Practice Problems 1 Fall 24 (PHY-105/2105)

1. A mass-spring system with a mass of m = 90 g is oscillating in SHM. At equilibrium position, the velocity is 70 ms^{-1} and at amplitude position, the acceleration is 720 ms^{-2}. If we have released the mass from amplitude at t = 0,

Determine the value of
i) displacement at t = 3s
ii) acceleration at t = 5 s
iii) total energy at t = 7 s

2. The equation of displacement of a mass-spring system is,

$$y = 5\cos(20t+\pi)$$

Calculate
i) Potential Energy at t = 0.1 s, kinetic energy at t = 2 s
ii) Maximum velocity and maximum acceleration
The mass attached to the spring is 70 g. Consider the units in S. I. system.

3. A body of mass 90 g is attached with a spring of spring constant 19.6 N/m. The body is displaced by 20 cm from its equilibrium position and released at t = 0. Then the body executes simple harmonic motion.

Calculate
(i) angular frequency
(ii) velocity at t = 3 s
(iii) acceleration at t = 1.5 s

4. A 0.24 kg body undergoes simple harmonic motion of amplitude 9 cm and period 0.30 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?

5. The equation of displacement of a mass-spring system is,

$$y = 3\cos(2\pi t-\frac{\pi}{3})$$

   Calculate
   i) compare the potential energy and kinetic energy at t = 3 s
   ii) at which time the potential energy will be equal to the kinetic energy
   Here the mass of the mass-spring system is 0.5 kg. Consider the units in S. I. system.

6. In an electric shaver, the blade moves back and forth over a distance of 5 mm in simple harmonic motion, with a frequency 240 Hz. Find (i) the amplitude, (ii) the maximum blade speed and (iii) the magnitude of the maximum acceleration of blade.

7. An oscillator consists of a block attached to a spring (k = 460 N/m). At some time t, the position (measured from the system's equilibrium location), velocity, and acceleration of the block are x = 0.150 m, v = -15 m/s, and a = -125 m/s^2. Calculate (i) the frequency of oscillation, (ii) the mass of the block, and (iii) the amplitude of the motion.

8. A body of mass 24 gm is attached with a spring of spring constant 840 dyns/cm. The body is displaced by 12 cm 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.

9. A particle executes SHM of amplitude 10 m when the particle is 5 m from its mean position, its acceleration is found to be 84 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= 0.40 cm and zero velocity. The frequency of the motion is 0.5 Hz, 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. In oscillatory circuit L= 0.4 h, C = 0.0020 μF.

    (i) What is maximum value of resistance (R) for the circuit to be oscillatory?
    (ii) What is its resonant frequency?

12. Find whether the discharge of capacitor through the following inductive series circuit is oscillatory or not. Given, C = 0.1μF, L = 10mh, and R 200 Ω. If oscillatory, find the frequency of oscillation and resonant frequency. If it is parallel circuit, then find out the similar characteristics of that circuit.

13. For a damped oscillator m =250gm, k = 85N/m and b = 70gm/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) The maximum displacement of undamped oscillator is 35 cm. If the damping is stopped after 20 cycles, What is the damping energy?
    (vi) What is the ratio of the oscillation amplitude to the initial oscillation amplitude at this cycle?

14. The equation of a travelling wave is $y = 4.0\sin(0.10x - 2t)$.

    Find
    (i) amplitude
    (ii) wavelength
    (iii) speed
    (iv) frequency of wave