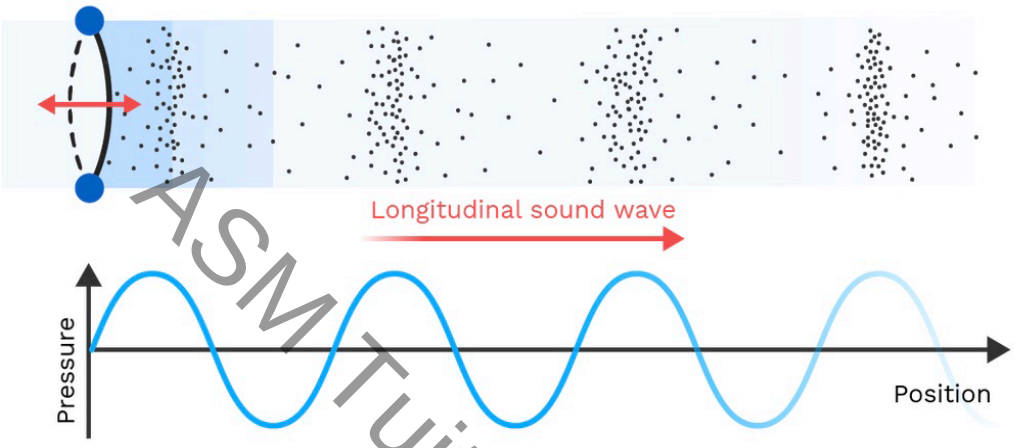
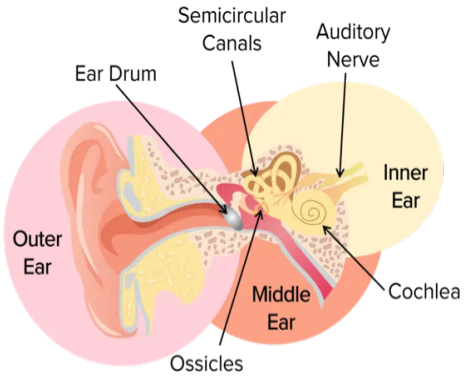
Sound waves

- Sound waves are **longitudinal waves**. They cause particles to vibrate parallel to the direction of wave travel. The vibrations can travel through solids, liquids or gases.
- The speed of sound depends on the medium through which it is traveling. When traveling through air, the speed of sound is about 330 meters per second (m/s). Sound cannot travel through a vacuum because there are no particles to carry the vibrations.



How we Hear Sound

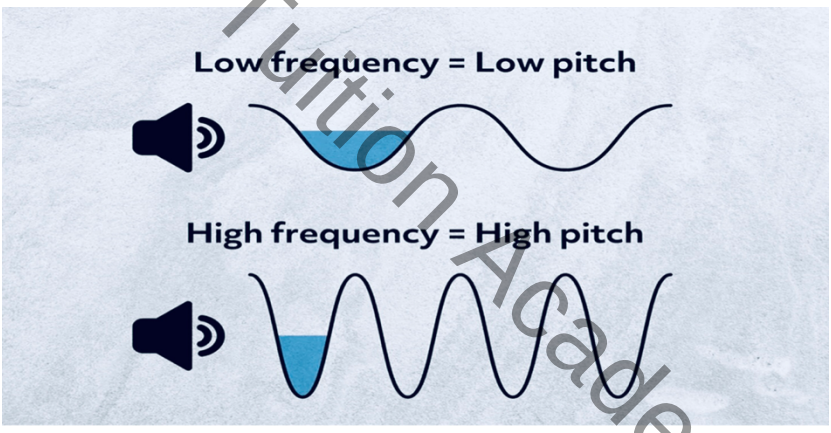
- Sound waves travel into your ear and cause the **ear drum** to vibrate. The ear drum passes on the vibrations to the **ossicles** (very small bones), through the **semicircular canals** and finally to the **cochlea**.
- The **cochlea** coverts the vibrations to electrical signals which are transported to your brain along the **auditory nerve**.
- The frequencies of sound waves that you can hear is limited by the size of your ear drum.
- Usually humans can hear within the range **20 Hz−20 kHz.** Outside of this range, a microphone may pick up the sound wave but you wont hear anything.



Properties of sound

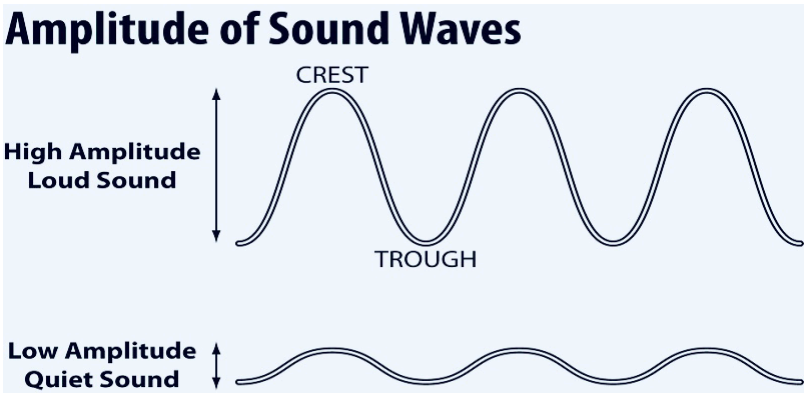
1. The frequency of a sound wave is related to the pitch that is heard:

- high frequency sound waves are high pitched (whistling and bird chirps)
- low frequency sound waves are low pitched (bass guitar, rumbling thunder)



2. The amplitude of a sound wave is related to the volume of the sound:

- high amplitude sound waves are loud
- low amplitude sound waves are quiet



3. Oscilloscope traces showing the following sounds:

   1. quiet, low pitch sound
   2. loud, low pitch sound
   3. loud, high pitch sound

Ultrasound waves:

- **Ultrasound** waves are sound waves with frequencies above 20000 Hz20000 Hz. This means that they can't be heard by the human ear.

- Like all waves, sound and ultrasound waves can be **reflected** and **refracted**. Echoes are reflections of sound.
- Some uses of reflection and refraction of ultrasound are:

1. Medical Imaging

- Ultrasound waves can pass through the body. However, when they reach a **tissue boundary**, some of the wave is **reflected** back. When ultrasound waves are projected into the body, the **time** taken for the same waves to be reflected back out of the body allows us to work out how far into the body the tissue boundary is. This can be processed by a computer to create an image of inside the body.

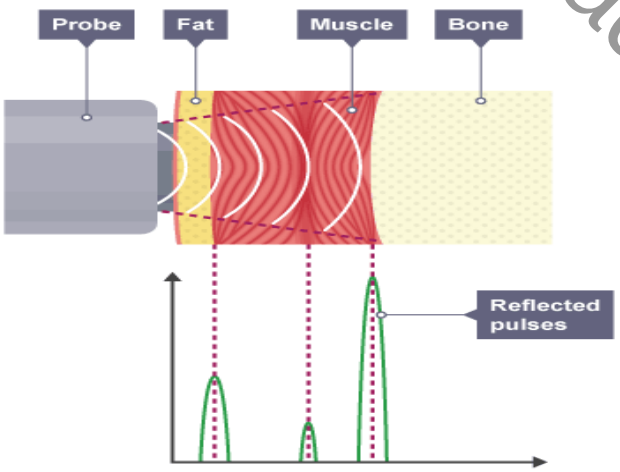
➤ A common application of ultrasound imaging is **pre-natal imaging** of a foetus.

➤ **Advantages of using ultrasound in medicine**

- ultrasound waves pass through tissue without causing harm, unlike x-rays which cause ionisation and can damage DNA inside cells;
- ultrasound equipment is relatively cheap, portable and easy to use;
- images of internal organs can be seen without having to operate on patients.

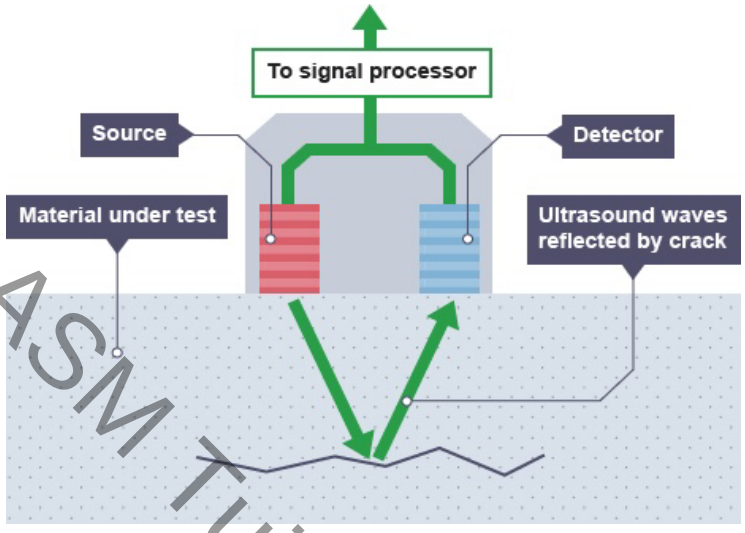
➤ Ultrasound imaging also helps to **diagnose problems** with the:

- heart;
- kidneys;
- blood vessels;
- bladder.



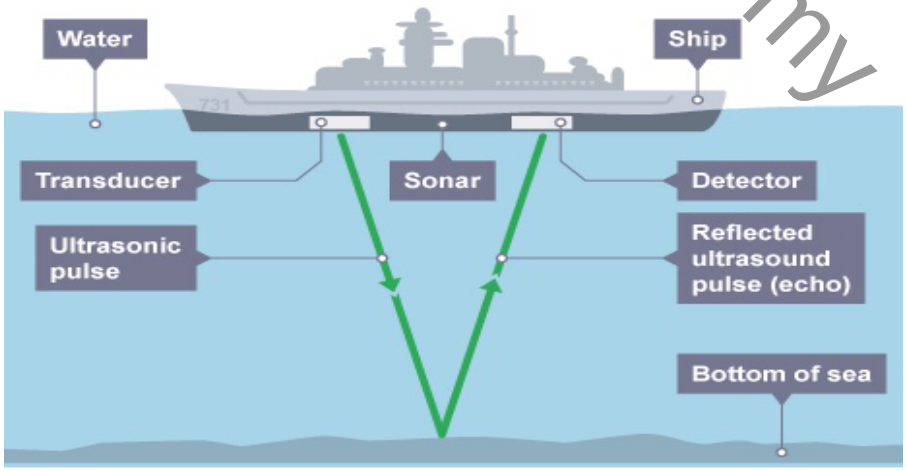
2. **Industrial Imaging**

- Similar to in medical imaging, ultrasound can be emitted into **pipes** or **materials** to find out about the inner structure of the material. Usually, the ultrasound wave will be reflected from the far side of the material.
- If there is a **fault** in the material it will be reflected sooner. The **time** taken for the echo to return to the detector is used to determine the position of the fault.



3. Echolocation

- Ultrasound can be used by **boats** and **submarines** to measure the depth of water or locate objects under the water.
- The **time** taken for ultrasound waves to reflect off the sea bed and return to the boat or submarine tells us how much distance there is between the sea bed and the bottom of the boat or submarine.
- This technique is applied in sonar systems used to measure the depth of the seabed and to find shipwrecks, submarines and shoals of fish.



Seismic waves

➤ Seismic waves are produced by earthquakes in the Earth's crust. They can cause damage to structures on the Earth's surface, as well as tsunamis.

Measuring Seismic Waves

➤ If an **earthquake** or **volcanic eruption** occurs, **seismic waves** are produced. These waves travel through the Earth and can be detected by instruments called **seismometers**.

➤ Scientists can use **seismic waves** to study the **inner structure** of the Earth. They measure:

- The time it takes for the seismic waves to reach different points on the surface of the Earth.
- Which places the seismic waves don't reach.

➤ If the wave does not reach a location, it must have been **reflected or refracted**by a boundary between different types of material.

Types of seismic waves

➤ There are two types of seismic waves:

1. **P waves** – these are **longitudinal** waves that travel at different speeds through solids and liquids.
2. **S waves** – these are **transverse** waves that cannot travel through liquids.

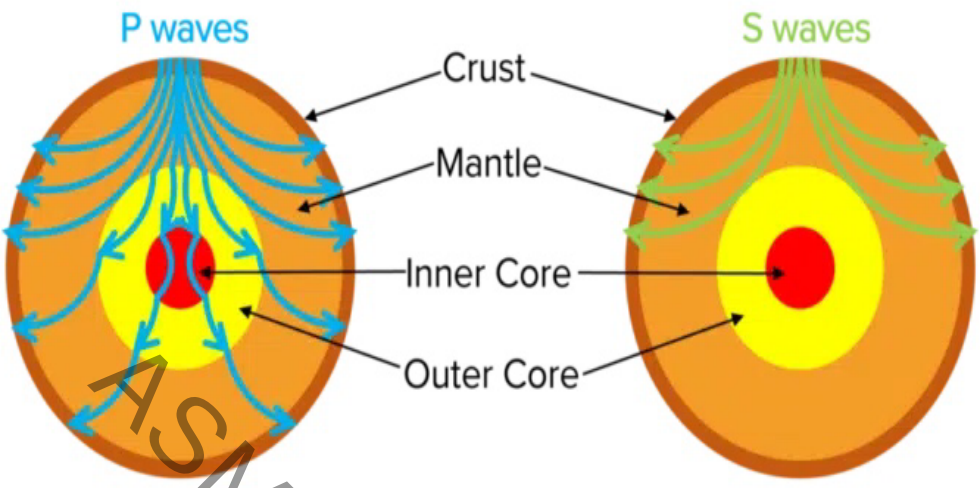
The Internal Structure of the Earth

➤ Because **P waves** and **S waves** have different properties, we can detect their paths after an earthquake or volcanic eruption to determine the inner structure of the Earth.

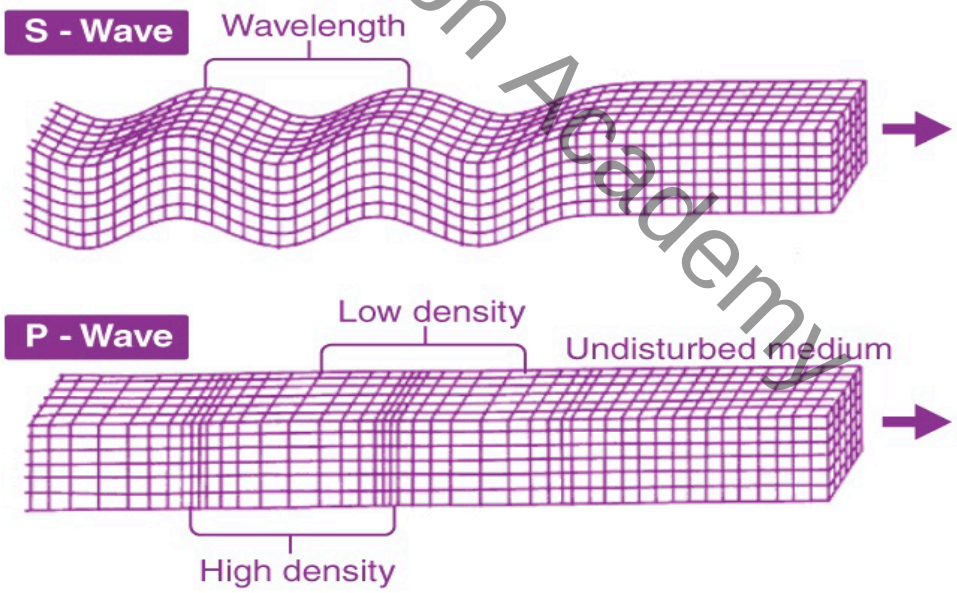
➤ The main layers in the Earth are:

- **Crust** – solid
- **Mantle** – almost solid

- **Outer Core** – liquid
- **Inner Core** – solid



- P waves are refracted at the boundaries between different layers in the Earth.
- S waves only travel through the crust and the mantle. This means that P waves reach more distant locations.



Difference between S wave and P wave

P-waves	S-waves
• First to arrive at surface- Primary waves • Virbate parallel to the direction of propagation of wave • Less destructive • These can travel through all mediums- Solid, liquid, gas. • These are compressional waves.	• Arrive at surface with some time lag- Secondary waves • Vibrate perpendicular to the direction of propagation of wave • More destructive • These can travel only through solids. • Causes displacement of rocks and collapse of structure