

## Oscillations — Assignment 1

Class 11 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.  
 (2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.  
 (3) Universal values:  $g = 10 \text{ m/s}^2$  unless stated. Give answers with correct SI units.

### Periodic Motion and SHM Basics

#### MCQ Questions (choose the correct option)

- In simple harmonic motion the acceleration is
  - proportional to  $-$ displacement
  - proportional to displacement
  - independent of displacement
  - proportional to velocity
- The SI unit of angular frequency is
  - $\text{rad s}^{-1}$
  - hertz
  - second
  - rad
- In the equation  $x = A \sin(\omega t + \phi)$ , the phase at  $t = 0$  is
  - $\phi$
  - $\omega$
  - $A$
  - $0$
- Which of the following relations represents simple harmonic motion?
  - $a = -10x$
  - $a = 10x$
  - $a = 10x^2$
  - $a = \text{constant}$

#### 1 Mark Questions

- Define simple harmonic motion.
- What is a restoring force?
- Define the phase of SHM.
- Write the expression for the displacement of a particle in SHM.

#### 2 Mark Questions

- A particle executes SHM with  $x = 0.05 \sin(4\pi t)$  m. Find its amplitude and time period. (Ans:  $A = 0.05 \text{ m}$ ,  $T = 0.5 \text{ s}$ )
- At a displacement  $x$  the velocity of a SHM particle is half its maximum value. Find  $x$  in terms of the amplitude  $A$ . (Ans:  $x = (\sqrt{3}/2)A$ )

#### 3 Mark Questions

- Show that the motion of a mass attached to a spring is simple harmonic and derive the expression for its time period. (Ans:  $T = 2\pi\sqrt{m/k}$ )

2. Starting from the restoring force, derive the differential equation  $x'' + \omega^2 x = 0$  and write down its solution representing SHM.

## Spring-Mass System and Simple Pendulum

### MCQ Questions (choose the correct option)

- The time period of a mass  $m$  attached to a spring of force constant  $k$  is
  - $2\pi\sqrt{m/k}$
  - $2\pi\sqrt{k/m}$
  - $2\pi\sqrt{m k}$
  - $\sqrt{m/k}$
- The time period of a simple pendulum of length  $l$  is
  - $2\pi\sqrt{l/g}$
  - $2\pi\sqrt{g/l}$
  - $2\pi\sqrt{l g}$
  - $\sqrt{l/g}$
- The time period of a simple pendulum depends on
  - its length and the value of  $g$
  - its mass
  - its amplitude for large swings
  - the material of the bob
- The frequency of a spring-mass system is
  - $(1/2\pi)\sqrt{k/m}$
  - $(1/2\pi)\sqrt{m/k}$
  - $2\pi\sqrt{k/m}$
  - $2\pi\sqrt{m/k}$

### 1 Mark Questions

- Write the time period of a mass-spring system.
- On what factors does the time period of a simple pendulum depend?
- What is the relation between frequency and time period?

### 2 Mark Questions

- A mass of 0.5 kg is attached to a spring of spring constant 200 N/m. Find its period of oscillation. (Ans:  $T = 2\pi\sqrt{m/k} \approx 0.31$  s)
- The period of a simple pendulum is 2 s on the Earth. Find its period on the Moon, where  $g$  is one-sixth of its value on Earth. (Ans:  $\sqrt{6} \times 2 \approx 4.9$  s)

### 3 Mark Questions

- Explain what is meant by the time period of a simple pendulum and derive its expression for small oscillations. (Ans:  $T = 2\pi\sqrt{l/g}$ )
- A mass hangs from springs of force constant  $k$  each. Derive its time period when supported by (i) a single spring and (ii) two springs in parallel. (Ans:  $T_1 = 2\pi\sqrt{m/k}$ ,  $T_2 = 2\pi\sqrt{m/2k}$ )

## Energy in SHM

**MCQ Questions (choose the correct option)**

1. The total energy of a particle executing SHM of amplitude  $A$  with force constant  $k$  is
  - (A)  $\frac{1}{2}kA^2$
  - (B)  $kA^2$
  - (C)  $\frac{1}{4}kA^2$
  - (D)  $2kA^2$
2. At the mean position the energy of a SHM particle is
  - (A) entirely kinetic
  - (B) entirely potential
  - (C) half kinetic and half potential
  - (D) zero
3. At the extreme position the energy of a SHM particle is
  - (A) entirely potential
  - (B) entirely kinetic
  - (C) half kinetic and half potential
  - (D) zero
4. The total energy of a particle executing SHM is
  - (A) constant at all positions
  - (B) maximum at the mean position
  - (C) maximum at the extremes
  - (D) zero at the mean position

**1 Mark Questions**

1. Write the expression for the total energy of a particle in SHM.
2. What form of energy does a SHM particle have at the mean position?
3. What form of energy does it have at the extreme position?

**2 Mark Questions**

1. A particle of mass  $m$  executes SHM of amplitude  $A$  and angular frequency  $\omega$ . Write its kinetic and potential energies as functions of displacement, and show that the total energy is constant.
2. At what displacement is the kinetic energy of a SHM particle equal to its potential energy? (Ans:  $x = A/\sqrt{2}$ )

**3 Mark Questions**

1. Derive the expressions for the kinetic and potential energies of a particle executing SHM and show that the total energy is conserved.
2. The kinetic energy of a SHM particle is maximum at the mean position and zero at the extremes. Explain this graphically and derive  $E = \frac{1}{2}m\omega^2A^2$ .

**Damped and Forced Oscillations****MCQ Questions (choose the correct option)**

1. Damped oscillations are characterised by
  - (A) a steadily decreasing amplitude
  - (B) a constant amplitude
  - (C) an increasing amplitude

- (D) a constant frequency only
2. The amplitude of a damped oscillator decreases
- (A) exponentially with time
  - (B) linearly with time
  - (C) as the square of time
  - (D) it does not change
3. Resonance occurs when the driving frequency
- (A) equals the natural frequency
  - (B) is zero
  - (C) is twice the natural frequency
  - (D) is very much greater than the natural frequency
4. A pendulum swinging in air eventually comes to rest. This is because of
- (A) damping
  - (B) resonance
  - (C) forced oscillation
  - (D) a change in  $g$

### 1 Mark Questions

1. Define damped oscillations.
2. What is meant by resonance?
3. Give one practical example of resonance.

### 2 Mark Questions

1. Distinguish between free, damped and forced oscillations, giving one example of each.
2. What is resonance? Give one example and explain why it can be both useful and hazardous.

### 3 Mark Questions

1. Define damped oscillations and resonance. Discuss the energy of SHM graphically and explain the difference between free, damped and forced oscillations, with an example of resonance.
2. Describe how the amplitude of a forced oscillator varies with the driving frequency, and explain the phenomenon of resonance from this graph.