Practice Problem Sheet-1

Course Code: PHY 2105/PHY 105 Spring 2024

Course Title: Physics Content: SHM

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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?

11. Draw the following equations of displacement vs time graph or phase shift diagram for the wave (i) y = A sin(ωt- $\frac{\pi}{3}$), (ii) y = A sin(ωt - $\frac{\pi}{2}$), (iii) y = A sin(ωt +π), (iv) y = A sin(ωt -π), and (v) y = A sin(ωt+ $\frac{3\pi}{4}$).

12. At t =0, the displacement x (0) of the block in a linear oscillator is -8.50 cm. The block's velocity v(0) then is -0.920 m/s, and its acceleration a(0) is +47.0 m/s^2. (i) What is the angular frequency ω of this system? (ii) What are the phase constant ϕ and amplitude x_m?

13. A loudspeaker produces a musical sound by means of the oscillation of a diaphragm whose amplitude is limited to 1.00 μm . (i) At what frequency is the magnitude a of the diaphragm's acceleration equal to g?

14. A 5.00 kg object on a horizontal frictionless surface is attached to a spring with k 1000 N/m. The object is displaced from equilibrium 50.0 cm horizontally and given an initial velocity of 10.0 m/s back toward the equilibrium position. What are (i) the motion's frequency, (ii) the initial potential energy of the block–spring system, (iii) the initial kinetic energy, and (iv) the motion's amplitude?

15. Two springs are joined and connected to a block of mass 0.245 kg that is set oscillating over a frictionless floor. The springs each have spring constant k=6430 N/m. What is the frequency of the oscillations?

16. An oscillating block–spring system has a mechanical energy of 1.00 J, an amplitude of 10.0 cm, and a maximum speed of 1.20 m/s. Find (i) the spring constant, (ii) the mass of the block, and (iii) the frequency of oscillation.