# Types of motion

- Translational Motion
- Periodic Motion
  - Wave Motion
  - Periodic Motion

## Wave Motion

Throwing a stone in a still water

Pushing a piece of domino

**Wave :**

It is the disturbance which propagate and carries energy in the direction of its propagation

## Types of waves

Some waves can be seen such as water waves , other waves cannot be seen but we detect them such as radio and TV waves.

- Waves
  - Mechanical waves
    - Transverse waves
      - Water waves
    - Longitudinal waves
      - Sound waves
  - Electromagnetic waves
    - Transverse waves
      - Radio waves

# Unit 1 Waves

## Chapter 1 Wave motion

### First : Mechanical waves

A disturbance that propagates in materialistic media.

**Examples:**

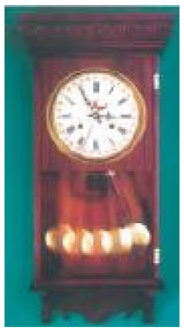
- Water waves
- Sound waves
- Waves that propagates in strings during its vibration.

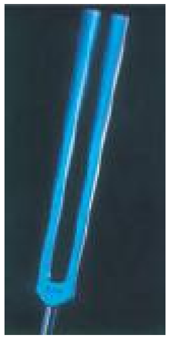
**Conditions of mechanical waves:**

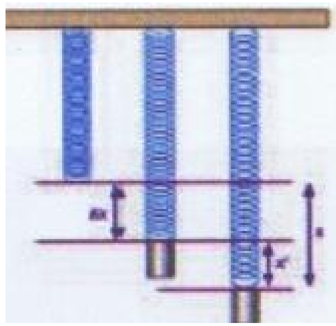
1) The presence of vibrating bodies / source (**vibrator**).
2) A kind of **disturbance** that can travel from vibrating source to the medium.
3) The presence of **medium** through which wave can propagate.

**(1 ) Source of vibration:**

Examples of vibrating bodies (sources ) that produce mechanical waves



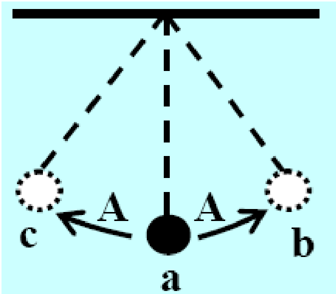


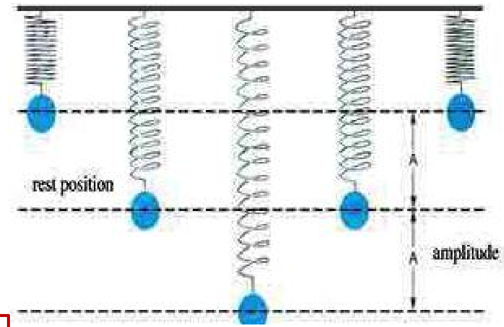


Simple pendulum, Prongs of tuning fork, Vibrating (string) ,a plumbheld in spiral spring *Yo-Yo*

## (2 ) Disturbance that transfers from the source to the medium

When the source vibrates , it produces disturbance




**Concepts related to oscillatory motion :**

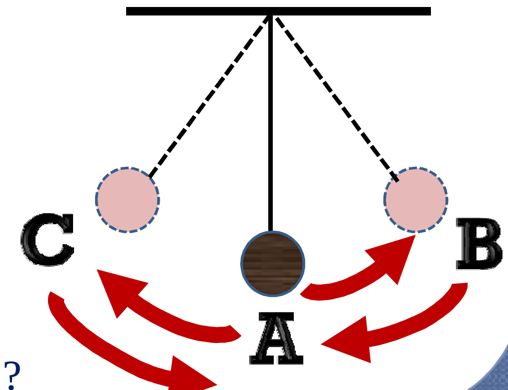
### 1 – Complete oscillation

It is the motion of vibrating body through the interval of time as it passes by a fixed point on its path two successive times in the same direction and same displacement.

When two points are said be in the same phase?

When the have the same direction and same displacement relative to the starting point

A → B → A → C → A



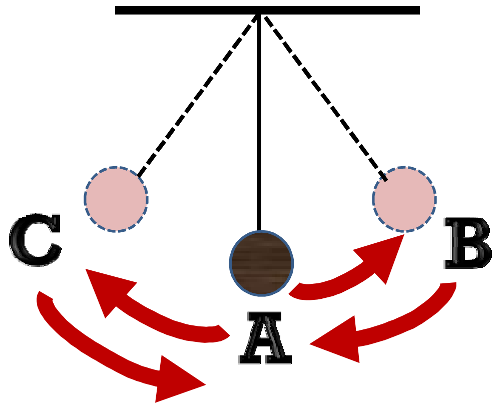

- Complete oscillation (vibration) = 4 amplitude
- What is the magnitude of displacement of complete oscillation?

## 2– Amplitude (A) :

It is : the maximum displacement(d) of the vibrating object.

**Or** : the distance between two points along the path of the object , where the velocity at one point is maximum and zero at the other

A → B A → C




The amplitude represents quarter of a complete oscillation.

What is the measuring unit of amplitude.

What is meant by :

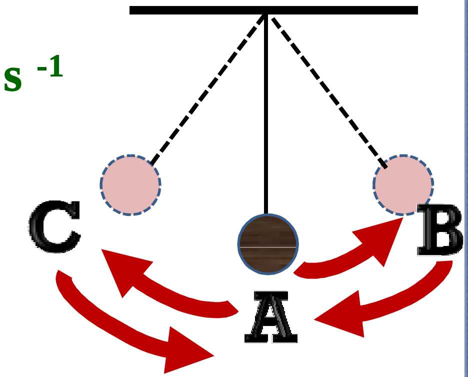
The amplitude of a vibrating body = 20 cm.

## 3– Frequency ($\nu$):

Its is the number of complete oscillations made by a vibrating body in one second.

**Measuring unit :**

**Vibrations / sec , cycles / sec , Hertz (Hz) , $s^{-1}$**




What is meant by :

The frequency of a tuning fork = 50 Hz.

If a vibrating body produces 360 vibrations in a minute. What is its frequency?

$$\nu = \frac{n}{t}$$

## 4– Periodic Time (T):

It is the time taken by vibrating body to complete one vibration.

**Or** : It is the time taken by a vibrating body to pass by a fixed point on its path two successive times in the same direction.

**Measuring unit :** **sec (s)**

What is meant by :

The periodic time of a tuning fork = 2 s

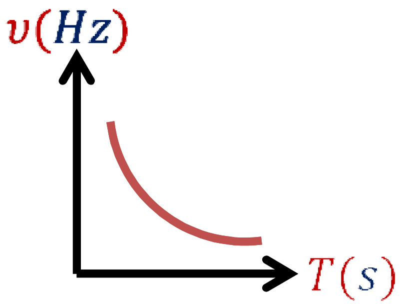
## The relation between the frequency and periodic Time:

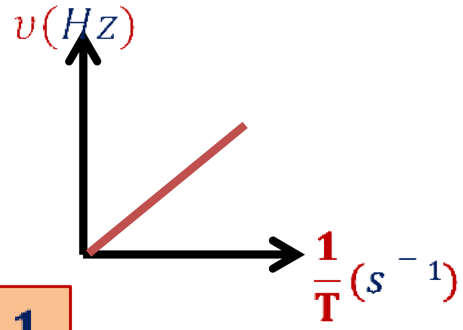
$$\upsilon = \frac{n}{t}$$

$$\therefore \upsilon = \frac{1}{T}$$

$$T = \frac{t}{n}$$

**Frequency = reciprocal of the periodic time.**
**Frequency is inversely proportional to the periodic time**

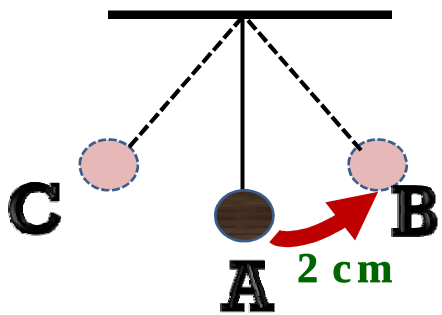



$$slope = \upsilon T = 1$$

In the opposite figure : If the time taken by the pendulum to move from A to B is 0.01 s , calculate :

1. The amplitude
2. The time of amplitude
3. The periodic time
4. The frequency




**1. A = 2 cm**

**2. t = 0.01 s**

**3. T = 4 × 0.01 = 0.04 s**

**4.** $\upsilon = \frac{1}{T} = \frac{1}{0.04} = 25\ Hz$

## (3) Medium transmits the disturbance through it:

Why does sound travels though solids faster than gases?

Mechanical waves need materialistic medium to travel through : because the medium particles vibrate to transfer the wave mechanical energy.

**So** : the particles that transfers the sound energy are closer to each other in case of solids.

We can't hear the voices of cosmic explosions that occur in the space. Give reason?

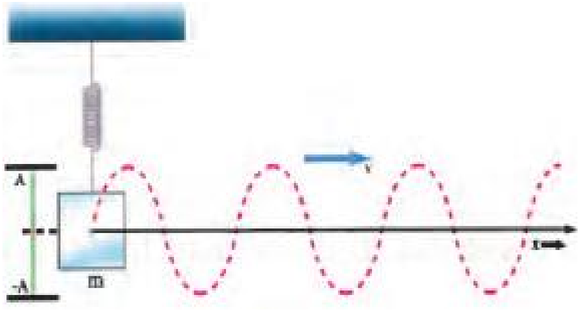
The astronauts use wireless devices to communicate with each other in space.Give reason?

Unit 1 **Waves**

**Chapter 1 Wave motion**

## Types of mechanical waves :

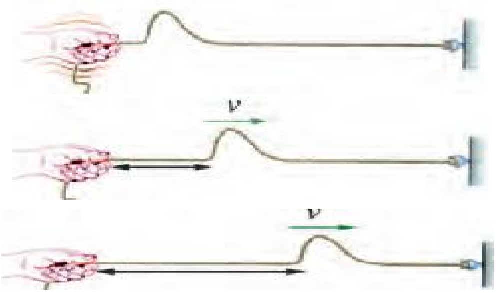
### First : Transverse Waves



- The load makes a simple harmonic motion upwards and downwards.
- The rope makes a similar motion.
- The motion transfers along the rope in the form of a moving horizontal (→) wave at a certain velocity while the parts of the rope move vertically (↕)

**Conclusion:**

- When the rope vibrates upwards and downwards , the wave transfers to the rope in the form of crests and troughs.
- The direction of vibration is perpendicular to the direction of wave propagation.
- The work done by the vibrating source is stored in the form of :
  1. Potential energy. ( in the pulling rope/string )
  2. Kinetic energy .( in the vibration of the rope /string)

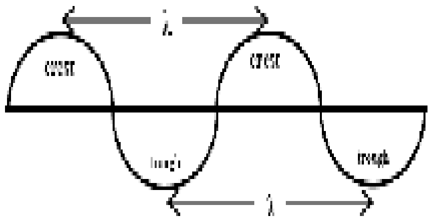


- Moving the hand up and down in the form of a pulse , the wave spreads in a pulse form along the rope.
- Which is known as **Traveling wave** :

**Traveling wave** : A continuous wave produced as a result of simple harmonic motion.

**Crest:**

The position of the maximum displacement of medium particles in the **positive** direction



**Trough :**

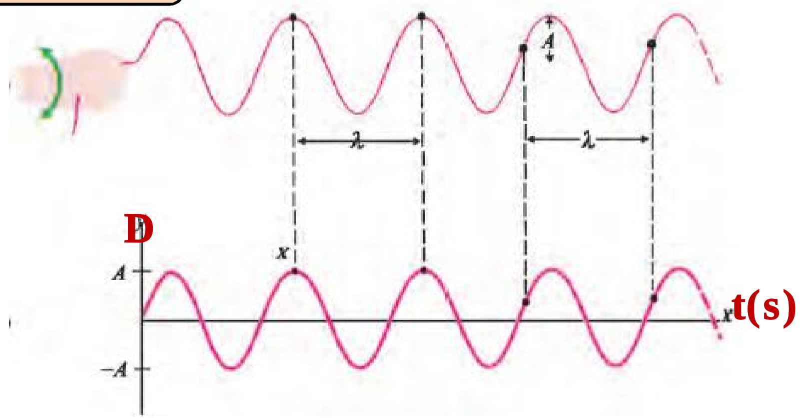
The position of the maximum displacement of medium particles in the **negative** direction

**Transverse wave :**

The wave in which the vibration of the medium particles is perpendicular to the direction of the wave propagation.

## Graphical representation of Transverse Waves

The relation : ( **displacement – distance** ) or ( **displacement – Time** ) can be represented in by a curve in the form of **sine** wave.




**Wave length :**

The distance between two successive crests or two successive troughs .
**Or** : The distance between any crest and the successive trough.
**Or** : The distance between any two points having the same phase.
**Or** : The distance covered by the wave during one periodic time.

**Frequency :**

The number of waves that passes a certain point along the wave motion in a time 1 s.
**Or**: The number of wavelengths covered by the propagated wave in a certain direction in 1 s

$$\text{wave length} : \lambda = \frac{\text{total distance}}{\text{number of waves}}$$

$$\text{Frequency} : \nu = \frac{\text{number of waves}}{\text{time}}$$

What is meant by : The wave length of a transverse wave = 20cm

If the distance between the first crest and fifth crest in a transverse wave = 20 cm , then the wave length = .................. cm

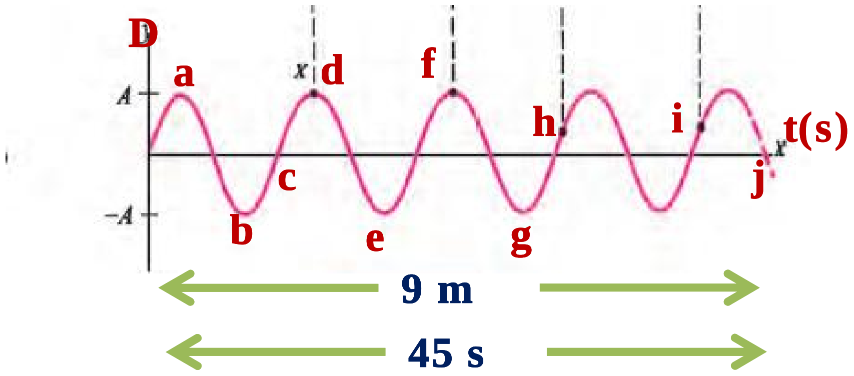
If the distance between the first trough and third crest in a transverse wave = 15cm , then the wave length = .................. cm

**From the opposite figure :**

1) What do these symbols refer to :

**D** **A** **t** **$\lambda$**

2) How can we describe points **h** and **i** ?

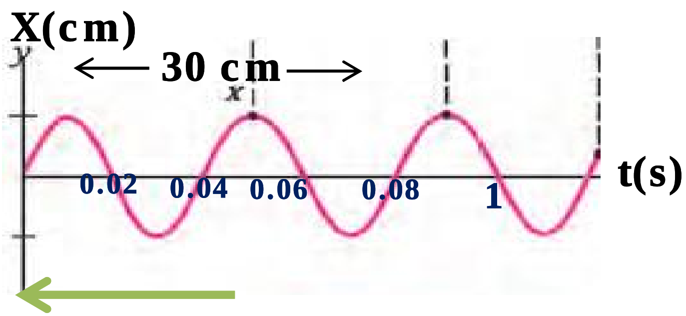



3) If the displacement of the medium particles at point **a** is 5 m , what is the displacement at point **b**?

4)The distance between points **h** and **i** = …… m

5)The frequency of the wave = …………. cycles/sec

6) The time covered at point **c** = …….. s



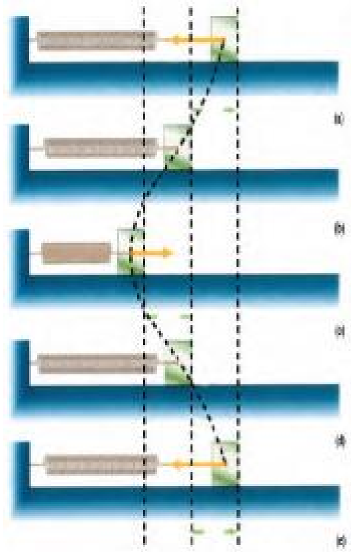

**From the opposite figure , calculate :**

1) Wave amplitude.
2 ) Frequency
3) The periodic Time
4 ) The wave length

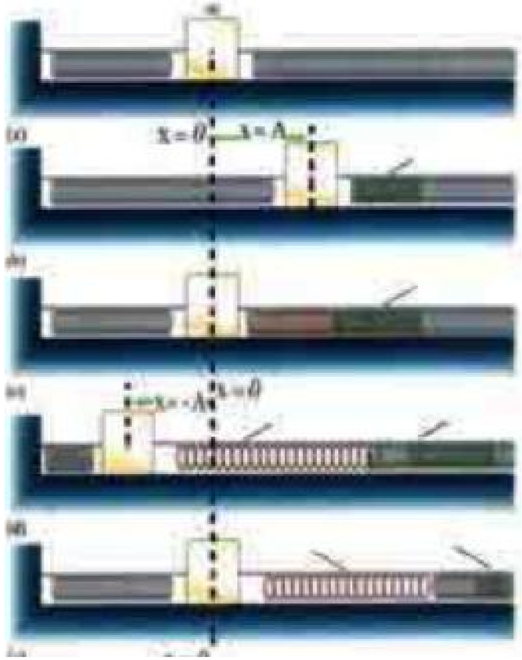
Unit 1 **Waves**

Chapter 1 **Wave motion**

## Second : Longitudinal; Waves



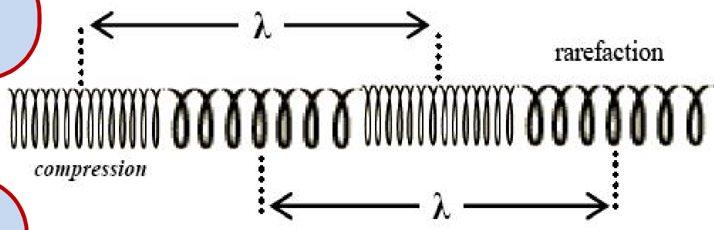
- The load makes a simple harmonic motion upwards and downwards.
- By drawing the curve what the center of gravity of the mass makes with respect to its rest position we will obtain a sine wave.



- The distance between the turns of the spring increases making **rarefaction** , which transfers successively through the spring.
- The distance between the turns of the spring decreases making **compression**, which transfers successively through the spring.
- During vibration, a group of compressions and refractions transfers along the spring.
- The group of compressions and refractions represents a wave propagates in the same direction of the vibration of the medium particles.

**Compression:**

The area in which the medium particles are close to each other.




**Rarefaction:**

The area in which the medium particles are far from each other.

**Longitudinal wave:**

The wave in which particles vibrate along the direction of the wave propagation around their equilibrium position.

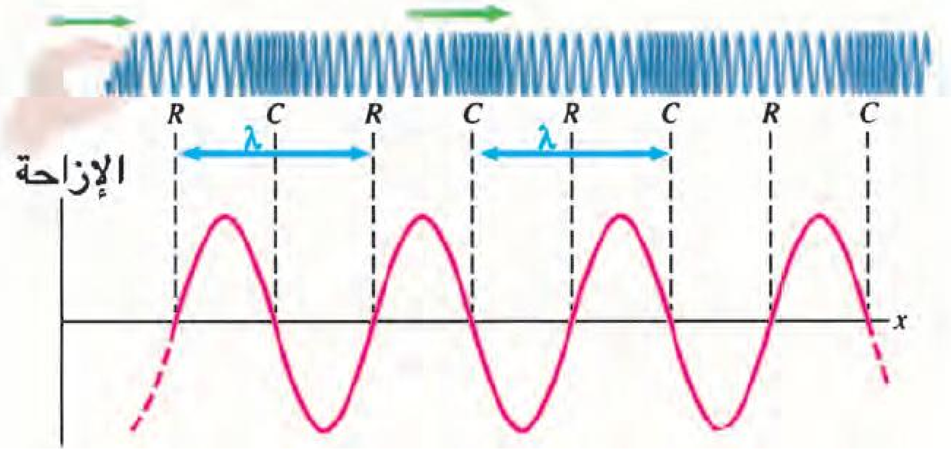
**Wave length :**

- The distance between the centers of two successive compressions or the centers of two successive rarefactions.
- The sum of successive compression and rarefaction

What is meant by : The wave length of a longitudinal wave = 20cm

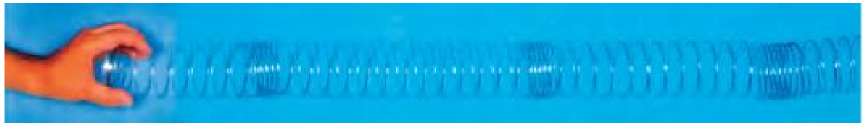
## Graphical representation of longitudinal Waves:

The relation : ( **displacement – distance** ) or ( **displacement – Time** ) can be represented in by a curve in the form of **sine** wave.



## Obtaining ( transverse / longitudinal) waves using a spiral spring:

Can we use a rope to obtain both types of waves ( transverse / longitudinal )?



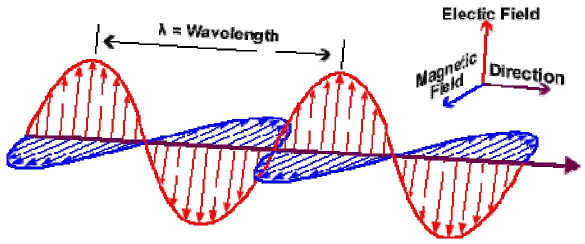
**Note:**

- Sound propagates in gases in the form of longitudinal waves. **Explain.**
- What kind of waves are formed :
  1 – on water surface
  2 – inside the water. **Explain**.

## Second : Electromagnetic waves

### Source :

- Originated fro the vibration of two fields ; one of them is electric field and the other is magnetic field, where both are perpendicular to each other and to the direction of wave propagation.




**Electromagnetic waves**

**Waves originated from vibrating electric and magnetic fields having the same phase** with frequency ($\upsilon$) , perpendicular to each other and to the direction of wave propagation and can spread in materialistic and non-materialistic media (space).

### Examples:

- Light waves
- X-rays
- Gamma rays
- Wireless waves , TV and cell phone ) , where :
  - Ø Sound or image are converted into waves received by the antenna.
  - Ø The waves are converted into electric signals in the receiver then to sound or image .

### Types :

- All electromagnetic waves are transverse waves only.

## The relation between frequency , wave length , and velocity:

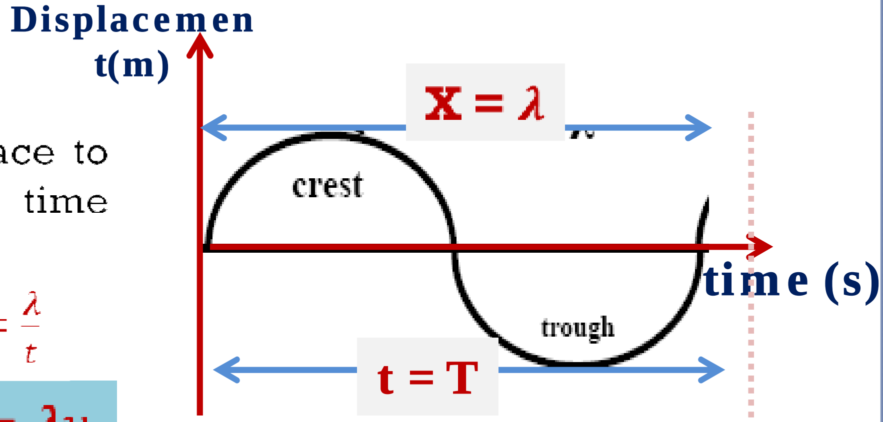
### Deduction of velocity of wave propagation :

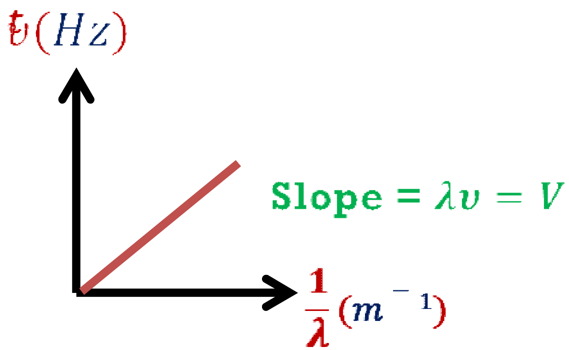
If a wave transfers at velocity (**V**) from a place to another at distance ($\lambda$ ) , the wave takes time equals the periodic time(**T**):

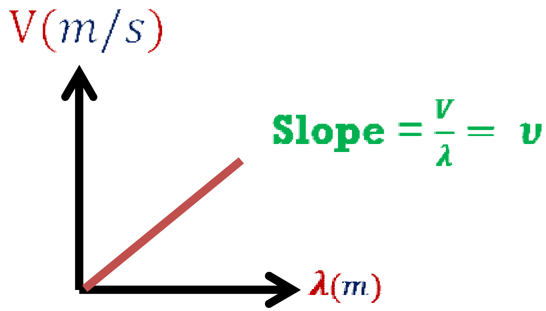
$\because V = \frac{X}{t}$ when $X = \lambda$ , $t = T$ $\therefore V = \frac{\lambda}{t}$

$\because \upsilon = \frac{1}{t}$

$$\therefore V = \lambda \upsilon$$




**Wave velocity :**

The distance covered by the wave in one second in a certain direction.

What is meant by : The wave velocity = 20 m/s

What happens when: The wavelength is doubled relative to its velocity?

The frequency of a wave increases relative to wavelength?

# Unit 1 Waves

## Chapter 1 Wave motion

$$V = \lambda \upsilon$$

§ Two waves propagate in the same medium , with different frequencies :

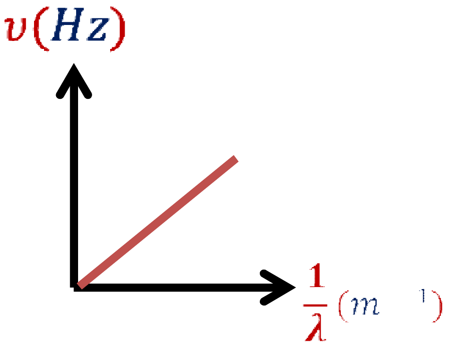
Ø Their velocities are the same.

$$V_1 = V_2$$

$$V_1 = \lambda_1 \upsilon_1 \qquad V_2 = \lambda_2 \upsilon_2$$

$$\lambda_1 \upsilon_1 = \lambda_2 \upsilon_2$$

$$\boxed{\frac{\lambda_1}{\lambda_2} = \frac{\upsilon_2}{\upsilon_1}}$$




Slope $= \lambda\upsilon = V$

Wave length is inversely proportional to the frequency at constant velocity

• A wave transfers from one medium to another :

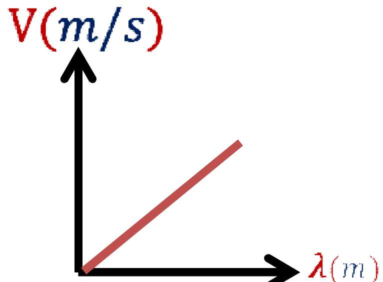
Ø Velocity wave length changes.

Ø Frequency remains constant.

$$\upsilon_1 = \upsilon_2$$

$$\frac{V_1}{\lambda_1} = \frac{V_2}{\lambda_2}$$

$$\boxed{\frac{\lambda_1}{\lambda_2} = \frac{\upsilon_1}{\upsilon_2}}$$




Slope $= \frac{V}{\lambda} = \upsilon$

Wave velocity is directly proportional to the wave length at constant frequency.