400$  N/m). At some time  $t$ , the position (measured from the system's equilibrium location), velocity, and acceleration of the block are  $x = 0.100$  m,  $v = -13.6$  m/s, and  $a = -123$  m/s<sup>2</sup>. Calculate (i) the frequency of oscillation, (ii) the mass of the block, and (iii) the amplitude of the motion.
6. A body of mass 25gm is attached with a spring of spring constant 400dyns/cm. The body is displaced by 10cm from its equilibrium position and released. Then the body executes simple harmonic motion. Calculate (i) the time period, (ii) frequency, (iii) angular frequency and (iv) maximum velocity.
7. A hydrogen atom has a mass of  $1.68 \times 10^{-27}$  kg, when it attach to a certain massive molecule, it oscillate as classical oscillator with frequency of  $10^{14}$  Hz and with amplitude of  $10^{-10}$  m. Calculate force acting on the hydrogen atom.
8. A body executes SHM such that its velocity at mean position is 1m/s and acceleration at one extremity is  $1.57\text{m/s}^2$ . Calculate time period of oscillation.
9. A particle executes SHM of amplitude 5m when the particle is 3m from its mean position, its acceleration is found to be  $48\text{m/s}^2$ . Find (i) velocity (ii) time period and (iii) maximum velocity.
10. Particle executes harmonic motion about the point  $x = 0$ ; at  $t = 0$  it has displacement  $x = 0.37\text{cm}$  and zero velocity. The frequency of the motion is 0.25Hz, determine, (i) the period, (ii) the angular frequency, (iii) the amplitude, (iv) the displacement at  $t = 3.0\text{s}$ , and (v) the velocity at  $t = 3.0\text{s}$ .

11. A body oscillates with SHM according to the equation  $x = 10\cos(3\pi t + \frac{\pi}{3})$ . Calculate (i) displacement at  $t=2.5s$ , (ii) velocity at  $t=3.0s$ , (iii) acceleration when  $t=2s$ , and (iv) maximum velocity.
12. A particle executes simple harmonic motion given by the equation  $x = 10\sin(10t - \frac{\pi}{6})$ . Calculate (i) frequency, (ii) time period, (iii) the maximum displacement, (iv) the maximum velocity, and (v) the maximum acceleration.
13. A mass oscillates with an amplitude of 4.00 m, a frequency of 0.5 Hz and a phase angle of  $\pi/4$ .  
(i) What is the period  $T$ ? (ii) Write an equation for the displacement of the particle, and (iii) Calculate the velocity and acceleration of the object at time  $t=5s$ .
14. A 2.00 kg block is attached to a spring and force constant of the spring is  $k = 196 \text{ N/m}$ . The block is held a distance of 5.00 cm from equilibrium and released at  $t = 0$ .  
(i) Find the angular frequency  $\omega$ , the frequency  $f$ , and the period  $T$ .  
(ii) Write an equation for  $x$  vs. time.
15. A body of mass 500 gm is suspended from a spring of negligible mass and it stretches the spring by 7 cm. For a displacement of 3 cm it is given a downward velocity 40 cm/s. Calculate (i) the spring constant, (ii) the angular frequency, (iii) the time period (iv) the initial potential energy, (v) the initial kinetic energy, and (vi) the amplitude of the ensuing motion of the spring.
16. Let the mass of the body is 25 gm, the force constant  $k$  be 400 dynes/cm, and let the motion be started by displacing the body 10 cm to the right of its equilibrium position and imparting to it a velocity toward the right of 40 cm/s. Compute (a) the period,  $T$ , (b) the frequency  $f$ , (c) the angular frequency  $\omega$ , (d) the total energy  $E$ , (e) the amplitude  $A$ , (f) the angle  $\theta_0$ , (g) the maximum velocity  $v_{max}$ , (h) the maximum acceleration  $a_{max}$ , (i) the coordinate equations, velocity, and acceleration, and (j) displacement, velocity, acceleration at a time  $\pi/8$  sec after the start of the motion.
17. Suppose a spring block-system moves between top and bottom point of a tall buildings as a mass dampers. The block has mass  $m=2.72 \times 10^5 \text{ kg}$  and designed to oscillate at a frequency  $f=10 \text{ Hz}$  with amplitude  $x_m=20 \text{ cm}$ . Calculate (i) the mechanical energy, (ii) what is the block speed as it passes through the equilibrium point?
18. Draw displacement vs time graph for  $\omega/\gamma = 10$ ,  $\omega/\gamma = 0.5$ , and  $\omega/\gamma = 0.03$ .
19. In oscillatory circuit  $L=0.4\text{h}$ ,  $C = 0.0020\mu\text{F}$ . (i) What is maximum value of resistance ( $R$ ) for the circuit to be oscillatory? and (ii) What is its resonant frequency?
20. Find whether the discharge of capacitor through the following inductive series circuit is oscillatory or not. Given,  $C = 0.1\mu\text{F}$ ,  $L = 10\text{mh}$ , and  $R = 200 \Omega$ . If Oscillatory, find the frequency of oscillation and resonant frequency. If it is parallel circuit, then find out the similar characteristics of that circuit.
21. For a damped oscillator  $m = 250\text{gm}$ ,  $k = 85\text{N/m}$  and  $b = 70\text{gm/s}$ . (i) What is the period of the motion? (ii) How long does it take for the amplitude of the damped oscillations to drop to half its initial value? (iii) How many oscillations does it complete in life time? (iv) What is its life time? (v) If the damping is stopped after 20 cycles, What is the damping energy and amplitude? (vi) What is the ratio of the oscillation amplitude to the initial oscillation amplitude at this cycle?

22. The equation of a travelling wave is  $y = 4.0\sin(0.10x - 2t)$  . Find (i) amplitude, (ii) wavelength, (iii) speed, and (iv) frequency of wave.
23. At time  $t=0$  the displacement of a particle in a medium is  $y = 4.0\sin 2\pi(\frac{x}{100})$  and the velocity of wave is 30cm/s. Find the displacement equation when  $t = 3s$ .
24. When a simple harmonic wave is propagated through a medium, the displacement of the particle at any instant of time is given by  $y = 5.0\sin \pi(360t - 0.15x)$ . Calculate (i) the amplitude of the vibrating particle, (ii) wave velocity, (iii) wave length, (iv) frequency and (v) time period.
25. A simple harmonic wave of amplitude 8units travels a line of particles in the direction of positive X axis. At any instant for a particle at a distance of 10cm from the origin, the displacement is +6units and at a distance a particle from the origin is 25units, the displacement is +4units. Calculate the wavelength.
26. Determine the length and frequency of a simple pendulum that will swing back and forth in simple harmonic motion with a period of 5.00 s.
27. Find out the resultant amplitude, node and antinode points in terms of  $\lambda$  of the following equations:  
 $y_1 = A \cos(\frac{1}{3}kx + \omega t)$  and  $y_2 = A \cos(\frac{1}{3}kx - \omega t)$ .