Chapter: 10

Simple Harmonic Motion and Waves

Exercise MCQs

1. Which of the following is an example of simple harmonic motion?

(A) The motion of simple pendulum
(B) The spinning of the earth on its axis
(C) The motion of ceiling fan
(D) A bouncing ball on a floor

2. If the mass of the bob of a pendulum is increased by a factor of 3, the period of the pendulum's motion will:

(A) Be increased by a factor of 2
(B) Be increased by a factor of 2
(C) Remain the same
(D) Be decreased by a factor of 4

3. Which of the following devices can be used to produce both transverse and longitudinal waves?

(A) A string (B) A helical spring (C) A ripple tank (D) a tuning fork

4. Waves transfer:

(A) Energy (B) Frequency (C) Amplitude (D) Wavelength

5. Which of the following is a method of energy transfer?

(A) Conduction (B) Radiation (C) Wave motion (D) All of these

6. In a vacuum, all electromagnetic waves have the same:

(A) Speed (B) Frequency (C) Amplitude (D) Wavelength

7. A large ripple tank with a vibrator working at a frequency of 30 Hz produces 25 complete waves at a distance of 50 cm. The velocity of the wave is:

(A) $53\ cms^{-1}$ (B) $750\ cms^{-1}$ (C) $60\ cms^{-1}$ (D) $1500\ cms^{-1}$

8. Which of the following characteristics of a wave is independent of the others?

(A) Speed (B) Frequency (C) Amplitude (D) Wavelength

9. The relation between vf and λ of a wave is:

(A) $Vf = \lambda$ (B) $V\lambda = f$ (C) $f\lambda = v$ (D) $v = \lambda / f$

Answer Key:

1	A	6	A
2	C	7	C
3	B	8	C
4	A	9	C
5	D		

Short Questions

1. What is Simple Harmonic Motion? What are the necessary conditions for a body to execute simple harmonic motion?

Ans: Simple Harmonic Motion:

Type of vibratory motion in which acceleration of a body is directly proportional to its displacement and the acceleration is always directed towards the equilibrium (mean) position is called simple harmonic motion.

$$\text{Acceleration} \propto -\text{displacement}$$

$$a \propto -x$$

Basics conditions to execute SHM:

- There must be elastic restoring force acting on the system.
- The system must have inertia.

2. Think of several examples of motion in everyday life that are simple harmonic?

Ans: Examples of SHM:

- Motion of a body attached to the end of an elastic spring
- Motion of the bob of a simple pendulum
- Motion of the wire of a guitar

3. What are damped oscillations? How damping progressively reduces the amplitude of oscillation?

Ans: Any oscillation in which the amplitude of the oscillating quantity decreases with time is called damped oscillation.

In practice, the amplitude of vibrations becomes progressively smaller as energy is lost due to friction between the oscillating body and the particles in the air.

4. How can you define the term wave? Elaborate the difference between mechanical and electromagnetic waves? Give examples of each.

Ans: "Wave is a disturbance or variation which travels through a medium".

Mechanical Waves	Electromagnetic Waves
Mechanical waves need a material medium for their propagation. **Example:** Sound and Water Waves.	Electromagnetic waves do not need any material medium for their propagation. **Example:** Radio and Light Waves.

5. Distinguish between longitudinal and transverse waves with suitable examples.

Ans: Difference between longitudinal and transverse waves is:

Longitudinal Waves	Transverse Waves
➢ Movement of a medium in the same direction as the wave. ➢ Waves act as One Dimension. ➢ It can be produced in a solid, liquid and gas. ➢ It is made up of compressions and rare fractions. **Example:** Sound Waves and Vibrations in gas.	➢ Movement of medium is at right angle to the direction. ➢ Waves act as Two Dimension. ➢ It can only produce in solid and surface of liquid. ➢ It is made up of crests and troughs. **Example:** Light and electromagnetic waves.

6. Derive a relationship between the velocity, frequency and wavelength of a wavelength of a wave.

Ans: **Relation of velocity, frequency and wavelength:**

We know that:

$$\text{Velocity} = \frac{\text{distance}}{\text{time}}$$

$$v = \frac{d}{t}$$

$$d = vt \qquad \therefore d = \lambda$$

$$\lambda = vt$$

$$\frac{\lambda}{t} = v \qquad \therefore f = \frac{1}{t}$$

$$v = f\lambda$$

7. Define Spring Constant. Write its formula also?

Ans: K is a constant called the spring constant. The value of K is a measure of the stiffness of the spring.

Formula:

$$K = -\frac{F}{x}$$

8. Explain the following properties of waves with reference to the ripple tank experiment.

(a) Reflection (b) Refraction (c) Diffraction

Ans: **Reflection:**

When waves moving in one medium fail on the surface of another medium they bounce back into the first medium such that the angle of incidence is equal to the angle of reflection.

Refraction:

When a wave from one medium enters in the second medium at some angle, its direction of travel changes is called Refraction.

Diffraction:

The bending or spreading of waves around the sharp edges or corners of obstacles or slits is called Diffraction.

9. Do mechanical waves pass through a vacuum that is empty space?

Ans: **No,** mechanical waves cannot pass through a vacuum because mechanical waves are material waves and always require some medium for their propagation.

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Conceptual Questions

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10. If the length of a simple pendulum is doubled, what will be the change in its period?

Ans: The time period increases by a factor $\sqrt{2}$

$$T = \sqrt{2}T$$

11. A ball is dropped from a certain height onto the floor and keeps bouncing. Is the motion of the ball simple harmonic? Explain.

Ans: The bouncing ball is not in simple harmonic motion. The ball experiences only the gravitational force, except for the brief time that it's in contact with the ground.

12. Define the Time Period. Write down a formula for the time period of pendulum.

Ans: The time required to complete one vibration is called the time period.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

13. What types of waves do not require any material medium for their propagation?

Ans: Electromagnetic waves do not require any material medium for their propagation.

14. If the time period of a simple pendulum is 1.99 second. Find its frequency.

Ans: As we know that:

$$f = \frac{1}{r}$$

$$f = \frac{1}{1.99}$$

$$f = 0.5025\ \text{Hz}$$

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Additional Short Questions

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1. Define Vibratory Motion.

Ans: To and fro motion of a body about its mean position is known as vibratory motion.

2. Define Restoring Force.

Ans: A restoring force always pushes or pulls the object performing oscillatory motion towards the mean position.

3. State Hooke's law and write its equation.

Ans: "The stress applied to a material is directly proportional to the strain on that material within the elastic limit is called Hooke's Law".

$$F = -kx$$

4. What is Ripple Tank?

Ans: It is a device to produce water waves and to study their characteristics.

5. Write Characteristics of Simple Harmonic Motion.

Ans: It is a device to produce water waves and to study their characteristics.

- A body executing SHM always vibrates about fixed position.
- Its acceleration is always directed towards the mean position.
- Its velocity is maximum at the mean position and zero at the extreme position.

6. Define Vibration.

Ans: One complete round tip of a vibrating body about its mean position.

7. Difference between Time period and Frequency.

Ans: Difference between Time period and Frequency:

Time Period	Frequency
➢ The time required to complete one vibration is called the time period. ➢ Its unit is Second.	➢ The number of vibrations which a body covers in one second is called frequency. ➢ Its unit is Hertz.

8. Define Amplitude.

Ans: The maximum displacement of a vibrating body on either side from its mean

position is called its amplitude.

9. Define Crest and Trough.

Ans: Such waves which are highest point from the mean position are called **Crest**.
Such waves which are lowest point from the mean position are called **Trough**.

10. How does a spider detect its prey?

Ans: A spider detects its prey due to vibration produced in the web.

11. Define Wave Motion.

Ans: A wave motion is a disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time.

12. On what does the frequency of tunning forks depends?

Ans: The frequency of tunning forks depends upon the mass of forks of tunning forks. If mass is more, then frequency is low. That means the pitch is low.

13. What is meant by compressions and Rarefactions?

Ans: Such a wave which is close together is called **Compressions.**
Such a wave which is far together is called **Rarefactions.**

14. Define a Simple Pendulum.

Ans: It consists of a small bob of mass (m) suspended from a light string of length (l) fixed at its upper end.

15. Who and when invented the pendulum clock?

Ans: Christian Huygens invented the pendulum clock in 1656.

16. What do the dark and bright fringes on the screen of ripple tank represent?

Ans: The dark and bright fringes on the screen of the ripple tank represent the crests and troughs of transverse waves. The crest appears as bright fringes and the trough appears as dark fringes on the screen.