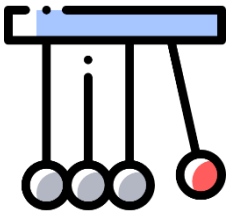

Practice Problem sheet – 1

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Topic: Simple Harmonic Motion

1. A 0.42 kg block is attached to the end of a horizontal ideal spring and rests on a frictionless surface. The block is pulled so that the spring stretches by 2.1cm relative to its unstrained length. When the block is released, it moves with an acceleration of $9.0 m/s^2$. What is the spring constant of the spring?

2. 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?

3. 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.

4. For the simple harmonic oscillation where k = 19.6 N/m, A= 0.1 m, x = - (0.1 m) cos (8.08 t) and v = (0.808 m/s) sin (8.08 t). Determine:
   i. The total Energy
   ii. The kinetic and potential energy as a function of time
   iii. The velocity when the mass is 0.05 m from equilibrium
   iv. The kinetic and potential energies at half amplitude

5. A 500g block on a spring is pulled a distance of 20 cm and released. The subsequent oscillations are measured to have a period of 0.80s. At what positions is the speed of the block 1.0 m/s?

6. A body executes SHM such that its velocity at mean position is 1m/s and acceleration at one extremity is $1.57 m/s^2$. Calculate time period of oscillation.
7. 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.
8. A simple harmonic oscillator consists of a block of mass 2.00 kg attached to a spring of spring constant 100 N/m. When t =1.00 s, the position and velocity of the block are x=0.129 m and v=3.415 m/s. (i) What is the amplitude of the oscillations? (ii) What were the position at t=0 s? and (iii) what were the velocity of the block at t=0 s?

9. 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.

10. 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.

11. The diaphragm of a loudspeaker moves back and forth in simple harmonic motion to create sound. The frequency of the motion is $f = 1.0\ kHz$ and the amplitude is $A = 0.2\ mm$.
    i. What is the maximum speed of the diaphragm?
    ii. In the motion where does this maximum speed occur?

12. What is the oscillation period of an FM radio station that broadcasts at 100 MHz?

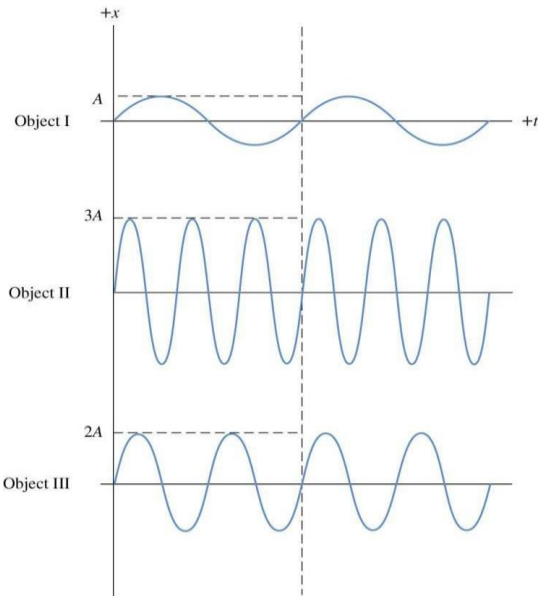
13. A hydrogen atom has a mass of 1.68×10-27kg, when it attach to a certain massive molecule, it oscillate as classical oscillator with frequency of 1014 Hz and with amplitude of 10-10m. Calculate force acting on the hydrogen atom.

14. 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.

15. 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?

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.

17. The Drawing shows plots of the displacement x versus the time t for three objects undergoing simple harmonic motion. Which object has the greatest velocity and why?



18. A 2.00 kg block is attached to a spring as shown. The force constant of the spring is 196 N/m. The block is held a distance of 5.00 cm from equilibrium and releases at t=0.
    i. Find the angular frequency
    ii. Linear frequency
    iii. Time period
    iv. Write the equation of motion for this system.

19. 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.

20. An air track glider is attached to a spring pulled 20 cm to the right, and released at t = 0. It makes 15 complete oscillations in 10 sec.
    i. Determine the period of oscillation?
    ii. Maximum speed?
    iii. Position and velocity at t=0.80 sec.
21. A mass, oscillating in simple harmonic motion, starts at x = A and has period T. At what time, as a fraction of T, does the mass first pass through x = ½ A?

22. 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.

23. 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.

24. 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.

25. A particle with mass 50 g executes SHM given by the equation $y = sin(10t - \frac{\pi}{4})$. Calculate the (i) maximum velocity and maximum acceleration (ii) total energy of the particle.

26. A motorbike can be mounted on four identical springs as far as vertical oscillations are concerned. The springs of a certain car are adjusted so that the oscillations have a frequency of 2 Hz.

    (i) What is the spring constant of each spring if the mass of the motorbike is 500 kg and the mass is evenly distributed over the springs?

    (ii) What will be the oscillation frequency if five passengers, averaging 73.0 kg each, ride in the car with an even distribution of mass?

27. The equation of displacement of a mass-spring system with mass 500 g is,

$$y = 7Sin(6\pi t + \frac{\pi}{9})$$

    Calculate
i) calculate the acceleration at t = 0.5 s
ii) compare the kinetic energy at, t = **L** s. Here **L** is the last one digit of your student ID. If the last digit of your ID is 0 then use **L**= 8.

28. A particle executes simple harmonic motion given by the equation

$$y = 12\ \sin\left(\frac{2}{10}\pi\ t + \frac{\pi}{4}\right)$$

    i. Determine amplitude
    ii. Frequency
    iii. Displacement at t = 1.25 sec
    iv. Velocity at t = 2.5 sec
    v. Acceleration at t = 5 sec.

29. A particle executes simple harmonic motion given by the equation

$$y = 10\ \cos\left(10t - \frac{\pi}{6}\right)$$

i. Determine time period
ii. Frequency
iii. Maximum Displacement
iv. Maximum Velocity
v. Maximum Acceleration

30. 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.

31. Draw the following equations of displacement vs time graph or phase shift diagram for the wave:

(i) $y = A \sin(\omega t - \frac{\pi}{3})$
(ii) (ii) $y = A \sin(\omega t - \frac{\pi}{2})$
(iii) (iii) $y = A \sin(\omega t + \pi)$
(iv) (iv) $y = A \sin(\omega t - \pi)$ and
(v) (v) $y = A \sin(\omega t + \frac{3\pi}{4})$

32. 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) $y_1 = A \sin(\omega t - \frac{\pi}{3})$, $y_2 = A \sin(\omega t + \frac{\pi}{3})$.