Waves – GCSE Physics

CONTENTS:

1. Introduction

- Waves are fundamental to our understanding of Energy Transfer.
- Waves are nature's way of moving energy without moving matter.

Real life Example:

Sound Waves

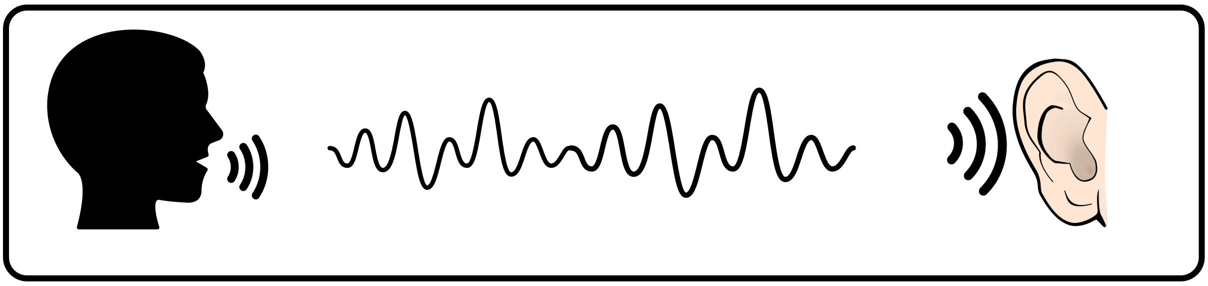
Light Waves

Ultrasound Waves

Microwaves

2. What are Waves?

- Waves are a means of transferring energy from one place to another without the actual transfer of matter.
- It is a fundamental concept in physics that applies to various types of waves, such as light waves and sound waves.
- There is a transfer of energy from a source to your senses.



Types of Waves:

There are mainly two big categories of waves:

Waves

Mechanical Waves

(Required Medium like air, water etc.)

- Transverse Waves
- Longitudinal Waves

Electromagnetic Waves

(Do not Required Medium)

- Radio Waves
- Microwaves
- Infrared Waves
- Ultraviolet (UV) Rays
- X-Rays

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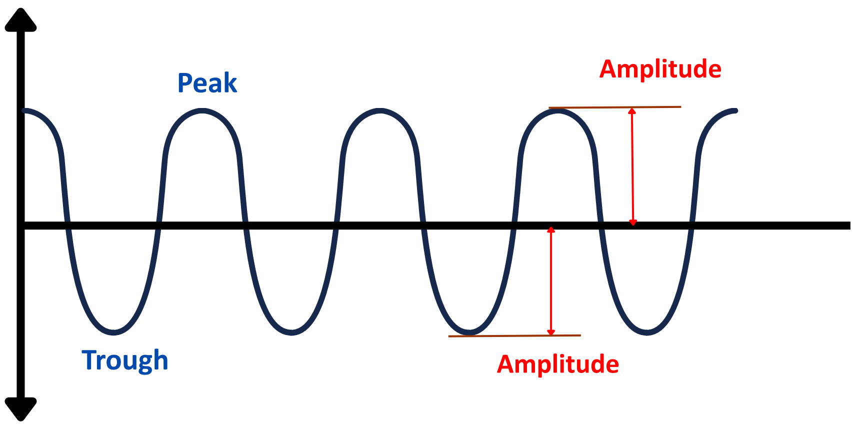
3. What are the components and properties of waves?

- To understand waves better, it's essential to know their key components and properties.

Amplitude:

- The amplitude of a wave is the maximum displacement from the equilibrium position.
- It's the height of a wave from its resting point.



Frequency:

- Frequency is the number of complete oscillations or cycles a wave completes per unit of time, typically measured in Hertz (Hz), which represents cycles per second.
- A higher frequency means more oscillations in a given time period.
- The frequency of a wave can be calculated using the equation:

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

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Wave Speed:

- Wave speed is a fundamental property that indicates how fast a wave travels.
- It's calculated by multiplying the wavelength by the frequency:

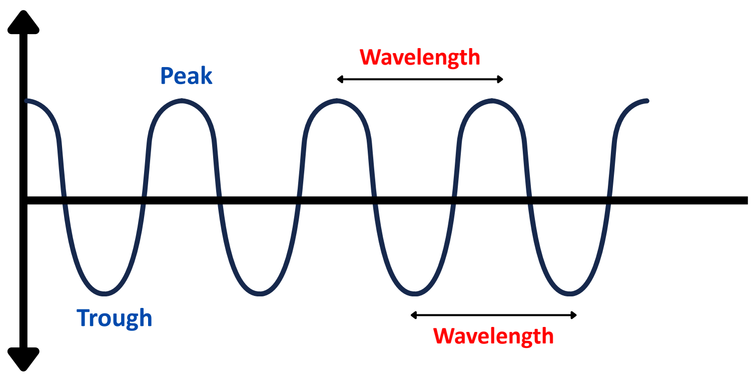
$$v = \lambda \times f$$

Where,

- **v =** It is the wave speed in meters per second (m/s).
- **λ =** It is the wavelength in meters (m).
- **f =** It is the frequency in Hertz.

Wavelength:

- Wavelength is the distance between two successive points in a wave that are in phase, typically measured from crest to crest or trough to trough.
- It represents the length of one complete oscillation in the wave.



Time Period:

- The Time Period of a wave is the time it takes to complete one full oscillation or one wavelength, measured in seconds.
- It can be Calculated as,

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

4. Distinguishing Between Transverse and Longitudinal Waves

- Waves are classified into two main types:

Transverse waves:

- In Transverse waves, the oscillations occur perpendicular (at right angles) to the direction of energy transfer.
- Picture a wave travelling horizontally from left to right.
- The particles involved in the wave move vertically, oscillating up and down.
- One common example of a transverse wave is a light wave.

Real life Example:

Ripples on Water

Guitar/String Instruments

Light Waves

Vibrations in a Rope

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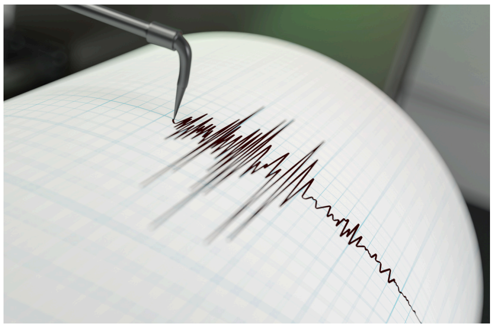
Longitudinal Waves:

- Longitudinal waves have oscillations parallel to the direction of energy transfer.
- Imagine a slinky toy being stretched and compressed horizontally.
- As the wave moves, the coils of the slinky move back and forth in the same direction as the wave itself.
- A classic example of a longitudinal wave is a sound wave.
- When you hear a sound, it's the result of air particles compressing and expanding as the wave of energy passes through.

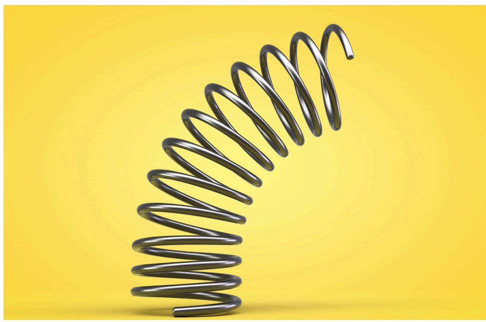
Real life Example:

Sound Waves



Seismic P Waves

Ultrasound Waves



Vibration in Spring

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5. How to Calculate Wave Speed?

- Calculating **Wave Speed** is a fundamental concept in understanding how waves behave and interact with their surroundings.
- It can be Calculated as:

$$v = \lambda \times f$$

Where,

- **Wave Speed (v) =** This is what we want to find, measured in meters per second (m/s).
- **Wavelength (λ) =** Measure the length of one complete oscillation, typically in meters (m).
- **Frequency (f) =** Determine how many complete oscillations occur per second, measured in Hertz (Hz).

Example: A sound wave has a frequency of 500 Hz and a wavelength of 0.68 m. Calculate its speed.

Solution:

Given:

- **Frequency (f) =** 500 Hz
- **Wavelength (λ) =** 0.68 m

Applying the formula,

$$v = \lambda \times f$$

$$v = 500 \times 0.68 = 340 m/s$$

The wave speed is **340 m/s**

6. Solved Examples

Problem1: A sound wave in water has a wavelength of 2.5 meters and travels at 1500 m/s. What is its frequency?

Solution:

Given:

- **Wave Speed (V) =** 1500 m/s
- **Wavelength (λ) =** 2.5 m

Applying the formula,

$$v = \lambda \times f \quad \text{or} \quad f = \frac{v}{\lambda}$$

$$f = \frac{1500}{2.5} = 600\text{Hz}$$

The Frequency is **600 Hz.**

Problem2: A radio station transmits at 105.3 MHz. If the speed of radio waves (a type of EM wave) is 3×10^8 m/s^3, what is the wavelength?

Solution:

Given:

- **Frequency (f) =** 105.3MHz = 105.3×10^6Hz
- **Wave Speed (v) =** 3×10^8 m/s^3

Applying the formula,

$$v = \lambda \times f \quad \text{or} \quad \lambda = \frac{v}{f}$$

$$\lambda = \frac{3\times10^8 \text{ m/s}^3}{105.3\times10^6} \approx 2.85\text{m}$$

The wavelength is **2.85 meters.**