S2 LIGHT & SOUND
Waves

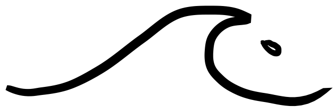
At the end of the section I can:

- ❑ 1 Identify what all waves have in common.
- ❑ 2 State that there are two types of waves.
- ❑ 3 Identify, from a diagram whether a wave is transverse or longitudinal and state a real world example of each.
- ❑ 4 Use the following terms correctly in context: wavelength, crest, trough and frequency.
- ❑ 5 State what is meant by frequency.
- ❑ 6 Carry out calculations involving the relationship between frequency, number of of waves and time.

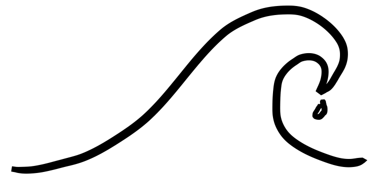
Waves

All waves transfer **energy** from one place to another.

For example: water waves transfer **kinetic energy**.

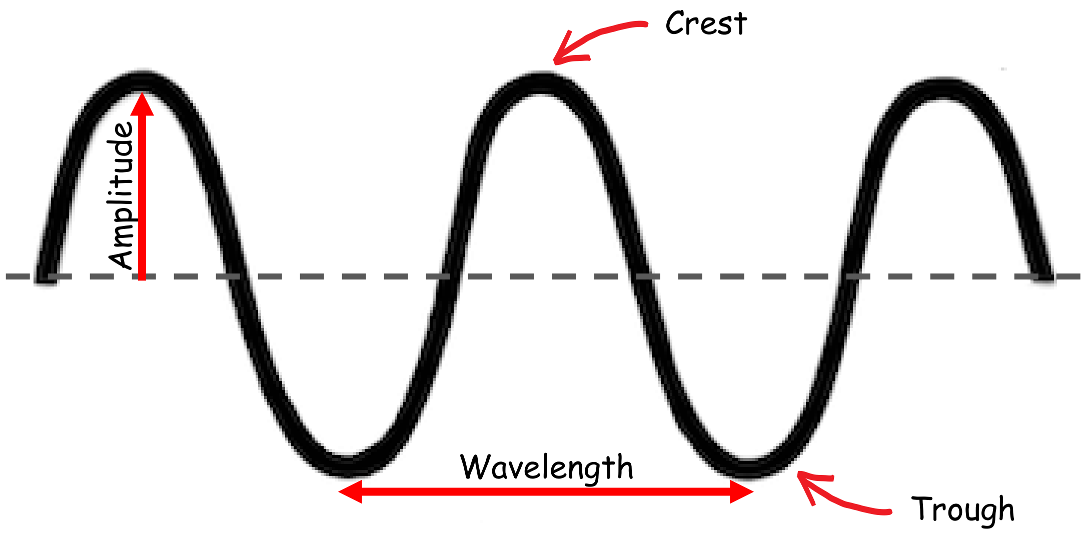


Smaller waves transfer less kinetic energy



Larger waves transfer more kinetic energy

Wave Characteristics



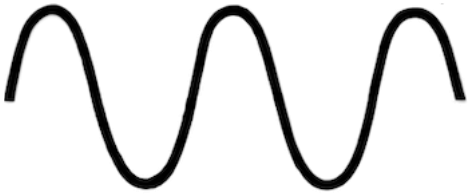
Wavelength: the distance between any point on one wave and the corresponding point on the next wave. The symbol for wavelength is ʎ (the Greek letter lambda). Wavelength is measured in metres (m).

Amplitude: the height of the wave measured from the centre line to the top of the crest, or bottom of the trough. The amplitude is a measure of the energy the wave possesses. The bigger the amplitude, the more energy the wave carries. The symbol for amplitude is A.

Types of Wave

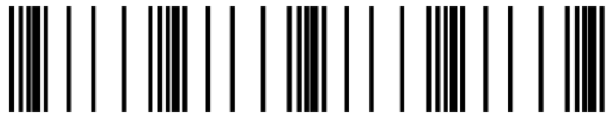
Waves can be split into two types:

Transverse



Light is an example of a transverse wave.

Longitudinal



Sound is an example of a longitudinal wave.

Frequency

Frequency is the number of waves that pass a point per second.

Frequency is measured in Hertz (Hz), it can be calculated using:

Number of waves

frequency (Hz) $$f = \frac{N}{t}$$

time (s)

Example:

The waves shown in the diagram pass a point in 2s.
Calculate the frequency of the waves.

Shopping list:

f = ?

N = 4

t = 2 s

$$f = \frac{N}{t}$$ Formula

$$f = \frac{4}{2}$$ Sub-in

$$f = 2\ \text{Hz}$$ Answer with units

S2 LIGHT & SOUND

Sound

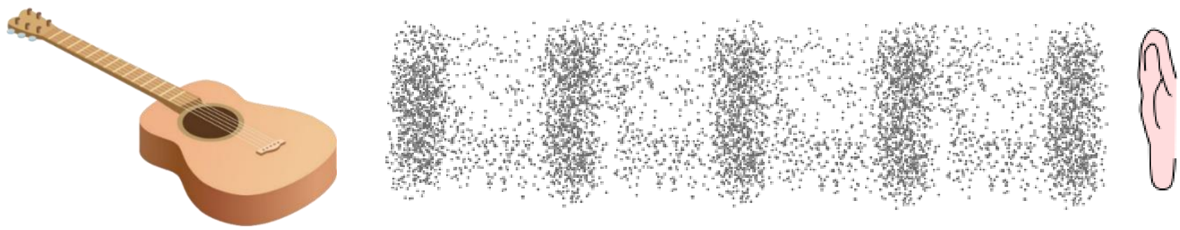
At the end of the section I can:

- ❑ 1 state the speed of sound in air is 340m/s
- ❑ 2 give an example which illustrates that the speed of sound in air is less than the speed of light in air, eg thunder and lightning
- ❑ 3 describe a method of measuring the speed of sound in air (using the relationship between distance, time and speed)
- ❑ 4 carry out calculations involving the relationship between distance, time and speed in problems on sound transmission
- ❑ 5 describe how sounds are produced
- ❑ 6 describe echo location and give examples of when it is used
- ❑ 7 describe the effect on the signal pattern displayed on an oscilloscope due to a change in a) loudness of sound
  b) frequency of sound
- ❑ 8 state that sound is a longitudinal wave

Sound

Before sound can be produced an object must be made to vibrate. Solids, liquids and gases are made up of particles. A sound wave makes the particles vibrate and the wave is transmitted from one particle to the next.

Eg:



You pluck a spring and it vibrates producing a sound.

Those vibrations pass into the particles in the air in the form of waves.

Sound cannot travel through a vacuum such as space as there are no particles to vibrate.

The Speed of Sound

Light travels very much faster than sound. So lightning is seen before thunder is heard, and an athlete sees a puff of smoke from the starter's gun before hearing the bang.

The speed of *sound* in air is about 340 metres per second.

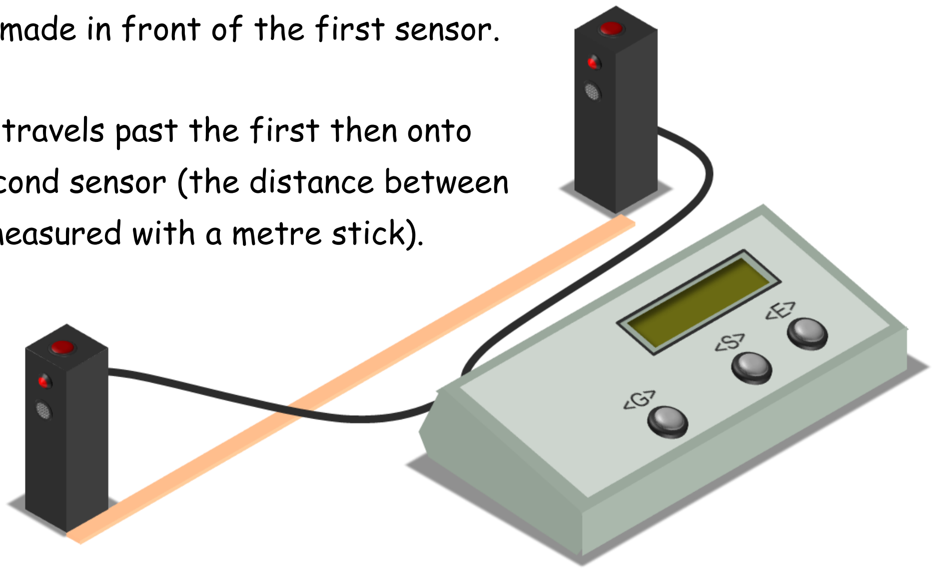
The speed of *light* in air is 300 000 000 metres per second.

Measuring the Speed of Sound

In the laboratory the apparatus below is used to measure the speed of sound in air.

1. First a sound is made in front of the first sensor.

2. The sound then travels past the first then onto and past the second sensor (the distance between the sensors is measured with a metre stick).

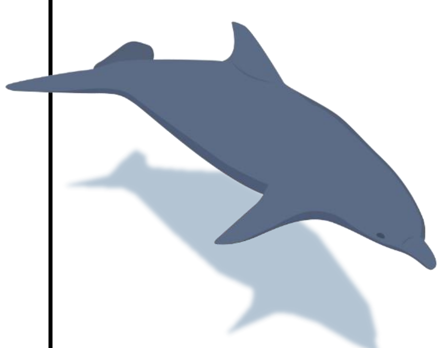


3. The time sensing assistant (TSA) records the time it takes the sound to travel between the two sensors.

4. The speed is calculated using:

$$v = \frac{d}{t}$$

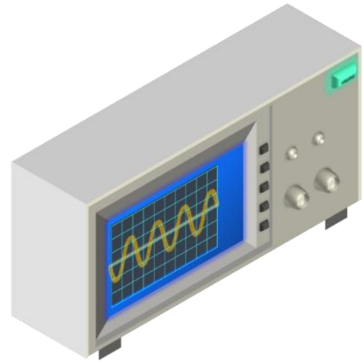
Echolocation



Many animals such as bats and dolphins use sound waves to navigate and hunt prey. They emit sound waves and use the concept of reflection to determine the distance between themselves and the things around them.

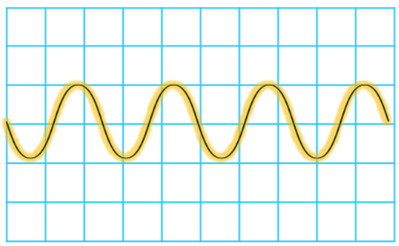
Echolocation is also used in various industries and in radar.

Oscilloscopes

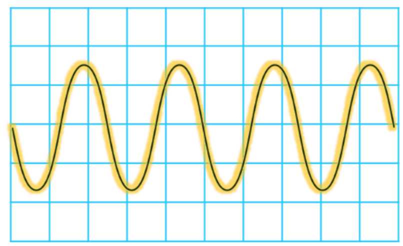


An oscilloscope can be used to show different waves. This can be used to determine whether a sound wave is loud or quiet, or whether a sound wave has a high or low frequency (pitch).

The oscilloscope patterns below display examples of sound:

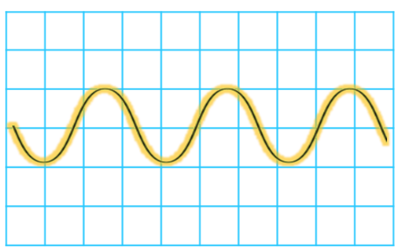


Small amplitude: quiet sound

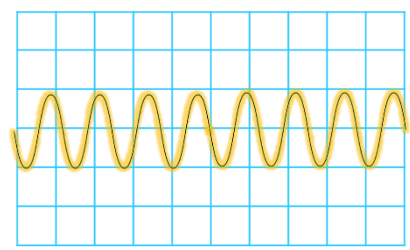


Large amplitude: loud sound

The greater the number of waves, the greater the frequency or pitch.



Low frequency: low pitch



High frequency: high pitch

Noise levels are measured in Decibels (dB) using a Decibel meter.

It is important to be aware of the noise levels around you. It can affect your hearing, cause you to go deaf and impact your mental health.

Unwanted sound is also known as noise pollution.

S2 LIGHT & SOUND
Light

At the end of the section I can:

- ❑ 1 state the law of reflection
- ❑ 2 label the following on a diagram: normal, angle of incidence, angle of reflection
- ❑ 3 give examples of when reflection is useful
- ❑ 4 explain why we see things as different colours
- ❑ 5 state that light travels at the air at 300 000 000 m/s
- ❑ 6 state that light is a transverse wave
- ❑ 7 state that mixing red, green and blue lights produces all colours seen on a colour television screen
- ❑ 8 explain how colour filters work

Light

Light is a type of energy that is transferred in transverse waves.

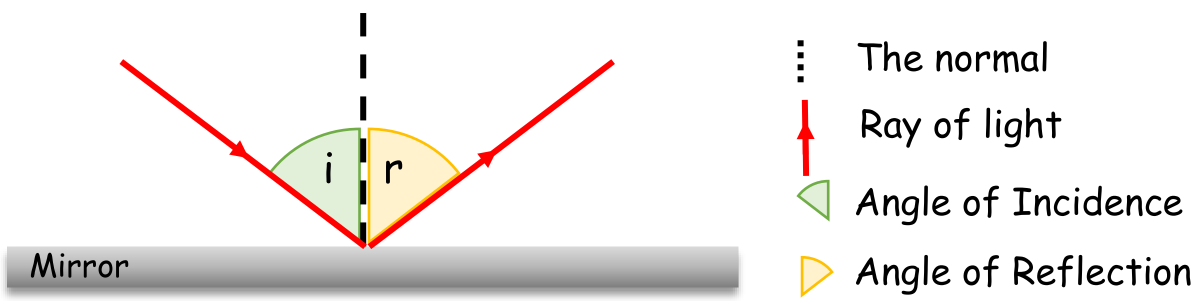
The colour of the light is dependent on the wavelength of the wave.

Light travels at 300,000,000 m/s in a vacuum. This is the fastest thing in the universe.

Reflection

Light travels in straight lines called rays. We use "ray-diagrams" to represent the path that can light take.

When light hits certain materials, it will reflect and "bounce" of the surface:



The normal is a line at right angles to the surface of the material.

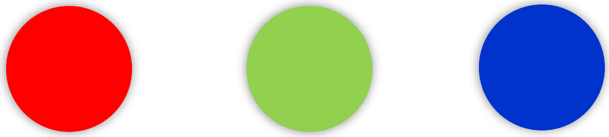
Law of Reflection:

The angle of incidence (i) is equal to the angle of reflection, (r).

$$i = r$$

Colour Mixing

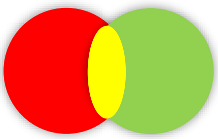
In Physics, there are three primary colours of light:



red green blue

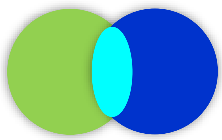
The primary colours can be mixed in the following way to make the secondary colours:

red + green



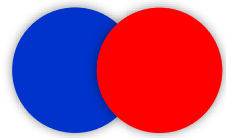
=yellow

green + blue



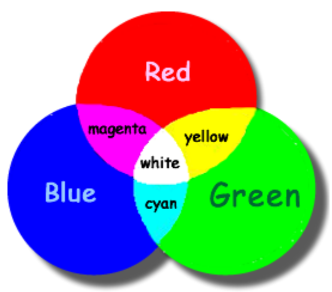
=cyan

blue + red



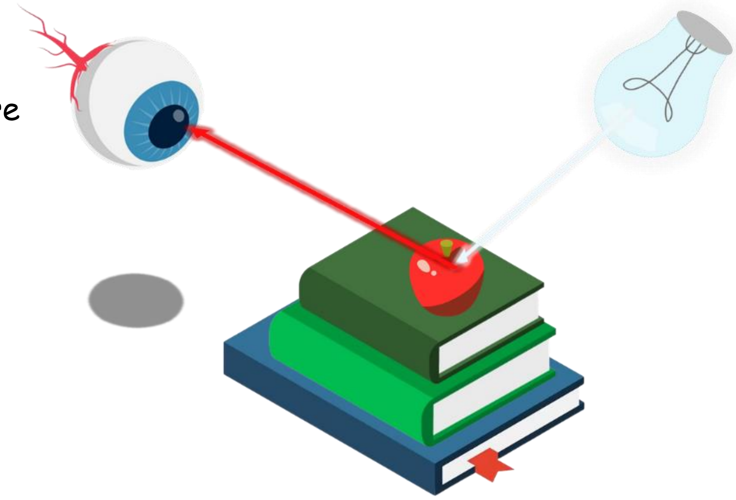
=magenta

When RED, GREEN and BLUE are all mixed together WHITE is made:



Seeing in Colour

We see because light reflects off objects. Some of the colours of light are absorbed by the object. Only colours that are not absorbed are reflected into our eyes. This is the colour we see.



Colour Filters

Colour filters will only allow some colours of light to pass through them (transmit). All other colours are absorbed.

For example, if you have a red filter:

- Red light is transmitted
- Blue and green light are absorbed.