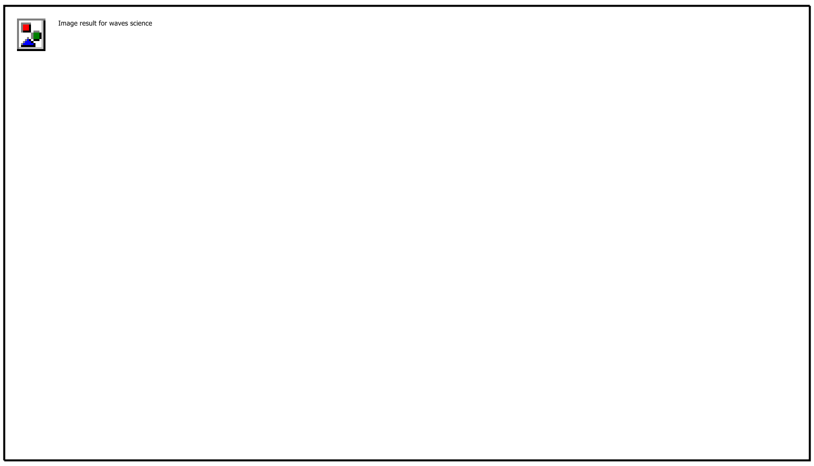
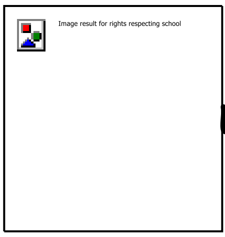
Year 8 Science Revision - Waves



This booklet contains all the content from the Waves topic. There are activities at the back of the booklet and you can also use the information to create your own revision resources too. Highlight/underline the key information, annotate it and identify your strengths and weaknesses.



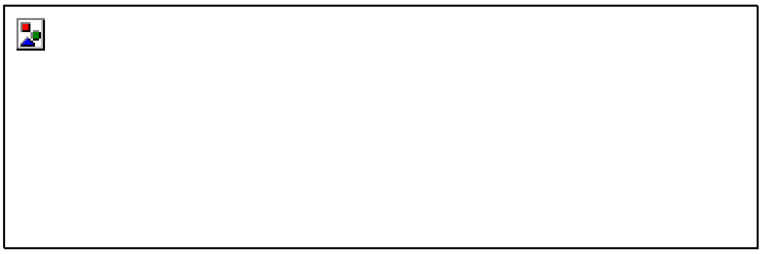
ARTICLE 28 – RIGHT TO EDUCATION: Every child has the right to an education.

AFL #1: Lesson 1- How can we describe waves?

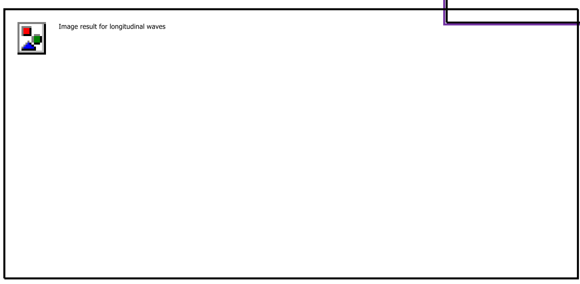
All waves transfer energy from one place to another through a sequence of vibrations (or oscillations). Waves do not transfer matter, they travel through a material, such as air, or even through a vacuum, such as space.

There are lots of different types of waves such as water wave, light waves, soundwaves and radio waves. Depending on how they travel the different types of waves fit into one of two categories- longitudinal or transverse.

Transverse waves



The vibrations in transverse waves are at right angles to the direction that the energy travels. If the wave is moving from left to right, then the vibrations are up and down.



Longitudinal waves

The vibrations in longitudinal waves are parallel to the direction that the energy travels. If the wave is moving from left to right, then the vibrations are left to right.

Water waves

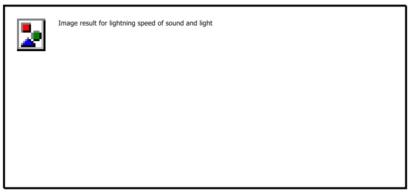
If you throw a pebble into a pond, ripples spread out from where it went in. These ripples are waves travelling through the water. The waves move with a transverse motion. The vibrations are at 90° to the direction of travel (up and down movement). For example, if you stand still in the sea, the water rises and falls as the waves move past you.

Superposition

Adding	Cancelling
If two waves meet each other in step, they add together and reinforce each other. They produce a wave with a greater amplitude	If two waves meet each other out of step, they cancel out.
	

AFL #1: Lesson 2- What are light waves?

Light travels as waves. These are transverse waves, like the ripples in a tank of water. The direction of vibration in the waves is at 90° to the direction that the light travels. Light travels in straight lines, so if you have to represent a ray of light in a drawing, always use a ruler.



The speed of light is 300,000,000 m/s (3×10^8 m/s), this is much faster than the speed of sound in air, which is only 340 m/s. This is why we see lightening before we hear it.

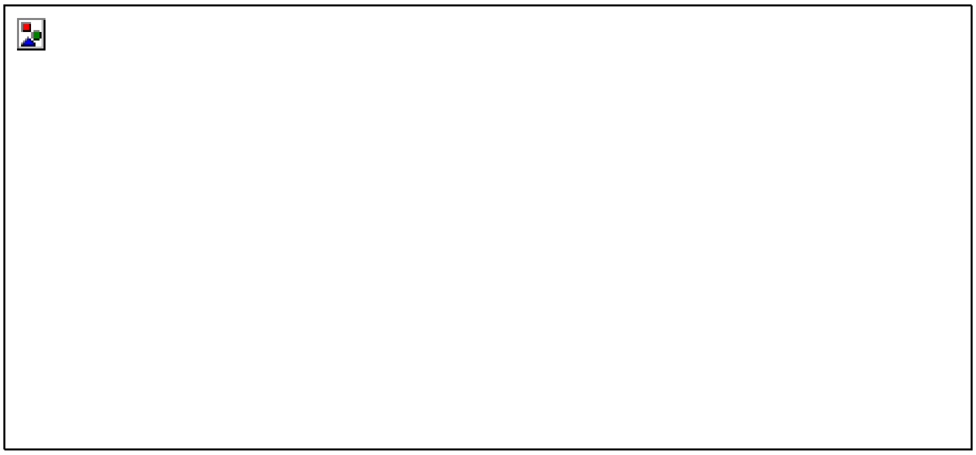
There are some key terms, linked to waves, that you need to become familiar with: absorb, reflect and transmit.

Absorb: To soak up or take in- for waves, it is when the wave disappears because the energy is transferred to the material.

Reflect: To bounce of a surface- for waves, it is when the wave bounces off the surface instead of passing through it or being absorbed.

Transmit: To pass through- for waves, it when the wave passes through something instead of being absorbed or reflected.

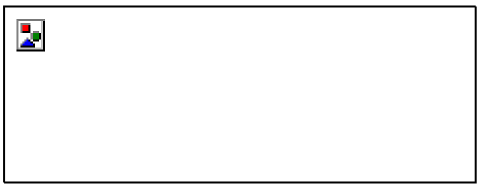
Light waves can travel through a vacuum (empty space). They do not need a substance to travel through, but they can travel through transparent and translucent substances. Light waves cannot travel through opaque substances- they get reflected or absorbed.



Drawing light ray diagrams

When drawing diagrams to show how a light ray travels there are some simple rules to follow:

- Always use a ruler because light travels in straight lines
- The light travels from the source, to the object and then to the receiver
- Make sure the light ray touches the source of light, the object and the observer (e.g. the eye or camera lens)
- The light ray must 'hit' and 'leave' the object in the same place if the light is reflected



AFL #1: Lesson 3- How are light waves reflected?

A ray diagram shows how light travels, including what happens when it reaches a surface. In a ray diagram, you draw each ray as:

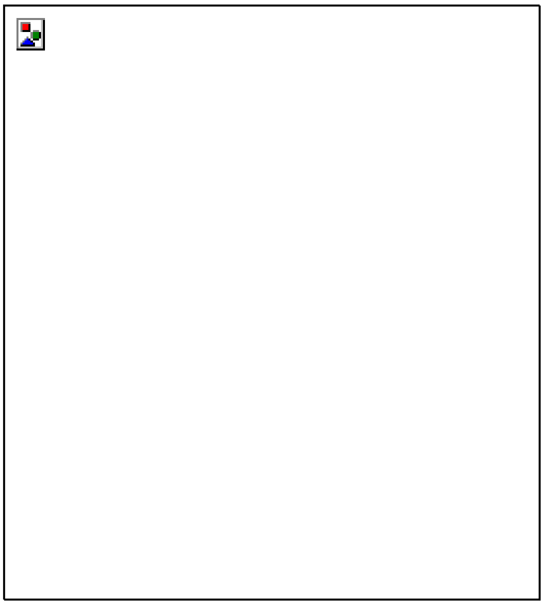
- a straight line
- with an arrowhead pointing in the direction that the light travels
- Remember to use a ruler and a sharp pencil.

The law of reflection

When light reaches a mirror, it reflects off the surface of the mirror:

- the incident ray is the light going towards the mirror
- the reflected ray is the light coming away from the mirror

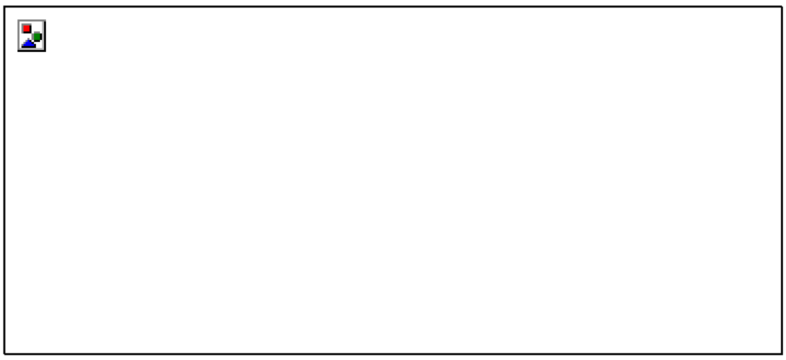
In the ray diagram:



- the hatched vertical line on the right represents the mirror
- the dashed line is called the normal, drawn at 90° to the surface of the mirror
- the angle of incidence, i, is the angle between the normal and incident ray
- the angle of reflection, r, is the angle between the normal and reflected ray

The law of reflection states that the angle of incidence equals the angle of reflection, i = r. It works for any angle. For example: the angle of reflection is 30° if the angle of incidence is 30°.

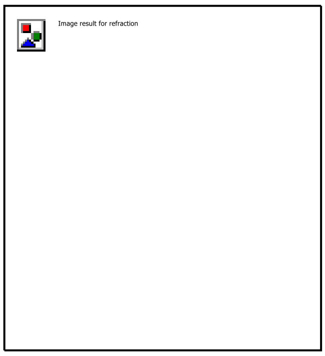
Specular reflection and diffuse scattering



The reflection of light from a flat surface such as a mirror is called specular reflection – light meeting the surface in one direction is all reflected in one direction.

If light meets a rough surface, each ray obeys the law of reflection. However, the different parts of the rough surface point in different directions, so the light is not all reflected in one direction. Instead, the light is reflected in all directions. This is called diffuse scattering. It explains why you can see a clear image of yourself in a shiny flat mirror, but not in a dull rough wall.

AFL #1: Lesson 4- How are light waves refracted?



Some objects appear to bend when they are placed in water- this is due to refraction.

Refraction is when light waves change direction as they pass across the boundary between two substances, such as air and water.

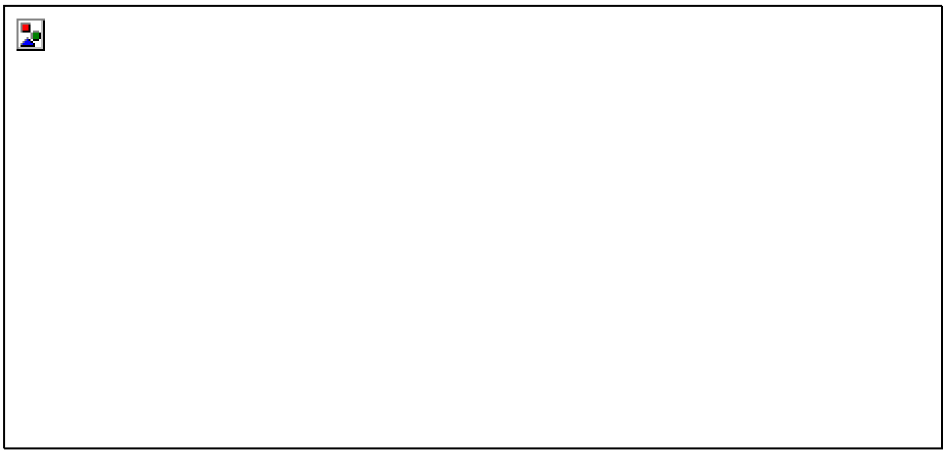
Refraction is caused because light changes speed as it crosses the boundary.

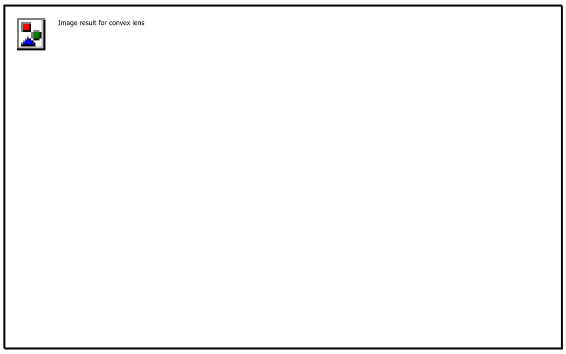
At the boundary between two transparent substances:

- If light passes from air into water, the light slows down going into a denser substance, and the ray bends towards the normal
- If light passes from water into air, the light speeds up going into a less dense substance, and the ray bends away from the normal

The diagram shows how this works for light passing into, and then out of, a glass block.

Light slows down as it enters and bends towards the normal. Light speeds up as it leaves and bends away from the normal.





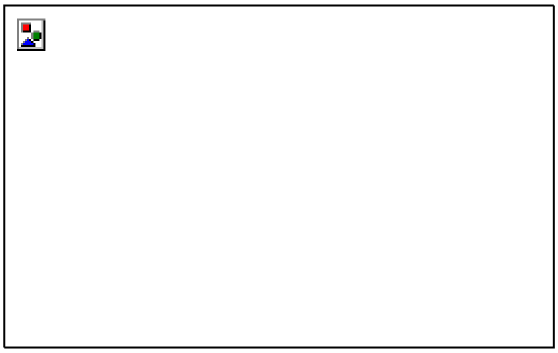
Convex lenses use refraction to help focus light on a certain point. Our eyes have lenses that help focus images onto the retina at the back of our eyes. Due to their curved shape the refraction causes all of the light rays to focus on a certain point- the focal point.

Lenses can create different types of images known as real images and virtual images.

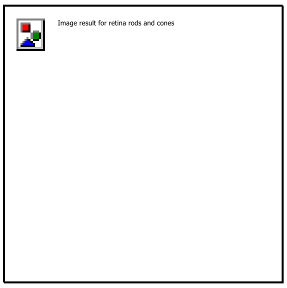
A real image can be projected onto a screen and is produced when the light rays actually meet where the image is formed.

A virtual image cannot be projected onto a screen and is produced when the light rays only appear to meet.

AFL #2: Lesson 5- How does the eye work?



The eye focuses light from an object onto a photo-sensitive material. In the eye, this material is called the retina. The retina contains cells that are sensitive to light, called rods and cones. They produce electrical impulses when they absorb light. These impulses are passed along the optic nerve to the brain, which interprets them as vision.



The cones are responsible for detecting colour and the rods detect the intensity of the light- they are used in low light situations.

As light enters the eye, through the pupil, it is refracted by the cornea and the lens, this helps to focus the light onto the retina. The iris, the coloured part of our eye, controls the size of the pupil, making it larger in dark environments and narrower when it is bright.

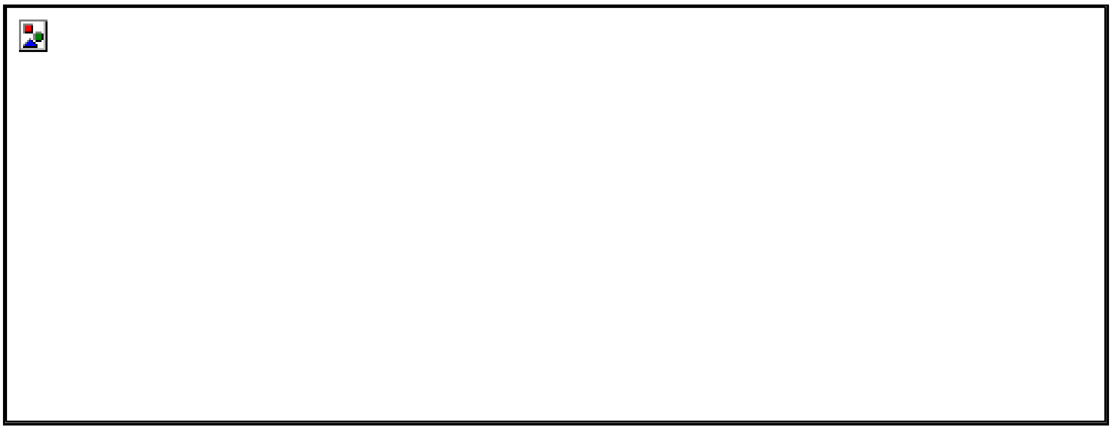
The camera

Cameras are devices that focus light from an object onto a photo-sensitive material using a lens. In an old-fashioned camera, the photo-sensitive material was camera film. When the film absorbed light, a chemical change produced an image in the film, called the 'negative'. This was used to produce a photograph on photo-sensitive paper.

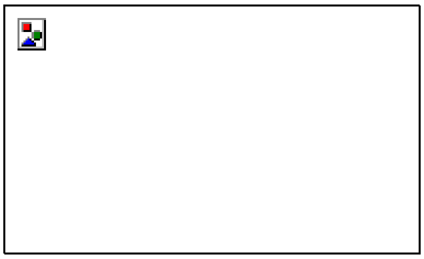
In a modern camera or the camera in a mobile phone, the photo-sensitive material produces electrical impulses, which are used to produce an image file. This can be viewed on the screen, or its information sent to a printer.

Comparing our eyes and cameras

Our eyes and cameras work in very similar ways; they both use lenses to focus light onto photosensitive surface in order to form images.



AFL #2: Lesson 6- What are the colours of light?



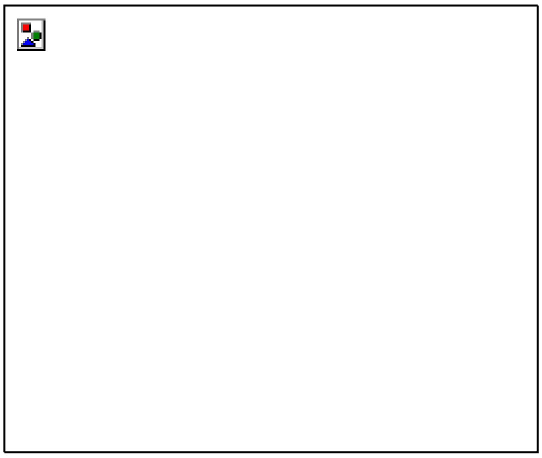
Sometimes, when it is sunny and raining at the same time, we see a rainbow. In science we call this rainbow the spectrum of visible light. The colours are: red, orange, yellow, green, blue, indigo and violet.

Coloured light

There are three primary colours of light that can be mixed together to create all other colours- these are slightly different to the primary colours of paint.

- The primary colours of light are: red, blue and green.

If these colours are mixed, then we make the secondary colour of light.

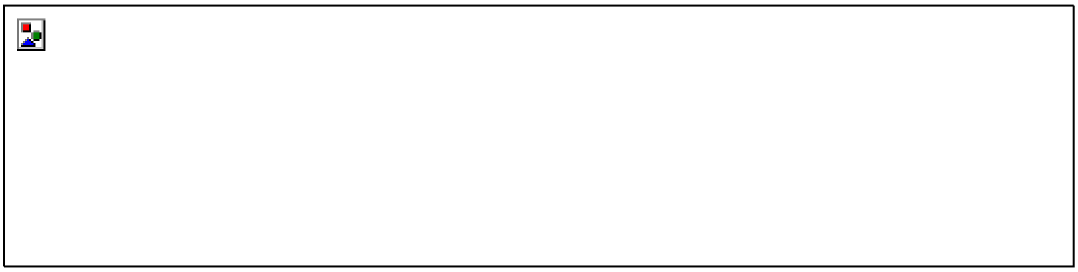


- The secondary colours of light are magenta, cyan and yellow.
- Magenta is made by mixing red and blue light
- Cyan is made by mixing blue and green light
- Yellow is made by mixing green and red light
- Mixing all three primary colours together gives us white light

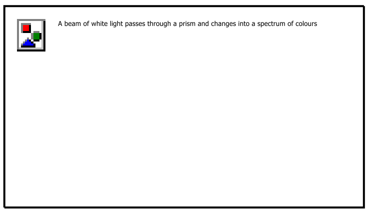
Different colours are made by mixing different amounts of each light.

Colour and frequency of light

Light waves have different colours due to their different frequencies. Red light has a longer wavelength and a lower frequency than violet light. The cones in that make up part of our retina interpret these different frequencies as different colours.



In a science classroom we can use a prism to the visible spectrum of light. Normal 'white' light contains all the colours of the spectrum mixed together. As the light enters the prism it slows down and is refracted towards the normal, as it leaves the prism it speeds up and refracts away from the normal. Light with a higher frequency (violet light) slows down and speeds up more than light with a lower frequency (red light). This is why violet light 'bends' further than red light and the spectrum of colours starts to split up into the different colours. This process is called dispersion.


A beam of white light passes through a prism and changes into a spectrum of colours

AFL #2: Lesson 7- Why do we see different colours?

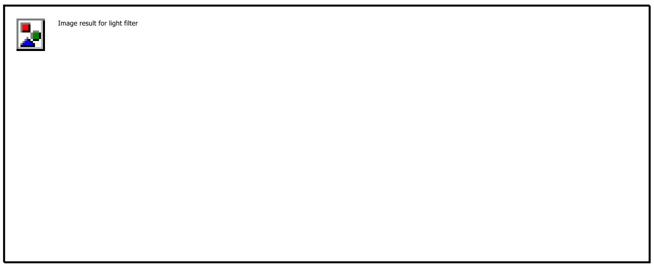
We see different objects as different colours due to the way light acts when it hits the object.

When light hits a surface, some of it is absorbed and some of it is reflected. The light that is reflected is the colour of the object in that light. For example, a blue object absorbs all the colours of the spectrum except blue: it reflects blue light.

The table, below, gives some more examples, displaying the colour of light shining on an object, the colour(s) absorbed by an object, the colour reflected by an object in this light and the colour of an object seen in this light.

	White paper	**Red apple**	**Green apple**
Colours(s) that the object can reflect	All	Red only	Green only
Appearance of object in white light	White (no colours absorbed)	Red (all colours absorbed except red)	Green (all colours absorbed except green)
Appearance of object in red light	Red (only red light to reflect)	Red	Black (no green light to reflect)
Appearance of object in green light	Green (only green light to reflect)	Black (no red light to reflect)	Green
Appearance of object in blue light	Blue (only blue light to reflect)	Black (no red light to reflect)	Black (no green light to reflect)

Objects appear black in white light because they absorb all colours and reflect none. Objects also appear black in any single colour of light if their colour is not the same as the light. For example, a green object appears black in any other light than green (or white which contains green) because there is no green light shining on it to reflect into your eyes.



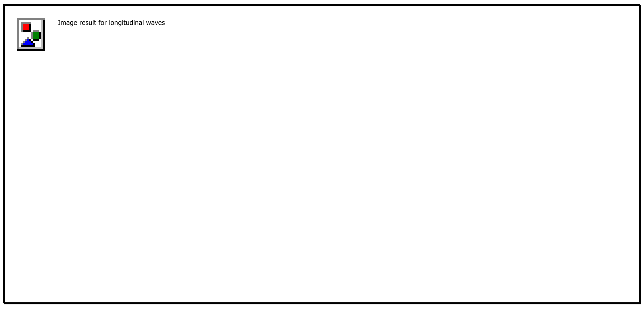
Filters

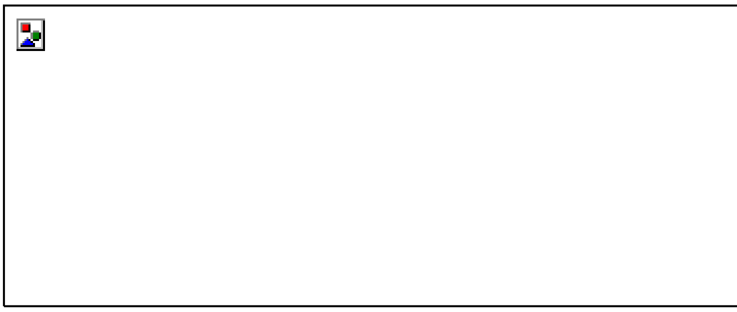
Filters will absorb some light and transmit (allow to pass through) other colours.

A filter will transmit its own colour and absorb all other colours. For example, a blue filter will transmit blue light and absorb all other colours, a magenta filter will transmit blue and red light and absorb all other colours. Filters can be used to produce light rays of different colours.

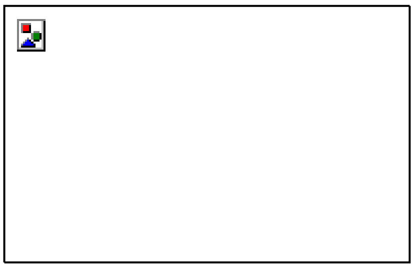
AFL #3: Lesson 8- What are sound waves?

When an object or substance vibrates, it produces sound. These sound waves can only travel through a solid, liquid or gas. They cannot travel through empty space, because there are no particles to vibrate. Sound waves are longitudinal waves - the vibrations are in the same direction as the direction of travel.

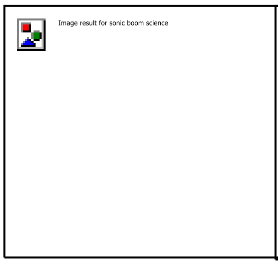


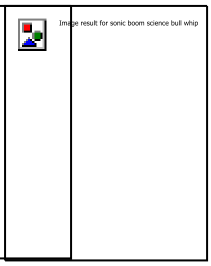


Sound waves travel through a series of vibrations, as the sound wave travels from the source to your ears the particles are forced to vibrate and they pass energy onto the particles next to them, they in turn vibrate and a pass energy to particles next to them. Sound travels faster through liquids and solids than it does through air and other gases. This is because the particles of gases are further apart than liquids and solids. Sound waves move more slowly when particles are further apart or less tightly packed.



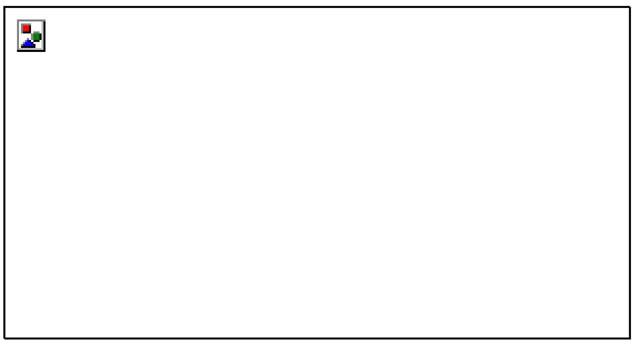
Sound waves travel fast, but not as fast as light. Some aeroplanes can travel faster than the speed of sound when the break the sound barrier they create a sonic boom





This is the same sound you hear when a bull whip 'cracks', the tails at the end of the whip travel faster than 343 m/s.

Sound waves are longitudinal, but we often convert them to transverse waves in order to more easily display the amplitude and wavelength.



You can see on this diagram how we can measure the wavelength and amplitude of sound waves.

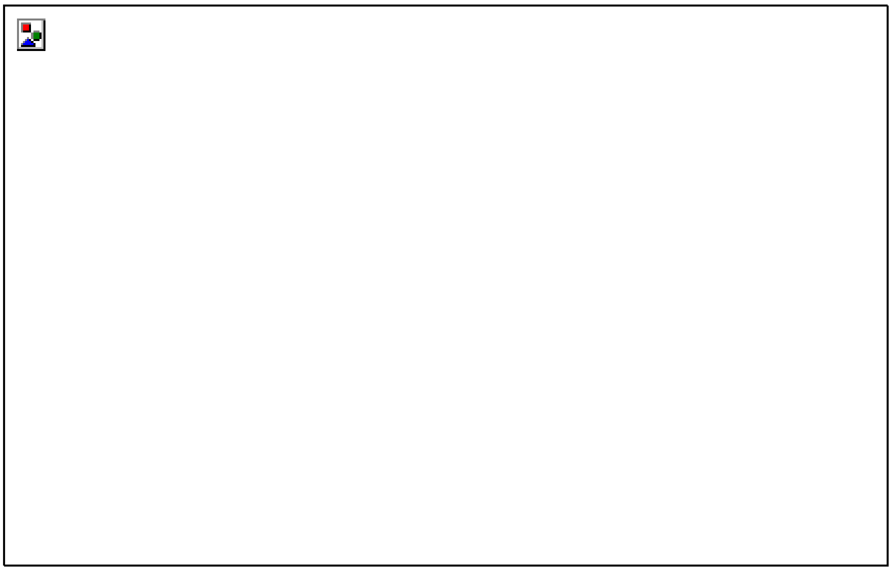
- The higher the wavelength is, the higher pitch the sound will be.
- Sounds with a higher amplitude will be louder.

AFL #3: Lesson 9- How do we hear sound?

The volume of sound is measured in decibels (dB); a whisper will be around 15 dB whilst normal conversation will be around 55 dB. A passenger car will have a volume of around 75 dB whilst a large aeroplane taking off will be around 120 dB. The frequency of sound is measured in hertz (Hz); humans have a hearing range of 20 – 20,000 Hz.

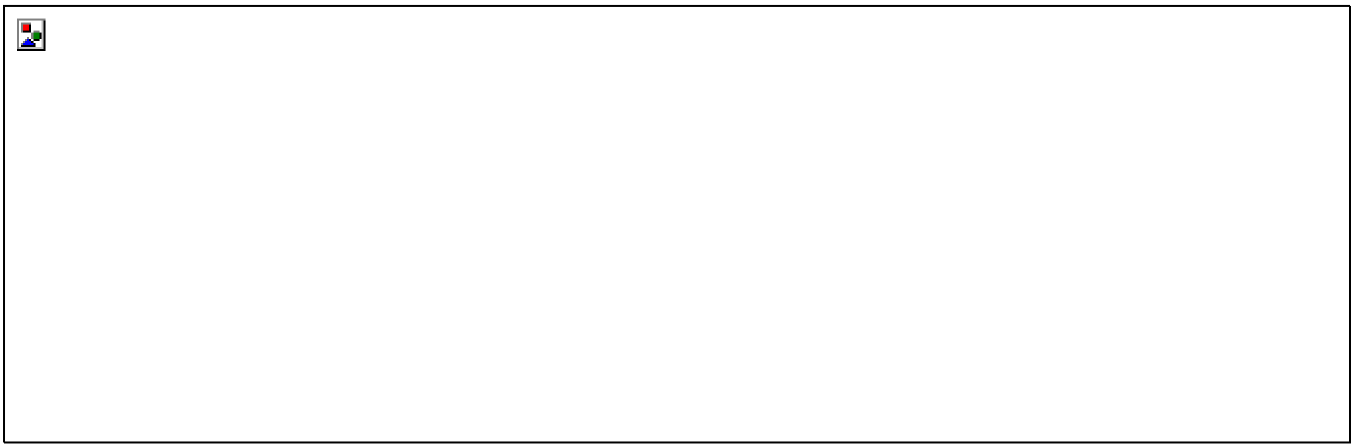
We can detect sound using our ears. An ear has an eardrum inside, connected to three small bones.

Sound waves are funnelled by the pinna and travel down the ear canal. The vibrations in the air make the eardrum vibrate, and these vibrations are passed through the three small bones to a spiral structure called the cochlea. Signals are passed from the cochlea to the brain through the auditory nerve, and our brain interprets these signals as sound.



Microphones

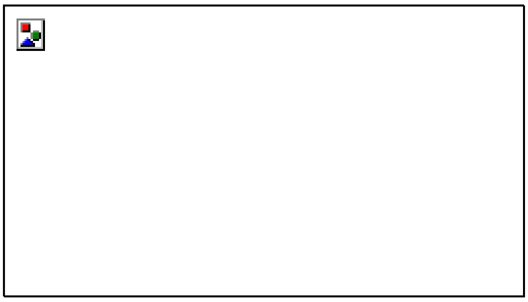
Mobile phones and telephones contain microphones. These devices contain a diaphragm, which does a similar job to an ear drum. The vibrations in air make the diaphragm vibrate, and these vibrations are changed to electrical impulses. In the lab, the electrical impulses can be sent to an oscilloscope, which represents them as a graph on a screen.



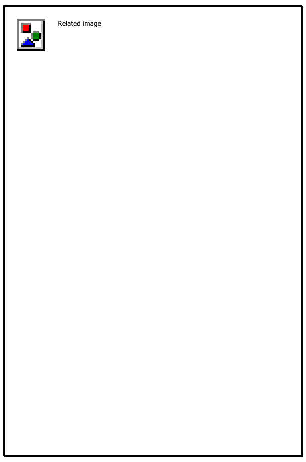
AFL #3: Lesson 10- How else can sound waves be used?

Loud sounds can damage our hearing. They can damage the eardrum or the hairs in the cochlea. Loud or unwanted sound is called noise. To protect our hearing, we can wear ear defenders, or limit our exposure to loud sounds (e.g. turn headphones down). Motorways are often surrounded by high verges or trees as these act to absorb the sound of the traffic. Our hearing tends to get worse as we get older and can be damaged by infections or diseases.

Humans can hear sounds that are between 20 and 20,000 Hz. Sounds that are lower than 20 Hz are called infrasound, soundwaves higher than 20 kHz are called ultrasound.



Some animals, such as bats and dolphins use ultrasound to help them locate prey. Humans can make use of ultrasound scans to check the health of unborn babies, and in SONAR. Ultrasound can also be used to treat muscle injuries and clean jewellery.

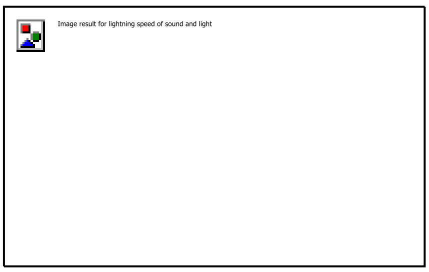


SONAR works through echoes, an echo is a reflected sound wave. An ultrasound pulse is sent out and is reflected from an object (sea bed, large fish, aeroplane) and returns to its starting point, this 'echo' is detected and the time between sending and receiving the signal can be used to calculate how far away the object is. All we need to know is how fast sound travels in the medium (e.g. sea water or air). We can use the equation 'distance = speed x time' to find the total distance travelled by the wave. We divide this distance by two, to find how far away the object is (remember the sound travelled there and back).

Measuring the speed of sound

We can use different methods to measure the speed of sound, one method is the clap-echo method which involves measuring the time taken for you to hear an echo from a sharp clap. You stand a long distance from a wall, clap, and listen for the echo. The distance travelled is twice the distance from you to the wall (because the sound has to travel to the wall and back).

One way to reduce timing errors in this method is to clap in time to the echoes. You then measure the time for 11 claps, which is the time for 10 journeys by the sound. This time can then be used to calculate an average time for the sound to travel to the wall and back.



You can use the time between seeing lightening and hearing thunder to calculate how far away a storm is. Sound travels to 340 m/s so will travel 1000 m (1 km) every 3 seconds.

Prove it Questions: AFL #1

Lesson 1- How can we describe waves?

1	Sketch a transverse wave and label the amplitude 'A' and the wavelength 'λ'. (2)	(2)
2a	Describe the movement of particles in a transverse wave. (2)	
2b	Describe the movement of particles in a longitudinal wave. (2)	(4)
3	Explain how the constructive superposition of ocean waves can cause 'rogue waves', sketch a diagram to support your answer. (4)	(4)

Lesson 2- What are light waves?

1a	State the speed of light. (1)	
1b	Are light waves transverse or longitudinal? (1)	(2)
2	A dog can see his bowl of food because light from a light bulb reflects from it and enters the dog's eyes. Draw a ray diagram to show how the dog sees his bowl of food.(4)	(4)
3	Explain what happens to light when it meets a transparent surface. (4)	(4)

Lesson 3- How are light waves reflected?

1a	State the law of reflection. (1)	
1b	A ray of light strikes a flat mirror at an incidence angle of 43°. State the angle of reflection for this ray of light. (1)	(2)
2	A student has a flat mirror, a ray box, a sharp pencil and a protractor. Describe an investigation to prove the law of reflection. (4)	(4)
3	Compare diffuse and specular reflection. (4)	(4)

Lesson 4- How are light waves refracted?

1	What is refraction? (2)	(2)
2a	Describe the difference between real and virtual images. (2)	
2b	Describe why light may refract away from the normal as it passes from water into air. (2)	(4)
3a	Explain what would happen if light passes from air into glass at an incidence angle of 40°. (2)	
3b	Explain how a convex lens can help form a clear image. (2)	(4)

Prove it Questions: AFL #2

Lesson 5- How does the eye work?

1	State two parts of the eye that help to focus light on the retina. (2)	(2)
2a	Describe how the eye reacts in bright light. (2)	
2b	State how the camera in a mobile phone takes a clear picture. (2)	(4)
3a	Compare the role of rods and cones in our retina. (2)	
3b	Compare the way in which a camera and our eyes form images. (2)	(4)

Lesson 6- What are the colours of light?

1a	State a primary colour of light. (1)	
1b	State a secondary colour of light (1)	(2)
2a	State the primary colours needed to produce the secondary colour from Q1b. (1)	
2b	Compare the wavelength and frequency of red and violet light. (3)	(4)
3	Explain how a prism can be used to produce the spectrum of visible light (a rainbow). (4)	(4)

Lesson 7- Why do we see different colours?

1a	What colour light does a red book reflect? (1)	
1b	What colour light does a red book absorb? (1)	(2)
2a	Describe why a black object will appear black in white light. (2)	
2b	Describe what happens to white light when it is passed through a blue filter. (2)	(4)
3	White light is passed through a filter. When a yellow object is placed in this light it appears green, a magenta object is also placed in this light and appears blue. Explain what colour the filter must be. (4)	(4)

Prove it Questions: AFL #3

Lesson 8- What are sound waves?

1	Sketch a longitudinal wave and label the wavelength 'λ'.	(2)
2a	State the speed of sound in air. (1)	
2b	Describe how sound waves travel from a speaker to your ears. (3)	(4)
3	Explain why sound waves travel faster in solids than they do in air. (4)	(4)

Lesson 9- How do we hear sound?

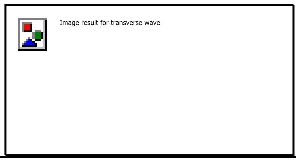
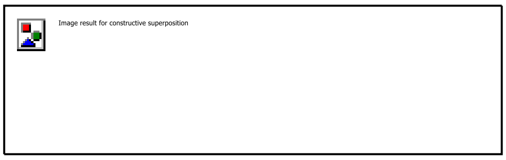
1a	State the range of frequencies that humans can hear. (1)	
1b	State the part of the ear that funnels sound into the ear canal. (1)	(2)
2a	Describe how sound waves are passed from the ear canal into the cochlea. (2)	
2b	Describe how sound waves travel from the cochlea to the brain. (2)	(4)
3a	Compare how our ears and microphones produce electrical impulses. (2)	
3b	Sketch a wave trace to show two sound waves that have the same volume but different pitch. (2)	(4)

Lesson 10- How else can sound waves be used?

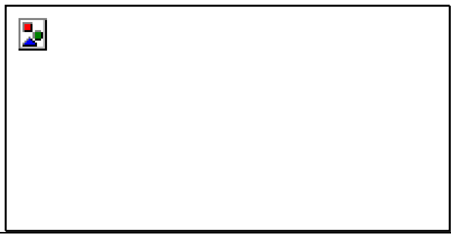
1a	State the name given to unpleasant or unwanted sounds. (1)	
1b	State the name given to sound waves with a frequency greater than 20,000 Hz. (1)	(2)
2	A teacher has a starter pistol, a trundle wheel and a stopwatch. Describe an investigation she could use to measure the speed of sound. (4)	(4)
3	Explain how a ship's SONAR can measure the depth of the ocean. (4)	(4)

Prove it Mark Scheme: AFL #1

Lesson 1- How can we describe waves?

1	 1 mark for correct wavelength label 1 mark for correct amplitude label If no other mark scored, then allow 1 mark for correct wave	(2)
2a	The particles vibrate (1) at right angles to the direction of movement (1)	
2b	The particles vibrate (1) parallel to the direction of movement (1)	(4)
3	 When two wave meet crest to crest (or trough to trough) (1) they can add together (1) to form a wave with a much larger amplitude (1) Up to 2 marks for correct sketch	(4)

Lesson 2- What are light waves?

1a	300,000,000 m/s (1)	
1b	Light waves are transverse (1)	(2)
2	 1 mark for straight lines 1 mark for arrows from bulb to bowl and from bowl to dog eye 1 mark for light ray touching and leaving dog bowl in the same place 1 mark for light rays that touch light bulb and dogs eye	(4)
3	Some light is absorbed (1) some light is reflected (1). Some light is transmitted (1) but it is scattered (1)	(4)

Lesson 3- How are light waves reflected?

1a	The angle of incidence is equal to the angle of reflection (1)	
1b	43° (1)	(2)
2	Draw where the mirror will be placed and draw the normal line (at 90°) (1) Shine a thin ray of light at the mirror (1) use a sharp pencil to mark the path of the light (1) use the pencil to mark the path of the reflected ray of light (1) use the protractor to measure the angles against the normal (1)	(4)
3	Specular reflection is from a smooth surface (1) the light is all reflected in the same direction (1) Diffuse reflection is from a rough surface (1) the light is scattered in different directions (1)	(4)

Lesson 4- How are light waves refracted?

1a	The bending of light (1) as it passes across the boundary between two substances (1)	(2)
2a	Real images can be formed on a screen (1) and the light rays meet where the image is formed (1) ORA	
2b	Air is less dense than water (1) so the light speeds up as it leaves (1)	(4)
3a	The light would slow down (1) so would refract towards the normal (1) producing an angle smaller than 40° (1)	
3b	The lens refracts the light (1) due to a change in speed (1) the shape of the lens causes all the light rays to meet at one point (1) the focal point (1)	(4)

Prove it Mark Scheme: AFL #2

Lesson 5- How does the eye work?

1	Cornea (1) lens (1)	(2)
2a	The iris (1) cause the pupil to get smaller (1)	
2b	The lens focuses the light (1) onto a photosensitive material (1) the electrical impulses produced are used to produce an image file (1)	(4)
3a	Cones detect colour (1) the rods detect light intensity (or are used when light levels are low) (1)	
3b	Both use a lens to focus light (1) our eyes have a retina (which is photosensitive) (1)	(4)

Lesson 6- What are the colours of light?

1a	Blue, red or green (1)	
1b	Magenta, cyan or yellow (1)	(2)
2a	Magenta = red and blue, cyan = blue and green, yellow = red and green (1)	
2b	Recognise that a longer wavelength will mean a lower frequency (1) The wavelength of red light is longer than violet light (1) the frequency of red light is lower than violet light (1)	(4)
3	Light slows down as it enters the prism (1) and speeds up when it leaves (1) different colour light has different wavelength (1) so changes speed by different amounts (1) violet light slows down/speeds up the most (1) so refracts/bends further than red light (1)	(4)

Lesson 7- Why do we see different colours?

1a	Red light (1)	
1b	All other colours (apart from red) (1) *allow any named colour*	(2)
2a	Black objects absorb all colours of light (1) and reflect no light (1)	
2b	Blue light is transmitted (1) all other colours (allow named colours) are absorbed (1)	(4)
3	The filter must be cyan (1) which transmits blue and green light (1) The yellow object reflect red and green light (but only green light is present) (1) the magenta object reflects blue and red light (but only blue light is present) (1)	(4)

Prove it Mark Scheme: AFL #3

Lesson 8- What are sound waves?

1	1 mark for correctly drawn wave 1 mark for correctly labelled wavelength	(2)
2a	340 m/s (1)	
2b	The speaker vibrates (1) this makes the nearby air particles vibrate (1) they pass this energy to other air particles (1) The sound waves are funnelled into eth ear by eth pinna (1)	(4)
3	Particles in a solid are closer together (1) and they are tightly bonded (1) this makes the vibrations (1) easier to pass from particle to particle (1)	(4)

Lesson 9- How do we hear sound?

1a	20 – 20 000 Hz (1)	
1b	The pinna (1)	(2)
2a	The sound waves make the ear drum vibrate (1) this in turn makes the three small bones vibrate (which are connected to the cochlea) (1)	
2b	Small hairs in the cochlea vibrate (1) these create electrical impulses (1) which travel down eth auditory nerve (to the brain) (1)	(4)
3a	They both have a diaphragm that vibrates (1) and they both produce electrical impulses (1)	
3b	1 mark for same amplitude (height) 1 mark for different wavelength	(4)

Lesson 10- How else can sound waves be used?

1a	Noise (1)	
1b	Ultrasound (1)	(2)
2	Measure out a long distance (greater than 400 m) (1) Fire the starter pistol (1) start the timer when you see the pistol fired (puff of smoke) (1) stop the stopwatch when you hear the sound (1) use the equation speed = distance ÷ time (1)	(4)
3	An ultrasound pulse is sent out and is reflected from the ocean floor (1) and returns to the ship (1), the time between sending and receiving the signal is measured (1) Use the equation 'distance = speed x time' to find the total distance travelled (1) divide this distance by two (1)	(4)

Prove it Review:

Once you have made your notes, answered the questions, marked and improved your responses you should review your performance. What level did you get? Is that at your target level? If not, then what do you still need to learn to do even better next time around?

Marks	**Level**
1-2	Emerging
3-4	Developing
5-7	Securing
8-10	Mastering