Practice Problems : Summer 24 (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^2. 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 1.68×10^{-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 1.57m/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 48m/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= 0.37cm 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= 3.0s, and (v) the velocity at t= 3.0s.

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 $\boldsymbol{k}$ = 196 N/m. The block is held a distance of 5.00 cm from equilibrium and released at $\boldsymbol{t}$ = 0.
(i) Find the angular frequency $\boldsymbol{w}$, the frequency $\boldsymbol{f}$, and the period $\boldsymbol{T}$.
(ii) Write an equation for $\boldsymbol{x}$ 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 ω, (d) the total energy E, (e) the amplitude A, (f) the angle θ_o, (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=2.72x10^5 kg and designed to oscillate at a frequency f=10 Hz with amplitude x_m=20 cm. Calculate (i) the mechanical energy, (ii) what is the block speed as it passes through the equilibrium point?

18. Draw the following equations of displacement vs time

(i) $\mathbf{y = A \sin(\omega t - \frac{\pi}{3})}$

(ii) $\mathbf{y = A \sin(\omega t - \frac{\pi}{2})}$

(iii) $\mathbf{y = A \sin(\omega t + \pi)}$

(iv) $\mathbf{y = A \sin(\omega t - \pi)}$

(v) $\mathbf{y = A \sin(\omega t + \frac{3\pi}{4})}$