

Waves — 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.

Wave Motion and Its Types

MCQ Questions (choose the correct option)

1. In a transverse wave, the particles of the medium vibrate —
 - (A) perpendicular to the direction of propagation
 - (B) parallel to the direction of propagation
 - (C) in circles about the direction of propagation
 - (D) randomly
2. Sound waves are —
 - (A) longitudinal mechanical waves
 - (B) transverse mechanical waves
 - (C) longitudinal electromagnetic waves
 - (D) transverse electromagnetic waves
3. A wave transfers —
 - (A) energy and momentum without transporting matter
 - (B) matter without energy
 - (C) only momentum, not energy
 - (D) neither energy nor momentum
4. Which of the following requires a material medium to travel? —
 - (A) Sound
 - (B) Light
 - (C) Radio waves
 - (D) X-rays

1 Mark Questions

1. Define a wave. Distinguish between mechanical and electromagnetic waves.
2. Give one example each of a transverse and a longitudinal wave.
3. In what direction do particles vibrate in a longitudinal wave?

2 Mark Questions

1. Distinguish between transverse and longitudinal waves with respect to particle displacement.
2. Explain why sound cannot travel in vacuum but light can.
3. Why can transverse waves travel in solids but generally not in gases?

3 Mark Questions

1. A wave travels the length of a 20 m string in 5 s. If consecutive crests are 0.4 m apart, find the frequency and period of the wave.

2. Describe how a particle at the surface of water vibrates as a ripple passes, and how that differs from the motion of the ripple itself.

Characteristics of a Wave

MCQ Questions (choose the correct option)

1. The distance between two successive crests of a wave is called the —
(A) wavelength
(B) amplitude
(C) frequency
(D) period
2. If the frequency of a wave is doubled while its speed stays constant, the wavelength —
(A) becomes half
(B) becomes double
(C) becomes four times
(D) remains unchanged
3. A sound wave of frequency 340 Hz travels with a speed of 680 m/s. Its wavelength is —
(A) 2 m
(B) 0.5 m
(C) 1 m
(D) 4 m
4. The frequency of a mechanical wave is determined by the —
(A) source that generates it
(B) medium in which it travels
(C) amplitude of the wave
(D) temperature of the medium

1 Mark Questions

1. Define wavelength and frequency of a wave.
2. Write the relation connecting wave speed, frequency and wavelength.
3. Define the hertz.

2 Mark Questions

1. Derive the relation $v = f\lambda$ starting from the definition of wave speed.
2. A tuning fork of frequency 512 Hz produces a wave in air with speed 345 m/s. Find the wavelength.
3. Why is the frequency of a wave fixed by its source and not by the medium?

3 Mark Questions

1. A source emits a wave of frequency 500 Hz. If the wave speed in the medium is 1500 m/s, find the wavelength and the time period, and state how far the wavefront travels in 2 s.
2. Explain the meaning of amplitude, frequency, wavelength and speed of a wave, and give their SI units.

The Speed of Sound

MCQ Questions (choose the correct option)

1. Sound travels fastest in —
(A) solids
(B) liquids
(C) gases
(D) vacuum
2. Newton's formula for the speed of sound in air gave a value that was —
(A) too low compared to the experimental value
(B) too high compared to the experimental value
(C) exactly equal to the experimental value
(D) higher at lower temperatures
3. The Laplace correction factor γ for air is approximately —
(A) 1.4
(B) 1.0
(C) 1.67
(D) 0.4
4. At a fixed temperature, the speed of sound in a gas is —
(A) independent of the pressure of the gas
(B) directly proportional to the pressure
(C) inversely proportional to the pressure
(D) directly proportional to the square of the pressure

1 Mark Questions

1. State Newton's formula for the speed of sound in a gas.
2. What correction did Laplace make and why?
3. In which medium is the speed of sound maximum — solid, liquid or gas?

2 Mark Questions

1. Explain the Laplace correction and derive $v = \sqrt{(\gamma P/\rho)}$.
2. The speed of sound in air at 0 °C is 331 m/s. Estimate its speed at 20 °C.
3. Why does the speed of sound increase with humidity?

3 Mark Questions

1. Derive an expression for the speed of sound in a gas using Newton's formula and apply the Laplace correction to obtain the standard result.
2. Compare the speed of sound in solids, liquids and gases, explaining the physical reasons for the order.
3. Show that the speed of sound in a gas is proportional to the square root of its absolute temperature.

Progressive Waves and Superposition

MCQ Questions (choose the correct option)

1. In the wave equation $y = A \sin(kx - \omega t)$, the quantity k is the —
(A) wave number equal to $2\pi/\lambda$
(B) angular frequency equal to $2\pi f$
(C) wavelength
(D) amplitude

2. The equation $y = A \sin(kx + \omega t)$ represents a wave travelling —
- (A) in the negative x direction
 - (B) in the positive x direction
 - (C) in the positive y direction
 - (D) in the negative y direction
3. A phase difference of 2π rad corresponds to a path difference of —
- (A) one wavelength
 - (B) half a wavelength
 - (C) quarter of a wavelength
 - (D) two wavelengths
4. According to the superposition principle, the resultant displacement of two overlapping waves at a point is the —
- (A) algebraic sum of the individual displacements
 - (B) product of the individual displacements
 - (C) difference of their amplitudes always
 - (D) average of the individual displacements

1 Mark Questions

1. Define a progressive wave.
2. State the superposition principle for waves.
3. What is the wave number? Write its relation with wavelength.

2 Mark Questions

1. Write the general equation of a one-dimensional progressive wave and identify each symbol.
2. Show that the wave speed $v = \omega/k$ follows from the constancy of the phase.
3. Derive the relation between phase difference and path difference.

3 Mark Questions

1. A progressive wave is described by $y = 0.05 \sin \pi(200t - 2x)$ m. Find its (a) frequency, (b) wavelength and (c) speed of propagation.
2. State and explain the principle of superposition of waves, and give three phenomena that it explains.

Reflection and Standing Waves

MCQ Questions (choose the correct option)

1. A wave pulse reflected from a rigid, fixed boundary undergoes a phase change of —
 - (A) π
 - (B) zero
 - (C) $\pi/2$
 - (D) 2π
2. In a standing wave, the distance between two consecutive nodes is —
 - (A) $\lambda/2$
 - (B) λ
 - (C) $\lambda/4$
 - (D) 2λ
3. At an antinode of a stationary wave on a string, the amplitude of vibration is —

- (A) maximum
 - (B) zero
 - (C) equal to the amplitude of one wave
 - (D) half the maximum
4. A standing wave is formed by the superposition of two waves having —
- (A) the same frequency and amplitude, travelling in opposite directions
 - (B) different frequencies travelling in the same direction
 - (C) the same frequency travelling in the same direction
 - (D) different amplitudes in the same direction

1 Mark Questions

1. Define a stationary or standing wave.
2. What is a node? What is an antinode?
3. What phase change does a wave suffer on reflection at a fixed boundary?

2 Mark Questions

1. Show that consecutive nodes (or antinodes) of a stationary wave are $\lambda/2$ apart.
2. Obtain the equation of a standing wave from two progressive waves of equal amplitude and frequency travelling in opposite directions.
3. Explain why a stationary wave does not transport energy along the medium.

3 Mark Questions

1. Describe the reflection of a travelling wave at a rigid boundary and at a free boundary, stating the phase change in each case with the reasoning.
2. Two waves $y_1 = A \sin(kx - \omega t)$ and $y_2 = A \sin(kx + \omega t)$ superpose on a string. Obtain the resultant wave and identify the positions of nodes and antinodes.

Standing Waves in Strings and Organ Pipes

MCQ Questions (choose the correct option)

1. The fundamental frequency of a string fixed at both ends of length L is —
 - (A) $v/2L$
 - (B) $v/4L$
 - (C) $2v/L$
 - (D) v/L
2. A closed organ pipe produces —
 - (A) only odd harmonics
 - (B) only even harmonics
 - (C) all harmonics
 - (D) no harmonics
3. To double the fundamental frequency of a stretched string without changing the tension, the length must be —
 - (A) halved
 - (B) doubled
 - (C) quadrupled
 - (D) kept the same

4. A string of length L vibrates in its second harmonic. The number of nodes (excluding the fixed end points being nodes) visible is —

- (A) 1 internal node
- (B) 2 internal nodes
- (C) 3 internal nodes
- (D) none

5. The wave speed on a stretched string is proportional to —

- (A) $\sqrt{T/\mu}$, where T is tension and μ the mass per unit length
- (B) T/μ
- (C) $\sqrt{T\mu}$
- (D) μ/T

1 Mark Questions

1. Write the expression for the fundamental frequency of a stretched string.
2. State the frequency formula for an open organ pipe and a closed organ pipe.
3. Why does a closed organ pipe produce only odd harmonics?

2 Mark Questions

1. Derive the expression for the frequencies of the normal modes of a string fixed at both ends.
2. A string of length 1 m has a fundamental frequency of 110 Hz. Find its wavelength and the speed of waves on the string.
3. Show that the fundamental frequency of a closed pipe is $v/4L$ and that only odd harmonics are possible.

3 Mark Questions

1. Compare the harmonics produced by an open organ pipe and a closed organ pipe of the same length.
2. A stretched wire of length 0.90 m and mass 3.6×10^{-3} kg is under a tension of 90 N. Calculate its fundamental frequency and the frequencies of its first three harmonics.
3. A closed organ pipe and an open organ pipe of the same length produce their fundamentals. Find the ratio of their frequencies.

Beats

MCQ Questions (choose the correct option)

1. Two tuning forks of 256 Hz and 260 Hz are sounded together. The beat frequency is —
 - (A) 4 Hz
 - (B) 258 Hz
 - (C) 516 Hz
 - (D) 2 Hz
2. Beats are produced when two waves of —
 - (A) slightly different frequencies superpose
 - (B) equal frequencies superpose
 - (C) different amplitudes superpose
 - (D) greatly different frequencies superpose
3. For beats to be distinctly heard, the frequency difference between the two sources should be —
 - (A) small (about 1–10 Hz)
 - (B) large (about 100 Hz)

- (C) exactly equal
 - (D) several thousand hertz
4. When a musician tunes a string by listening to beats against a tuning fork, she adjusts the tension until —
- (A) the beats disappear
 - (B) the beats are fastest
 - (C) the beats are slowest but finite
 - (D) the string vibrates twice as fast

1 Mark Questions

1. Define beats.
2. Write the formula for the beat frequency when two waves of frequencies f_1 and f_2 superpose.
3. Why are beats heard only when the two frequencies are close together?

2 Mark Questions

1. Explain how beats arise from the principle of superposition.
2. Two tuning forks A (300 Hz) and B produce 4 beats per second. What are the possible frequencies of B?
3. How are beats used to tune musical instruments?

3 Mark Questions

1. Derive an expression for the resultant intensity of two waves of slightly different frequencies and show that the intensity oscillates at the beat frequency.
2. A fork of unknown frequency produces 5 beats/s with a 256 Hz fork. When the unknown fork is slightly loaded with wax, the beats drop to 3 beats/s. Find the unknown frequency and justify your answer.

The Doppler Effect

MCQ Questions (choose the correct option)

1. When a sound source moves towards a stationary observer, the apparent frequency is —
 - (A) higher than the actual frequency
 - (B) lower than the actual frequency
 - (C) equal to the actual frequency
 - (D) zero
2. The Doppler effect in sound is observed when —
 - (A) source or observer moves relative to the medium
 - (B) only the medium moves with the source
 - (C) the source is at rest and the observer is also at rest
 - (D) the intensity of sound changes
3. A stationary source of frequency f is heard by an observer moving towards it with speed v_0 . If v is the speed of sound, the apparent frequency observed is —
 - (A) $f(v + v_0)/v$
 - (B) $f(v - v_0)/v$
 - (C) $fv/(v + v_0)$
 - (D) $fv/(v - v_0)$
4. The apparent frequency of a whistle of a train approaching a stationary observer —
 - (A) increases

- (B) decreases
- (C) stays the same
- (D) becomes zero

1 Mark Questions

1. State the Doppler effect for sound.
2. Write the expression for apparent frequency when the observer moves towards a stationary source.
3. What happens to the apparent frequency as a source recedes from a stationary observer?

2 Mark Questions

1. Derive the expression $f' = fv/(v - v_s)$ for a source moving towards a stationary observer.
2. A whistle of frequency 400 Hz is sounded by a train moving at 30 m/s. For a stationary observer towards whom the train moves, find the apparent frequency. (Speed of sound = 330 m/s.)
3. Give two applications of the Doppler effect in technology.

3 Mark Questions

1. Derive a general expression for the apparent frequency of sound when both the source and the observer are moving, and discuss the sign conventions.
2. A source of sound of frequency 500 Hz moves towards a stationary observer at 20 m/s while the observer walks towards the source at 5 m/s. Find the apparent frequency heard. (Speed of sound = 340 m/s.)