

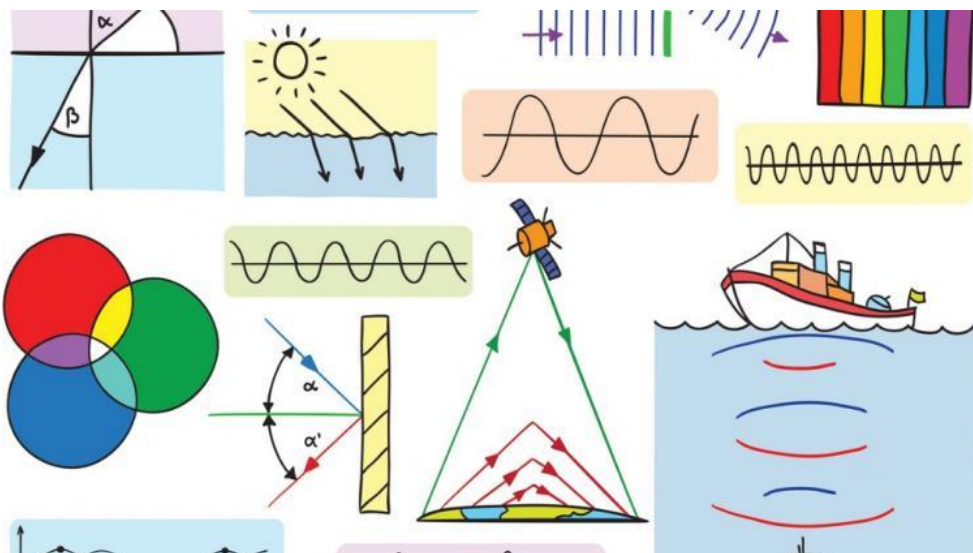


Stafford Manor High School

Assessment 1 Revision



Diet and Waves



Revision 2a: Nutrition

Lesson 2.1: What is a Balanced Diet?



A balanced diet contains the different nutrients in the correct amounts to keep us healthy. There are 5 main food groups:

- Carbohydrates (33%)
- Protein/Meat (11%)
- Fats and Sugars (8%)
- Fruit and Veg (33%)
- Dairy (17%)

These food groups contain the 7 main nutrients needed for a balanced diet:

Nutrient	Use in the body	Good sources
Carbohydrate	To provide energy for respiration	Cereals, bread, pasta, rice and potatoes
Protein	For growth and repair	Fish, meat, eggs, beans, pulses and dairy products
Fats	To provide energy. Also, to store energy in the body and insulate it against the cold.	Butter, oil and nuts
Minerals	Needed in small amounts to maintain health	Salt, milk (for calcium) and liver (for iron)
Vitamins	Needed in small amounts to maintain health	Fruit, vegetables, dairy foods
Dietary fibre	To provide roughage to help to keep the food moving through the gut	Vegetables, bran
Water	Needed for cells and body fluids	Water, fruit juice, milk

Energy calculations

The average man needs about 10,000 kJ per day, and the average woman needs about 8,000 kJ per day. Food labels show how much energy the food provides.

Food group:	RDA (Child)	RDA (Adult)
Energy	8000kJ	9000kJ
Fat	70g	70g
Carbohydrates	220g	230g
Sugar	85g	90g
Protein	24g	45g
Fibre	15g	24g

Nutrition Facts

Serving Size 216 g

Amount Per Serving

Calories 590 Calories from Fat 306

Total Fat 34g

Saturated Fat 11g

Trans Fat

Cholesterol 85mg

Sodium 1070mg

Total Carbohydrate 47g

Dietary Fiber 3g

Sugars 8g

Protein 24g

Looking at the food label for a pizza, on the left, you can see that eating a Big Mac from McDonalds contains 34g.

From the table above, you can see that both children and adults should be getting 70g of fat in their diet per day.

To work out the percentage of their recommended daily allowance used up, you divide the amount per serving by the recommended daily allowance. You then multiply by 100:

$$\frac{34g \text{ (Amount per serving)}}{70g \text{ (RDA)}} \times 100 = 48.6\%$$

Revision 2a: Nutrition

Lesson 2.2: Food tests

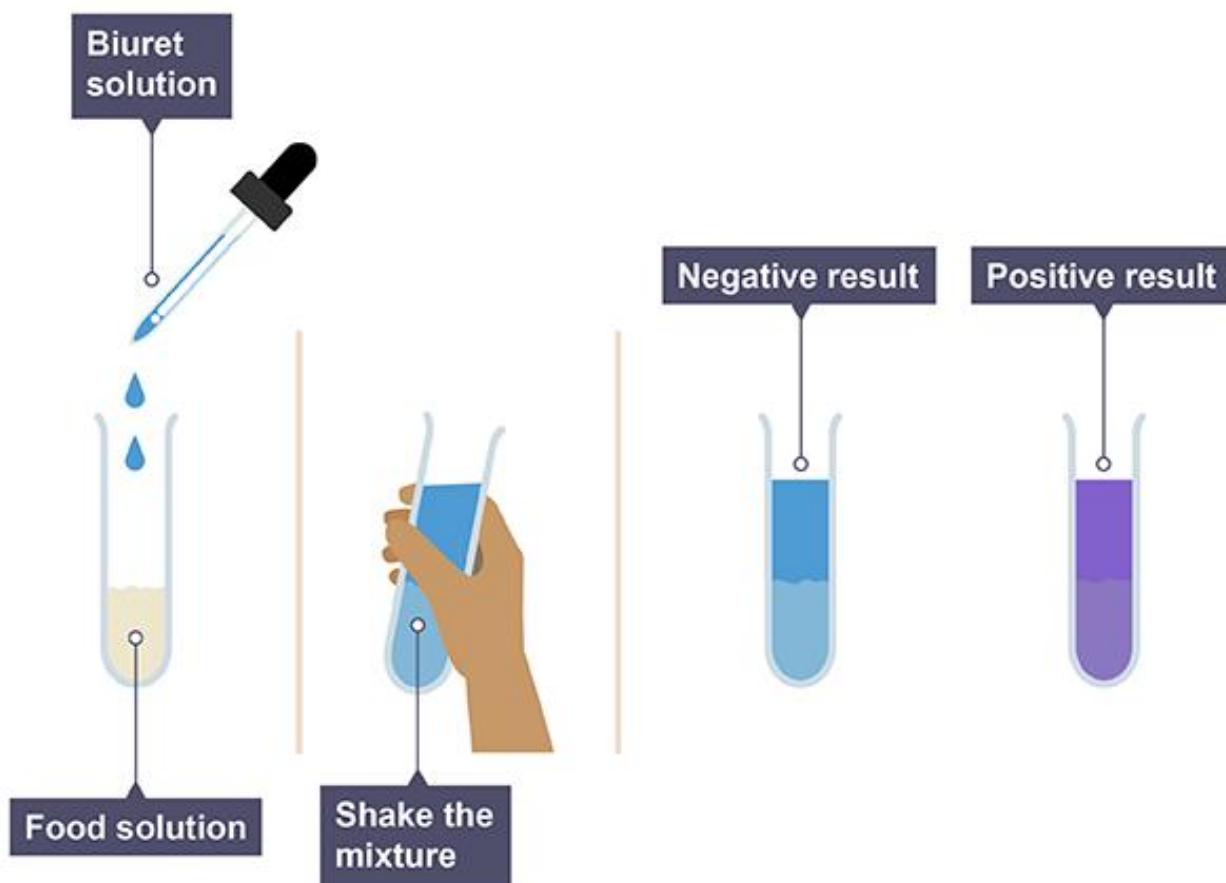
There are different tests which can be used to detect carbohydrates, proteins and fats.

They involve adding a chemical to a food sample which changes colour depending on what biological molecules are present.

Sometimes it may be necessary to crush the food or add water to the food before adding the chemicals.

Food sample	Chemical Added:	Method:	Initial colour:	Positive Result:
Starch	Iodine solution	Add iodine reagent to the food.	Yellow/brown	Blue-black
Fat	NA	Rub the food onto paper and then wipe away. Hold to the light.	Colourless	Greasy Mark
Protein	Biuret solution	Add Biuret reagent to the food.	Blue	Lilac/purple
Sugars	Benedict's solution	Add Benedict's reagent to the food and boil in a water bath.	Blue	Brick red

Example: Test for Protein



Revision 2a: Nutrition

Lesson 2.3: Unbalanced Diets

Each person needs a different amount of energy depending on factors such as:

- gender (male or female)
- age
- amount of daily activity

The amount of energy you need is measured in kilojoules (kJ), where 1kJ = 1,000 joules. The amount needed depends on the amount of energy you use a day. For example, to maintain weight, you would need:

- **Olympic swimmer in training:** 15,600 kJ each day.
- **A baby that has not learnt to crawl:** 2,400kJ each day.
- **Someone who sits at a desk all day:** 7,000kJ each day

Effects of a poor diet

An imbalanced or poor diet can contain too much or too little of a particular nutrient. If you have too little of a particular nutrient, we say that you have a deficiency in that nutrient. For example, fibre is needed to keep food moving through the intestines easily, and people who have a fibre deficiency in their diet may get constipation.



What happens if you eat too much?

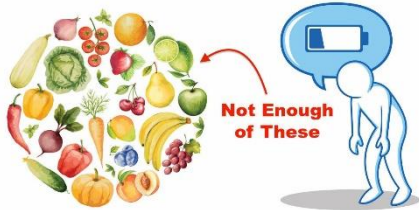
Obesity happens when you eat so much food that your body becomes very overweight. This is because the body stores the excess (extra) food as fat. This leads to a greater risk of **type-2 diabetes, heart disease** and some types of **cancer**.



What happens if you don't eat enough?

Starvation happens if you eat so little food that your body becomes very underweight. This can lead to anorexia. This can cause a lack of energy, becoming less able to resist infection from diseases, and can lead to developing deficiency diseases (see below)

What happens if you don't get enough vitamins/minerals?



- Not enough iron in the diet can cause anaemia. There aren't enough red blood cells, so less respiration can occur – causing tiredness.
- Not enough Vitamin A? You could go blind.
- Not enough Vitamin C? You could get scurvy – causing your gums to bleed.
- Not enough Vitamin D? You could get rickets – which makes the legs bow outwards in growing children.

Is being a vegan a problem?

A lifestyle choice made by many is to skip eating meat. This can lead to deficiencies (not enough of) in the following:

- **Vitamin B:** Develops red blood cells and maintains nerves.
- **Vitamin D3:** Can lead to heart disease
- **Creatine:** Strengthens Muscles and endurance.
- **Iron:** Can cause anaemia

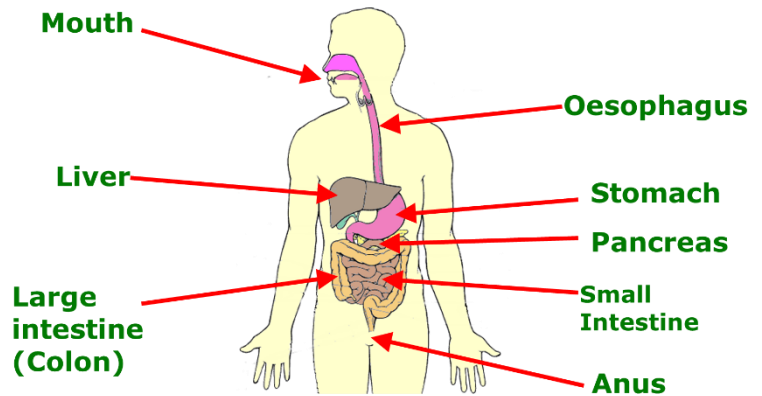


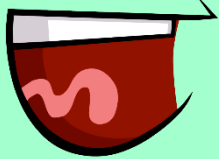
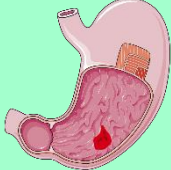
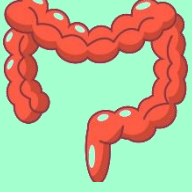
Revision 2b: Digestion

Lesson 2.4: What happens to food during digestion?

The food we eat has to be broken down into other substances that our bodies can use. This is called digestion. Without digestion, we could not absorb food into our bodies and use it.

Digestion happens in the digestive system, which begins at the mouth and ends at the anus.



Phase 1: The Mouth		- Food is chewed by the teeth – starting to break the food down. This is a mechanical process. - The food is also mixed with saliva which softens the food and contains enzymes (amylase) to start to break down the food. This is a chemical process.
Phase 2: The Oesophagus		- The food is then swallowed and squeezed along the oesophagus (food pipe / gullet). - The food is pushed down the oesophagus using peristalsis. This allows you to swallow upside down!
Phase 3: The Stomach		- Food enters the stomach, which is a muscular bag, filled with acid. The food is churned around. - The stomach contains enzymes called proteases, which breakdown protein. Germs are destroyed by the acid.
Phase 4: The Pancreas		- The pancreas makes the enzymes which go into the small intestine: Protease for protein Lipase for fats Amylase for sugars/carbohydrates
Phase 5: The Small Intestine		- Food enters the small intestine from the stomach, where it is mixed with more enzymes. Digestion is completed here. - The soluble food is now absorbed into the blood through the walls of the small intestine.
Phase 6: The Large Intestine		- The waste undigested food (E.G. fibre) is then passed on to large intestine. - This is where the water is absorbed back into the body.
Phase 7: The Rectum		The waste material is passed to the rectum where it is stored until it leaves the body (egested) through the anus.

Revision 2b: Digestion

Lesson 2.6: How do Enzymes aid Digestion?

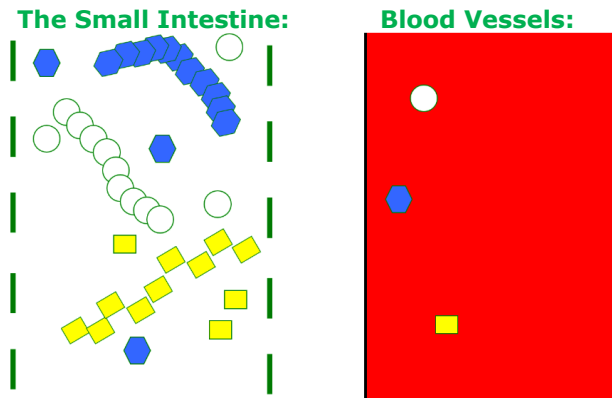
Catalyst Definition: Something that speeds up a chemical reaction without being used up and remaining unchanged at the end of the reaction.

Enzyme Definition: Biological catalysts. Special proteins that can break large molecules into small molecules.

Why do we need Enzymes?

The food we eat contains protein, starch and fats. These molecules are much too big to be absorbed into the blood. Only the smaller parts can move into the blood. Enzymes help to break down these larger molecules into smaller ones:

- **Amylase** breaks down starch into sugar
- **Protease** breaks down proteins into amino acids
- **Lipase** breaks down lipids (fats and oils) into fatty acids and glycerol

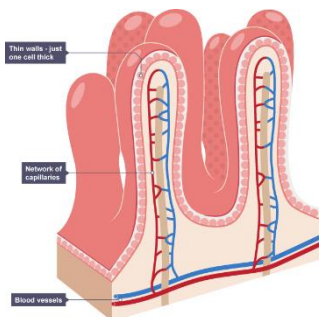


Substances that are not digested:

Minerals, vitamins and water are already small enough to be absorbed by the body without being broken down, so they are not digested.

Digestive enzymes cannot break down dietary fibre, which is why the body cannot absorb it.

What happens after the Enzymes break down the food?



Digested food molecules are **absorbed** in the small intestine. They pass through the small intestine and into the bloodstream.

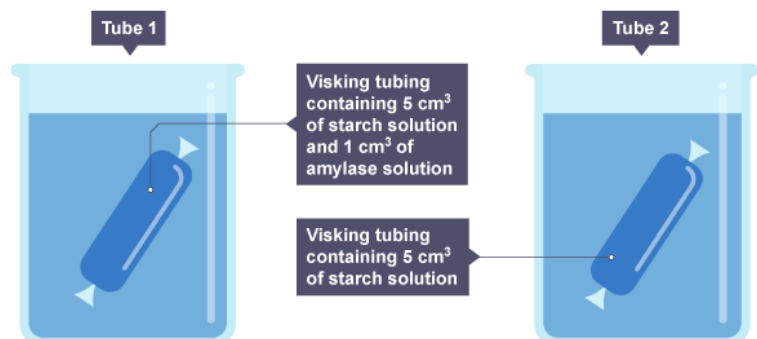
The small intestine contains lots of small **villi** which:

- Have **thin** walls, just one cell thick, meaning the nutrients don't have to travel far.
- Have a **high surface area** which means that more of the nutrients can be absorbed at any one time.

Both adaptations mean that the nutrients can be **absorbed** quickly and transported to the cells where they are needed.

Modelling Enzyme activity:

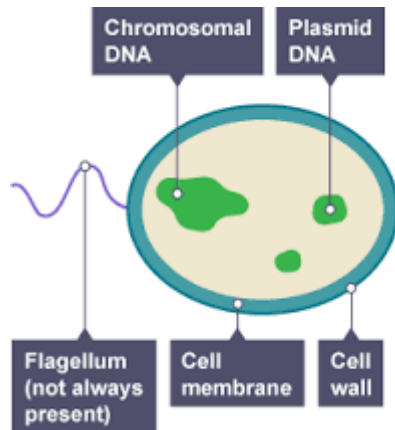
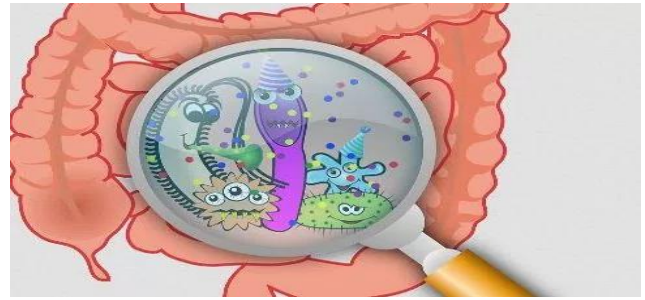
1. Set up two sets of the apparatus as in the diagram.
2. Put 1cm³ of amylase enzyme into tube 1 but not tube 2.
3. Leave at room temperature for 20 minutes.
4. Test for starch using iodine and glucose using Benedict's reagent inside and outside both tubes.
5. Test tube 1 may contain some starch inside the Visking tube (blue-black with iodine) but will definitely contain glucose outside (red) showing that the starch has been broken down.
6. Test tube 2 will contain starch inside the Visking tube (blue-black with iodine) but will not contain glucose/starch outside showing that the starch has not been broken down.



Revision 2b: Digestion

Lesson 2.7: How does bacteria aid digestion?

The digestive system contains lots of bacteria, lots of which can help with digestion. Bacteria are single celled organisms, needing a microscope to see them.



About half of the weight of faeces consists of bacteria.

Bacteria in the digestive system are important. For example, they:

- can digest some substances that humans cannot digest, such as certain carbohydrates
- reduce the chance of harmful bacteria multiplying and causing disease
- produce some vitamins that humans need, such as vitamins B and K

How Many Bacteria Live in the Gut?

The best estimates put the actual number of bacterial cells in the digestive system at any one time at about 100 trillion. The number of different species is thought to be somewhere between 300 and 1000.

Why Aren't Gut Bacteria Digested?

Friendly bacteria don't harm the digestive system because they appear to the body's immune system as **part of** the digestive system. This means that our white blood cells don't target these types of bacteria.

Some of the friendly bacteria coat themselves with sugar molecules which helps to disguise the bacteria and hide them from the immune system. This prevents them from being digested by the body.

What Benefits Do Gut Bacteria Provide?

Friendly bacteria are very useful to the human digestive system because they produce enzymes that digest plants. Without these enzymes, we wouldn't get any of the nutrients needed from our vegetables.

Some types of bacteria in the digestive system make vitamin's K and B – which the human body cannot make alone.

Friendly gut bacteria may also help in breaking down drugs, hormones that are not needed any more, and environmental substances that have the potential to be cancer-causing.

As the bacteria that live in the human gut are beneficial to their host, and the bacteria enjoy a safe environment to live, the relationship that we have with these tiny organisms is described as symbiosis or mutualism.

Revision 2c: Drugs and Abuse

Lesson 2.7: What effect does alcohol have on the body?

The alcohol in alcoholic drinks - such as wines, beers and spirits - is called ethanol. It is a depressant, which means it slows down signals in the nerves and brain.

There are legal limits to the level of alcohol that drivers and pilots can have in the body. This is because alcohol impairs the ability of people to control their vehicles properly.



Short-term effects

Alcohol has short-term effects such as sleepiness and impaired judgment, balance and muscle control. This leads to blurred vision and slurred speech. Vasodilation occurs - blood vessels in the skin carry more blood - leading to heat loss.

Long-term effects

The long-term effects of alcohol include damage to the liver and brain. The liver removes alcohol from the bloodstream because it's a toxic chemical. Over time, alcohol consumption can lead to liver damage (cirrhosis).

Alcohol and the Liver:	Drinking excess alcohol can damage the liver, the organ responsible for processing and breaking down alcohol. The liver can regenerate its cells, but long-term alcohol abuse can cause the liver to stop repairing itself. This can lead to the alcoholic feeling sick and experiencing weight loss. Eventually, the liver can get to a point where it becomes scarred - and can no longer function. This is called cirrhosis, which is irreversible. 
Alcohol and Transplants:	If an organ in the body has been damaged, then it can be replaced by a healthy organ from a donor - someone who had healthy organs but very recently died from other causes. This is called a transplant. A successful transplant has to have: • similar tissues from donor to patient • similar ages of donor and patient • similar locations as organs deteriorate quickly Organ donation can be an ethical issue especially as the supply of organs is limited. Many people believe that an alcoholic, who has damaged their liver through drinking, shouldn't be allowed to have a liver transplant because they are likely to continue drinking and damage their new liver. They believe the liver should go to someone that is going to look after it and 'deserves' it more. However, if that person does not receive a new liver, it could lead to death.
Alcohol and the Brain:	Alcohol affects the brain in several ways, it: • slows reaction time, • causes difficulty walking, • can impair memory, • causes slurred speech, • causes changes in sleep patterns and mood, including increased anxiety and depression Longer term drinking of excess alcohol: • causes brain shrinkage • leads to memory problems • leads to psychiatric problems • may result in the patient requiring long-term care 

Revision 2c: Drugs and Abuse

Lesson 2.8: What effect do different drugs have on the body?

Drugs are chemicals that cause changes in the body. They can be divided into legal and illegal drugs. Drugs can also be medical (drugs taken to cure illness) or recreational (drugs taken because they have pleasing effects). Some drugs can be addictive – more and more is needed to achieve the same effect.

Drugs can be separated into the following categories:

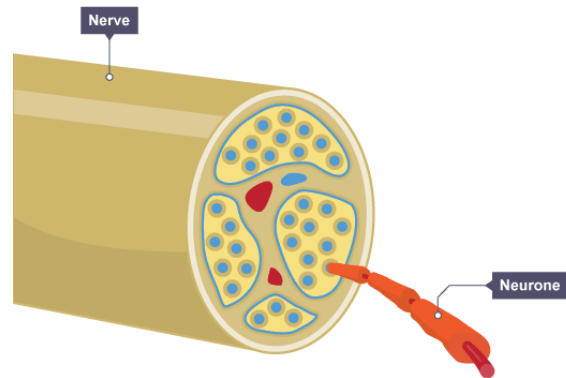
Type of drug	Effect on body	Example
Depressant	Slows down nerve and brain activity	Alcohol, solvents, temazepam
Hallucinogen	Alters what we see and hear	LSD
Painkiller	Blocks nerve impulses	Aspirin, paracetamol, ibuprofen
Performance enhancer	Improves muscle development	Anabolic steroids
Stimulant	Increases nerve and brain activity	Nicotine, caffeine, ecstasy

How do drugs work?

When we **react** to something, information is sent along our nerves – called **neurones**.

There are many neurones, which contain small gaps between them, called **synapses**.

Stimulants and depressants affect the speed that information can be passed across these synapses



Stimulants

Stimulants **speed up** the transmission (passing) of **electrical** signals across the **synapse** from one neurone to the next.

This means that electrical impulses get to the brain quicker, allowing us to make decisions quicker. This leads to **increased** alertness, heart rate and breathing rate.

However, in the long term, stimulants can produce 'highs' and then extreme 'lows' or even depression. They can be addictive because the body needs a constant 'top-up' to maintain the effect.



Depressants:

Depressants **slow down** transmission (passing) of **electrical** signals across the **synapse** from one neurone to the next.

This means that electrical impulses get to the brain slower, slowing down decision making. This leads to a **decrease** in alertness, heart rate and breathing rate.

Revision 2c: Drugs and Abuse

Lesson 2.9: How do drugs impact on society?

Taking drugs, like alcohol, can have a big effect on our society:

Accidents:		For drivers, alcohol can: • reduce your ability to see distant objects – night vision can be reduced by 25% • make you have blurred and double vision • slow reaction times, so you can't react to danger in time • make you lose your peripheral vision. This makes it much more likely to have an accident when drunk.
Violence:		Alcohol causes chemical changes in the brain which can initially make you feel relaxed. This lowers our inhibitions (we have less self-control) and stops us from acting the way we normally would. This can make some people more violent when drunk. Other people can get caught up in violence because they don't notice danger as a result of being relaxed and therefore, cannot avoid the danger in time.
The NHS:		Alcohol is estimated to cost the NHS around £3.5bn per year, which amounts to £120 for every taxpayer. Excessive (binge) drinking is a major factor in A&E admissions but isn't the only reason that alcohol and drugs cost the NHS so much. Large costs include treatment for: • Alcohol/drug addiction. • Treatment for long term effects, such as liver disease and heart disease • Violent assaults. • Accidents (such as car accidents) • Accidental deaths. • Suicides.
The Police:		Most of the alcohol consumption occurs at the weekend and mainly in the evenings. During these times, we see a big increase in fights due to alcohol. As a result of this, more police are needed during these times to help to stop these fights from occurring. This means more money for jail cells and police officers.

Revision 4a: Light Waves

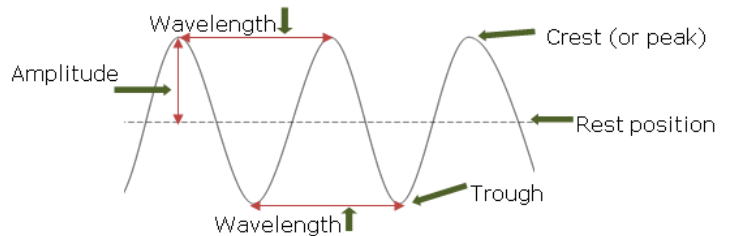
Lesson 4.1: How can we describe waves?

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.

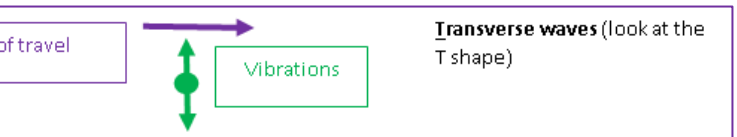
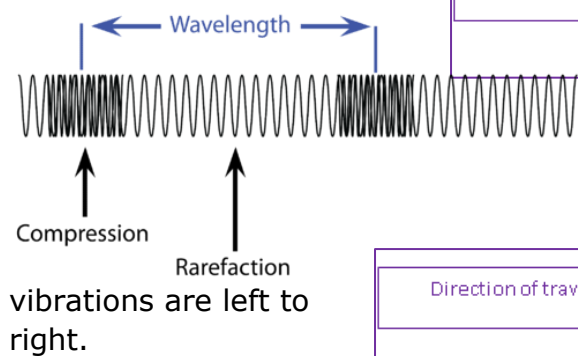
There are lots of different types of waves such as water wave, light waves, soundwaves and radio waves. Depending on how they travel the different types of waves fit into one of two categories- longitudinal or transverse.

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



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.

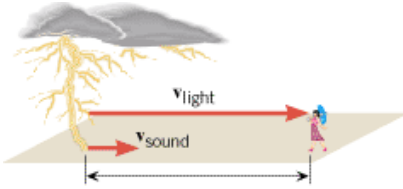
Superposition

Adding (constructive)	Cancelling (destructive)
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.

Revision 4a: Light Waves

Lesson 4.2: 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 $300,000,000 \text{ m/s}$ ($3 \times 10^8 \text{ m/s}$), 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 off 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 is 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

Transparent	Translucent	Opaque
Light passes straight through	Some light passes through, but is scattered Some light is absorbed or reflected	No light passes through, it is absorbed or reflected

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



Revision 4a: Light Waves

Lesson 4.3: 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.

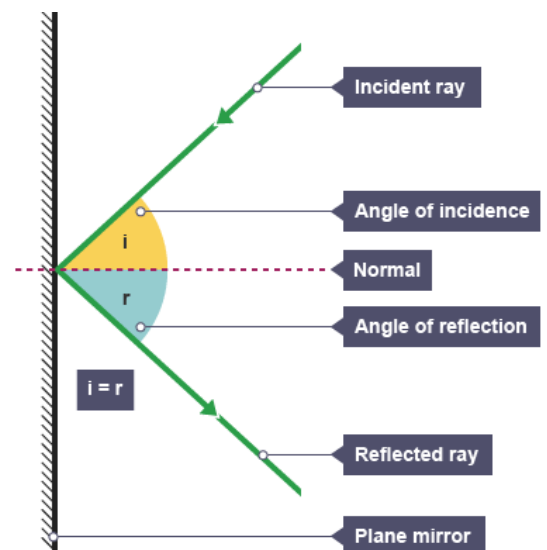
The law of reflection

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:

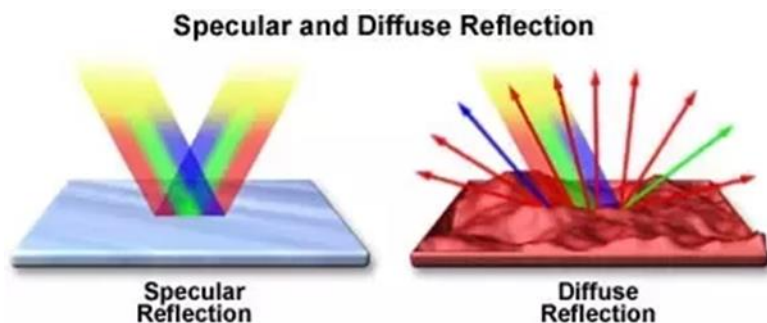
- the hatched vertical line on the right represents the mirror
- the dashed line is called the normal, drawn at 90° to the surface of the mirror
- the angle of incidence, i , is the angle between the normal and incident ray
- the angle of reflection, r , is the angle between the normal and reflected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

Revision 4a: Light Waves

Lesson 4.4: How are light waves refracted?

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

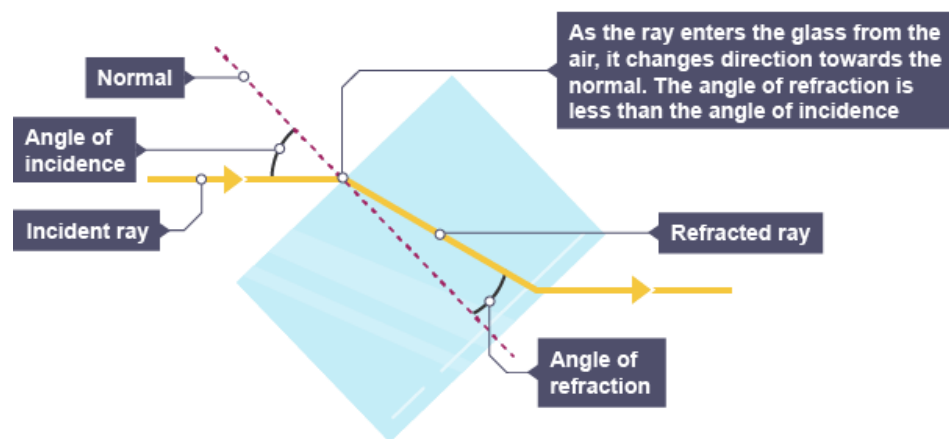
Refraction is when light waves change direction as they pass across the boundary between two substances, such as air and water.

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

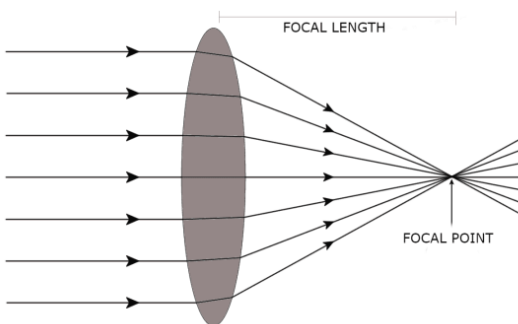
At the boundary between two transparent substances:

- 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.

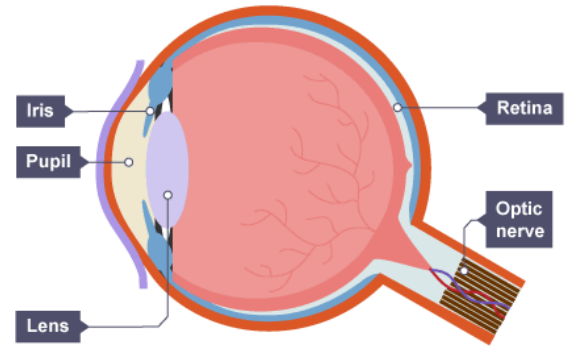
A real image can be projected onto a screen and is produced when the light rays actually meet where the image is formed.

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

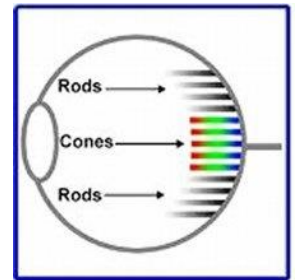
Revision 4b: The Eye

Lesson 4.5: 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.

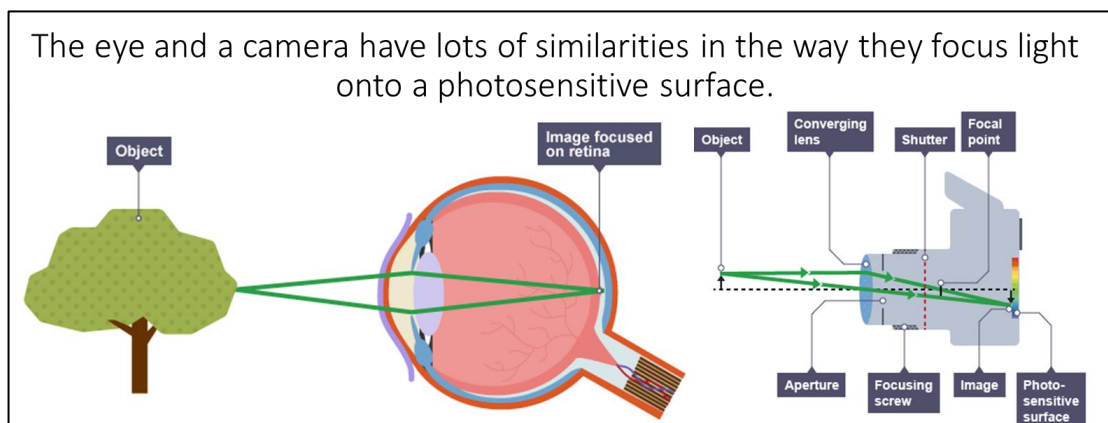
The camera

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.



Revision 4b: The Eye

Lesson 4.6: 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.

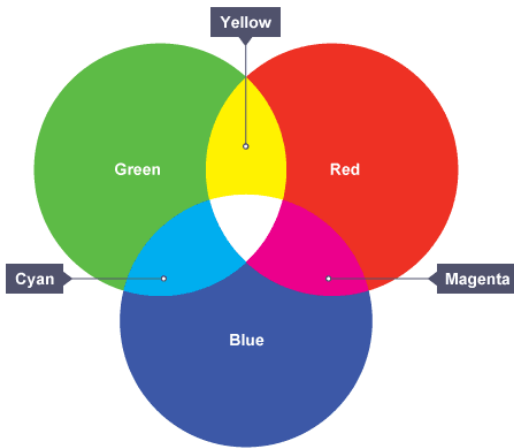


Coloured light

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.

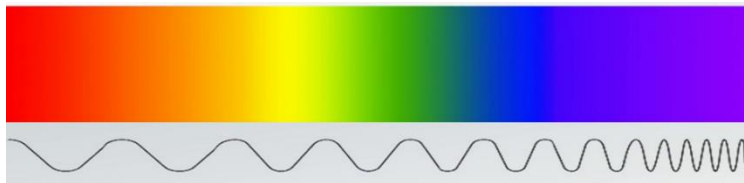


- The secondary colours of light are magenta, cyan and yellow.
- Magenta is made by mixing red and blue light
- Cyan is made by mixing blue and green light
- Yellow is made by mixing green and red light
- Mixing all three primary colours together gives us white light

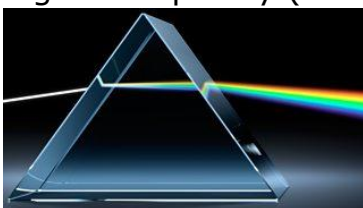
Different colours are made by mixing different amounts of each light.

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.

Revision 4b: The Eye

Lesson 4.7: 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.

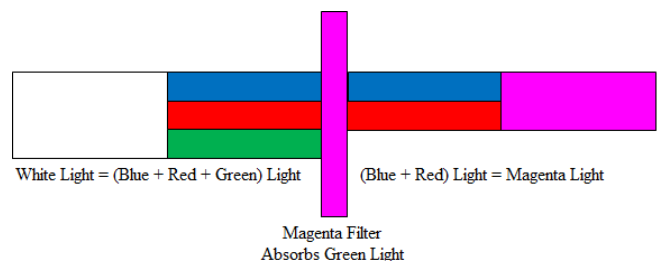
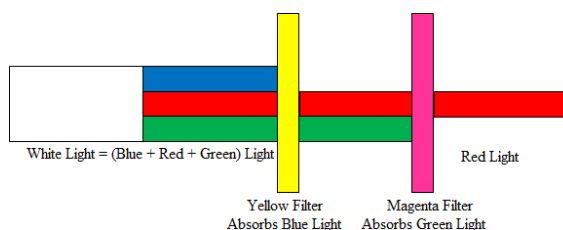
The table, below, gives some more examples, displaying the colour of light shining on an object, the colour(s) absorbed by an object, the colour reflected by an object in this light and the colour of an object seen in this light.

	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.

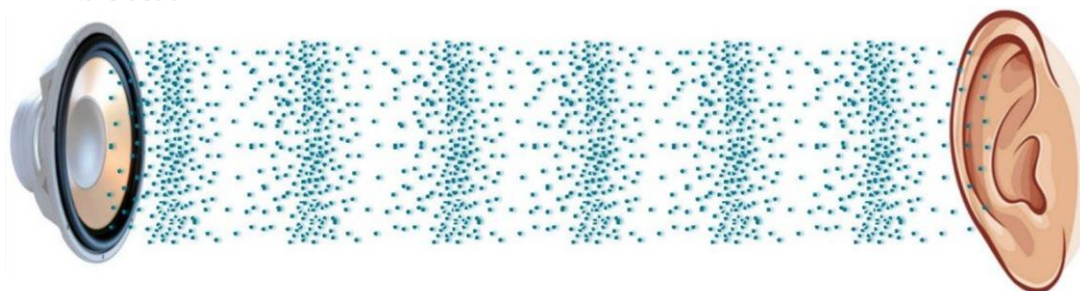
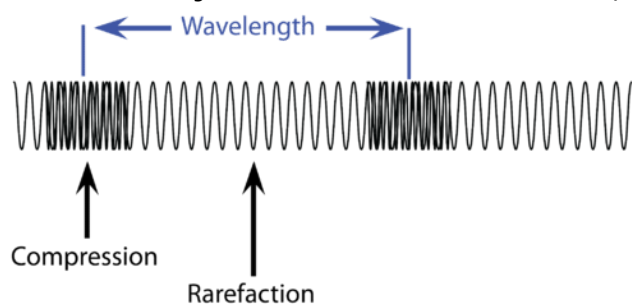


A filter will transmit its own colour and absorb all other colours. For example, a blue filter will transmit blue light and absorb all other colours, a magenta filter will transmit blue and red light and absorb all other colours. Filters can be used to produce light rays of different colours.

Revision 4c: Sound

Lesson 4.8: What are sound waves?

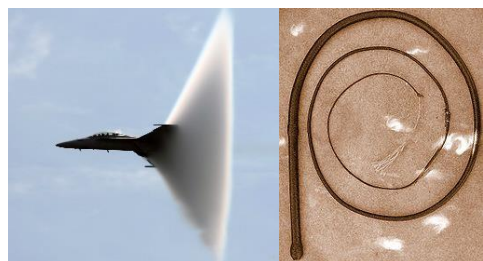
When an object or substance vibrates, it produces sound. These sound waves can only travel through a solid, liquid or gas. They cannot travel through empty space, because there are no particles to vibrate. Sound waves are longitudinal waves - the vibrations are in the same direction as the direction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

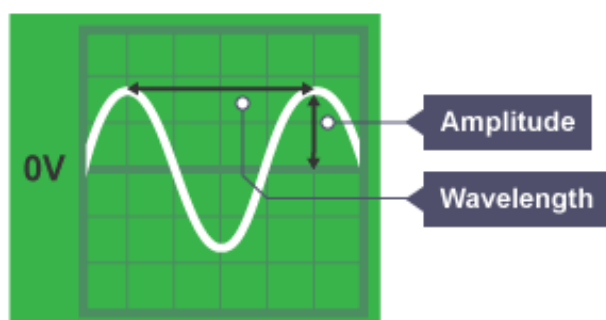
Substance	Speed of sound
Air	343 m/s
Water	1493 m/s
Steel	5130 m/s

Sound waves travel fast, but not as fast as light. Some aeroplanes can travel faster than the speed of sound when they 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 shorter the wavelength is, the higher pitch the sound will be.
- Sounds with a higher amplitude will be louder.

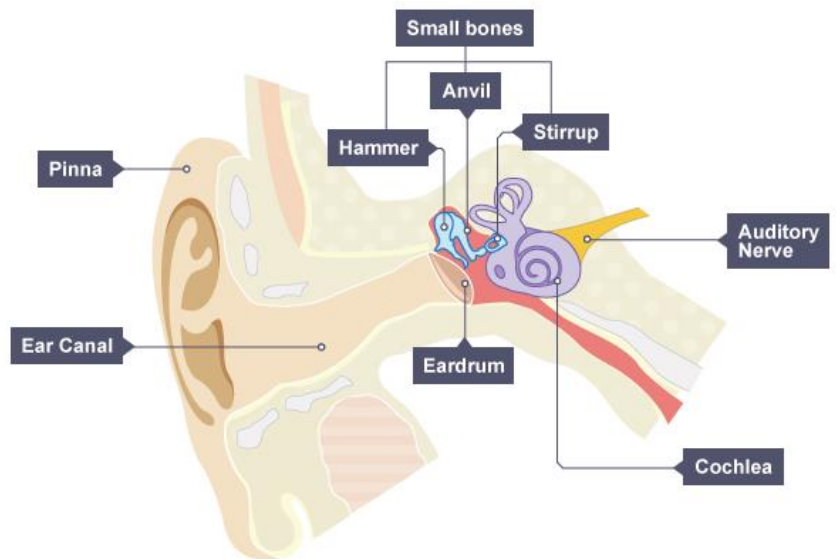
Revision 4c: Sound

Lesson 4.9: 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.

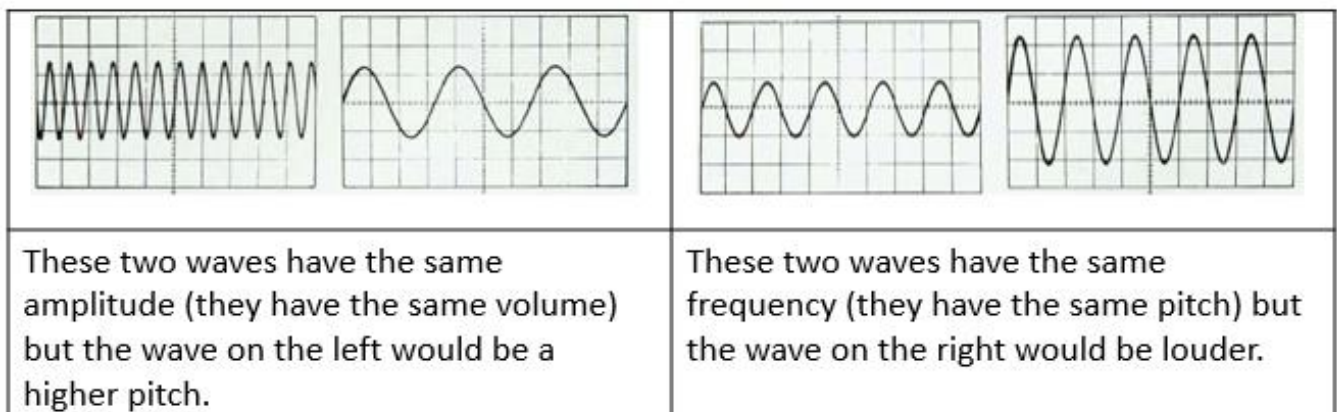
We can detect sound using our ears. An ear has an eardrum inside, connected to three small bones.

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.



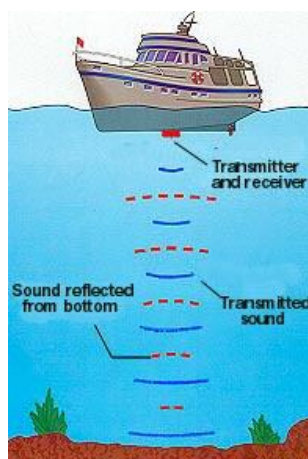
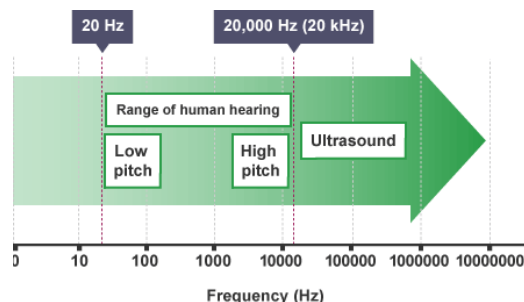
Revision 4c: Sound

Lesson 4.10: 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 jewelry.



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 ' $\text{distance} = \text{speed} \times \text{time}$ ' 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.

