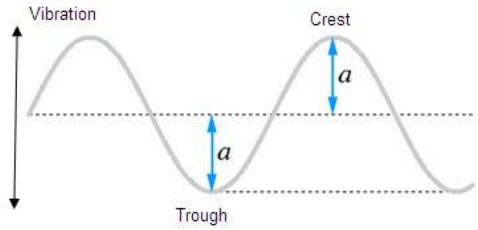
Waves

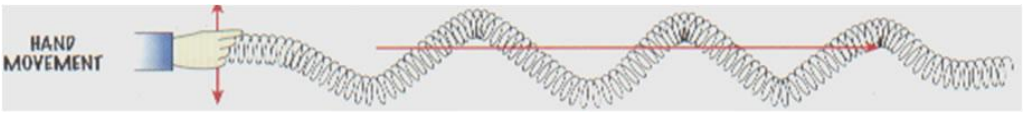
Wave is the transferring of energy from one point to another point in the result of disturbance of the particles in the medium. For example, sound waves, infrared heat, television, mobile phone and radio waves are reaching us constantly.
There are two types of waves. Transverse Waves and Longitudinal Waves.

Transverse waves:

Those waves in which particles of the medium vibrate at right angle to the direction of motion of the wave are called transverse waves. For example: Water waves, light, radio and all other electromagnetic waves.



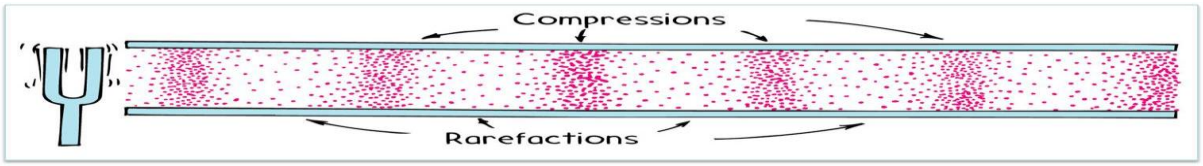
Transverse waves can be produced with the help of spring as shown below.



Longitudinal Waves :

Those waves in which particles of the medium vibrate along the direction of motion of the wave are called longitudinal waves. For example: Sound waves. Longitudinal waves in terms of wavefronts can be shown as:

Longitudinal wave consists of compressions and rarefactions.



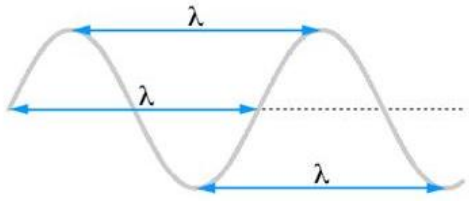
Medium is a matter through which waves can move. Generally there is focus on air, water (shallow and deeper), and glass as medium. Electromagnetic waves do not need any medium or material to travel, they can pass through vacuum or space. Atoms or molecules of the medium are considered as particles of the medium, which are responsible for the transferring of energy during the motion of the wave.

Wavefront

It is the locus of all those points which have the same phase of vibration. OR It is a moving line that joins all the points on the crest of a wave.

Wavelength

In case of transverse waves, it is the distance between two adjacent crests or troughs.



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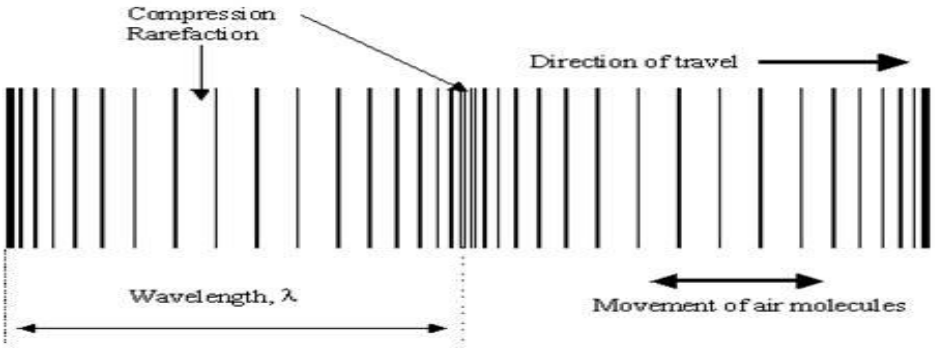
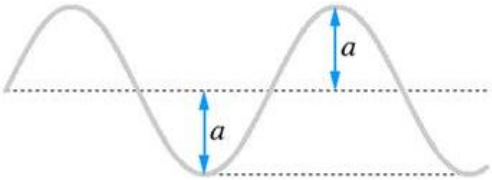
In case of longitudinal waves, it is the distance between two points of maximum compression or the distance between two points of minimum rarefaction. The S.I. unit of wavelength is meter (m). Wavelength in terms of compressions and rarefactions can be shown as below.



Common features of Wave:

- All the waves have the repeating pattern or shape.
- All the waves carry energy without moving material along.
- All the waves have wavelength, frequency, amplitude and time period.
- The speed of the wave depends on the medium, in which it is travelling.

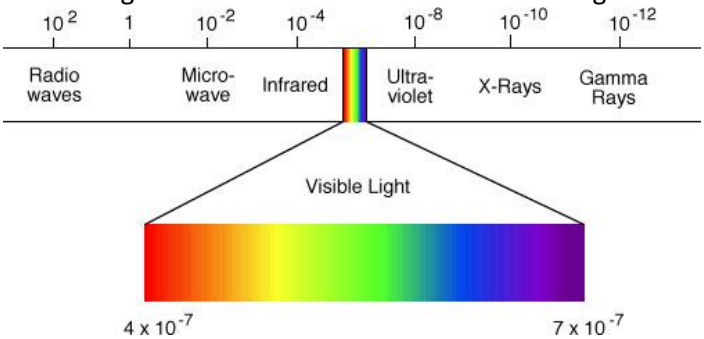
Amplitude is the maximum displacement of the particle in the medium from the central position. The S.I. unit of amplitude is meter (m).



Time period is the time taken by the wave to pass through any point. It is represented by T. Its unit is second(s). Time period and frequency of the wave are closely linked by the relation **f=1/T** or **T=1/f**

Speed of the wave is the distance covered by the wave in one second. The speed of the wave in a given medium is always constant. The speed of the wave (v), frequency (f) and wavelength (λ) are related by the relation **V=fλ** Speed of the wave is usually measured in meter/second (m/s)

Electromagnetic Spectrum - The electromagnetic spectrum describes the various types of electromagnetic radiation based on their wavelengths.



Radio Waves: Radio is at the weak end of the spectrum, with low energy and long wavelength. It's used for transmission of data, via modulation. Television, mobile phones, wireless networking and amateur radio all use it.

Microwaves: Microwaves come next. They can cause entire molecules to resonate. This resonance causes water to move rapidly and enables the microwave oven to cook food. Uses include Microwave communication links (Radio and television); Microwave cooking, Radar communication

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Infra-red Radiation: The next category is infra-red. This makes chemical bonds resonate. When a chemical bond resonates, the vibrations add internal energy to the molecule. The molecule becomes hot. The bulk substance becomes hot when its molecules' bonds are all resonating. When you touch it, you feel its warmth or you lose the tip of your finger, depending on how violent the resonance is. Used in Radiators (Keeps occupants of room warm in winter); Cooking food; Finding buried warm bodies; IR satellite photos reveal diseased crops; Televisions controllers; Intruder alarms

Visible radiation (light): After infra-red comes visible light. This is the range in which the sun and stars similar to it emit most of their radiation. When this is scattered or reflected by an object, we can infer the existence of the object. ROY-G-BIV = the colors Red Orange Yellow Green Blue Indigo Violet

Ultraviolet (UV): They are emitted by sun, is harmful for human body. They cause skin burn. They can ionize atoms. They can cause skin cancer. They cause mutagen. They are absorbed by ozone layer mostly.

X-rays: After UV come X-rays. Hard X-rays are of shorter wavelength than soft X-rays. X-rays are used for seeing through some things and not others, as well as for high-energy physics and astronomy.

Gamma rays: After hard X-rays come gamma rays. These are the most energetic photons, having no lower limit to their wavelength. They are useful to astronomers.

Common Properties of Waves

1) **Reflection:** The properties of reflection on a mirror are also followed by a wave. When a wave reflects then the angle of incidence is equal to the angle of reflection.
2) **Interference**: When waves of equal frequency and nearly equal amplitude are super imposed then the phenomenon of interference occurs. It focuses on two kinds such as constructive interference and destructive interference.
3) **Absorption**: The property of absorption is also followed during wave motion. It can be absorbed by some surface leading to the change in the type of energy.
4) **Refraction**: While traveling from one medium to another the wave may change its speed. This property is called Refraction. The amount of refraction is dependent on the refractive index of the medium.
5) **Diffraction:** The phenomenon of spreading of wave when it passes or emerges from an opening or it bends when it encounters an obstacle is called Diffraction. These effects are more significant if the size of the opening is comparable to the wave's wavelength.
6) **Polarization:** A wave oscillating in one plane or direction is called a Polarized wave. It can be circular polarized or plane polarized. We can use the polarization filter for this purpose.
7) **Dispersion:** The phenomenon of dispersion is also followed by the wave. Dispersion is the breaking into the component colors like when the white light passes through the prism then it is dispersed into 7 colors.

Sound Waves

Sound waves are longitudinal waves. Following are the properties of Sound waves:

- Material medium is mandatory for the propagation of the sound waves.
- Sound waves are mostly longitudinal in common nature.
- Speed of sound in air at N.T.P is 332 m/s.
- Sound is audible only between 20 Hz to 20 KHz.
- Sound waves cannot be polarized.
- Sound waves travel through the air in the form of longitudinal wave.
- Vibrations of air column in organ pipes are longitudinal.

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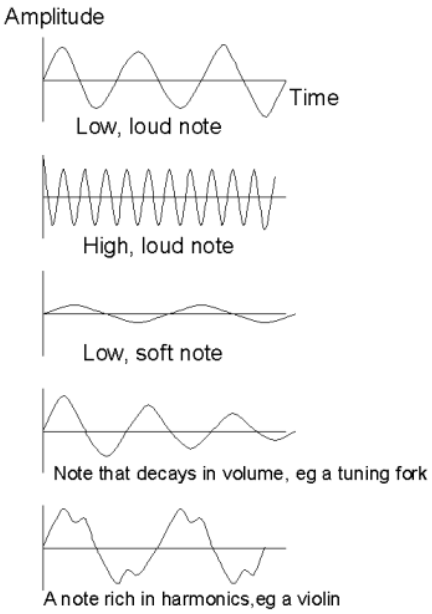
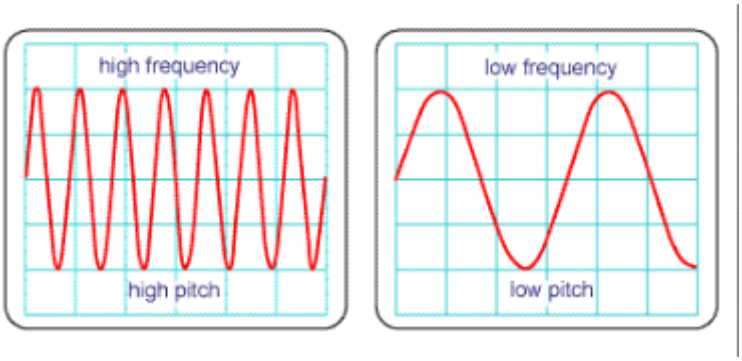
Words to know:
Frequency: the number of vibrations per second.
Pitch: how high or low a note sounds.
Amplitude: the height of a wave
Volume: How loud a note is.
If the frequency increases then the pitch will increase.
If the amplitude increases then the volume will increase.
Some waveforms





Echoes
An echo is heard when sound is reflected off a distant object.
Sonar make use of echoes to measure the distance (or shape) of an object (eg the sea floor).
It does this by measuring the length of time it takes to hear the echo.
Ultrasound
Ultra sound is too high for us to hear (maybe about 40kHz). It is used to produce pictures of unborn babies, in burglar alarms and also in some cleaning devices

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