Practice Problem Sheet-1

Course Code: PHY 2105/PHY 105 Spring 2025

Course Title: Physics Content: SHM

1. A mass-spring system with a mass of m = 90 g is oscillating in Simple Harmonic Motion (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, and (iii) total energy at t = 7 s.
2. The equation of displacement of a mass-spring system is, $y = 2\cos(20t+2\pi)$ m. Calculate (i) Potential Energy at t = 0.1 s, kinetic energy at t = 2 s and (ii) Maximum velocity and maximum acceleration. Given, the mass attached to the spring is 70 g.

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

4. A 0.24 kg body undergoes SHM 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, $y = 3\cos(2\pi t - \frac{\pi}{3})$ m. Calculate (i) the potential energy and kinetic energy at t = 3 s, (ii) compare the potential and kinetic energy, (iii) 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.
6. In an electric shaver, the blade moves back and forth over a distance of 5 mm in SHM, with a frequency 240 Hz. Find (i) the amplitude, (ii) the maximum blade speed, and (iii) the magnitude of the maximum acceleration of the blade.

7. A body of mass 24 gm is attached with a spring of spring constant 840 dynes/cm. The body is displaced by 12 cm from its equilibrium position and released. Then the body executes SHM. Calculate (i) the time period, (ii) frequency, (iii) angular frequency, (iv) maximum velocity, and (v) maximum acceleration.

8. A particle executes SHM 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.

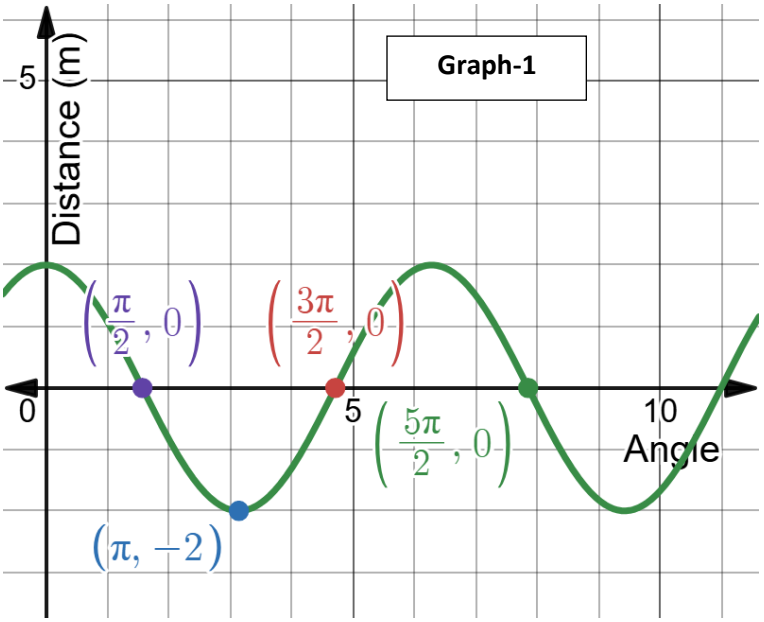
9. An object undergoing simple harmonic motion takes 0.25 s to travel from one point of zero velocity to the next such point. The distance between those points is 36 cm. Calculate the (i) period, (ii) frequency, and (iii) amplitude of the motion.

10. A body executes SHM such that its velocity at mean position is 1 m/s and acceleration at one extremity is 1.57 m/s^2. Calculate time period of oscillation.

11. Draw the phase difference diagram for the waves: (i) $y_2 = A \sin(\omega t - \frac{\pi}{3})$, $y_1 = A \sin \omega t$; (ii) $y_2 = A \sin(\omega t + \frac{\pi}{4})$, $y_1 = A \sin \omega t$; (iii) $y_1 = A \sin(\omega t + \frac{2\pi}{3})$, $y_2 = A \sin(\omega t + \frac{\pi}{3})$; (iv) $y_1 = A \sin(\omega t + \frac{3\pi}{4})$, $y_2 = A \sin(\omega t - \frac{\pi}{4})$; and (v) $y_1 = A \sin(\omega t - \frac{\pi}{3})$, $y_2 = A \sin(\omega t + \frac{\pi}{3})$.
12. 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 (t=4 sec), (v) V_{max} , (vi) a (t=4 sec), (vii) a_{max}, (viii) displacement at t=0 sec, t=7 sec, and (ix) velocity at a displacement x=0.11 m, x=0.04 m.

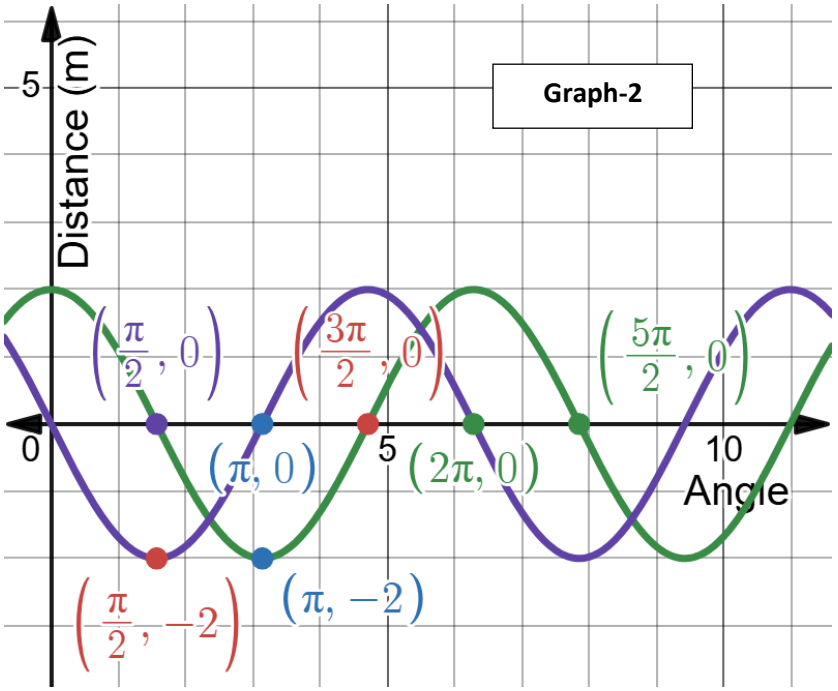
13. A mass oscillates with amplitude of 4.00 m, a frequency of 0.5 Hz and a phase angle of π/4. (i) What is the period T? (ii) Write an equation for the displacement of the particle, and (iii) Calculate the velocity and acceleration of the object at time t=5 s.

14. A 2.00 kg block is attached to a spring and force constant of the spring is k =196 N/m. The block is held a distance of 5.00 cm from equilibrium and released at t = 0. (i) Find the angular frequency ω, the frequency f, and the period T. (ii) Write an equation for displacement, ***x*** vs. time, ***t***.



15. Graph-1 illustrates the position vs. displacement graph for a mass spring system oscillating in Simple Harmonic Oscillation. The mass of the mass-spring system is 500 g.
(i) Calculate the equation of displacement vs. time.
(ii) Calculate the acceleration at t = 2 sec.
(iii) Determine the kinetic energy at t = 0.5 sec.

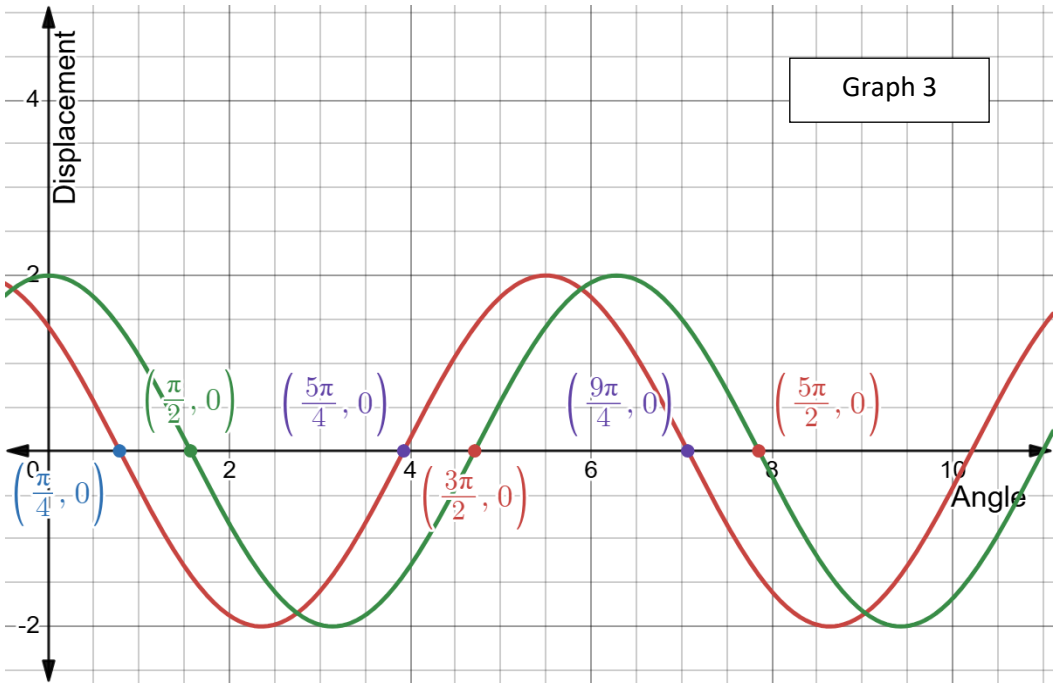
16. Construct the equation of displacement of two objects oscillating in simple harmonic oscillations and find out their phase difference according to Graph-2.



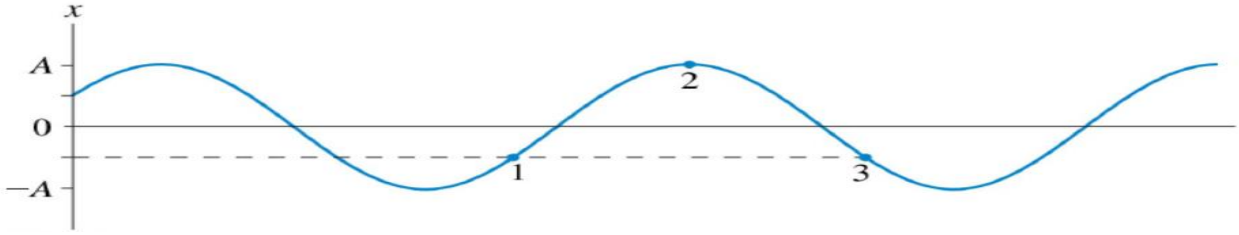
17. Determine the length and frequency of a simple pendulum that will swing back and forth in SHM with a period of 5 s.

18. 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.

19. Construct the equation of displacement of two objects oscillating in simple harmonic oscillations and find out their phase difference according to Graph 3.



20. A particle executes SHM of amplitude 5 m when the particle is 2.5 m from its mean position, its acceleration is found to be 80 m/s^2. Find the (i) velocity (ii) time period and (iii) maximum velocity.
21. The figure shows below a position-versus-time graph for a particle in SHM. What is the phase constant? What is the phase at point 2?



22. An object in simple harmonic motion has an amplitude of 4.0 cm, a frequency of 2.0 Hz, and a phase constant of 2π/3 rad. Draw a position graph showing two cycles of motion.
23. Graph 4 illustrates the position vs. displacement graph for a mass spring system oscillating in Simple Harmonic Oscillation. The mass of the mass-spring system is 500 g. (i) Calculate the equation of displacement vs. time, (ii) Calculate the acceleration at t = 2 sec, and (iii) Determine the kinetic energy at t = 0.5 sec.