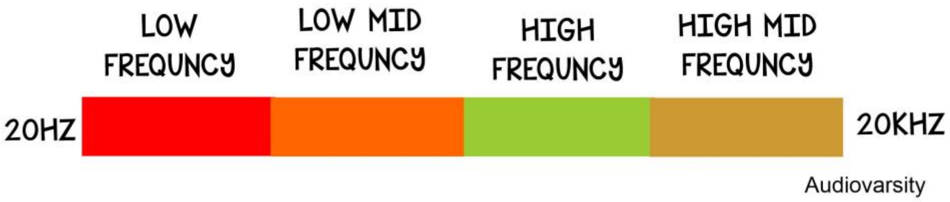
1 WHAT IS SOUND?

1.1 DEFINITION OF SOUND WAVES.

Sound is anything that we as humans can perceive with our ears.

The term Audio and sound is used interchangeably. The human ear is capable of perceiving frequencies ranging from 20 hertz to 20 kHz. This frequency range is known as the frequency spectrum or the audible bandwidth.



The audible bandwidth can be divided into 4 separate sections. Low frequencies, low mid frequencies, high frequencies and high mid frequencies. 20 hertz is the lowest or bassiest frequency humans can perceive while 20 khz is the highest frequency a human can perceive. We will explain more about that in due course.

1.2 PROPERTIES OF SOUND WAVES

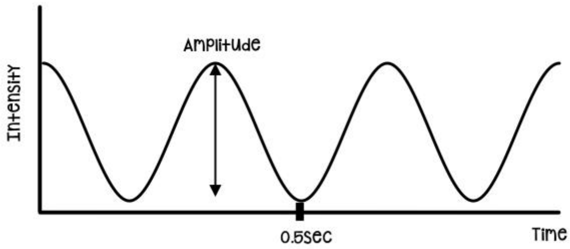
1.2.1 Frequency

Frequency by definition is the number of times the wavelength occurs in one second. Measured in Hertz (Hz), or cycles per second. The faster the sound source vibrates, the higher the frequency.

- A low frequency (like 50 Hz) sounds deep, like a bass drum.
- A high frequency (like 5,000 Hz) sounds high-pitched, like a whistle.

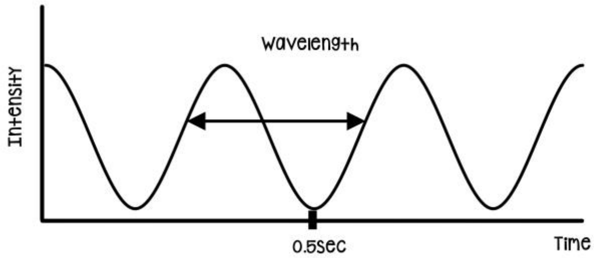
1.2.2 Amplitude

Amplitude is strength or power of a wave signal. It is the "height" of a wave when viewed as a graph. Higher amplitudes are interpreted as a higher volume, hence the name "amplifier" for a device which increases amplitude.



1.2.3 Wavelength

wavelength is the distance between any point on a wave and the equivalent point on the next phase. Literally, the length of the wave. This is how long a sound wave is. Imagine waves on a beach — the distance between two wave crests is the wavelength. In sound, it's the distance between two compressions.



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1.2.4 Phase

Phase is all about timing. If two waves hit your ears at the same time (in phase), they sound louder together. If they arrive just slightly out of sync (out of phase), they can cancel each other out and sound quieter or even disappear.

Example: Two people clapping at the exact same time sound loud — but if one claps just a little off, it doesn't sound as full.

So, every sound you hear is made up of these wave properties: how fast it vibrates (frequency), how long each wave is (wavelength), how strong it is (amplitude), and how well it lines up with other sounds (phase).

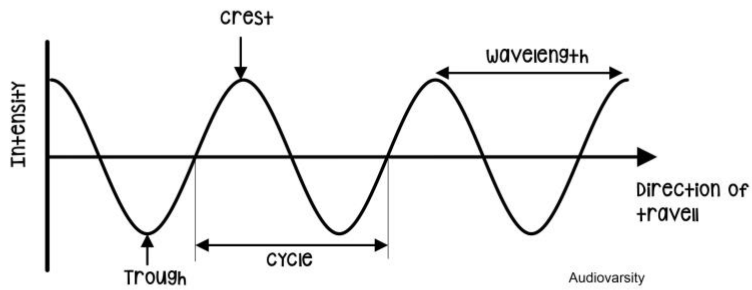
1.3 TYPES OF WAVES: TRANSVERSE AND LONGITUDINAL

Waves are disturbances that transfer energy through a medium or space without transporting matter. They are fundamental to understanding sound, light, and many other phenomena in physics and audio engineering. Waves can be broadly classified based on how they move.

The two main types are transverse waves and longitudinal waves. Each type behaves differently and appears in different contexts — for instance, transverse waves in light and water, and longitudinal waves in sound and seismic activity.

1.3.1 Transverse Waves

Transverse waves are waves in which the particles of the medium move perpendicular to the direction of the wave's propagation. This means that if the wave is moving horizontally, the particles move up and down.



Crests and Troughs

A transverse wave has two main features: crests and troughs.

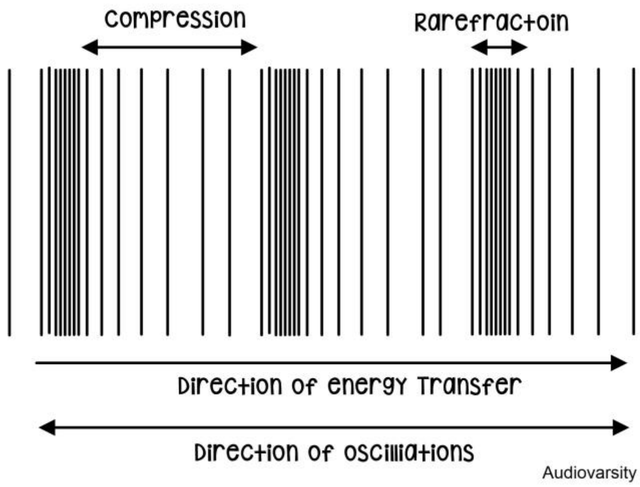
- Crests are the highest points when a medium (such as water or rope) reaches its maximum height.
- The trough is the lowest point where the surface drops down. The wavelength of a wave is defined as the distance between crests or troughs.

A good example of a transverse wave is a water wave — the water surface moves up and down while the wave travels across the surface. Another classic example is electromagnetic waves, such as light and radio waves, where the oscillations of the electric and magnetic fields are perpendicular to the direction of wave travel. In audio-visual contexts, transverse waves are often discussed in relation to visible light and screen-based signal patterns, especially when dealing with waveforms on visual displays.

1.3.2 Longitudinal Waves

Longitudinal waves are waves in which the particles of the medium move parallel to the direction of wave propagation. This means the particles vibrate back and forth along the same path that the wave travels.

Visualize a slinky toy. When you compress a few coils at one end and then release them, a bunching and spreading effect occurs down the length of the slinky. This clumping and spreading motion, which occurs in the same direction as the disturbance, is a longitudinal wave.



Compression and Rarefaction

Compressions and rarefactions are key ideas for comprehending longitudinal waves.

Compressions are areas where particles in a material are closer together or more bunched together. In the slinky example, compressions are locations when the coils are close together.

Rarefactions are places where particles are spread out or have a lower density. Rarefactions are stretches of the slinky’s coils that are spaced farther apart.

These longitudinal wave characteristics are similar to the crests and troughs seen in transverse waves.

Sound waves in air are a primary example. When a sound is produced, it creates compressions and rarefactions in the air molecules — areas where particles are pushed together and then spread apart.
These fluctuations travel as longitudinal waves to our ears, where they're interpreted as sound.

Longitudinal waves are crucial to audio engineering, as they directly relate to how we capture, manipulate, and reproduce sound in different environments. They also appear in other mediums like liquids and solids, though with varying speeds and behaviors.

1.4 EXAMPLES OF NATURAL AND ARTIFICIAL SOUND SOURCES.

Natural Sound Sources Originate from nature without human intervention.

Examples:

- Wind blowing through trees
- Rainfall
- Ocean waves
- Animal calls (e.g., birds chirping, dogs barking)
- Human sounds without technology (e.g., clapping, shouting)
- Often used in field recordings and environmental sound design.
- These sounds vary in intensity, duration, and pitch.

Artificial Sound Sources Created or enhanced using man-made tools or technology.
Examples:

- Musical instruments (guitars, pianos, drums)
- Machinery (engines, sirens)
- Digital and synthesized sounds
- Common in studio production, live performance, and multimedia content.
- Easier to control, manipulate, and replicate in a production environment.