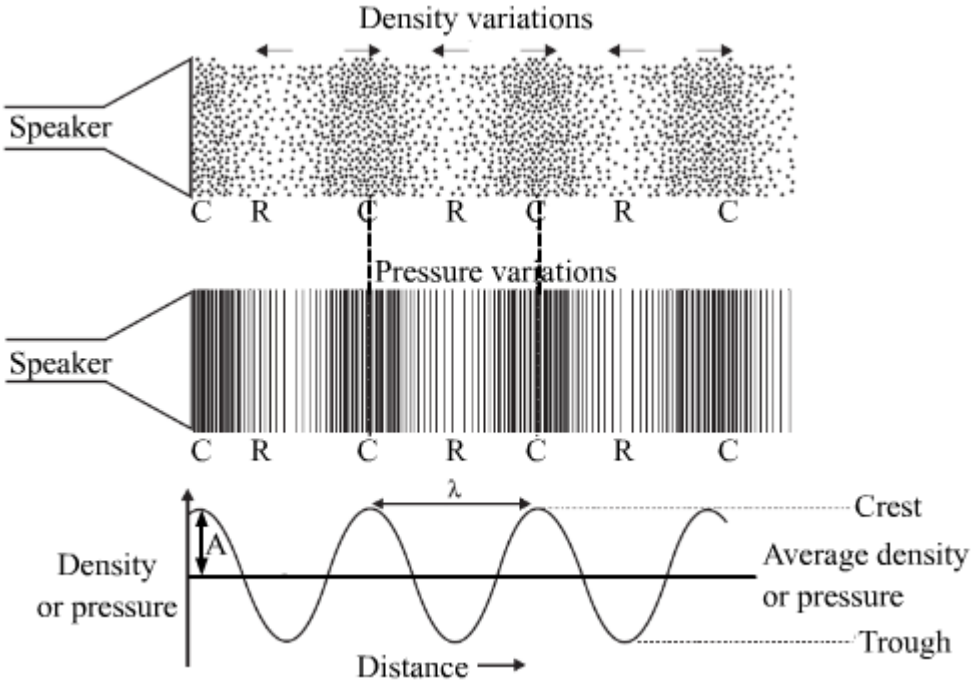
Sound

- Sound is a form of energy that is produced by producing vibrations in an object.
- Sound cannot move through vacuum.
- Sound is a wave that requires a medium for its propagation. The medium particles vibrate only to and fro. They do not move with the sound.
- **Longitudinal wave**: Individual particles of the medium move in the direction parallel to the direction of wave propagation
- **Transverse wave**: Particle movement is perpendicular to the direction of wave propagation

Sound waves propagate through continuous medium by **compressions** and **rarefactions** of particle that compromises the medium.

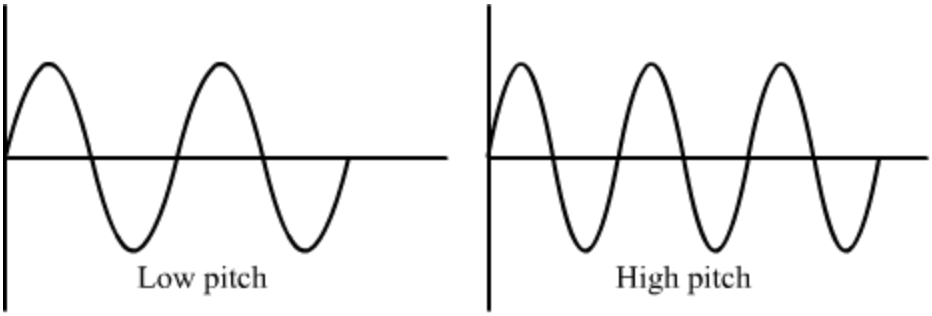


- This diagram also helps to understand how vibration in your school bell disturbs the air near it and sound progresses because of this disturbance.
- **Characteristics of sound waves**

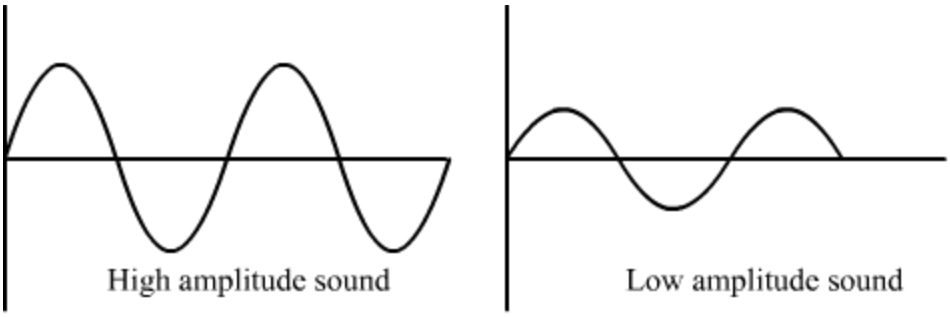
- **Amplitude –** Magnitude of maximum displacement from mean position
- **Wavelength (λ)** – Distance between two consecutive compressions or two consecutive rarefactions
- **Frequency (Unit - Hertz, Hz)** – Number of oscillations per unit time
- **Time period** – Time taken by two consecutive compressions or rarefactions to cross a fixed point

- Frequency = 1Time period1Time period

- **Pitch** – Higher the frequency, higher the pitch



- **Loudness** – Determined by amplitude



- **Tone** – Sound of a single frequency
- **Quality or timbre**

  Differentiate between two sounds of same pitch and loudness

- If the notes produce an unpleasant sound in the ear, then it is a **dischord** or **dissonance**.
- **Harmony -** Harmony is the pleasant effect produced due to concord, when two or more notes are sounded together.

- **Melody** - Melody is the pleasant effect produced by two or more notes when they are sounded one after another.

- **Musical intervals** - Musical interval is the ratio of frequencies of two notes in the musical scale.

- **Musical scale** - Musical scale is the series of notes separated by a fixed musical interval. Keynote is the starting note of a musical scale.

- **Diatonic** scale

- When two notes are sounded simultaneously and produce pleasant sensation in the ear, then it is **concord** or **consonance**.

- It contains series of eight notes.

- **Octave** is the interval between the keynote and the last tone.

- **Advantages of a diatonic scale**

  - This scale provides the same order and the duration of chords and intervals, which succeed each other, that are required for a musical effect.
  - This scale can produce musical compositions with the lower and higher multiples of frequencies of the notes.

Speed of sound

- Speed of sound $v = \nu \times \lambda$

- Speed in solid > Speed in liquid > Speed in gas

- Speed depends on temperature, pressure, humidity and nature of the material of the medium.

- Speed increases with increasing temperature.

- In air, speed of sound is 344 m s^{-1} at 22 °C

- Supersonic – The rate of distance travelled by the object is more than the speed of sound.

- Sonic boom - loud noise produced by supersonic object is sonic boom

- **Laws of reflections of sound:**

  (i) The incident sound, the reflected sound, and the normal to the screen at the point of incidence – all lie in the same plane.

(ii) The angle of reflection of sound is always equal to the angle of incidence.

- **Echo**

  - Reflection of sound
  - Sensation of sound persists $\frac{1}{10} = 0.1\text{s}$ in the human brain
  - Minimum distance to hear echo

    $\frac{344 \times 0.1}{2} = 17.2\ \text{m}$

- **Reverberation**

  - Persistence of sound by repeated reflection

- **Use of Reflection of Sound –** Loud speaker, stethoscope, curved ceiling of a concert hall, soundboard in a big hall

- Curved board or walls are used in concert halls and the speaker or the source of sound is placed at the focus of the curved wall so that sound gets reflected evenly from the wall to the audience.

- **Range of hearing for humans**: 20 – 20000 Hz

- Rhinoceroses use infrasound (<20Hz) and bats use ultrasound (>20000Hz)

- **Hearing Aid**
  It is a device that amplifies sound and enables hearing impaired hear. It consists of a microphone, an amplifier, and a speaker.

- Sound is a longitudinal wave which needs material to travel. Its velocity (v), frequency (f) and wavelength (λ) are related as, $v = f\lambda$

- **Properties of ultrasound**

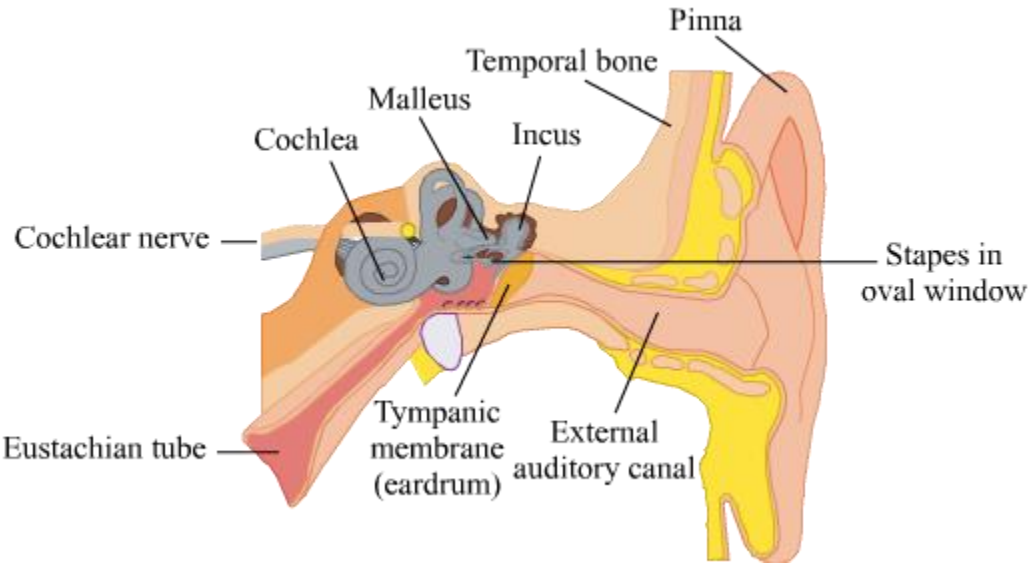
  Ultrasonc waves are high-frequency sound waves that cannot be heard or sensed by humans. These are so energetic that they can penetrate human muscles

- **Application of ultrasound**

  - Cleaning, detecting defects in metals, echocardiography, ultrasonography, to break small kidney stone

  - **SONAR**(Sound navigation and Ranging): Used by ships and submarines to navigate, communicate or detect under water.

- Human ear has three parts outer, middle and inner.



- Shape of the outer part of the ear is like a funnel.
- In human ear, the eardrum vibrates and passes vibration to the inner ear.
- The eardrum is like a stretched rubber sheet.
- Sound vibrations make the eardrum vibrate, from there the signal goes to the brain.
- Noise level of 85 dB can damage the human ear.