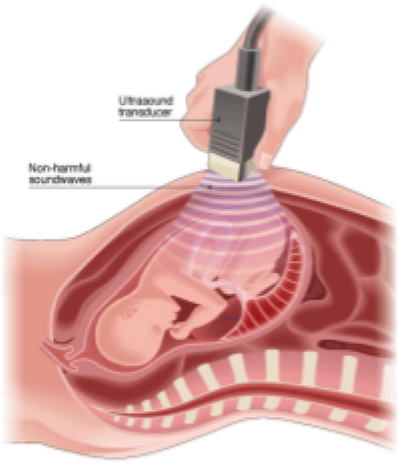
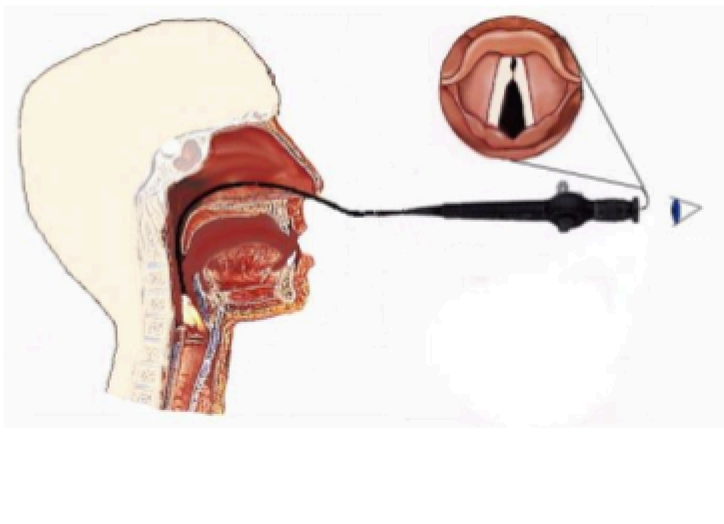
S2 Waves



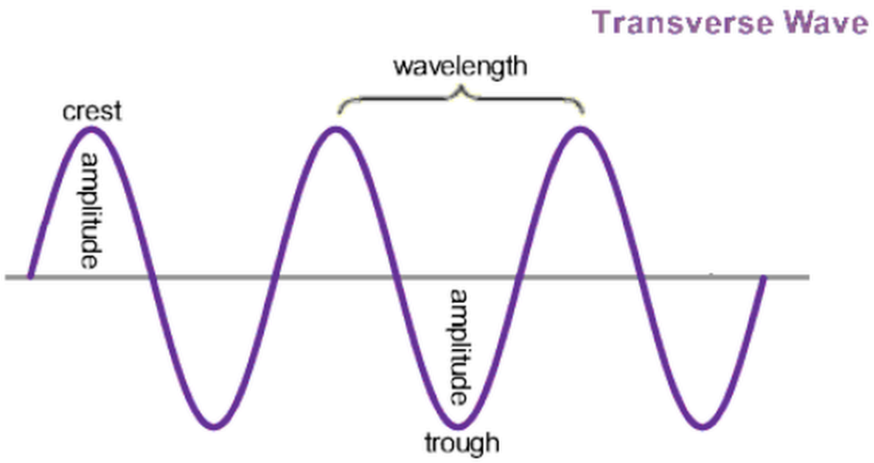


Summary notes

Wave Terminology

Success Criteria: I can…. • Know that waves carry energy • Describe and label the parts of a wave • Give some examples of waves. • Be able to use the frequency, number of waves and time equation	L4

Waves transfer **ENERGY** from one place to another. There are 2 main types of waves; **TRANSVERSE** and LONGITUDINAL.



The **frequency, f,** of a wave is the number of waves that pass a point in 1 s. Frequency is measured in hertz (Hz).

The **wavelength,** λ**,** of a wave is the horizontal distance between two adjacent troughs or crests or any two corresponding points on the wave. Wavelength is measured in metres (m).

The **amplitude** of a wave is half the vertical distance between a trough and a crest. Amplitude is measured in metres (m).

<u>Waves: Speed, Distance and Time</u>

Use the speed, distance and time formula. *Describe and experiment to measure the speed of sound in air.* *State that the speed of sound in air is 340 m/s.* *Use the speed, distance and time formula in echo questions.*	L4

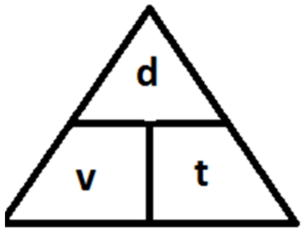
Waves **transfer energy**, e.g. water waves can transfer energy across the water. Radio and television signals are waves that travel through the air at 300 million metres per second (3×10^8 m/s) - the same speed as the speed of light.
The light from a thunderstorm is seen before the sound of the thunder since the speed of light is much greater than the speed of sound.
The speed of a wave can be calculated using this equation:

Distance (m)

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

Velocity (m/s)

Time (s)



v = velocity
d = distance
t = time

Velocity Formula

<u>Example</u>

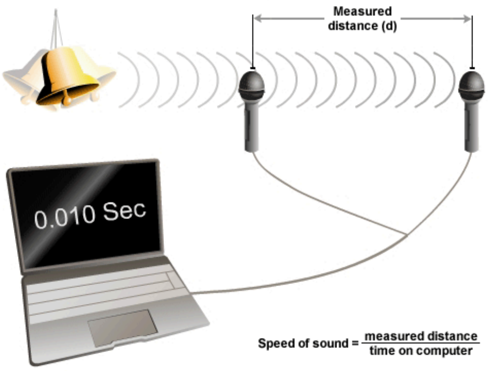
A sound wave takes 4 seconds to travel a distance of 2400 metres through a liquid. How fast is the sound wave travelling in m/s?

V=? t= 4s d=2400m

$$V = \frac{d}{t} = \frac{2400}{4} = 600\text{m/s}$$

Sound Waves: Speed of Sound

To find the speed of sound in a material you need to measure the distance the sound travels and the time it takes to travel that distance.
You can do this using microphones connected to a timer. The timer will start when the first microphone picks up the sound a stop when the second microphone does. If we know the distance between the microphones then we can calculate speed using our speed equation.

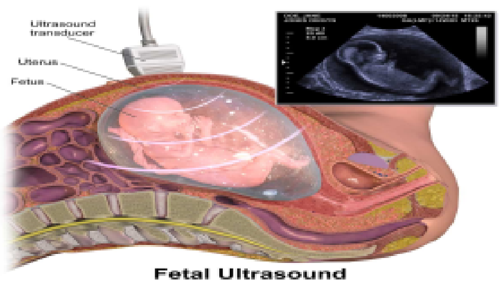


Using Sound: Ultrasound

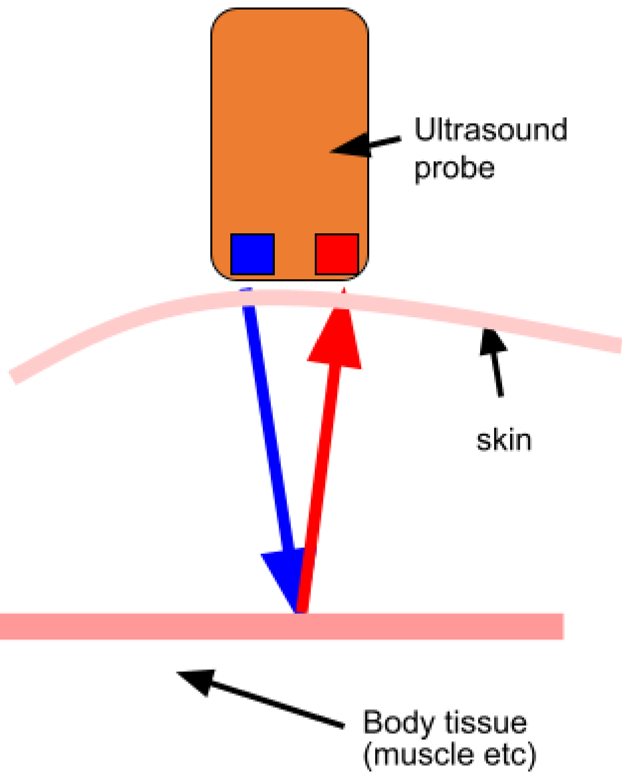
State the frequency range of human hearing. Explain how an ultrasound image is formed.	L4

Humans can usually only hear sounds with frequencies of between 20Hz and 20 000 Hz .

- **Any sound of a frequency** higher than 20kHz is known as "ultrasound".
- Ultrasound can be used in different ways, the most common of these ways is to produce pictures of unborn babies in the mother's womb;
- **Pulses of ultrasound** are transmitted into the patient.
- A gel is used to **stop the pulses reflecting** from the patients' skin.
- The ultrasound **waves reflect off of different tissues.**
- The computer measures the **time for each reflection.**
- **Using these times and the speed of sound in tissue,** it **calculates distances** and so builds up a picture of the unborn baby.



Fetal Ultrasound



<u>Using Sound: The Stethoscope</u>

Label the parts of the stethoscope. *Describe how the stethoscope works.* *Describe how it is used in medicine.*	L4

The stethoscope has two "bells" which are used to amplify sounds from inside the patient's body.

<u>Using Sound: Ear Protection</u>

State the sound levels, in dB, for everyday sounds. *Identify sounds that are noise pollution.* *Describe how sound levels are reduced in the workplace.*	L4

Amplifying sound is useful in medicine, however, many everyday sound levels are considered to be dangerous. Sound levels are measured in decibels (dB).

Some examples of typical sound levels are:

Threshold of hearing	0 dB
Whisper	20 dB
Ordinary conversation	60 dB
Heavy lorry passing 1m away	95 dB
Pneumatic drill	100 dB
Rock group at 1m	120 dB
Threshold of pain	140 dB

Any sound of 90 dB or above is considered to be <u>noise pollution.</u>

Over exposure to a source of noise pollution can cause permanent damage to hearing. That's why older people cannot hear high frequency sounds their ear drums cannot vibrate at such frequencies due to damage in their youth.

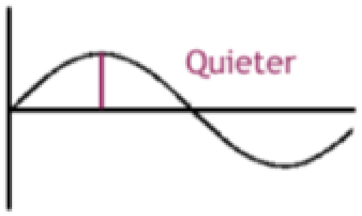
Can you think of any jobs that require the use of ear protectors?

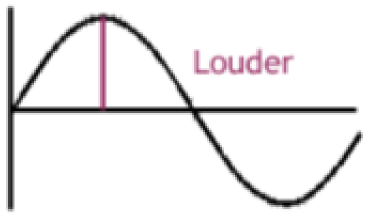
Sound Waves: Producing a Trace

Describe the effect changes in amplitude and frequency have on a sound.	L4

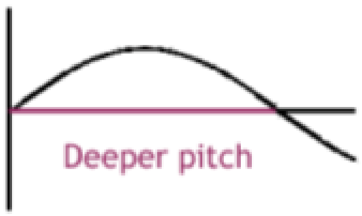
A signal generator can also be used to display waves on an oscilloscope. Unfortunately, it will not display a longitudinal sound wave. It can only display transverse waves.

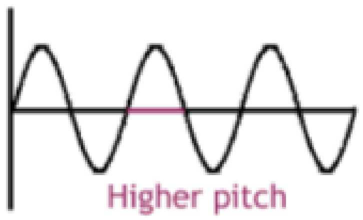
Sound waves with a bigger amplitude will be louder.





Waves with a lower frequency (bigger wavelength) will have a deeper pitch



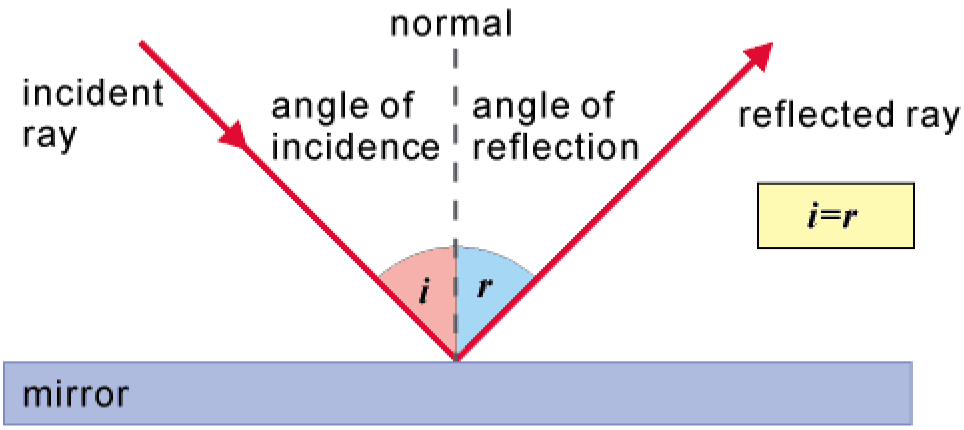


Visible Light: Law of Reflection

State the law of reflection. Label a ray diagram from investigating the law of reflection.	L3

When a light ray reflects of a surface, the angle the light comes in at (angle of incidence) is equal to the angle it leaves at (angle of reflection).

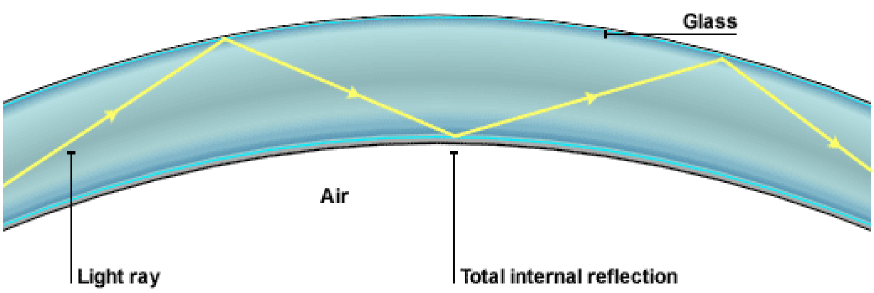
These angles are measure form the normal line. This is an imaginary line that is drawn in at a right angle (90^0) to the surface.



Using Reflection: Fibre Optics

State the definition for 'total internal reflection.' Describe a use for fibre optics in medicine.	L3

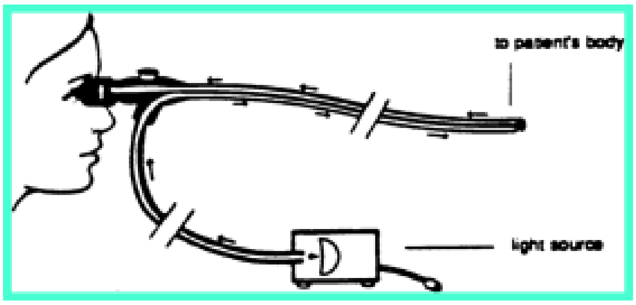
A fibre optic is a long thin solid piece of glass or plastic which is very flexible. Fibre optics can be used as a transmission system for "cold light." Light travels through the fibre by total internal reflection, obeying the law of reflection.



Fibrescopes have two bundles of fibre optics joined together. It is used to collect visual information from inside a patient.

The first bundle of fibre carries light into the patient.
The light then reflects off the inside of the patient.

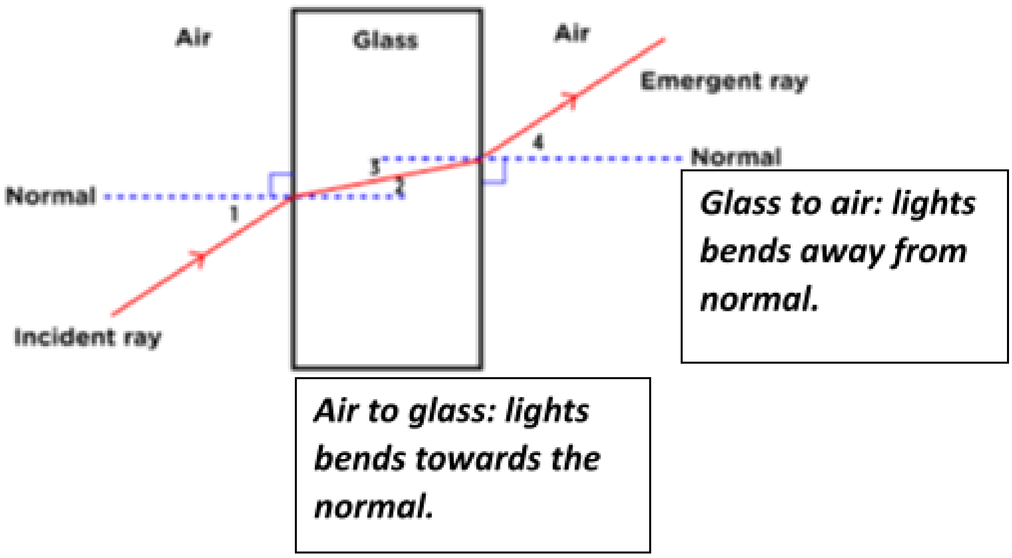
The second bundle of fibre then carries the light back to the doctors eye where diagnosis can be made.



Visible Light: Refraction

State the definition of refraction in terms of speed. *State the evidence for refraction in term of angle, from air to glass and glass to air.* *Label a ray diagram from investigating refraction.*	L3

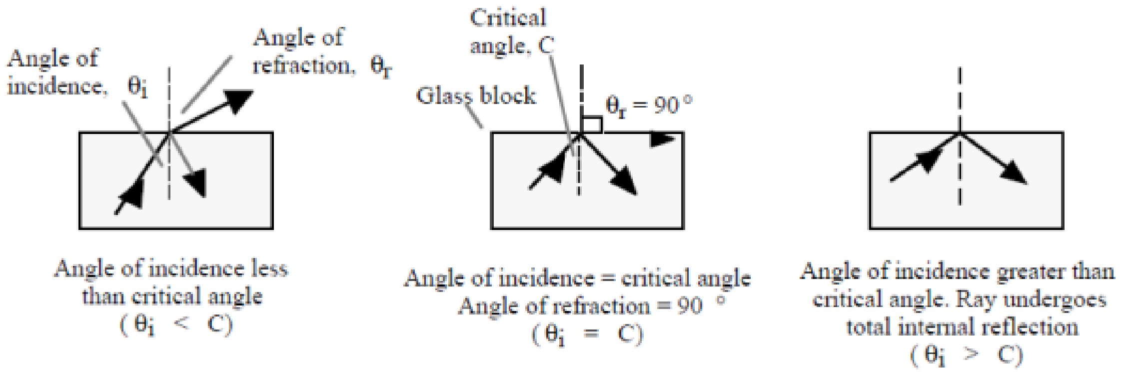
Light rays bend towards the normal when entering a transparent object and bend away from the normal when leaving the object. It is caused by the light slowing down in the denser medium.
The change in speed of light as it changes medium (e.g. air to glass) is known as refraction.



Comparing Refraction and Reflection

Use refraction and reflection to predict the path of an incident ray.	L3

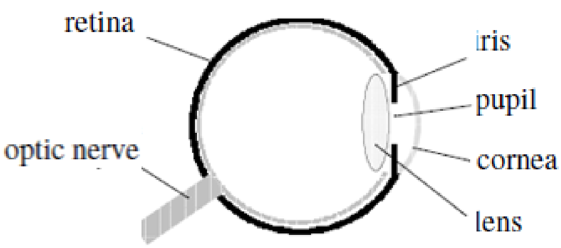
The critical angle is used to determine if refraction or reflection will happen. It is an angle of incidence, specific to each material.

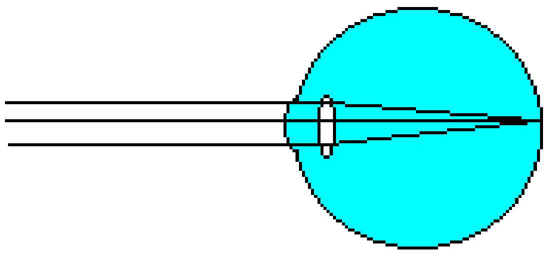


Using Refraction: The Eye

Label the parts of the eye. *Describe how a sharp image is formed on the retina.*	L3

The human eye is a detector of light. Light is focused on the retina of the eye by the **cornea** and **lens**. The image formed on the retina is smaller than the object viewed and upside down.

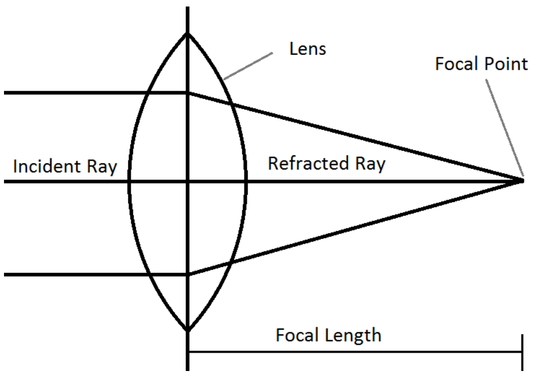




Most of the refraction takes place at the cornea. The lens changes shape and allows the eye to focus on objects at different distances.

Using Refraction: Focal Length

Focal length is the distance from the centre of a lens or curved mirror to its focal point. The focal point is the place where all the light rays are brought to a point where the image becomes 'in focus.'

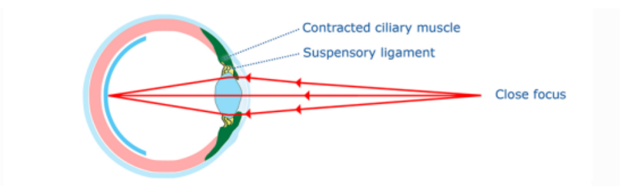


Using Refraction: Lens Accommodation

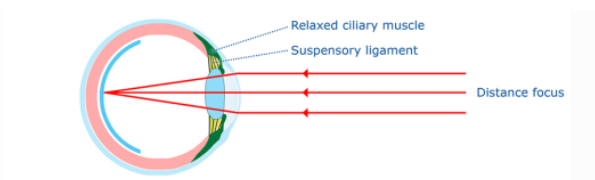
Explain lens accommodation.	L3

The ability of the eye lens to adjust its focal length is known as accommodation.

For nearby objects, the ciliary muscles contract and squeeze the lens into a more convex shape. This results in more refraction of light, shortening the focal length.



For distant objects, the ciliary muscles relax and the lens returns to a flatter shape. This results in less refraction, increasing the focal length.

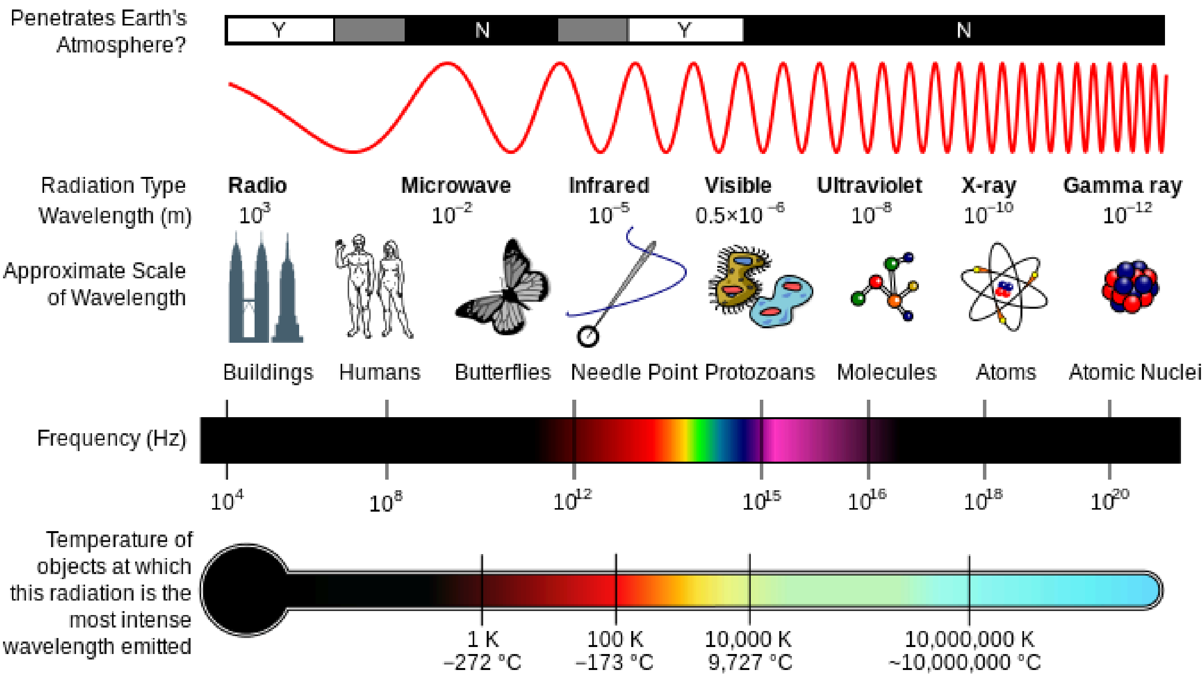


The Electromagnetic Spectrum

Describe why the EM spectrum is a family of waves.	L3

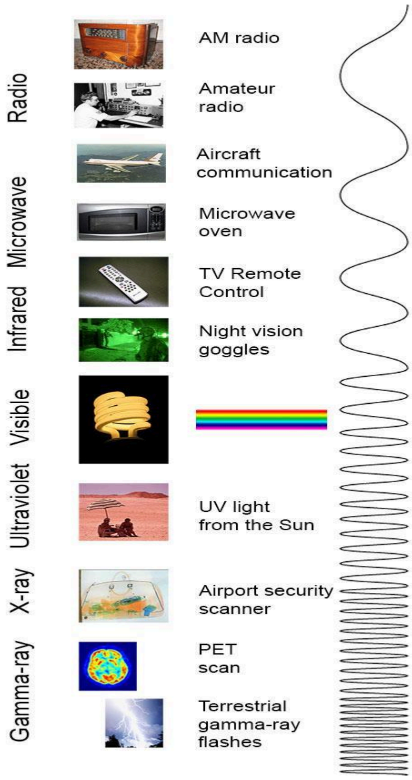
Medical physics uses most parts of the electromagnetic spectrum to diagnose and treat illnesses.
The electromagnetic spectrum is a family of waves as they all:

1. travel as transverse waves
2. have a speed 3×10^8 m/s



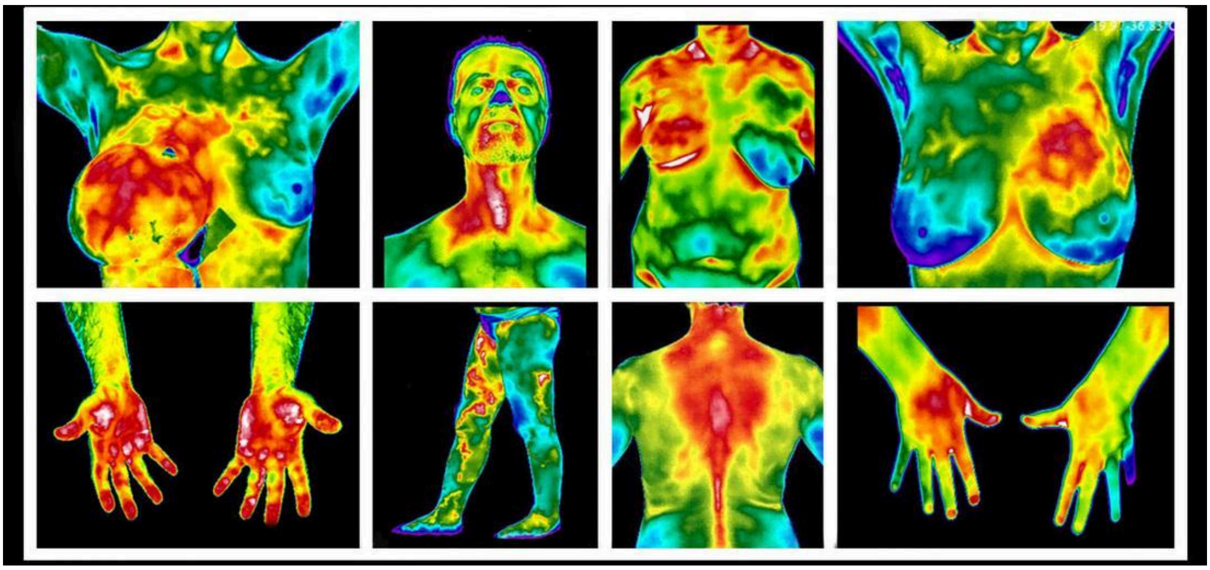
Using the Spectrum

Describe at least one application for each part of the EM spectrum. Research and report on one of the applications.	L3



Infrared

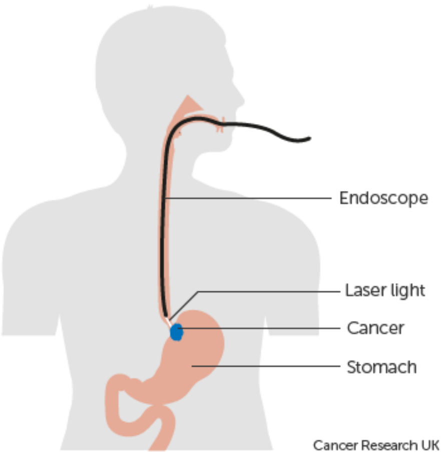
Diagnostics: Thermo grams show areas of different temperature. This means they can show areas of inflammation within tissues. Tumours are warmer than healthy tissue and show up clearly.



Treatment: Infrared wavelengths can penetrate the skin with minimal risk to the patient. This is why IR health lamps are used to manage muscular pain.

<u>**Visible light**</u>

A laser produces a narrow beam of very intense light. Laser light is (can be passed along an endoscope) concentrated on the tumour and so vaporises it.



Laser light can also be used to:

-make incisions in the body, sealing blood vessels as it goes. This is known as a laser scalpel.

- remove birthmarks.

-treat damaged retinas.

<u>**Ultraviolet**</u>

Patients in hospital are sometimes exposed to ultraviolet lamps to compensate for their lack of sunlight. E.g. babies with jaundice.
Carefully controlled amounts of ultraviolet radiation are used in the treatment of skin disorders such as acne.
Ultraviolet radiation can also be used to kill harmful bacteria as it damages living cells. However too much exposure to radiation can cause skin cancer.

<u>**X-Rays**</u>

X-rays can detect broken bones.

- Transparent photographic film turns black when exposed to x-rays.
- Bones placed between the x-ray generator and the photographic film, absorb the x-rays and do no reach the film, leaving it clear.