TOPIC 12 General Wave Properties

Objectives

Candidates should be able to:

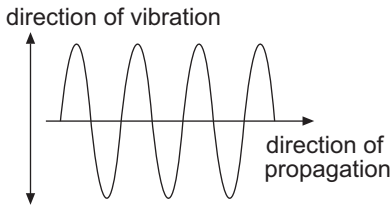
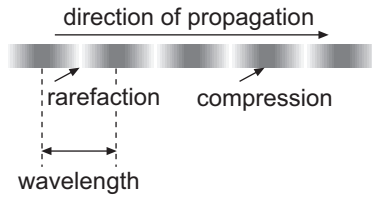
(a) describe what is meant by wave motion as illustrated by vibrations in ropes and springs and by waves in a ripple tank
(b) show understanding that waves transfer energy without transferring matter
(c) define speed, frequency, wavelength, period and amplitude
(d) state what is meant by the term wavefront
(e) recall and apply the relationship *velocity* = *frequency* × *wavelength* to new situations or to solve related problems
(f) compare transverse and longitudinal waves and give suitable examples of each

NOTES

12.1 Introduction

1. Wave motion is the propagation of oscillatory movement or disturbance from one region to another.
2. A wave transfers energy from one place to another without transferring matter.
3. All waves follow the laws of reflection and refraction.
4. Mechanical waves require a medium (i.e. water or air molecules) for propagation.
5. Electromagnetic waves (See Topic 14) are propagations of oscillations in electromagnetic fields. The propagation does not require a medium, thus electromagnetic waves can travel in vacuum.

6. We classify waves in this topic into two types based on their propagation method:
   (a) Transverse
   (b) Longitudinal

Transverse waves	Longitudinal waves
	
Movement of particles in the medium: Perpendicular to the direction of propagation (movement) of wave	**Movement of particles in the medium:** Parallel to the direction of propagation (movement) of wave
Examples Water waves, electromagnetic waves **Characteristics** 1. The particles oscillate perpendicularly (up and down) to the direction of travel. 2. Peak: Highest point reached by the particle from its neutral position 3. Trough: Lowest point reached by the particle from its neutral position 4. The distance between adjacent particles remains constant, in the direction of the propagation of the wave.	**Examples** Sound wave **Characteristics** 1. The particles oscillate along (to-and-fro) the direction of travel. 2. Compression: Section in which the particles are closest together 3. Rarefaction: Section in which the particles are furthest apart. 4. The distance between adjacent particles varies from a maximum value (furthest apart) to a minimum value (closest together), in the direction of the propagation of the wave.

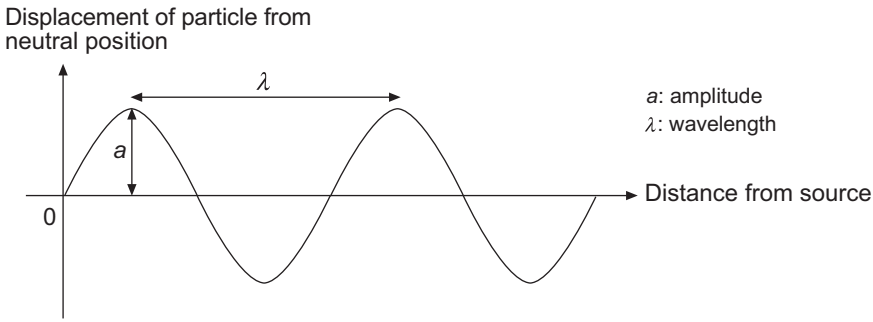
12.2 Terms used to describe a wave

1. For both transverse and longitudinal waves, the particles oscillate about their undisturbed positions (neutral positions). The neutral positions lie along an axis in the direction of wave propagation.

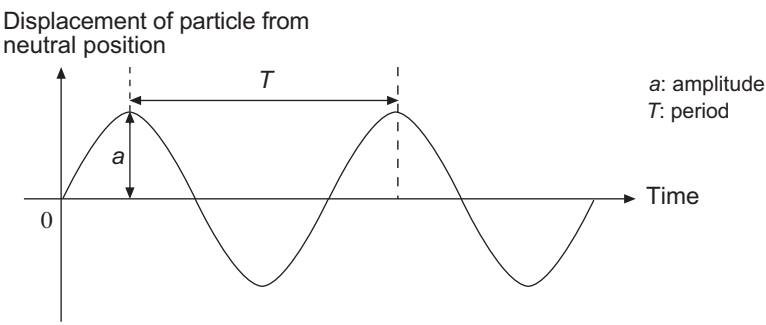
2. The following graphs show sine-curves used to describe the wave terms used for both types of waves.

Note: These are graphs and not transverse waves!

Displacement-distance Graph



Displacement-time Graph



3. Common wave terms:

Term	Transverse waves	Longitudinal waves
Amplitude, a (m)	The maximum displacement of the particle from its neutral position **perpendicular** to the direction of propagation. (i.e. height of crest from neutral position.)	The maximum displacement of the particle from its neutral position **along** the direction of propagation.
Wavelength, λ (m)	The distance between two successive crests or two successive troughs.	The distance between two successive compressions or two successive rarefractions.
Frequency, f (Hz)	The number of complete waves produced in one second.	
Period, T (s)	The time taken to produce one complete wave. **Formula:** $T = \frac{1}{f}$	
Speed, v (m)	The distance moved by any part of the wave in one second. **Formula:** $v = f\lambda$	

12.3 Wavefront

1. A wavefront is a line or surface, in the path of a wave motion, on which all particles are oscillating in phase.
2. There are two types of wavefronts:
   (a) Circular wavefront (close to point source of disturbance)
   (b) Plane wavefront (straight wavefronts far from point source of disturbance)
3. The amplitude of particles along the same wavefront is the same.