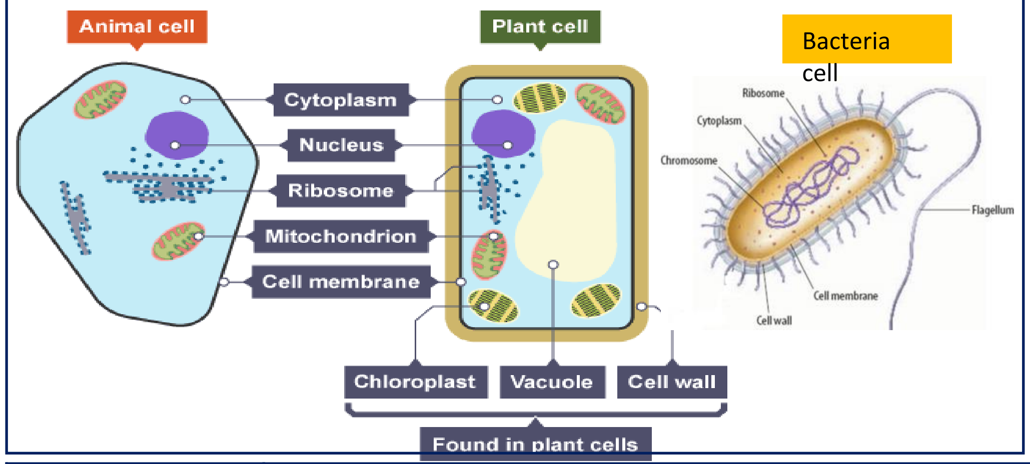
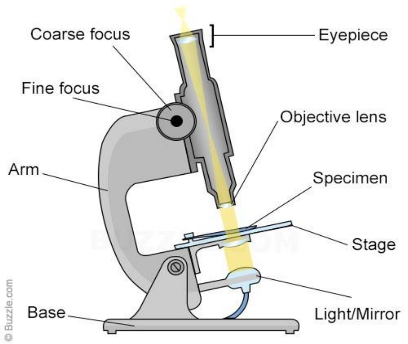
Unicellular organisms are made of one cell (eg bacteria)
Multicellular organisms are made of many cells (eg plants and humans)



Parts of the microscope



- Put the slide on the stage
- Always start on the lowest magnification as it gives you the widest field of vision
- Use the focus to see your object
- Then increase the magnification

Cells, tissues and organs

Cell → Tissue → Organ → Organ system

Cell	The smallest structural unit of all organisms
Tissue	Made from a group of cells with a similar structure and function, which all work together to do a particular job
Organ	Made from a group of different tissues, which all work together to do a particular job
Organ System	Made from a group of different organs, which all work together to do a particular job

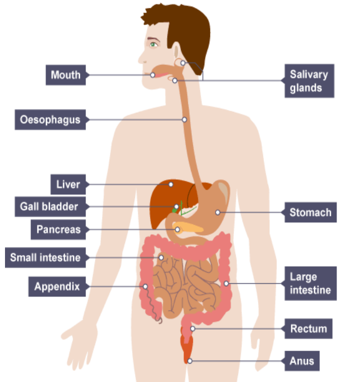
Organelle	Function
Nucleus	*Contains genetic material which controls the cell's activities*
Cell Membrane	*Controls the movement of substances in and out of the cell*
Cytoplasm	*Where chemical reactions happen*
Mitochondria	*Where energy is released in respiration*
Ribosome	*Where protein synthesis happens*
Cell Wall	*Provides strength and support*
Chloroplast	*Absorb light energy for photosynthesis (contains **chlorophyll**)*
Vacuole	*Filled with cell sap.*

Digestive system

Role: to break down large food molecules into smaller molecules that can be absorbed

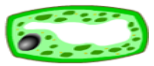
Adaptations

- The intestine is a highly folded structure, which increases surface area which speeds up diffusion
- The intestine is covered in many villi which are further covered by microvilli = large surface area → faster rate of diffusion
- Thin membranes → shorter distance to diffuse → faster rate of diffusion
- Covered in blood vessels → keeps blood moving to maintain concentration differences → faster rate of diffusion

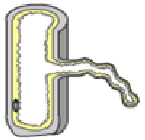


These are some examples of **specialised cells**; cells that are **adapted** to do a specific job.

Sperm cell
Streamlined – swim fast
Lots of mitochondria that release energy for swimming



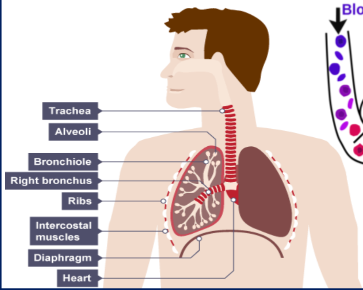
Palisade cell
lots of chloroplasts that absorb sunlight for photosynthesis

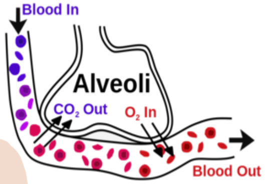


Root hair cell
large vacuole for storing cell sap
large surface area to absorb water and minerals more efficiently

Respiratory system

Role: to take in oxygen for respiration and remove carbon dioxide



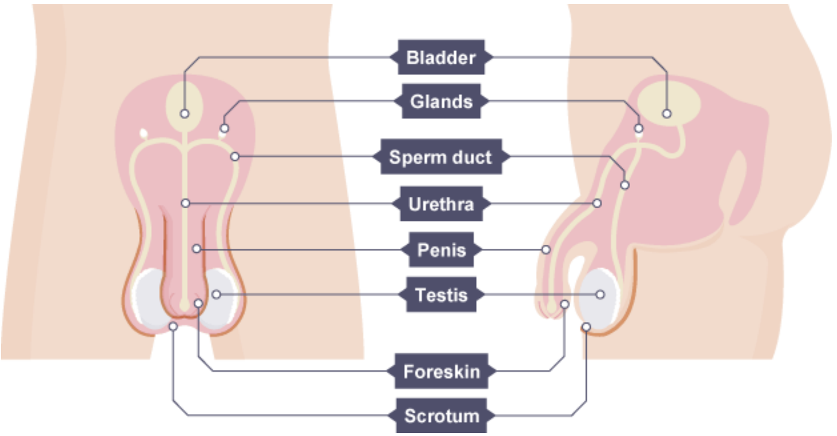


Inhaled air contains more oxygen than exhaled air. Exhaled air contains more carbon dioxide than inhaled air

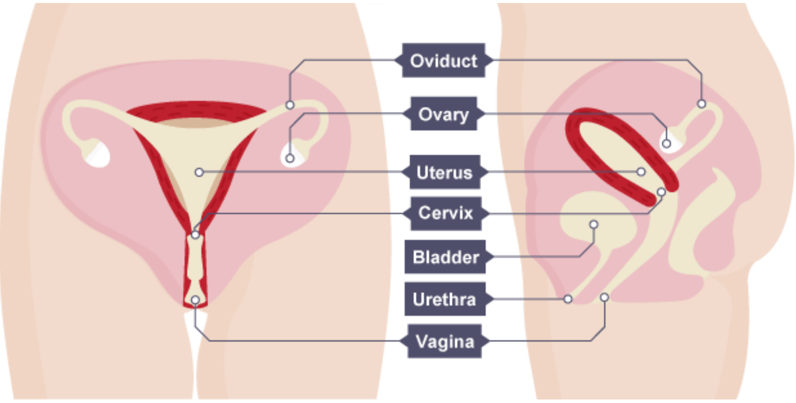
Main adaptations

Trachea	Contains C ring cartilage which keeps the airway open leaving a clear passage for air to travel in and out of the lungs
Alveoli	• **Thin membranes** → reduced diffusion distance • **Good blood supply** → maintains concentration gradients • **Highly folded membrane** → increased surface area All of the above adaptation ensure that **gas exchange**, by **diffusion**, happens efficiently.

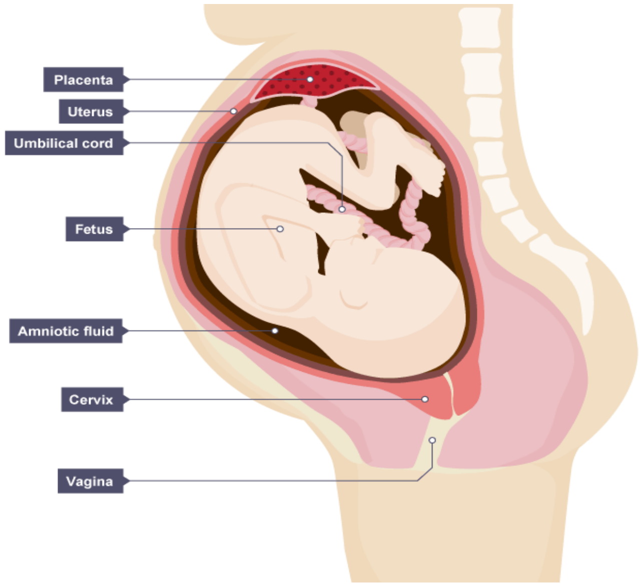
Reproduction



Testes - produces gametes (sex cells) called sperm; make male sex hormones.
Glands - produce a fluid which is mixed with sperm. The mixture of sperm and fluid is called **semen**.
Sperm ducts – takes the sperm from the testes to the penis
Urethra – semen passes through here during **ejaculation**;
Penis - passes urine out of the man's body; passes semen out of the man's body.



Ovaries - contain hundreds of undeveloped female gametes (sex cells) called **ova** (egg cells).
Oviducts – connect the ovary to the uterus; lined with **cilia**. Every month, an egg develops, becomes mature and is released from an ovary to the uterus;
Uterus - a muscular bag with a soft lining; where a baby develops until birth;
Cervix - a ring of muscle at the lower end of the uterus; keeps baby in place during pregnancy;
Vagina - muscular tube leading from cervix to the outside of a woman's body. The penis goes into the vagina during sexual intercourse.



Fertilisation → Zygote → Embryo → Foetus → Baby → Birth

A **foetus** develops in the **uterus**
The foetus relies on its mother for:

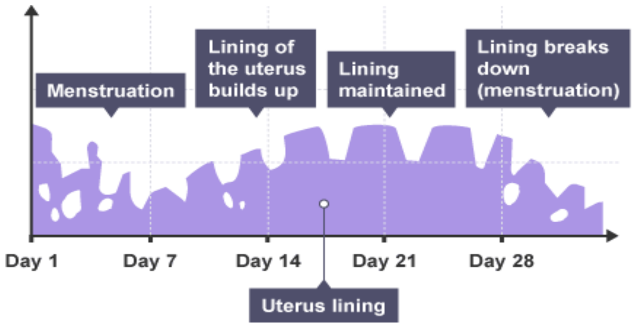
- protection against bumps, and temperature changes;
- oxygen for respiration;
- nutrients (food and water).

The foetus also needs its waste substances removing.

The foetus is protected by the **uterus** and the **amniotic fluid**, a liquid contained in a bag called the **amnion**.

The **placenta** provides oxygen and nutrients, and removes waste (eg carbon dioxide). The **umbilical cord** joins the placenta to the foetus, and transfers substances between the two.

The menstrual cycle



The thickness of the uterus lining varies during the menstrual cycle.

The **menstrual cycle** lasts about **28 days**, it stops while a woman is pregnant:

- **Day 1,** is when bleeding from the vagina begins, caused by the loss of the uterus lining, with a little blood. This is called **menstruation** or having a **period**.
- **Day 5**, the loss of blood stops. The uterus lining begins to re-grow; an egg cell starts to mature in one of the ovaries.
- **Day 14**, the mature egg cell is released from the **ovary**. This is called **ovulation**. The egg cell travels through the **oviduct** towards the **uterus**.

If the egg cell does not meet with a sperm cell in the oviduct, the lining of the uterus begins to break down and the cycle repeats.

Fertilisation happens if the egg cell meets and joins with a sperm cell in the **oviduct**. The fertilised egg (**zygote**) attaches to the lining of the **uterus**.

The woman becomes pregnant, the lining of the uterus does not break down and menstruation does not happen

Reproduction

<u>Plant reproduction</u>

Pollen grains need to move from the **anther** of one flower to the **stigma** of another flower.

This is called **pollination**.
Plants can be **insect pollinated** or **wind pollinated**.

Structure	Function
Sepals	Protect the unopened flower
Petals	May be brightly coloured to attract insects
Stamens	The male parts of the flower (each consists of an anther held up on a filament)
Anthers	Produce male sex cells (pollen grains)
Stigma	The top of the female part of the flower which collects pollen grains
Ovary	Produces the female sex cells (contained in the ovules)
Nectary	Produce a sugary solution called **nectar**, which attracts insects

<u>Plant fertilisation</u>

- **Pollen grain** starts to grow when it lands on stigma;
- **Pollen tube** grows until it reaches an **ovule** inside the **ovary**;
- The **nucleus** of the pollen grain (the **male gamete**) moves along the tube and joins with nucleus of the ovule (the **female gamete**);
- the **ovules** become **seeds.**

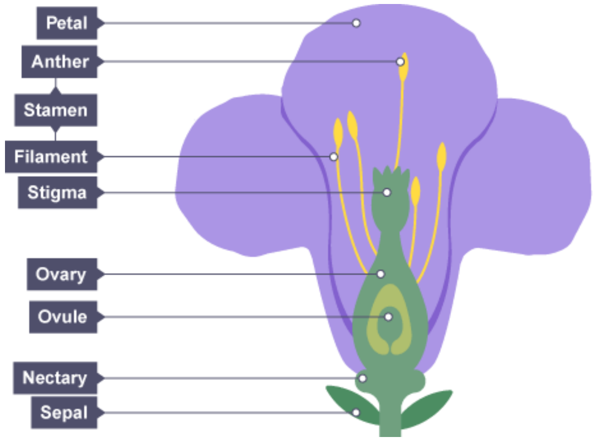
Feature	Insect-pollinated	Wind-pollinated
Petals	Large and brightly-coloured – to attract insects	Small, often dull green or brown – no need to attract insects
Scent and nectar	Usually scented and with nectar – to attract insects	No scent or nectar – no need to attract insects
Number of pollen grains	Moderate - insects transfer pollen grains efficiently	Large amounts – most pollen grains are not transferred to another flower
Pollen grains	Sticky or spiky - sticks to insects well	Smooth and light – easily carried by the wind without clumping together
Anthers	Inside flower, stiff and firmly attached - to brush against insects	Outside flower, loose on long filaments – to release pollen grains easily
Stigma	Inside flower, sticky - pollen grains stick to it when an insect brushes past	Outside flower, feathery – form a network to catch drifting pollen grains

<u>Seed dispersal</u>

Plants compete with each other for:

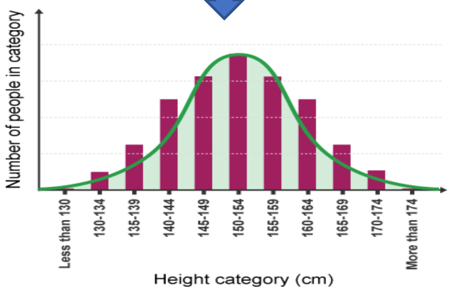
- light
- water
- space
- minerals in the soil

Seeds must be **dispersed** from each other and from the parent. This reduces **competition.**

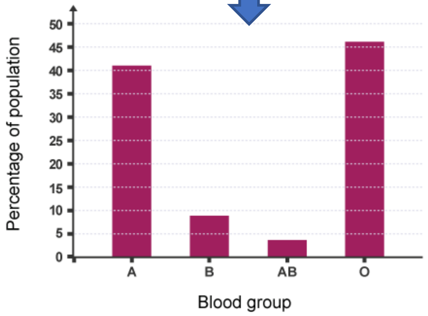


Differences between living things is called **variation**.

Continuous variation can be any **value** in a **range**, eg height or weight



Discontinuous variation has values that are one thing or another, but have no values in between.
eg blood group, gender (male or female), eye colour.



Method	Detail	Examples
Wind	Seeds have lightweight parts, wings or parachutes	Dandelion, sycamore
Animals (inside)	Brightly coloured and tasty fruits contain seeds with indigestible coats, so that the seeds pass through the animal's digestive system undamaged	Tomato, plum, raspberry, grape
Animals (outside)	Fruits have hooks that attach them to the fur of passing animals	Goose grass, burdock
Self-propelled	Have a pod that bursts open when ripe, throwing the seeds away from the plant	Pea pod

Explaining the properties of solids

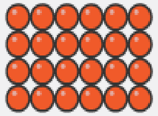
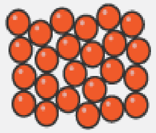
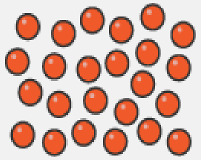
Property	Reason
Fixed shape & cannot flow	Particles cannot move from place to place
Cannot be compressed (squashed)	Particles are close together and have no space to move into

Explaining the properties of liquids

Property	Reason
They flow and take the shape of their container	The particles can move around each other
They cannot be compressed (squashed)	The particles are close together and have no space to move into

Explaining the properties of gases

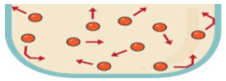
Property	Reason
They flow and completely fill their container	The particles can move quickly in all directions
They can be compressed (squashed)	The particles are far apart and have space to move into

State	Solid	Liquid	Gas
Diagram			
Arrangement of particles	Regular arrangement	Randomly arranged	Randomly arranged
Movement of particles	Vibrate about a fixed position	Move around each other	Move quickly in all directions
Closeness of particles	Very close	Close	Far apart

Particles

Gas Pressure

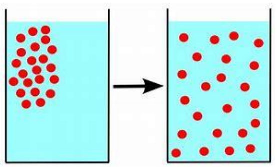
When gas particles hit the walls of their container, they cause pressure. The faster the particles move, the higher the gas pressure.



Diffusion

Diffusion is the movement of a substance from an **area of high concentration** to an **area of low concentration**.

Diffusion happens in **liquids** and **gases** because their particles move randomly from place to place.



Conservation of mass

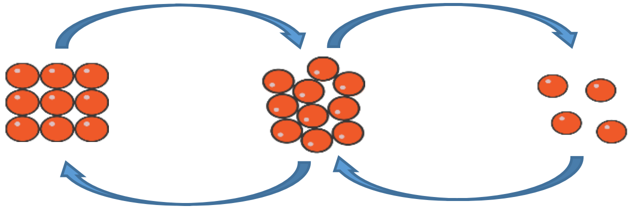
The particles stay the same when a substance changes state - only their **closeness**, **arrangement** or **motion** change. This means that the **mass of the substance stays the same**.

For example, 10 g of water boils to form 10 g of steam, or freezes to form 10 g of ice. This is called **conservation of mass**.

Gaining energy

melting

Boiling (or evaporating)



Freezing

Condensing

Losing energy

Losing energy

	Condensing	Freezing
Description	Gas to liquid	Liquid to solid
Closeness of particles	Become much closer together	Stay close together
Arrangement of particles	Stay random	Random to regular
Motion of particles	Stop moving quickly in all directions, and can only move around each other	Stop moving around each other, and only vibrate on the spot

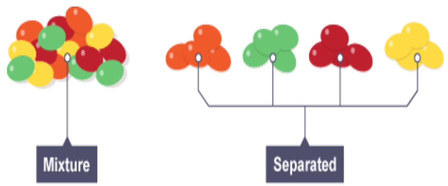
Gaining energy

	Melting	Evaporating or boiling
Description	Solid to liquid	Liquid to gas
Closeness of particles	Stay close together	Become much further apart
Arrangement of particles	Regular to random	Stay random
Motion of particles	Start to move around each other	Start to move quickly in all directions

Particles

A pure substance contains only one type of particle.
For example:
- Pure iron contains only iron particles (called iron atoms);
- Pure water contains only water particles (called water molecules);
- Pure oxygen only contains oxygen particles (called oxygen molecules).

A mixture contains more than one type of particle that are not chemically joined together.
For example:
- Steel contains iron particles and small amounts of carbon particles (called carbon atoms);
- Tap water contains water particles and small amounts of other particles (called ions);
- Air contains 21% oxygen, 78% nitrogen and 1% of other gases (eg argon and carbon dioxide).



We can separate mixtures in different ways depending on their properties:

- Filtration
- Evaporation
- Chromatography
- Distillation

Dissolving is one way to make a mixture. For example, when salt is stirred into water, the salt **dissolves** in the water to make salt **solution**.

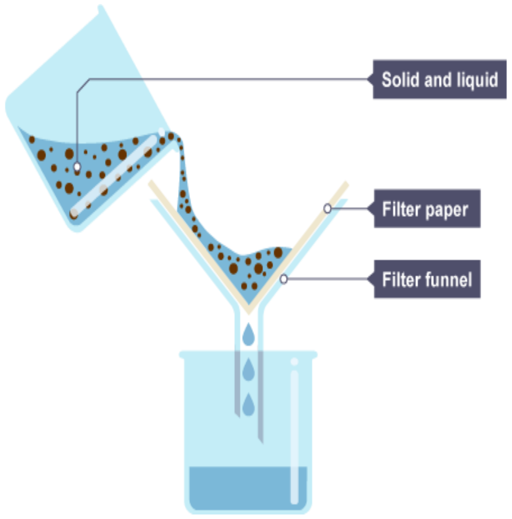
In a solution:
- the substance that dissolves is called the **solute**;
- the substance that the solute dissolves in is called the **solvent**.

E.G In salt solution, salt is the solute and water is the solvent.

When you can't dissolve any more solute in a solvent, we say the solution is **saturated.**

Filtration is a method for separating an **insoluble** solid from a liquid.

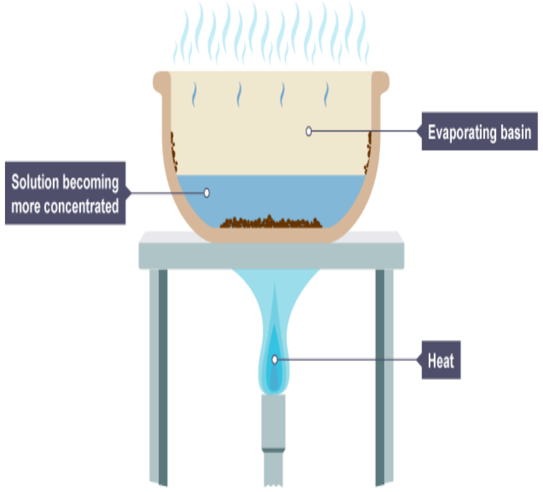
When a mixture of sand and water is filtered:
- the sand stays behind in the filter paper (it becomes the **residue**);
- the water passes through the filter paper (it becomes the **filtrate**).



Evaporation is used to separate a **soluble** solid from a liquid.

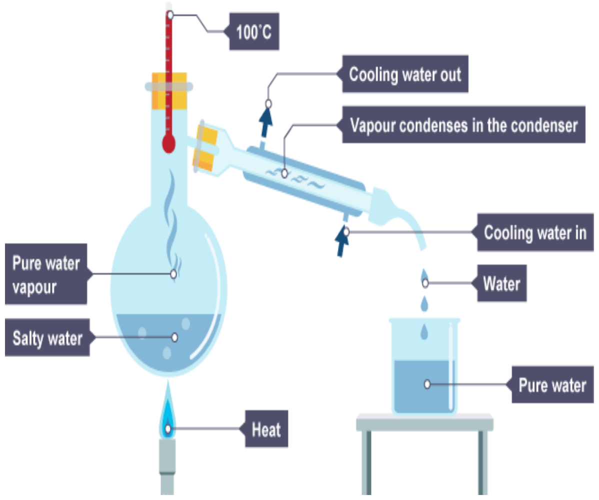
For example, copper sulphate is soluble in water – its crystals dissolve in water to form copper sulphate solution.

During evaporation, the water **evaporates** away leaving solid copper sulphate crystals behind.



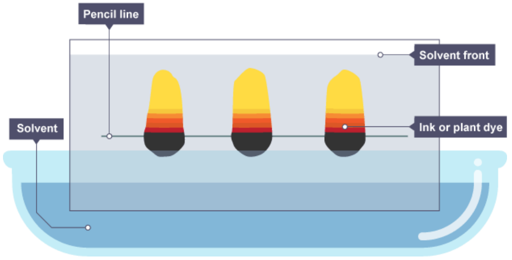
Distillation is a method for separating the solvent from a solution.

For example, water can be separated from salt solution because water has a much lower boiling point than salt. When the solution is heated, the water **evaporates**. It is then cooled and **condensed** into a separate container. The salt does not evaporate and so it stays behind.



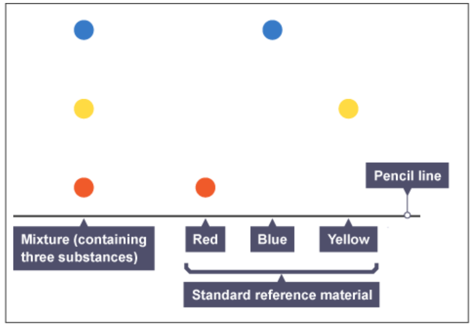
Chromatography is a method for separating dissolved substances from one another.

It works because some of the coloured substances dissolve better than others, so they travel further up the paper.



A pencil line is drawn, and spots of ink or dye are placed on it. There is a container of solvent (eg water or ethanol).

As the solvent continues to travel up the paper, the different coloured substances spread apart.



A **chromatogram**, the results of chromatography experiment.

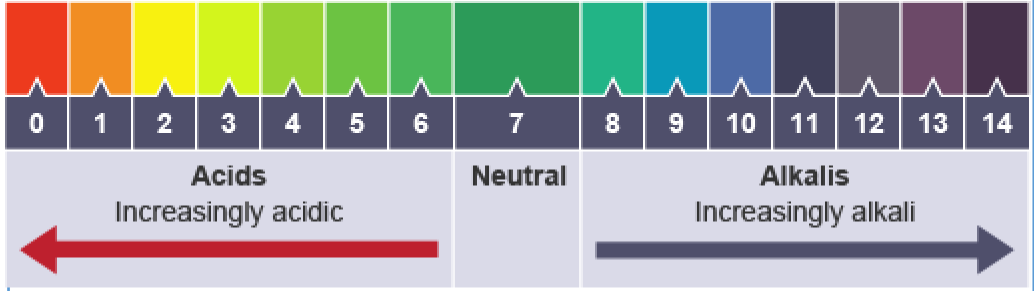
Chemical Reactions

The pH scale

Solutions can be **acidic**, **alkaline** or **neutral**:

- **Acidic solutions** form when **acids** dissolve in water;
- **Alkaline solutions** form when **alkalis** dissolve in water;
- Solutions that are neither acidic nor alkaline are **neutral**
- Pure water is neutral.

Universal indicator can tell us how strong acidic or alkaline a solution is. This is measured using the **pH scale**, which runs from pH 0 to pH 14:



- **The closer to pH 0** you go, the **more strongly acidic** it is;
- **The closer to pH 14** you go, the **more strongly alkaline** it is.

Conservation of mass

Total mass of reactants = **Total mass of products**

We say that **mass is conserved** in a chemical reaction.

Oxidation reactions

An example of an oxidation reaction is where metals react with oxygen to make metal oxides.

metal + oxygen → metal oxide

E.g. magnesium + oxygen → magnesium oxide

Another example is a combustion reaction, where we burn fuels in oxygen:

Fuel + oxygen → carbon dioxide + water

We can represent theses reactions using **WORD EQUATIONS**

The substances that react together are called the **reactants**

The substances that are formed in the reaction are called the **products**

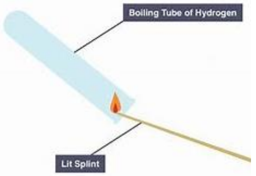
The → shows that we are making something new

Reacting metals with acids

metal + acid → metal salt + hydrogen

E.g. zinc + hydrochloric acid → zinc chloride + hydrogen

To test if **hydrogen is produced**, hold a **lit splint** to the gas and listen for it to **burn with a squeaky pop**.



Hazard signs to be aware of when dealing with acid and alkalis:

Corrosive

Irritant

Neutralisation

When an acid reacts with an alkali (or **base**), a **neutral** salt solution is formed. This is called **neutralisation**.

acid + alkali → salt + water

eg sodium hydroxide + hydrochloric acid → sodium chloride + water

Naming salts

The name of a salt has two parts:

❖ The first name comes from the **metal** in the alkali used.

❖ The second name comes from the **acid** that was used.

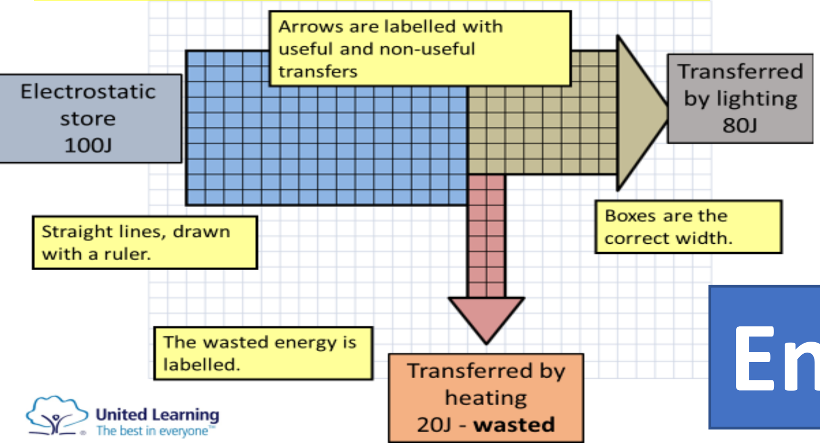
Potassium nitrate

Potassium ↑ From an alkali containing potassium, eg potassium hydroxide

nitrate ↓ From the acid "NITRIC ACID"

Acid used	Second name of salt
hydrochloric acid	chloride
sulfuric acid	sulfate
nitric acid	nitrate

Total energy before transfer = total energy after transfer



United Learning
The best in everyone

Energy supplied = useful energy + wasted energy

Efficiency (%) = $\frac{\text{Useful Energy Transferred (Joules)}}{\text{Total Energy Supplied (Joules)}}$ x 100 (%)

Energy

The energy laws:

1) Energy cannot be destroyed or created, only transferred - this is called **conservation of energy**;
2) Energy tends to spread out and become less useful (eg hot objects always eventually cool down).

Power is a measure of how fast energy is being transferred.

Units of power:
watts (W);
kilowatts (kW).

__Power__

Power is calculated by dividing energy transferred by time taken

P = E/t

P= :Power (W); E = energy (J); t = time (s)

__**Different energy stores:**__

- **Chemical**
- **Kinetic**
- **Gravitational potential**
- **Elastic potential**
- **Magnetic**
- **Electrostatic**
- **Thermal**
- **Nuclear**

We can measure the amount of energy in a store

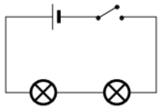
Units of energy:
joules (J)
kilojoules (kJ)
kilowatt-hours (kWh).

__**Electrical circuits**__

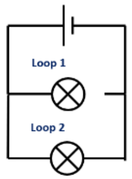
The energy in an electrical circuit is transferred **from the battery or power pack** to the **components.**
Energy is transferred by **electrons (charges)** that are able to move when there is a **potential difference and a complete circuit**
The potential difference is the amount of **energy transferred** to the charges at the battery and from the charges at the components.
When the charges move, there is an electrical **current.**
Current is the **rate of flow of charges.**

There are 2 types of circuit:

Series
Single loop



Parallel
2 or more loops



__**Pathways**__

There are 4 main **pathways** by which energy can be transferred:

- by **mechanical** work (a **force** causing an object to move);
- by **electrical** work (when charges move due to a potential difference);
- By **heating** (due to a difference in temperature);
- By **light or sound**

__**Renewable and non-renewable resources:**__

1) Non-renewable energy resources cannot be replaced once they are all used up;

- ***Fossil fuels (coal, oil, gas)***
  - releases carbon dioxide (a greenhouse gas and increases global warming). - releases sulphur dioxide and nitrogen oxides, which cause acid rain
- ***Nuclear***
  + nuclear fuels do not produce carbon dioxide or sulphur dioxide
  - non-renewable energy resources. They will run out one day
  - risk of radioactive material being released into the environment

2) Renewable energy resources can be replaced, and will not run out;

- ***Wind***
  + no release of carbon dioxide or sulphur dioxide
  - if there is no wind, there is no electricity.
- ***Water** (**wave**, **tidal** or **hydroelectric**)*
  + noif there is no wind, there is no electricity.
  release of carbon dioxide or sulphur dioxide
  - difficult for wave machines to produce large amounts of electricity.
  - tidal barrages destroy the habitats;
  - hydroelectric floods farmland and push people from their homes.
- ***Geothermal***
  + no release of carbon dioxide or sulphur dioxide
  - most parts of the world do not have suitable areas for geothermal
- ***Solar***
  + no release of carbon dioxide or sulphur dioxide
  - if there is no sunlight, there is no electricity.

__**Heat transfer**__ – two ways to transfer heat:

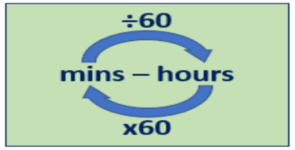
1) Conduction – heat transfer in a solid
The solid particles are always __**vibrating**__**.**
__**Heat**__ makes the particles __**vibrate more**__.
Because they are __**touching**__, the particles __**collide**__ with the particles next to them with more energy, and this transfers the heat along.
2) Convection – heat transfer in fluids (liquids and gases)
***Particles** in a fluid gain **energy** and **move further apart**. This makes that region of the fluid **less dense**, causing it to **rise**.*

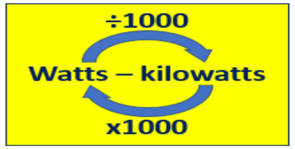
__**Energy costs money.**__

To work out how much it costs you need to know:

- the amount of **units** of energy used (in **kWh** __not__ **joules**);
- the **cost per unit** (1 unit is 1 kWh) – you will be told this

total cost (p) = number of kilowatt-hours (kWh) × cost per kilowatt-hour (p)





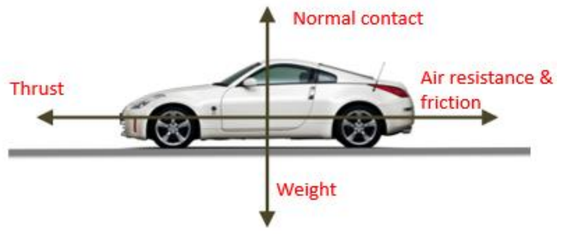
You can work out how many units something uses if you know its power (in kW) and how long you have used it for (in hours):

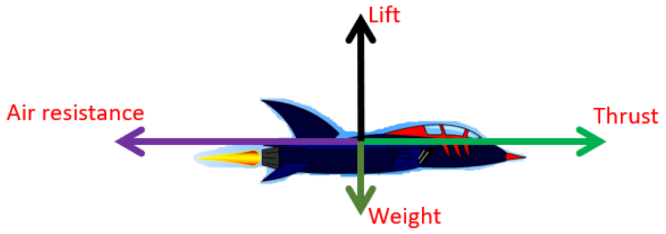
number of units of energy used (kWh) = power (kW) x time (s)

Forces & Motion

Force diagrams should always include three pieces of information about each force:

1. **Direction** - Use arrows to state the direction of the force;
2. **Size** - The longer the arrow the bigger the force;
3. **Name** - Label your force arrow with a name of the force.





Forces are measured **Newtons (N)** using a **Newton meter**

Using forces to explain motion:

1. **Balanced forces** acting on an object will cause it to **stay stationary** or travel with **constant speed**
2. **Unbalanced forces** acting on an object will cause it to **accelerate, decelerate** or **change direction**

How to present calculations in physics:

1) Write down the values that you know;
2) Identify the value that you are trying to work out;
3) Write down the formula that you will use;
4) Substitute the known values into the formula;
5) Calculate your answer and write it down;
6) Underline your answer;
7) Include the correct unit.

- d = 20m; t = 5s;
- v = ?;
- v = d/t
- v = 20/5
- v = 4 m/s

Pressure

Pressure is a measure of how spread out a force is. We calculate it by using:

p = F/A

p= pressure (Pa or N/m^2); F = Force (N); = Area (m^2).

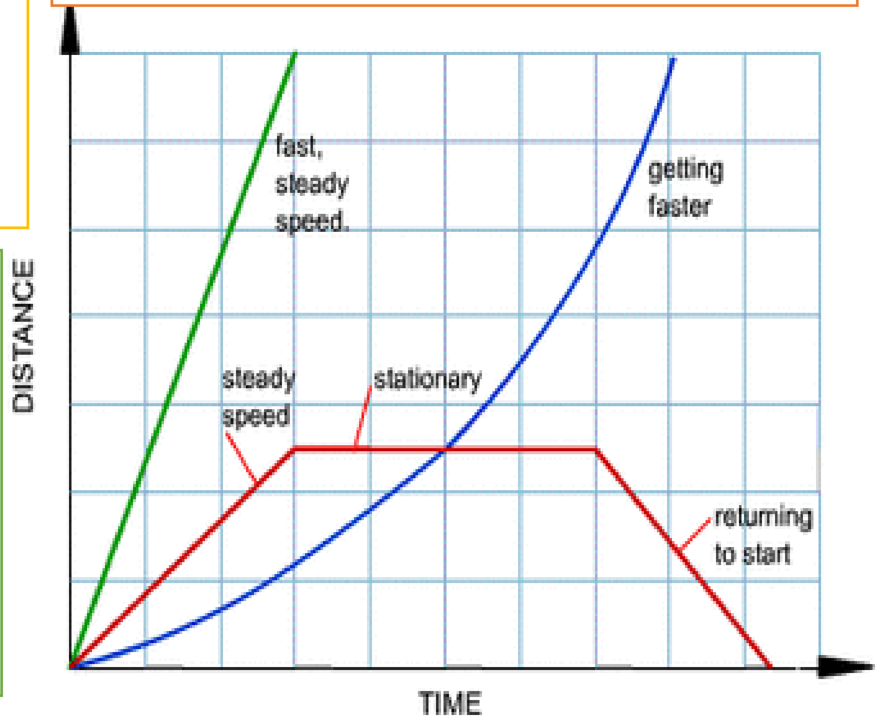
Velocity and speed

Speed is a measure of how quickly an object travels a given distance.

We calculate speed by using:

Speed (m/s) = distance (m) / time (s)

Velocity is the same as speed, but tells us the direction we are travelling in as well (ie forwards or backwards).



Names for types of force:

- Air resistance
- Friction
- Lift
- Magnetic force
- Normal contact
- Tension
- Thrust
- Upthrust
- Water resistance
- Weight

Mass, weight and gravity

Mass is a measure of how much matter an object is made up of. It is measured in **kilograms** (**kg**).

Weight is the force of gravity pulling on every kg of mass. It is measured in **Newtons** (**N**).
We can calculate weight by using:

W = m x g

W = weight (N); m = mass (kg); g = gravitational field strength (N/kg)

Gravitational field strength of Earth is 10N/kg