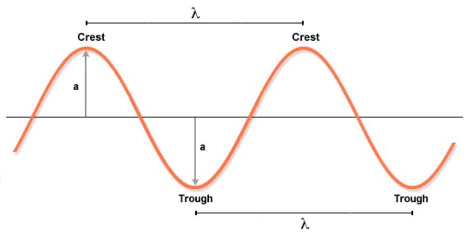
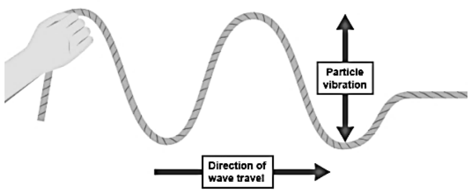
# P4 Waves

| 1. Describing waves | |
|---|---|
| **Waves** | Transfer energy without transferring matter. |
| **Oscillate** | When particles vibrate backwards and forwards or up and down. |
| **Transverse waves** | Waves in which particles oscillate at right angles to the direction of energy movement. E.g., waves on the surface of the water, some seismic waves and light waves (all electromagnetic waves). |
| **Longitudinal waves** | Waves in which particles oscillate parallel to the direction of energy movement. E.g., sound waves and some seismic waves. |
| **Medium** | The material that waves travel through. Light (all electromagnetic waves) waves are the only waves that have no medium. |
| **Seismic waves** | Waves of vibrating rock caused by earthquakes. |
| **Frequency, f** | The number of waves that pass a point every second. |
| **Hertz, Hz** | The unit of frequency. 1 Hz = 1 wave per second. |
| **Period, T** | The length of time it takes for a single wave to pass. |
| **Wavelength, λ** | The distance in m from the top of one wave to the top of the next. |
| **Amplitude, a or A** | The maximum distance a particle vibrates away from its resting point, |
| **Velocity, v** | The speed of a wave in m/s. |

Transverse wave




Transverse wave




Longitudinal wave

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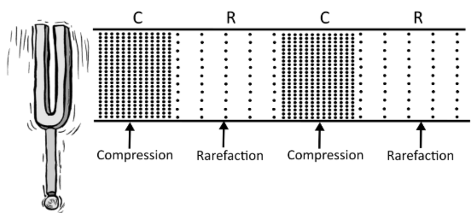
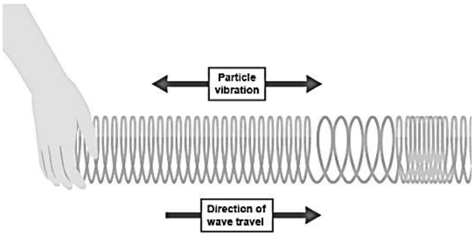
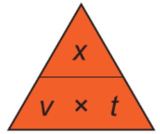
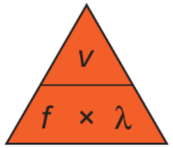
Compression and rarefactions of a longitudinal wave




Longitudinal wave




| 2. Wave speeds | |
|---|---|
| **Speed, distance and time** | $wave\ speed\ (m/s) = \frac{distance\ (m)}{time\ (s)}$   Wave speed = v<br>Distance = x<br>Time = t |
| **Speed, frequency and wavelength** | $wave\ speed\ \left(\frac{m}{s}\right) = frequency\ (Hz) \times wavelength\ (m)$   Wave speed = v<br>Frequency = f<br>Wavelength = λ |
| **Measuring wave speed** | Time how long they take to travel a certain distance. (stopwatch)<br>Distance between two points.(tape measure) |
| **Changing speed** | Waves travel at a different speed in a different medium. Light is slower in water than air. |

| 3. Core practical – Investigating waves | |
|---|---|
| **CP4 - Aim** | To measure the speed of waves in a liquid and a solid. |
| **CP4 – Water waves 1** | 1. Count the number of waves in 10 s and use this to find the frequency.<br>2. Measure the wavelength with a ruler<br>Wave speed = frequency x wavelength |
| **CP4 – Water waves 2** | 1. Time how long a wave takes to pass two points, 0.3 m apart.<br>Wave speed = dist / time |
| **CP4 - Waves in a solid** | 1. Hit suspended metal bar with hammer and measure the frequency using an app.<br>Measure the metal bar – double the length gives the wavelength |

| 4. Refraction | |
|---|---|
| **Refraction** | Bending of waves when they enter a new medium at an angle. |
| **Interface** | The boundary between two media (mediums) such as air and water. |
| **Normal** | An imaginary line drawn at 90º to where light hits an interface (boundary). |
| **Angle of incidence** | The angle between an incoming light ray and the normal. |
| **Angle of refraction** | The angle between the normal and a ray of light that has been refracted. |
| **Travelling from air to glass or water** | Light bends towards the normal |
| **Travelling from glass or air to water** | Light bends away from the normal. |
| **Explaining refraction** | Light waves slow down as they go from air to water. The 'bottom' of the wave hits the water and slows down first, causing refraction. |

| 5. Waves crossing boundaries | |
|---|---|
| **Reflection** | When a wave is bounced off a surface instead of passing through it or being absorbed. |
| **Refraction** | Bending of waves when they enter a new medium at an angle. |
| **Transmit** | When the wave passes through something and is not absorbed or reflected. |

| | |
|---|---|
| **Absorb** | It is when the wave disappears as the energy it is carrying is transferred to a material. |
| **White light** | Normal daylight, or the light from light bulbs, is white light. Is made up of a mixture of different frequencies of light. |

## Higher only 6. Ears and hearing

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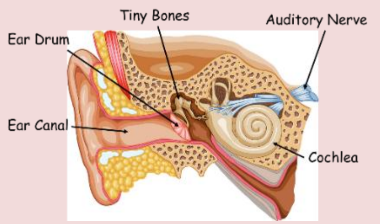
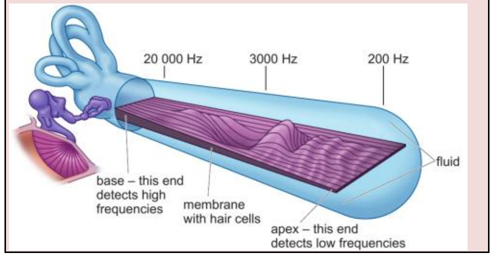
|---|---|
| **Sound** | Human ear can detect sounds from 20 Hz to 20 000 Hz. |
| **The parts of the ear** | Ear canal, eardrum, tiny bones, cochlea, auditory nerve |
| **Ear canal** | The tube in the head that leads to the eardrum. |
| **Eardrum** | A thin membrane inside the ear that vibrates when sound reaches it. |
| **Tiny bones** | Tiny bones amplify the vibrations. |
| **Cochlea** | The part of the ear that changes vibrations into electrical impulses. |
| **Auditory nerve** | The nerve that carries impulses from an ear to the brain. |




**How the cochlea works?**

- The cochlea is a coiled tube containing a liquid.
- The membrane in the middle of the tube is thicker and stiffer at the base and thinner at the apex.
- The part of the membrane that vibrates depends on the frequency of the sound waves in the liquid inside the cochlea, as different thicknesses of the membrane vibrate best at different frequencies.
- There are thousands of hair cells along the membrane, which detects its vibrations.
- Each hair cell is connected to a neurone that sends impulses to the brain.
- The brain interprets signals from different neurones as pitches of sound.

Diagram shows what the coiled tube of the cochlea would look like if it were unwound.




## Highr only 7. Ultrasound

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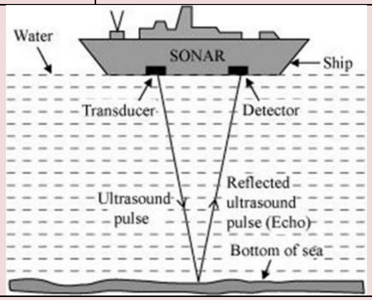
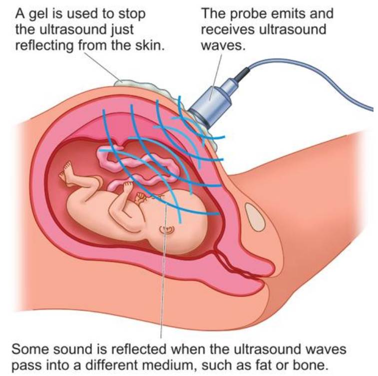
|---|---|
| **Ultrasound** | Sound made by waves with higher frequencies than 20 000 HZ are called ultrasound. |
| **Sonar** | A way of finding the distance to an underwater object (such as the sea floor) by timing how long it takes for a pulse of ultrasound to be reflected. |




Distance travelled equation

| | | | | |
|---|---|---|---|---|
| distance | = | speed | × | time |
| (metre, m) | | (metre/second, m/s) | | (second, s) |

**Ultrasound scan**




## Higher only 8. Infrasound

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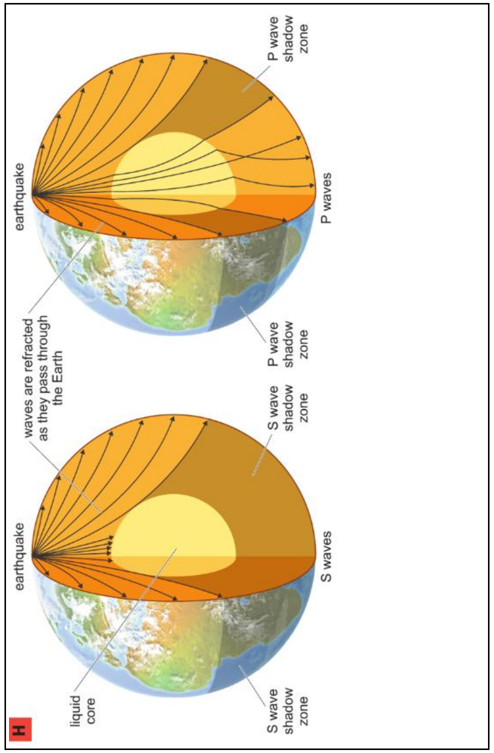
|---|---|
| **Infrasound** | Sound waves with a frequency bellow 20 Hz, which is too low for the human ear to detect. |
| **P waves** | Longitudinal seismic waves that travel through the Earth. |
| **S waves** | Transverse seismic waves that travel through the Earth. |
| **Seismic waves** | Waves produced by an explosion or an earthquake and which travel through the Earth. They include S waves and P waves. |
| **Seismometer** | An instrument that detects seismic waves. |
| **Longitudinal waves** | Can be transmitted through solids, liquid and gases. |
| **Transverse waves** | That need a medium can only be transmitted by solids. |
| **Shadow zone** | A part of the Earth's surface that P waves or S waves from an earthquake do not reach because of the way they have been reflected or refracted within the Earth. |




| Lesson | Memorised? |
|---|---|
| 1. Describing waves | |
| 2. Wave speeds | |
| 3. Core practical – Investigating waves | |
| 4. Refraction | |
| 5. Waves crossing boundaries | |
| 6. Ears and hearing | |
| 7. Ultrasound | |
| 8. Infrasound | |