Knowledge Organiser – 4.1.1 Cell Biology

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4.1.1.1. Eukaryotes & Prokaryotes

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4.1.1.2 Animal & plant cells

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4.1.1.4 Cell differentiation

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4.1.1 Cell Structure

4.1.1.1. Eukaryotes & Prokaryotes:

Eukaryotic (plant, animal & fungal cells).

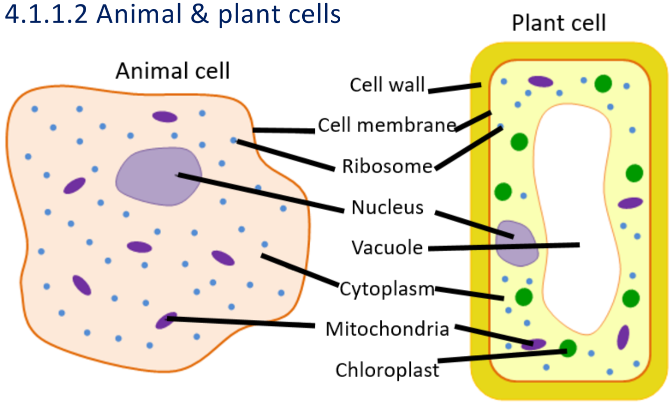
- Cell membrane
- Cytoplasm
- Genetic material enclosed in membrane

Prokaryotic (bacteria and archea).

- smaller with no true nucleus.
- No mitochondria or chloroplasts.
- DNA loops called plasmids
- Bacteria are prokaryotes.

4.1.1.2	Definitions
eukaryotic	A type of cell that has a nucleus.
prokaryotic cell	A simple cell that does not have a nucleus – the DNA is free in the cytoplasm.
mitochondria	Structures in the cytoplasm of all cells where aerobic respiration takes place
ribosome	The site of protein synthesis.
sub-cellular	Structures smaller than a cell that are found within it.
tissue	A group of similar cells that carry out the same function, eg muscle tissue.
Nucleus	Contains the cell's genetic materials
Cell membrane	Controls the movement of substances in and out of the cell
Cytoplasm	where many chemical reactions take place
Chloroplasts	where photosynthesis occurs
Vacuole	Filled with cell sap to help support the plant
Cell wall	made of cellulose to strengthen the cell.

4.1.1.2 Animal & plant cells



You must be able to label the animal and plant cells

Sub-cellular structures:

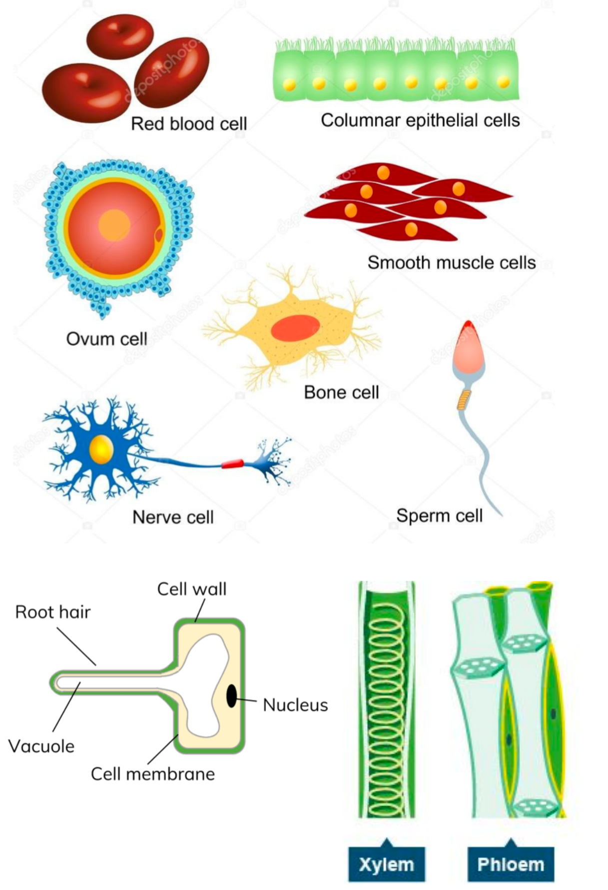
Most animal cells have the following

- **nucleus**
- **cytoplasm**
- **a cell membrane**
- **mitochondria**
- **ribosomes.**

In addition to the parts found in animal cells, plant cells often have:

- **chloroplasts**
- a permanent **vacuole** filled with cell sap.
- Plant and algal cells also have a **cell wall made of cellulose**, which strengthens the cell

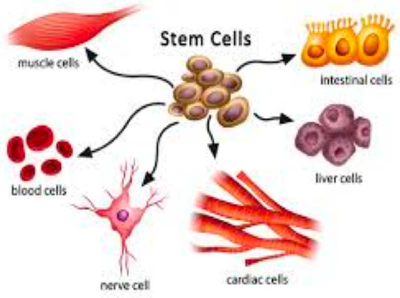
4.1.1.3. Cell specialisation:



4.1.1.4 Cell differentiation

As an organism develops, cells differentiate to form different types of cells.

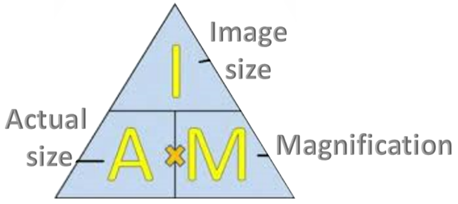
- Most types of animal cell differentiate at an early stage.
- Many types of plant cells retain the ability to differentiate throughout life.



4.1.1.5 Microscopy

Electron microscope

- has much **higher magnification** and **resolving power** than a light microscope.
- Can be used to **study cells in much finer detail.**
- Enabled biologists to see and **understand many more sub-cellular structures**.



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$$\text{Magnification} = \frac{\text{Image size}}{\text{Actual size}}$$

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4.1.1.5 Microscopy

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Knowledge Organiser – 4.1.2 Cell Biology

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4.1.2 Cell Division: Mitosis

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[Amoeba Sisters]

4.1.2.3. Stem cells - Plants

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[freesciencelessons]

4.1.2.3 Stem cells – animals

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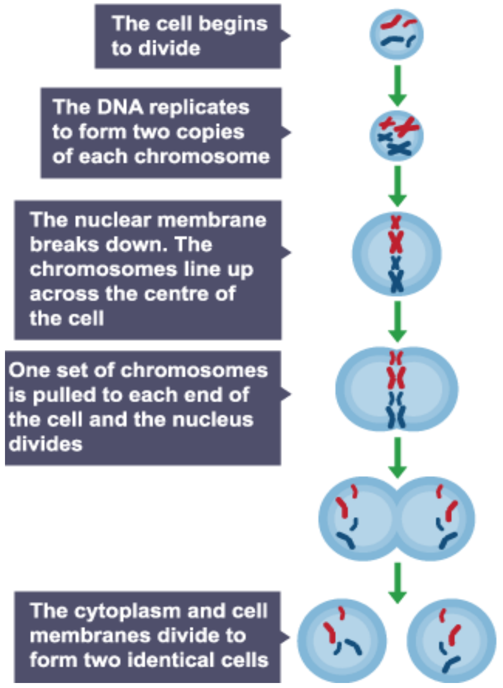
4.1.2 Cell Division : MITOSIS

- The nucleus of a cell contains **chromosomes** made of **DNA** molecules.
- Each chromosome carries a large number of **genes**.
- In body cells the chromosomes are **normally found in pairs**.
- **Mitosis** is **cell division for growth & repair**.
- 2 genetically identical daughter cells are formed.

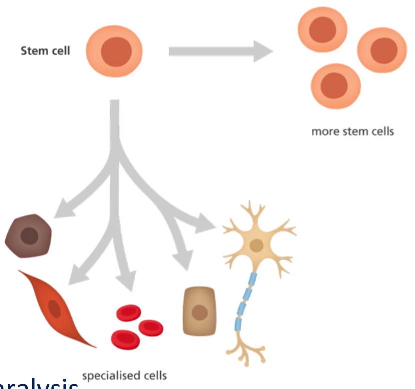


4.1.2.3 Stem cells - Plants

- **Meristem tissue** in plants can **differentiate into any type of plant cell**, throughout the life of the plant.
- can be used to **produce clones** of plants quickly and economically and to prevent extinction.
- **Crop plants** with special features such as disease resistance can be cloned to produce large numbers of identical plants for farmers.

4.1.2.3 Stem cells - animals

- A **stem cell is an undifferentiated cell of an organism** which is capable of giving rise to cells of any type.
- **Stem cells from human embryos can be cloned** and made to **differentiate into most** types of human cells.
- **Stem cells from adult bone marrow** can form many types of cells including **blood cells.**

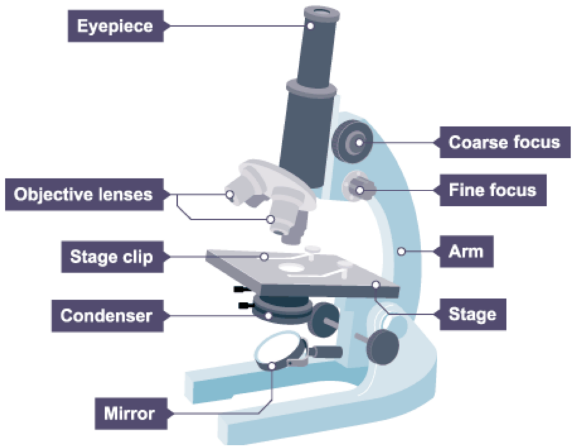


Treatment with stem cells

- may be able to help conditions such as diabetes and paralysis.
- In **therapeutic cloning** an embryo is produced with the same genes as the patient. Stem cells from the embryo are not rejected by the patient's body so they may be used for medical treatment.
- The use of stem cells has potential risks such as transfer of viral infection, and some people have ethical or religious objections.

RPA: Microscopy	Definitions
calibrate	To set an instrument or scale against a standard.
field of view	The area seen when looking through a microscope.
graticule	The graticule has a scale ruled on it and is used to estimate the size of a specimen when viewed with a microscope.
magnification	The amount that an image of something is scaled up when viewed through a microscope.
order of magnitude	For each order of magnitude, a number is ten times the previous one.
resolution	The fineness of detail that can be seen in an image - the higher the resolution of an image, the more detail it holds.
significant figure	Giving a number to a specified number of significant figures is a method of rounding. E.g., in the number 7483, the most significant, or important, figure is 7, as its value is 7000. To give 7483 correct to one significant figure (1 sf), would be 7000. To 2 sf, it would be 7500.
stage micrometer	A glass slide with a scale etched on it. It is used to calibrate the eyepiece graticule of a microscope.
standard form	A system in which numbers are written as a number greater than 1 and less than 10 multiplied by a power of 10 (either positive or negative.)

Required practical activity: use a light microscope to observe, draw and label a selection of plant and animal cells.
A magnification scale must be included



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Required Practical: Miscroscopy

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[Using a graticule]

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Knowledge Organiser – 4.1.3 Transport in Cells

Click on the links below for online content

4.1.3.1 Diffusion

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4.1.3.1 Diffusion across Alveoli

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4.1.3.1 Diffusion across leaf

[freesciencelessons]

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4.1.3.1 Diffusion

Substances may move into and out of cells across the cell membranes via diffusion.

- Diffusion is the spreading out of the particles of any substance in solution, or particles of a gas, resulting in **a net movement from an area of higher concentration to an area of lower concentration**.

Some of the substances transported in and out of cells by diffusion are:

- **oxygen** and **carbon dioxide** in gas exchange,
- waste product **urea** from cells into the blood plasma for excretion in the kidney.

Factors which affect the rate of diffusion are:

- the difference in concentrations **(concentration gradient)**
- the **temperature**
- the **surface area** of the membrane.

The effectiveness of an exchange surface is increased by:

- having a **large surface area**
- a membrane that is **thin** to provide a short diffusion path
- (in animals) having an **efficient blood supply**
- (in animals, for gaseous exchange) being **ventilated**.

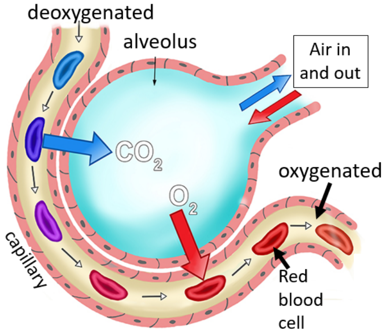
4.1.3.1 Diffusion - examples

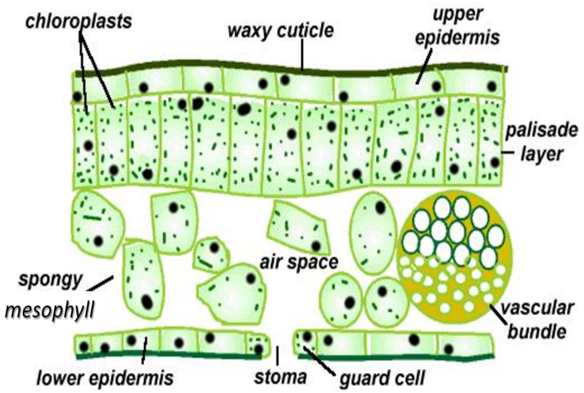
Single-celled organisms have a **large surface area to volume ratio**, allowing sufficient transport of molecules in and out of the cell.

Multicellular organisms have a **relatively small surface area to volume ratio** so they **need specialised exchange surfaces** and a transport system:

- Large surface area
- Thin membranes for a short diffusion path
- Efficient blood supply (animals)
- Being ventilated (animals)

Gas exchange in the alveoli





CO_2 diffuses from high concentration in the air space to a low concentration inside the mesophyll cells

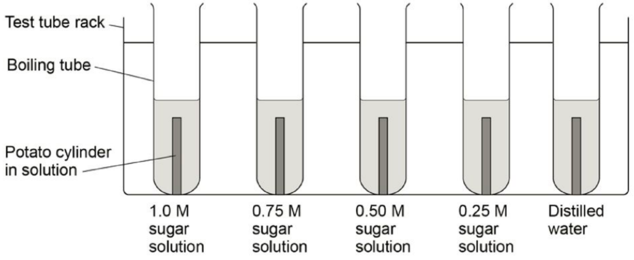
4.1.3.2 Osmosis

Osmosis is the **diffusion of water from a dilute solution** to a **concentrated solution** through a partially permeable membrane.

Effects of Osmosis on Plant Cells

In dilute solution = turgid	**In isotonic solution = same**	**In concentrated solution = flaccid**	**Plasmolysed cell= cytoplasm pulls away from cell wall**

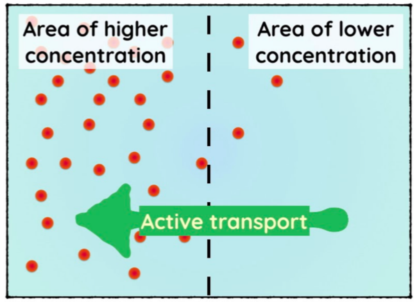
RPA: investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue



4.1.3.3 Active Transport

Is the movement of substances from a more dilute to a more concentrated solution (<u>against</u> the concentration gradient).
It needs ENERGY from respiration.
for respiration.

Eg 1- **Mineral ions** absorbed **into root hair cells** from very dilute solutions in the soil.
Eg 2- **Sugar molecules** absorbed **from the gut** (lower concentration) into the blood for respiration.



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4.1.3.2 Osmosis

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Required Practical: Osmosis

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4.1.3.3 Active Transport

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Knowledge Organiser – 4.2 Organisation

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4.2.1 Principles of organisation

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4.2.2.1 Human digestive system

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4.2.2.1 Enzymes

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[& freesciencelessons]

[AmoebaSisters]

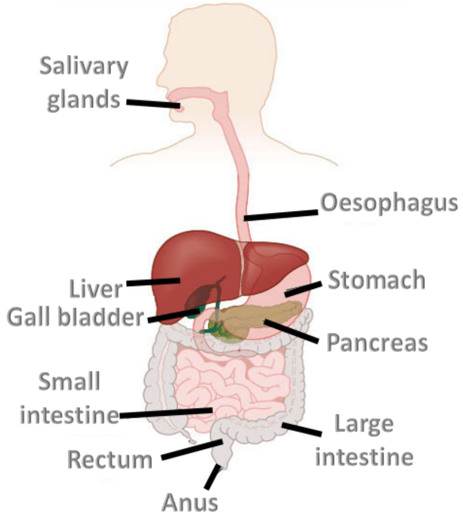
[FocuseLearning]

4.2.1 Principles of organisation

4.2.1	Definitions
Cells	The basic building blocks of all living organisms. Eg. Muscle, skin, nerve, root hair and palisade leaf cells
Tissue	A group of cells with a similar structure and function (job). Eg. Muscle, heart, xylem and epidermal tissue
Organs	A group of tissues performing a specific function. Eg. Heart, liver, brain, roots, stem, leaf & flower
Organ systems	Groups of organs working together to form an organism. Eg. circulatory, nervous & transpiration systems
Digestive system	Organ system in which several organs work together to digest & absorb food.

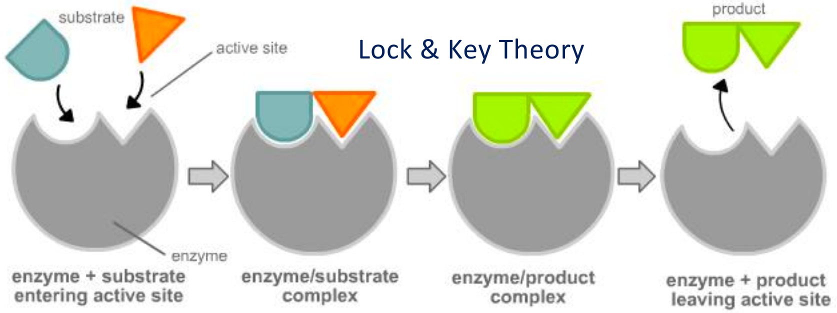
4.2.2 Animal tissues, organs and organ systems

4.2.2.1 The human digestive system



Enzyme	Produced	Nutrients acted upon	Products (smaller molecules)	Optimum pH & temperature
Carbohydrase Eg. Amylase	Salivary glands	Carbohydrate Eg. starch	Simple sugars Eg. glucose	pH7 37°C
Protease	Stomach, pancreas	Protein	Amino acids	pH2 37°C
Lipase	Pancreas, small intestine	Lipid (fats & oils)	Glycerol & fatty acids	pH8 37°C

Enzymes are **biological catalysts** that breakdown food into small, soluble molecules that can be absorbed into the bloodstream from the digestive system.



Denature. If the optimum conditions are not correct for an enzyme, it loses it's shape and cannot attach to the substrate (nutrient molecule). It is "denatured".

bile	Made in the liver, stored in gall bladder. Emulsifies fats to for digestion and neutralises stomach acid.
carbohydrate	Food consisting of sugars, starch and cellulose. Carbohydrates are vital for energy in humans and are stored as fat if eaten in excess.
digestion	The breakdown of large insoluble food molecules to smaller soluble ones.
digestive system	Organ system involved in breaking food down so that it can be absorbed into the bloodstream.
egestion	The process of passing out the remains of food that has not been digested, as faeces, through the anus.
emulsify	To mix water with lipids to produce a cloudy mixture called an emulsion.
fats	Naturally occurring compounds of carbon, hydrogen and oxygen. They are esters made from fatty acids and glycerol.
fatty acids	Carboxylic acids with a long chain of carbon atoms. Fatty acids react with glycerol to produce lipids (fats and oils).
gall bladder	Stores bile before releasing it into the duodenum.
glucose	A simple sugar used by cells for respiration.
glycogen	Animals store glucose as glycogen in their liver and muscle tissues.
gut	The digestive system.
lipid	Fat or oils, composed of fatty acids and glycerol.
liver	The large organ, beside the stomach, which has many functions, including processing substances absorbed by the digestive system and a role in the storage of the body's carbohydrate.
metabolism	All the chemical reactions in the cells of an organism, including respiration.
microvilli	Projections from the surface of an epithelial cell of the small intestine wall.
pancreas	Large gland located in the abdomen near the stomach which produces digestive enzymes and the hormone insulin.
protein	Organic compound made up of amino acid molecules. Proteins are needed by the body for cell growth and repair.
starch	A type of carbohydrate. Plants can turn the glucose produced in photosynthesis into starch for storage
sugar	A simple carbohydrate that is sweet to the taste.
villi	Finger-like projections in the small intestine that provide a large surface area for the absorption of food.

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RPA: Amylase

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RPA: Food Tests

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4.2.2.3 Blood

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RPA: investigate the effect of pH on the rate of reaction of amylase on starch

Amylase breaks down starch. Starch turns blue/black when iodine (an orange solution) is added.

- Starch solution (CV)
- Amylase solution (CV)
- Buffer solutions of
- different pH (**IV**)
- Spotting tiles
- Test tubes
- Water bath (temp CV)
- Iodine solution
- Stop clock

DV is the time at which the starch/ amylase solution no longer turns blue/black.

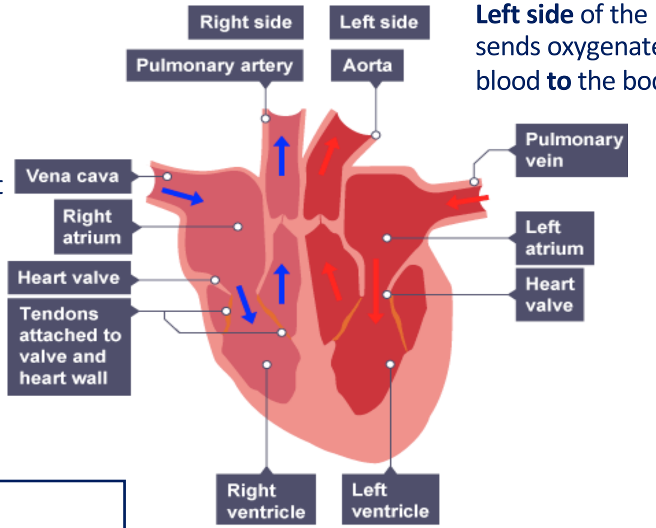
RPA: use qualitative reagents to test for carbohydrates (starch and glucose), proteins and lipids

Food group	Reagent	Positive result
Glucose	Benedict's solution (heated)	Bright blue to orange/ brick red
Protein	Biuret's solution	Bright blue to lilac
Starch	Iodine solution	Orange to blue/ black
Lipid (Fat/oil)	Ethanol & water	Clear to Milky/ cloudy

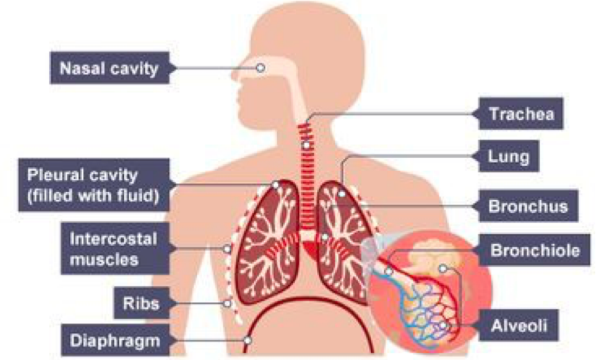
4.2.2.2 The heart and blood vessels

Right side of the heart receives deoxygenated blood **from** the body and pumps it to the lungs.

Pacemaker
Group of cells in the right atrium that control resting heart rate.



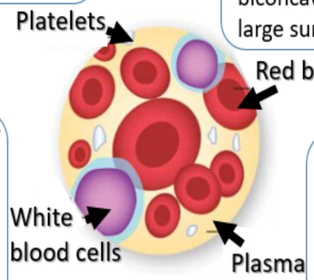
Left side of the heart sends oxygenated blood **to** the body.



4.2.2.2 The heart and blood vessels

Fragments of cells which collect at wounds & trigger clotting.

Transport oxygen to cells for respiration. No nucleus, biconcave shape to large surface area

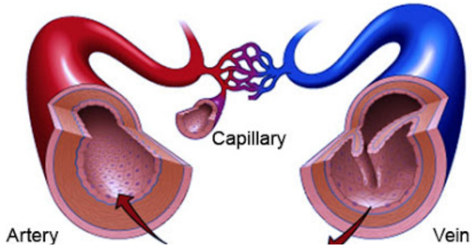


Protect the body from infection. Phagocytosis. Antibody & antitoxin production

Transports cells, hormones, antibodies, urea, carbon dioxide & products of digestion.

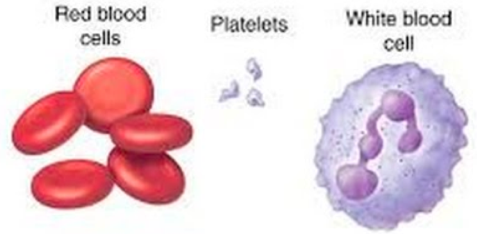
4.2.2.3 Blood

- Blood away from heart
- Thick muscular wall
- Small lumen
- Under high pressure



- Blood towards from heart
- Thinner wall
- Large lumen
- Under low pressure

4.2.2.3 Blood



Blood is a tissue consisting of plasma containing red blood cells, white blood cells and platelets

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4.2.2.2 The heart

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4.2.2.2 Blood Vessels

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4.2.2.4 Coronary Heart Disease

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4.2.3.1 Plant Tissues

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4.2.2.5 Health issues & Types of disease

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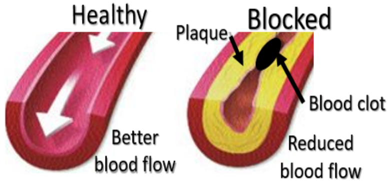
4.2.2.4 Coronary heart disease: a non-communicable disease

- **Coronary heart disease** layers of fatty material build up inside the coronary arteries, narrowing them.
- Reduces the flow of blood through the coronary arteries, resulting in a lack of oxygen for the heart muscle.
- Stents are used to keep the coronary arteries open.
- Statins are widely used to reduce blood cholesterol levels which slows down the rate of fatty material deposit.

- **Heart valves may become faulty**, preventing the valve from opening fully, or the heart valve might develop a leak.
- Faulty heart valves can be replaced using biological or mechanical valves.

- **Heart Transplants**: the case of heart failure a donor heart, or heart and lungs can be transplanted.
- Artificial hearts are occasionally used to keep patients alive whilst waiting for a heart transplant, or the heart to rest as an aid to recovery.



4.2.2.5 Health issues & types of disease

communicable, can be transferred from one organism to another, e.g. measles, food poisoning and malaria

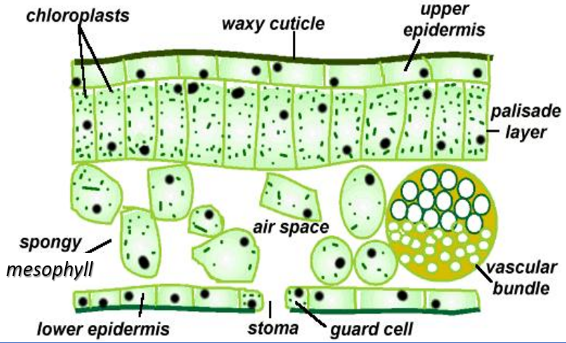
non-communicable, which are not transferred between people or other organisms, e.g.

- **cancer**
- **diabetes**
- **genetic diseases** and conditions
- heart disease
- neurological disorders

Other factors that can effect physical and mental health include:

- **diet**
- **lifestyle factors** such as alcohol and other drugs
- **stress**
- situations that may occur in a person's life

4.2.3.1 Plant tissues



Epidermis	Covers outer leaf surface for protection
Palisade mesophyll	Main site for photosynthesis. Many chloroplasts
Spongy mesophyll	Air spaces between cells allow gases to diffuse

4.2.2.6 lifestyle on non-communicable disease

Risk factors are linked to increased rate of a disease. aspects of a person's lifestyle

- substances in the body or environment.
- The effects of diet, smoking and exercise on cardiovascular disease.
- Obesity as a risk factor for Type 2 diabetes.
- The effect of alcohol on liver & brain function.
- Effect of smoking on lung disease & lung cancer.
- Effects of smoking & alcohol on unborn babies.
- Carcinogens, including ionising radiation, as risk factors in cancer.

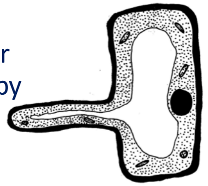
4.2.2.7 Cancer

Benign tumours are abnormal cell growths contained in one area, **usually within a membrane**. They do not invade other parts of the body.

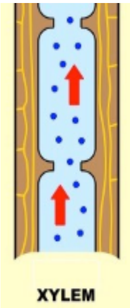
Malignant tumour cells are cancers. Invade neighbouring tissues and **spread to different parts of the body** where they form secondary tumours.

4.2.3.2 Plant organ system

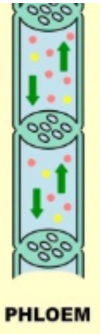
Roots, stem, leaves form plant transport organ system.



- **Root hair cells** are adapted for the efficient uptake of water by osmosis, and mineral ions by active transport.

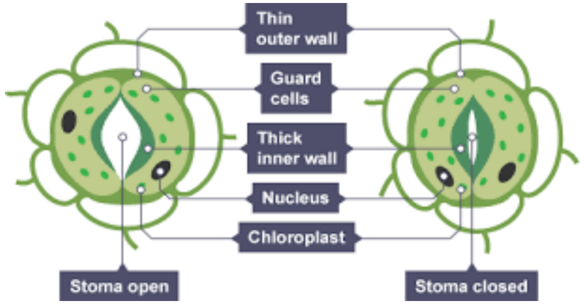


- **Xylem tissue** transports water and mineral ions from the roots to the stems and leaves.
- Made of hollow tubes strengthened by **lignin** adapted for the transport of water in the **transpiration** stream.



- **Phloem tissue** transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage. This transport is called **translocation**.
- **Phloem** is composed of tubes of elongated cells. **Cell sap can move from one phloem cell to the next through pores in the end walls.**

- **Stomata** and **guard cells** control gas exchange and water loss.



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4.2.2.6: Lifestyle effect on non-communicable disease

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4.2.2.7 Cancer

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4.2.3.2 Plant Organ System

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Knowledge Organiser – 4.3 Infection and response

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4.3.1.1. Communicable diseases

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4.3.1.2 Viral Diseases

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4.3.1.3 Bacterial Diseases

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4.3.1.1 Communicable (infectious) diseases

Pathogens are microorganisms that cause infectious disease.

Pathogens may be **viruses**, **bacteria**, **protists** or **fungi**.

- They may infect plants or animals and can be spread by direct contact, by water or by air.
- Bacteria and viruses may reproduce rapidly inside the body.
- Bacteria may produce poisons (toxins) that damage tissues and make us feel ill.
- Viruses live and reproduce inside cells, causing cell damage. Viruses are not considered to be living organisms.

Pathogen	Example in animals	Example in plants	Treatment
Viruses	Measles, HIV potentially leading to AIDS	Tobacco mosaic virus	Vaccination
Bacteria	Salmonella Gonorrhoea	Agrobacterium	Antibiotics
Fungi	Athlete's foot	Rose black spot	Anti fungal medication & Fungicides.
Protists	Malaria (Spread by mosquitos)	Downy mildew	Anti malarial drugs, prevention from vector contact eg mosquito nets

Tobacco mosaic virus

Rose Black Spot

Downy mildew

4.3.1.2 Viral diseases

Measles is a **viral disease**

- Symptoms: fever and a red skin rash.
- Measles can be fatal if complications arise.
- Most young children are vaccinated against measles.
- The measles virus is spread by inhalation of droplets from sneezes and coughs.

HIV initially causes a flu-like illness.

- Unless successfully controlled with antiretroviral drugs the virus attacks the body's immune cells.
- Late stage HIV infection, or AIDS, occurs when the body's immune system becomes so badly damaged it can no longer deal with other infections or cancers.
- HIV is spread by sexual contact or exchange of body fluids such as blood which occurs when drug users share needles.

Tobacco mosaic virus (TMV) is a widespread plant pathogen

- Affecting many species of plants including tomatoes.
- Symptoms: Gives a distinctive 'mosaic' pattern of discolouration on the leaves which affects the growth of the plant due to lack of photosynthesis.

4.3.1.3 Bacterial diseases

Salmonella food poisoning

- Spread by bacteria ingested in food, or on food prepared in unhygienic conditions.
- In the UK, poultry are vaccinated against salmonella to control the spread.
- Symptoms: Fever, abdominal cramps, vomiting and diarrhoea are caused by the bacteria and the toxins they secrete.

Gonorrhoea is a sexually transmitted disease (STD)

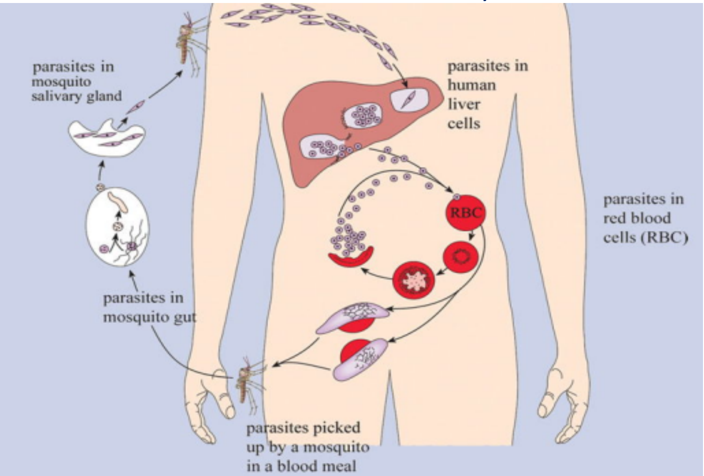
- Symptoms: thick yellow or green discharge from the vagina or penis and pain on urinating.
- Was easily treated with the antibiotic penicillin until many **resistant strains appeared**.
- Spread by sexual contact.
- The spread can be controlled by treatment with antibiotics or the use of a barrier method of contraception such as a condom.

4.3.1.4 Fungal diseases

Rose black spot is a fungal disease

- Symptoms: purple or black spots develop on leaves, which often turn yellow and drop early.
- It affects the growth of the plant as photosynthesis is reduced.
- It is spread in the environment by water or wind. Rose black spot can be treated by using fungicides and/or removing and destroying the affected leaves.

4.3.1.5 Protist diseases : Malaria Life Cycle



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4.3.1.5 Protist Diseases

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Knowledge Organiser – 4.3.1.6 Human defence systems

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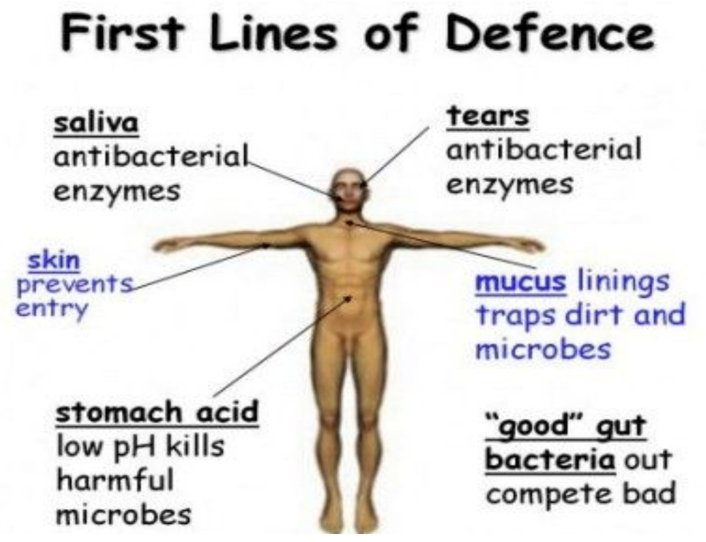
4.3.1.6 Human defence systems

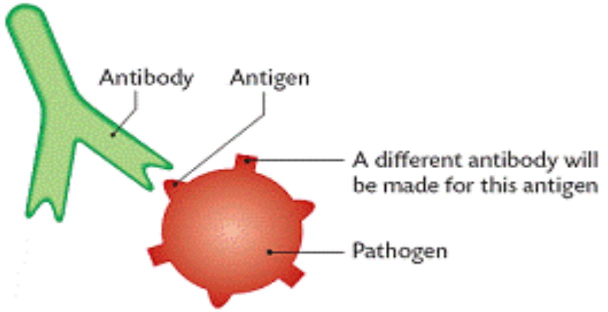
Humans have a variety of **specific** and **non specific** Human defences against invading pathogens.

Non-specific:	**Specific via white blood cells**
Skin (physical barrier)	Phagocytosis
Nose (mucus)	Antibodies
Trachea and bronchi (cilia)	Antitoxins
Stomach (acid)	



4.3.1.7 Vaccination

- Introducing small **quantities of dead or inactive pathogens** to **stimulate antibody production**.
- This leads to a quicker response in future infections.



4.3.1.8 Antibiotics and pain killers

- **Antibiotics**, such as **penicillin**, are medicines that help to cure bacterial disease by killing infective bacteria inside the body.
- Specific bacteria should be treated by specific antibiotics
- **Emergence of antibiotic resistant bacteria** is of great concern.
- **Antibiotics CANNOT kill viral pathogens**
- Painkillers and other drugs are used to treat the symptoms of disease, but do not kill pathogens.

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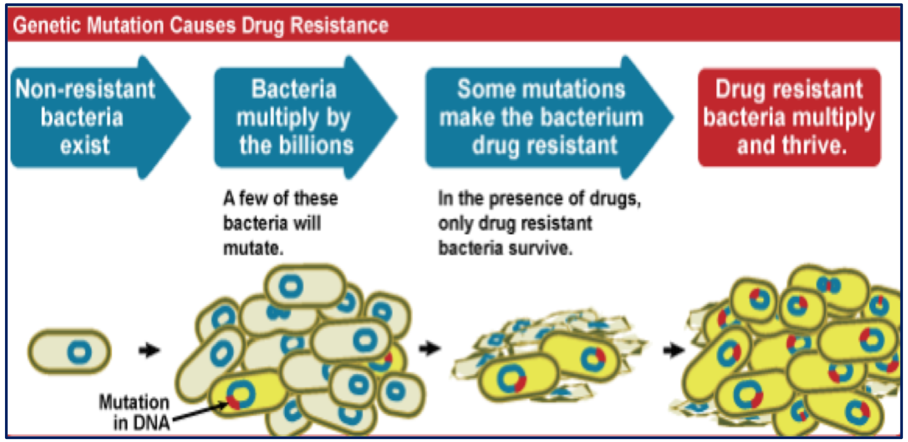

4.3.1.7 Vaccination

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4.3.1.9 Discovery and Development of drugs

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4.3.1.9 Discovery and development of drugs

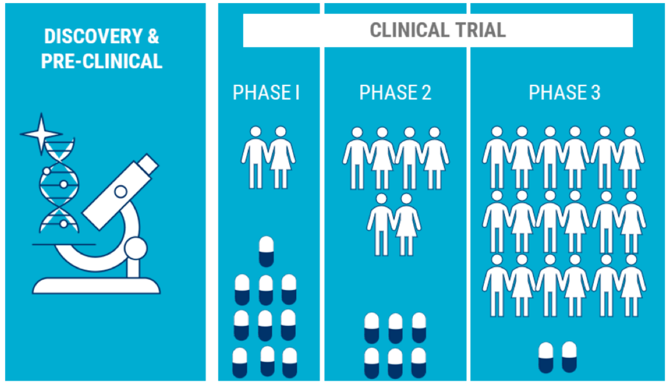
Have traditionally been extracted from Plants and microorganisms.

Digitalis – Foxgloves

Asprin – Willow

Penicillin – Penicillium mould

- Most new drugs are **synthesised by chemists** in pharmaceutical industry
- New drugs have to be **tested** and **trialled** before use to check they are **safe and effective**.
- New drugs tested for **toxicity, efficacy and dose**



Clinical trials use healthy volunteers and patients.

- Very low doses of the drug are given at the start of the clinical trial.
- If the drug is found to be safe, further clinical trials are carried out to find the optimum dose for the drug.
- In double blind trials, some patients are given a placebo

Knowledge Organiser – 5.1 Atomic structure & the periodic table

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5.1.1.1 Atoms, elements & compounds

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5.1.1.3 Development of model of atom

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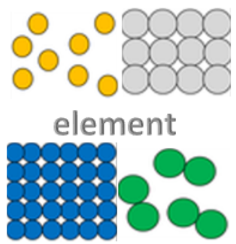
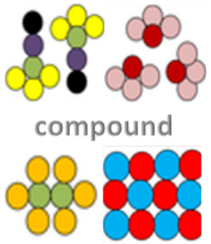
5.1.1.1 Atoms, elements & compounds

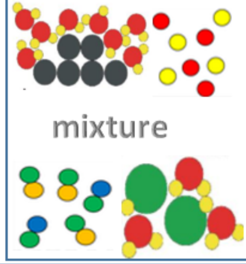
An **Atom** is the **smallest part of an element that can exist.**



Made from only one type of atom e.g. Gold is made of only gold atoms



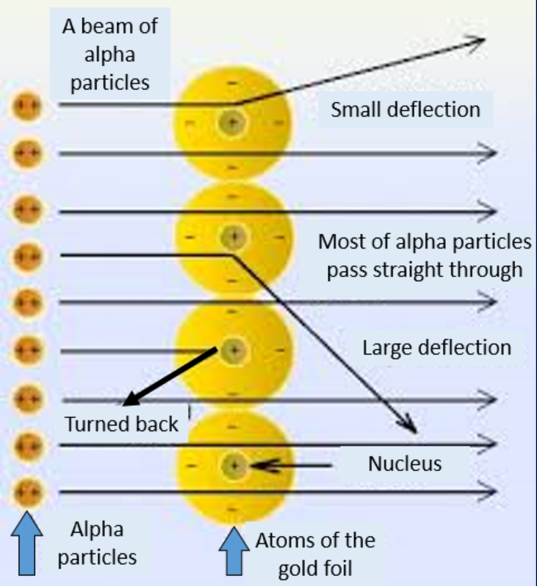
Two or more elements chemically bonded (joined) together. Separated by chemical reactions



Two or more elements that are NOT chemically combined together. Separated by physical processes

5.1.1.3 The development of the model of the atom

Ideas about atoms have changed over time. Scientists developed new atomic **models** as they gathered new experimental evidence.

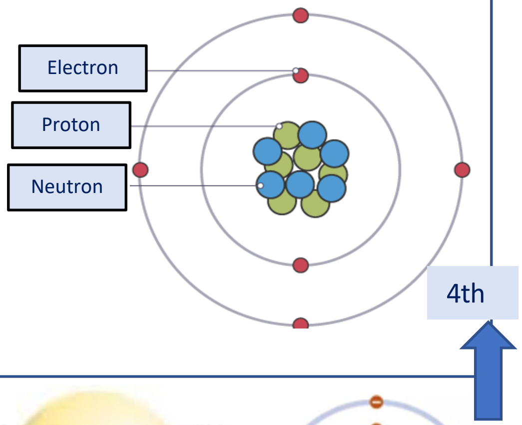


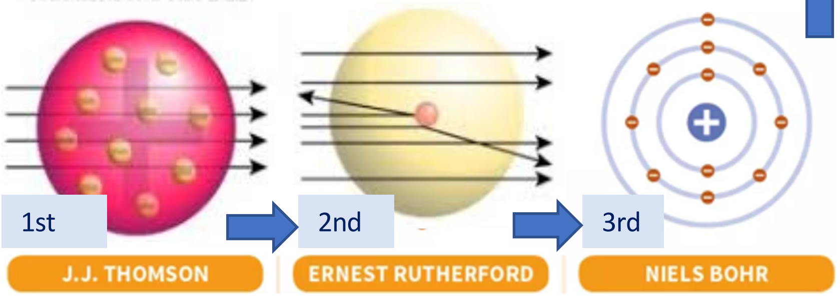
Ernest Rutherford's Gold scattering experiment

- **Positive alpha particles** fired at gold leaf
- **Most passed straight through** suggesting the atom was mainly empty space
- **Some deflected at angles** suggesting the presence of electrons
- **Some bounced straight back** suggesting a positive nucleus repelled the alpha particles.

The Nuclear Model

In 1932 James Chadwick found evidence for the existence of particles in the nucleus with mass but no charge. These particles are called **neutrons.**
This atomic model is still used today.





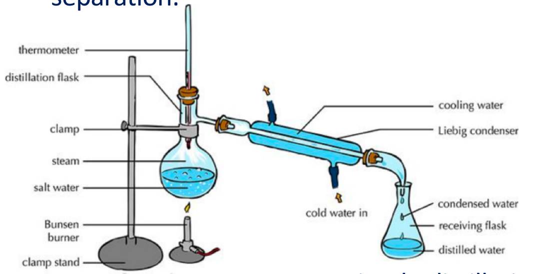
1904- **electron** discovered, placed in a sphere of positive charge (the **plum pudding model**)

1911 - gold scattering experiment discovered mass was concentrated in a central positive **nucleus** (the nuclear model)- further experiments led to discovery of **protons**

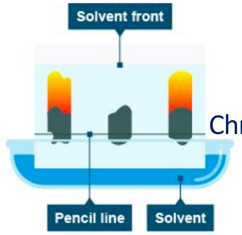
1913 - Suggested electrons orbit the nucleus in **shells**. The shells are at certain distances from the nucleus.

5.1.1.2 Mixtures

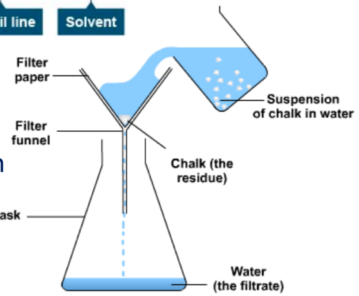
- Mixtures can be **separated by physical processes** such as **filtration, crystallisation, simple distillation, fractional distillation & chromatography**.
- These physical processes **do not involve chemical reactions** and **no new substances are made.**
- Examples of the specified processes of separation:



Simple distillation



Chromatography



Filtration

Crystallisation

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5.1.1.2 Mixtures

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Knowledge Organiser – 5.1 Atomic structure & the periodic table

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5.1.1.4 Relative electrical charges of subatomic particles

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5.1.1.5 Size and mass of atoms

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5.1.2.2 Dev. Of the periodic table

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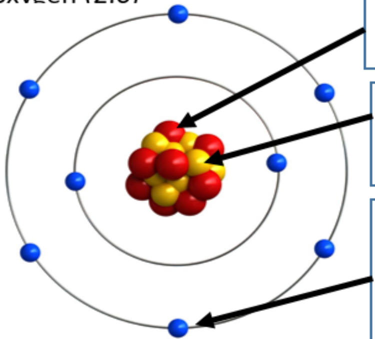
5.1.1.4 Relative electrical charges of subatomic particles & 5.1.1.7 Electron structure

Innermost, lowest energy level, **shell** has **2 electrons**.
Next shell 8, next shell 8. (2,8,8)

Electronic structure an be shown as a diagram or a number eg. oxygen (2.6)

Sub-atomic Particles



Proton: Positive subatomic particle in the nucleus. Relative mass 1, charge +1

Neutron: Neutral subatomic particle in the nucleus. Relative mass 1, Charge 0 (no charge)

Electron: Negative subatomic particle orbiting the nucleus. Very small relative mass. Charge -1. Can be represented by dots or crosses

Atomic radius: 0.1 nm

Nucleus: The centre of an atom in which most of the mass of the atom is concentrated

5.1.1.5 Size and mass of atoms

- Atoms are **very small**, having a radius of about 0.1 nm (1 x 10-10 m).
- Atomic mass number: The sum (total) of the protons and neutrons in the nucleus of an atom of an element.
- Atomic (Proton) number: The number of protons in an atom of an element. Balanced by number of electrons in an atom of that element. (so atoms have no overall charge).

Name of particle	Relative mass
Proton	1
Neutron	1
Electron	Very small

12
C
carbon
6

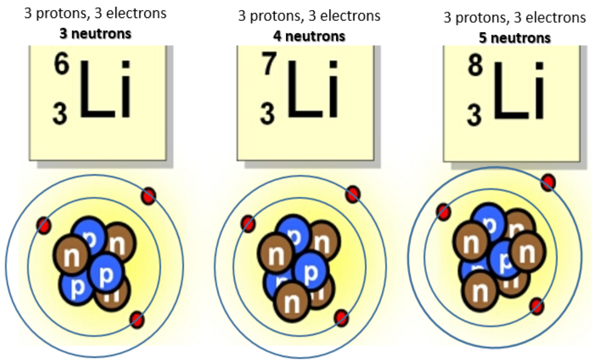
5.1.2.2 Development of the periodic table

- Early versions organized by atomic mass
- Didn't take account of isotopes
- Many elements missing
- Mendeleev ordered elements by atomic (proton) number
- Left gaps for undiscovered elements. Later discoveries proved him right.

5.1.1.6 Relative atomic mass

Isotopes are atoms of the same element with **different numbers of neutrons** in the nucleus.

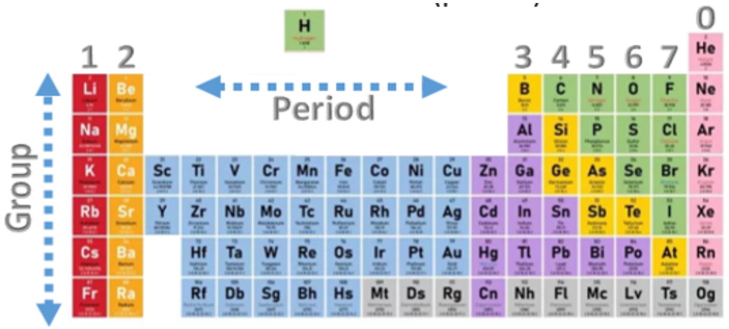
Relative atomic mass: Average value that takes account of the **abundance** of the different isotopes of that element.



5.1.2 Periodic Table

Shows the ~100 known elements in order of atomic (proton) number

Elements in groups have similar properties and have the same number of electrons in their outer shell



Group 0: Noble Gases
Have full outer shells so stable and unreactive. Boiling points increase going down the group.

Group 1: Alkali Metals
1 electron on the outer shell. Reactivity INCREASES going down the group. Vigorous reactions with oxygen, chlorine and water.

Group 7: Halogens
7 electrons on the outer shell. Non-metals. Exist as diatomic (2 atoms) molecules. Reactivity decreases going down the group.

5.1.2.3 Metals & Non-metals

vs

Elements that react to form positive ions are **metals.**

Elements that do NOT form positive ions are **non-metals.**

Metals	Non-metals
Good conductors of heat and electricity	Bad conductors of heat and electricity
Malleable: can be beaten into thin sheets, hammered into shape	Brittle: breaks easily if solid
Ductile: can be stretched into wires	Non-ductile: snap easily
Shiny (lustre)	Dull

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5.1.1.6 Relative atomic mass

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5.1.2 Periodic table

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5.1.2.3 Metals & Non-metals

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Knowledge Organiser – 5.2 Structure & bonding

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5.2.1.2 Ionic bonding

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5.2.1.3 Ionic compounds

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5.2.1.4 Covalent Bonding

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5.2.2.1 States of matter

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5.2.1.1 Chemical bonds

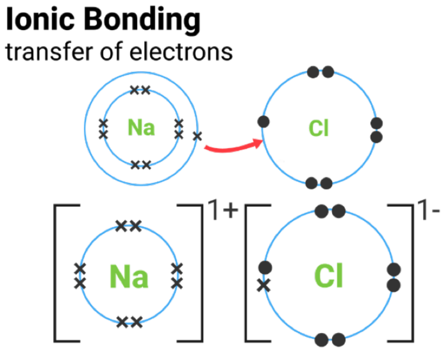
There are three types of strong chemical bonds: ionic, covalent and metallic.

Ionic bonding: particles are oppositely charged ions. Ionic bonding occurs in compounds formed from metals combined with non-metals

Covalent bonding the particles are atoms which share pairs of electrons. Covalent bonding occurs in most non-metallic elements and in compounds of non-metals

Metallic bonding the particles are atoms which share delocalised electrons. Metallic bonding occurs in metallic elements and alloys.

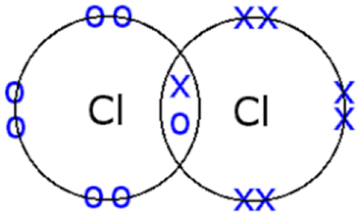
5.2.1.2 Ionic Bonding

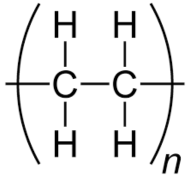


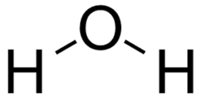
- Between a metal atom and a non-metal atom
- Metals lose electrons to form positive ions
- Non-metals gain electrons & form negative ions
- Electrons **transferred** (**ions** formed)
- Strong **electrostatic** forces
- Giant **lattice** structures
- High melting/boiling points
- If **molten** or in **solution** ions will conduct electricity

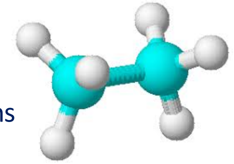
5.2.1.4 Covalent Bonding

Sharing electrons







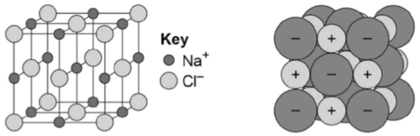


- Between two non-metal atoms
- Electrons are **shared**
- A **covalent** bond is one pair of shared electrons
- Covalent bonds are ALWAYS STRONG

5.2.1.3 Ionic compounds

- An ionic compound is a **giant structure of ions**.
- Ionic compounds are held together by **strong electrostatic forces of attraction** between oppositely charged ions.
- These **forces act in all directions in the lattice** and this is called **ionic bonding**.

Eg: structure of sodium chloride



5.2.2.1. The three states of matter

- **Freezing** take place at the **melting point**
- **Boiling** and **condensing** take place at the **boiling point**.
- **Particle theory** can help to explain melting, boiling, freezing and condensing.
- The **amount of energy needed to change state** from solid to liquid and from liquid to gas **depends on the strength of the forces** between the particles of the substance.
- **The stronger the forces between the particles the higher the melting point and boiling point of the substance.**

5.2.2.3 Properties of Ionic compounds

- have **high melting points** and **high boiling points because** of the **large amounts of energy needed to break the many strong bonds.**
- When melted or dissolved in water, ionic compounds **conduct electricity because the ions are free to move and so charge can flow.**

5.2.2.4 Properties of Small molecules

- Usually **gases or liquids** with **low melting point & low boiling point.**
- Weak **intermolecular** forces (because they are small molecules) which are overcome when substance melts or boils.
- e.g. gases, water
- Do not conduct electricity as no overall electric charge.

5.2.2.5 Polymers

- **Long** molecules with atoms linked by **strong covalent bonds**.
- Solid at room temperature as **relatively strong intermolecular forces.**
- **Repeating** units
  e.g. plastics

5.2.2.6 Giant covalent structures

Giant lattices

- High melting point and boiling point
- Strong covalent bonds which must be overcome to melt or boil.
- e.g. silicon dioxide, diamond, graphite

5.2.2.2. State symbols

In chemical equations, the three states of matter are shown as (s), (l) and (g).

(aq) for aqueous solutions eg salt water or acid solutions.

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5.2.2.4 Prop. Of small molecules

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5.2.2.5 Polymers

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5.2.2.6 Giant Covalent structures

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Knowledge Organiser – 5.2 Structure & bonding

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5.2.1.5 Metallic bonding

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5.2.2.7 Properties of metals and alloys

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5.2.28 Metals as Conductors

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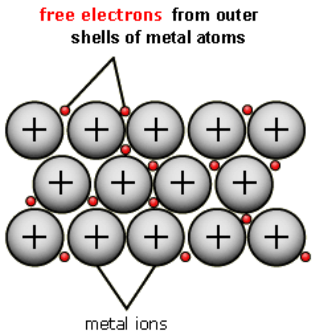
5.2.1.5 Metallic Bonding

- Bonding between atoms of a metal
- **Delocalised** electrons (negative) & metal ions (positive)
- Shared delocalised electrons form strong metallic bonds
- Delocalised electrons **conduct** heat and electricity



- Pure metals are soft: layers of atoms can slide over each other

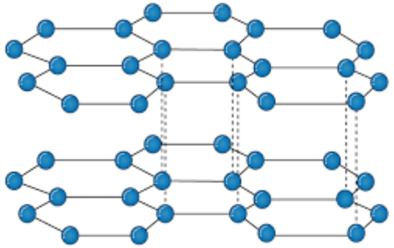
5.2.2.7 Properties of metals and alloys

- Metals have **giant structures of atoms** with **strong metallic bonding**. Therefore most metals have **high melting and boiling points.**
- In **pure metals, atoms are arranged in layers**, which allows metals to be **bent and shaped**. (malleable)
- **Pure metals** are too soft for many uses and so **are mixed with other metals to make alloys which are harder**.
- In **alloys**, different atoms **disrupt** the layers
- Alloys are **harder** than pure metals

5.2.2.8 Metals as conductors

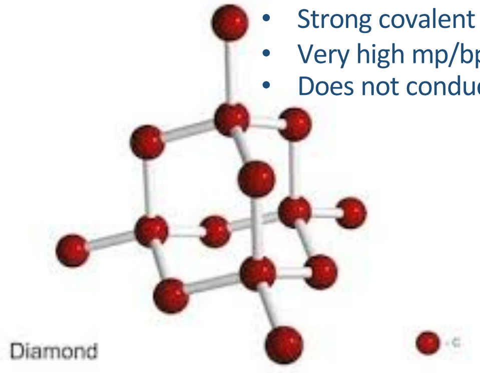
- Metals are **good conductors of electricity** because the **delocalised electrons** in the metal **carry electrical charge** through the metal.
- Metals are **good conductors of thermal energy** because **energy is transferred by the delocalised electrons**.

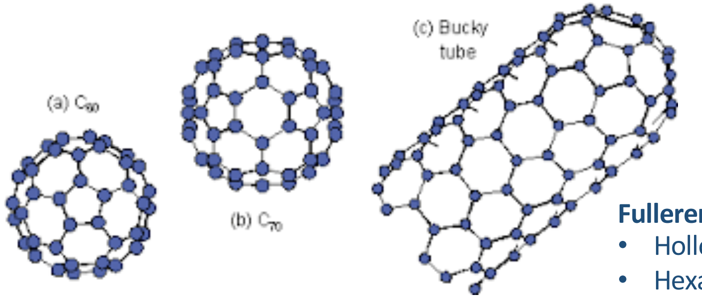
5.2.3 Structure & bonding of carbon



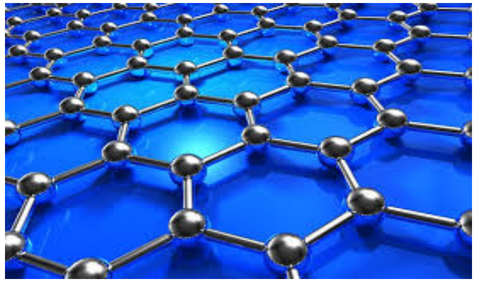
Graphite
- Giant lattice (in layers)
- Each C forms 3 bonds
- Layers of hexagonal rings with no bonds between layers
- Giving 1 delocalised electron
- Good conductor

Diamond: Giant lattice
- Each C forms 4 bonds
- Strong covalent bonds
- Very high mp/bp
- Does not conduct electricity





Fullerenes
- Hollow shapes
- Hexagonal rings, but may also contain rings of 5 or 7 Cs
- Buckminsterfullerene (C_{60}) spherical.
- Carbon nanotubes are cylindrical. Very useful for nanotechnology, electronics



Graphene
- A single layer of graphite
- Useful in electronics and composites

Note: carbon is a non-metal so the bonds between carbon atoms must be COVALENT.

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5.2.3 Structure & bonding of carbon

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Knowledge Organiser – 6.1 Energy

joule (J) = unit of energy

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6.1.1.1. Energy stores and symptoms

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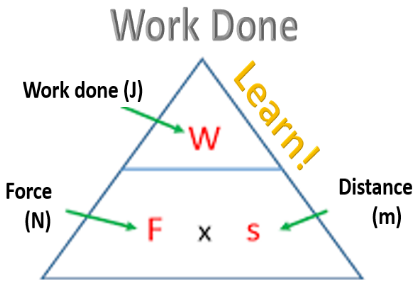
6.1.1.1 Energy stores and systems

Energy store	Description	Examples
Magnetic	The energy stored when **repelling poles have been pushed closer** together or when **attracting poles have been pulled further apart.**	Fridge magnets, compasses, maglev trains which use magnetic levitation.
Internal (thermal)	Total kinetic and potential energy of the particles in an object, eg **the vibrations - also known as the kinetic energy - of particles**. In **hotter objects, the particles have more internal energy** & vibrate faster.	Human bodies, hot coffees, stoves or hobs. Ice particles vibrate slower, but still have energy.
Chemical	The energy **stored in chemical bonds**, such as those between molecules.	Foods, muscles, electrical cells.
Kinetic	Energy of a **moving object**.	Runners, buses, comets.
Electrostatic	The energy stored when **repelling charges have been moved closer together** or when attracting charges have been pulled further apart.	Thunderclouds, Van De Graaff generators.
Elastic potential	The energy stored when an **object is stretched or squashed**.	Drawn catapults, compressed springs, inflated balloons.
Gravitational potential	The energy of an **object at height**.	Aeroplanes, kites, mugs on a table.
Nuclear	The energy stored in the **nucleus of an atom.**	Uranium nuclear power, nuclear reactors.

- When a **force** causes a body to move, work is being done on the object by the force.
- Work is the measure of energy transfer when a force (*F*) moves an object through a distance (*d*).
- When work is done, **energy** has been transferred from one energy store to another.
- Therefore Energy transferred = work done



Distance must be in the line of action of the force

Quantity	Unit
Current	A
Energy	J
Mass	kg
Power	W
Time	s
Temp	°c
Height	m
Velocity	m/s
Extension	m
Spring constant	N/m
Force	N
Gravitational field strength	N/kg
Specific heat capacity	J/kg°C

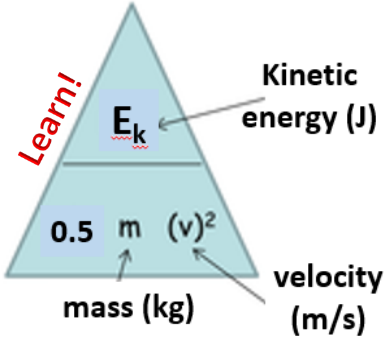
6.1.1.2 Changes in energy

Kinetic energy of a moving object can be calculated using the equation:

kinetic energy = 0.5 × mass × speed²

$E_k = \frac{1}{2} m (v)^2$

- kinetic energy, *Ek*, in joules, J
- mass, *m*, in kilograms, kg
- speed, *v*, in metres per second, m/s

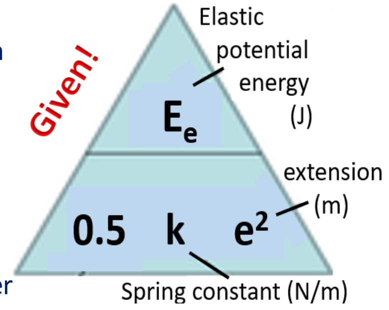


Elastic potential energy stored in a stretched spring can be calculated using the equation (assuming the limit of proportionality has not been exceeded:

elastic potential energy = 0.5 × spring constant × extension²

$E_e = \frac{1}{2} k e^2$

- elastic potential energy, *Ee*, in joules, J
- spring constant, *k*, in newtons per metre, N/m
- extension, *e*, in metres, m

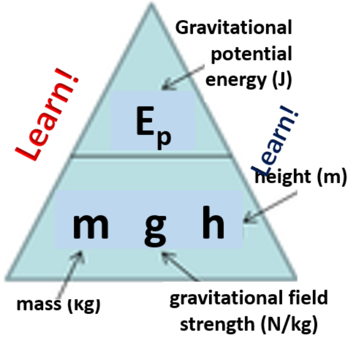


Gravitational potential energy gained by an object raised above ground level can be calculated using the equation:

g.p.e. = mass × gravitational field strength × height

Ep =mgh

- gravitational potential energy, *Ep*, in joules, J
- mass, *m*, in kilograms, kg
- gravitational field strength, *g*, in newtons per kilogram, N/kg
- height, *h*, in metres, m



Gravitational field strength is 9.8N/kg on Earth.
(g will be given in the exam).

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6.1.1.2 Changes of energy

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6.1.1.3 Energy changes in systems

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RPA Specific Heat Capacity

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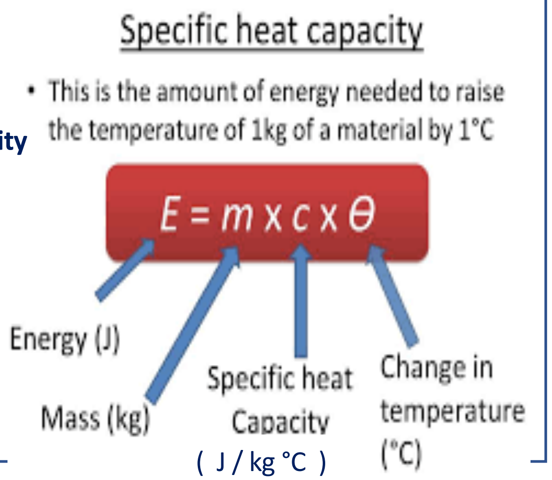
6.1.1.3 Energy changes in systems

The amount of energy stored in or released from a system as its temperature changes can be calculated using the equation:

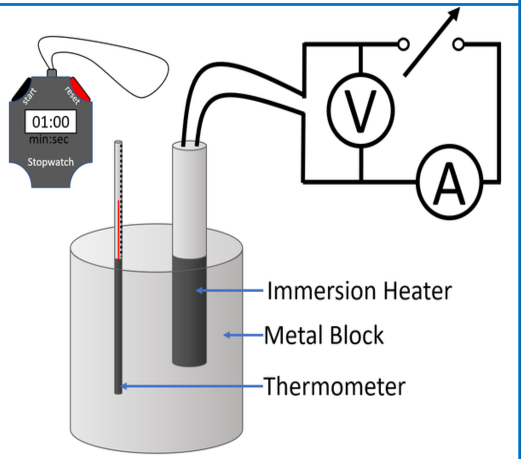
change in thermal energy = mass × specific heat capacity × temperature change

$$\Delta E = m\,c\,\Delta\theta$$ Given!



- change in thermal energy, ΔE, in joules, J
- mass, m, in kilograms, kg
- specific heat capacity, c, in joules per kilogram per degree Celsius, J/kg °C
- temperature change, $\Delta\vartheta$, in degrees Celsius, °C

RPA: an investigation to determine the specific heat capacity of one or more materials. The investigation involve linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored



Method:

1. Place the immersion heater into central hole at top of block.
2. Place the thermometer into smaller hole and add drops of oil into the hole to ensure thermometer is surrounded by hot material.
3. Fully insulate the block by wrapping it loosely with cotton wool.
4. Record the temperature of the block.
5. Connect the heater to the power supply and turn it off after ten minutes. After ten minutes the temperature will still rise even though the heater has been turned off and then it will begin to cool.
6. Record the highest temperature that it reaches and calculate the temperature rise during the experiment.

Improving accuracy:

- Place the metal block on a heatproof mat to reduce the thermal energy lost to the table surface by conduction.
- Wrap the metal block in a thermal insulator to reduce the thermal energy lost to the air.
- Place the electronic balance on a flat, level surface to get an accurate reading of the mass.

Improving precision:

- Use a data logger rather than a thermometer to reduce the random error & add more decimal places.
- Ensure the immersion heater and block begin at room temperature to reduce the error in repeat readings.
- Ensure the same thickness and type of insulator is used for every repeat measurement reduce anomalies.

6.1.1.4 Power

Power is defined as the rate at which energy is transferred or the rate at which work is done.

- power, P, in watts, W
- energy transferred, E, in joules, J
- time, t, in seconds, s
- work done, W, in joules, J

An energy transfer of 1 joule per second is equal to a power of 1 watt

$$\text{power (W)} = \frac{\text{work done (J)}}{\text{time taken (s)}}$$

$$\text{power (W)} = \frac{\text{energy transferred (J)}}{\text{time taken (s)}}$$

Learn!

Example

Two electric motors are used to lift a 5 N weight through a vertical height of 6 m.
Motor A does this in 5 seconds.
Motor B does this in 10 seconds.

For both motors the work done is:
W = F x d = 5N x 6m = 30J

For motor A: $P = \frac{W}{t} = \frac{30J}{5s} = 6W$

For motor B: $P = \frac{W}{t} = \frac{30J}{10s} = 3W$

Motor B is twice as powerful as motor A.

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6.1.1.4 Power

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6.1.2.1 Energy transfers in a system

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Thermal conductivity

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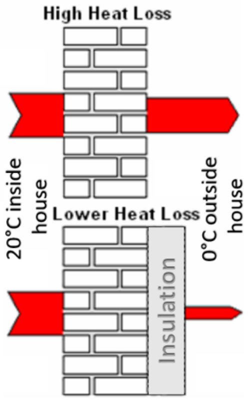
6.1.2.1 Energy transfers in a system

Energy cannot be created or destroyed, only transformed from one form to another (**Law of conservation of energy**).
"**Work done**" is another way of describing energy transfer.

- where there are energy transfers in a **closed system**, there is **no net change to the total energy.**
- In all system changes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being 'wasted'.
- Unwanted energy transfers can be reduced, eg. through lubrication and the use of thermal insulation.
- The higher the thermal conductivity of a material the higher the rate of energy transfer by conduction across the material.



The rate of cooling of a building is affected by the **thickness** and **thermal conductivity of its walls.**
Higher thermal conductivity = higher rate of energy transfer = house cools down quicker.

6.1.2.2 Efficiency

$$\frac{\textbf{Useful energy output}}{\textbf{total energy input}} \times 100\%$$

OR

$$\frac{\textbf{Useful power output}}{\textbf{total power input}} \times 100\%$$

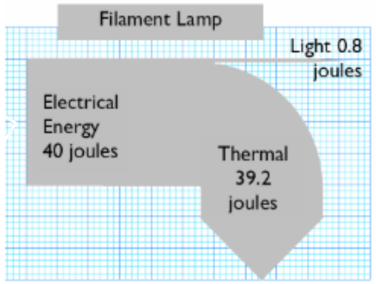
Learn!

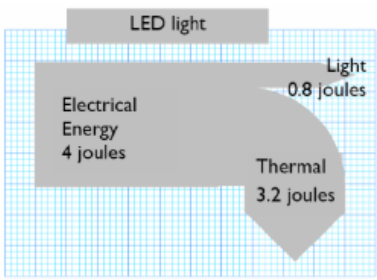
Efficiency can be represented as a decimal or percentage. It has to be <100% (or <1.0) as all energy transfers involve wasted energy.

In a closed system there is no net change to the total energy

Total IN = total OUT

Increase efficiency by insulating or streamlining/ lubricating to reduce friction.





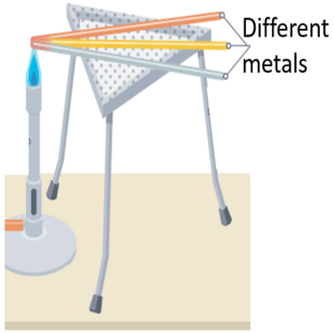
$\frac{0.8}{40} \times 100 =$ 2%

$\frac{0.8}{4} \times 100 =$ 20%

The LED is 10 x more efficient than the filament lamp

Investigate thermal conductivity using rods of different materials

Whichever rod gets hottest first at the other end is the best conductor. The material that **heats the quickest** is said to have a higher thermal conductivity



6.1.3 National and Global energy resources

- Main energy resources available for use on Earth include: fossil fuels (coal, oil and gas), nuclear fuel, biofuel, wind, hydro-electricity, geothermal, the tides, the Sun and water waves.
- A **renewable energy** resource is one that is **being** (or can be) **replenished** as it is used.
- A **Non-renewable energy** source **cannot be replaced** after it has been used. It is **finite**
- The uses of energy resources include: transport, electricity generation and heating.

	Positives	Negatives
Fossil fuel (coal/oil/gas)	Reliable, cheap to run and mine	Finite, atmospheric pollution (CO_2, SO_2, NO_x)
Nuclear	Reliable, No CO_2, lots energy released	Long-lasting toxic waste, finite
Wind	Infinite, free, no atmospheric pollution	Unreliable (not always windy), visual pollution, costly to build, sometime noisy
Sun	Infinite, free, put on buildings/ in fields	Costly to set up, pollution from batteries
Geothermal	Infinite, free, no atmospheric pollution	Products from ground may contain toxic elements
Tidal	Barrages reduce flooding eg Thames, free, no pollution, reliable(2 tides/day)	Disturb ecology and shipping lanes, costly to build
Biofuel	Can be regrown, cheap, carbon neutral	Use up land that could grow food/ livestock
Hydroelectricity	No atmospheric pollution, free	High rainfall needed, floods valleys therefore habitats/ villages destroyed
Water Waves	No atmospheric pollution, free	Disturb ecology and shipping lanes, costly to build, unreliable (sea does not always have waves)

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6.1.2.2 Efficiency

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6.1.3 National & Global energy resources

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Knowledge Organiser – 6.2 Electricity

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6.2.1.2 Electrical charge and current

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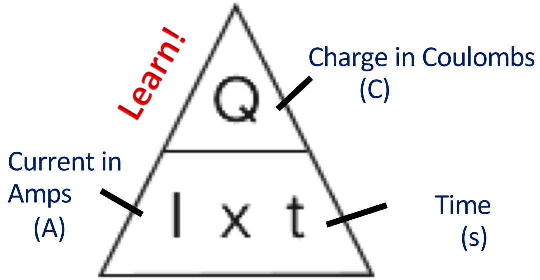
6.2.1.2 Electrical charge and current

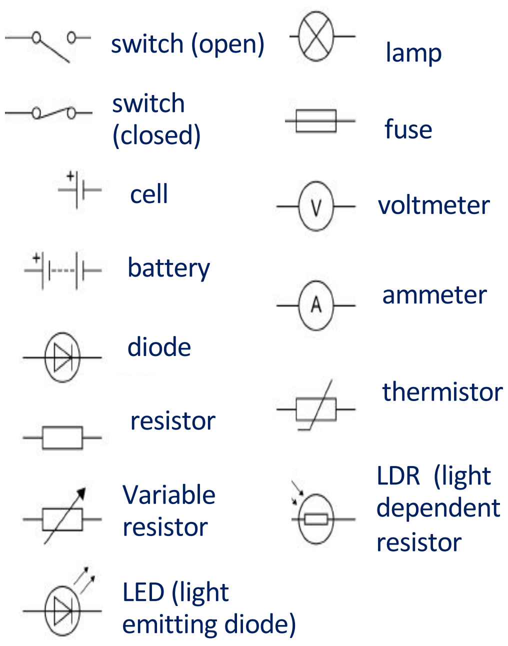
Electric current is a flow of electrical charge.
Size of current is **rate of flow of electrical charge.**

Charge flow, current and time are linked by the equation:
charge flow = current × time



- Current has **same value at any point in a single closed loop**.
- Measured with **Ammeter**

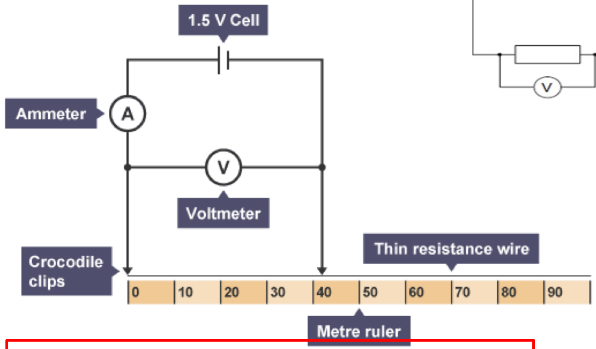
6.2.1.1 Standard circuit diagram symbols



RPA: use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits.

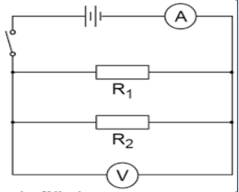
- the length of a wire at constant temperature
- combinations of resistors in series and parallel.

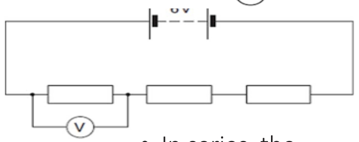
IV: Length of a wire



Hazard	Consequences	Control measures
Heating of wires	Minor burns	Set up circuit before closing the switch

IV: resistors in series or parallel





- In series, the resistance of the network is equal to the sum of the other resistances.
- In parallel, the resistance of the network is less than either of the other resistances.

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6.2.1.1 Standard circuit diagrams

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RPA Circuits

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6.2.1.3 Current, resistant and potential difference

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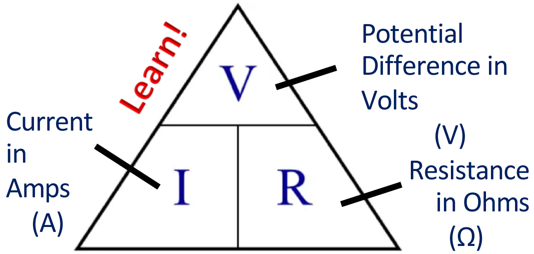
6.2.1.3 Current, resistance and potential difference

- **Potential difference** is the amount of work energy required to move an electric charge (Coulomb) from one point to another
- Current (*I*) through a component depends on the **resistance** (*R*) of the component and the **potential difference** (*V*) **across the component**.
- The **greater the resistance** of the component the **smaller the current for a given potential difference (pd) across the component**.
- Measured with **Voltmeter**
- **Voltmeter must be connected in parallel**

Current, potential difference and **resistance** can be calculated using the equation:

potential difference = current × resistance



Resistance

- **Metal atoms (ions)** in a **wire have delocalised electrons** which are free to move and **carry the charge**.
- **Electrons moving** around the circuit **collide with the ions**.
- This is called **resistance**.

Units of resistance = ohms, Ω

Components with high resistance often **get hot** (e.g. filament lamp).
- **Electrons colliding** with the ions **transfer energy** as **heat** and **light**.
- **Causes the ions to vibrate more, increasing** the **resistance** even more.
- This makes it harder for the electrons to pass through without collisions.

E.g. What is the resistance of a component if 12 V causes a current of 2 A through it?
R = V / I = 12V / 2A = 6Ω

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6.2.1.4 Resistors

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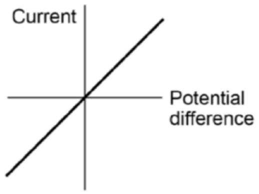
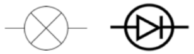
6.2.1.4 Resistors

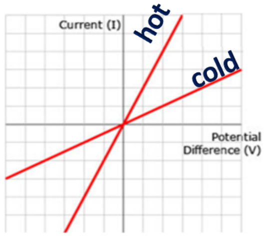
- **Current through an ohmic conductor** (at a constant temperature) is **directly proportional to the potential difference** across the resistor.
- **Resistance remains constant as the current changes.**



- **Resistance of components such as lamps, diodes, thermistors** and **LDRs** is **not** constant; it **changes with the current through the component.**
- SEE RPA

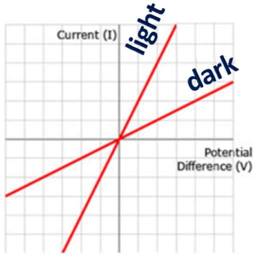


- **Resistance of a thermistor decreases as the temperature** increases.
- Low temperature = High resistance
- Used in heat activate fire alarms and thermostats



- **Resistance of an LDR decreases** as **light intensity increases**

  Low light levels = high resistance.
- An **LDR** can be used in lights that come on when it's dark.



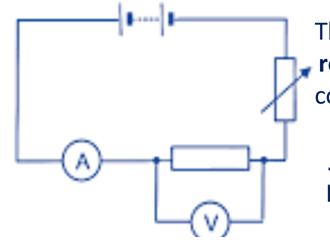
Unit	symbol
Potential difference	V
Current	A
Energy	J
Work done	J
Charge	C
Time	s
Power	W
Resistance	Ω

Charge is a property of a body which experiences a force in an electric field. **Charge** is measured in **coulombs** (C).

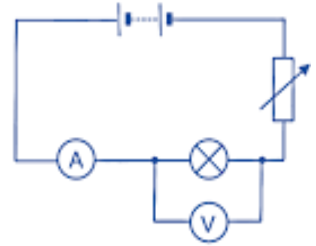
Since electrons are so small and one electron will not have much of an effect anywhere, it is more useful to refer to packages of electrons. One coulomb of charge is a package equivalent to 6,250,000,000,000,000,000 electrons.

One volt is the **potential difference when one coulomb** of **charge** transfers one **joule** of energy.

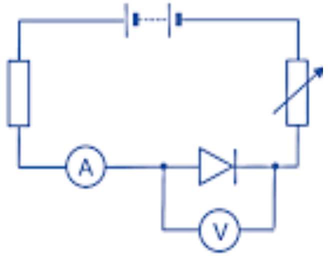
RPA: use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature



The current through a **resistor** at constant a constant temperature is directly proportional to the potential difference across the resistor.



The resistance of a **bulb** increases as the temperature of the filament increases.



The current through a **diode** flows in one direction. It has very high resistance in the opposite direction.

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6.2.2 Series and Parallel circuits

For components connected in series:

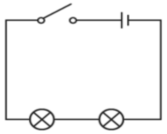
- same **current (A)** through each component
- total **potential difference (V)** of the power supply is **shared between components**
- total resistance of two components is the sum of the resistance of each component.

  Rtotal = $R1$ + $R2$ resistance, R, in ohms, Ω

For components connected in parallel:

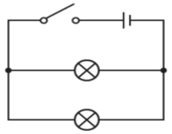
- **potential difference** across each component is the **same**
- **total current** through the whole circuit is **sum of the currents** through the separate components
- **total resistance** of **two resistors is less** than the **resistance** of the **smallest individual resistor.**

Series



	A	V
Series	Same	Shared
Parallel	Shared	Same

Parallel



6.2.2 Series and Parallel circuits

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6.2.3.1 Direct and alternating potential difference

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6.2.3.2 Mains Electricity

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6.2.4.2 Energy Transfers

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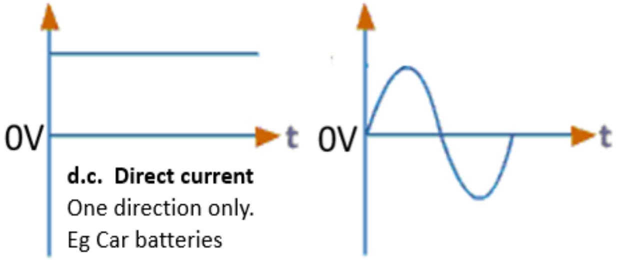
6.2.3 Domestic uses and safety

6.2.3.1 Direct and alternating potential difference



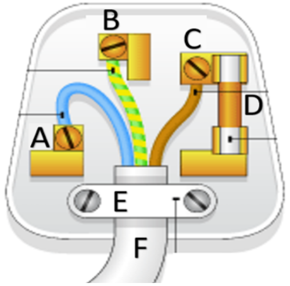
d.c. Direct current
One direction only.
Eg Car batteries

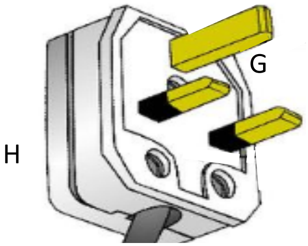
a.c. Alternating current
In the UK, electricity has a p.d. of 230V & a frequency of 50Hz (it changes direction 50 times a second).

6.2.3.2 Mains electricity

A= neutral wire, close to 0V.
B= earth wire, 0V, only carries current if there's a fault, stops appliance becoming live.
C= live wire, 230V between earth and live.
D= Fuse, internal wire melts when current is too big so breaks the circuit.

E= cable grip
F= three-core cable, copper wire = flexible and good conductor, plastic coating.
G= brass pins, hard wearing, good conductor
H= plastic casing is an insulator

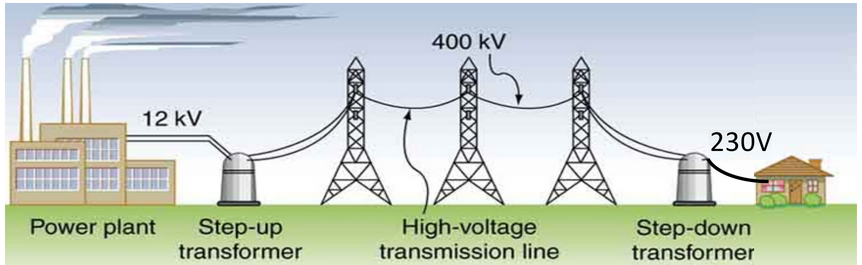




- a live wire may be dangerous even when a switch in the mains circuit is open
- It is dangerous to provide any connection between the live wire and earth.

6.2.4 Energy Transfers

6.2.4.3 The National Grid



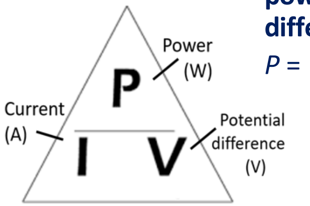
- Network of cables and transformers linking power stations to consumers
- Step-up transformers = higher potential difference
- Reduced energy loss because resistance is lower in cables (high volts = fewer amps for same power)
- Step-down transformers = decrease potential difference to safe level for domestic use (about 230V in UK)
- Underground cables protected from bad weather but get damaged by diggers in building projects

E.g. What is the potential difference between two points if 5 C of charge shifts 10 J?
V= E/Q
= 10J / 5C
= **2 volts**

6.2.4.1 Power

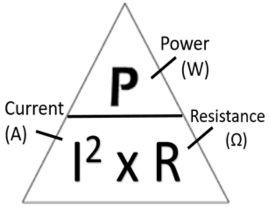
power = potential difference × current

P = V I



power = current² × resistance

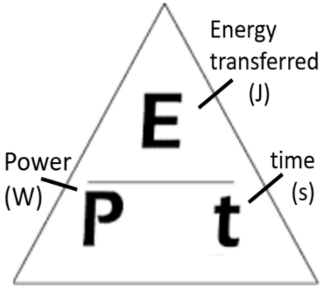
$P = I^2 R$

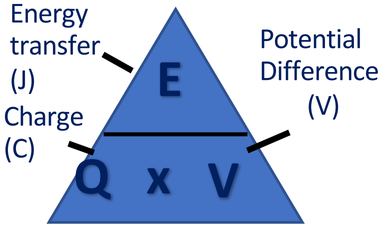


- power, *P*, in watts, W
- potential difference, *V*, in volts, V
- current, *I*, in amps, A
- resistance, *R*, in ohms, Ω

6.2.4.2 Energy transfers in everyday appliances

- The rate at which energy is transferred by an appliance is called the **power**.
- Also known as "**work done**" by the components in the circuit when charge flows.
- The energy transferred by an appliance depends on how long it is switched on for and the power of the appliance.





- energy transferred, *E*, in joules, J
- power, *P*, in watts, W
- time, *t*, in seconds, s
- charge flow, *Q*, in coulombs, C
- potential difference, *V*, in volts, V

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6.2.4.3 The National Grid

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6.2.4.1 Power

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Knowledge Organiser – 6.3 Particle model of matter

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6.3.1.1 Density of materials

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6.3.1.2 Changes of state

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6.3.1.3 Internal Energy

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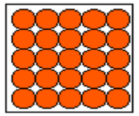
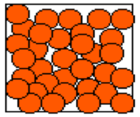
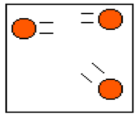
6.3.1.1 Density of materials

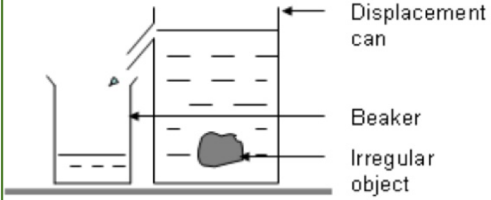
$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\left[\ \rho = \frac{m}{V}\ \right]$$

- density, ρ, in kilograms per metre cubed, kg/m
- mass, m, in kilograms, kg volume, V, in metres cubed, m3
- The particle model can be used to explain
- the different states of matter
- differences in density.

Solid	Liquid	Gas
Particles closely packed - vibrate - Little energy - Very strong forces of attraction	Particles touching, - Move past each other - Some energy - Relatively strong forces of attraction	Particles very far apart - Move very fast - Lots of energy - Weak forces of attraction
		

RPA: Measuring volume of irregular objects and calculating density



Method 1: Regular solids

Calculate volume

Regular shape: Length x width x height

Sphere: $\frac{4}{3}\pi(\frac{d}{2})^3$

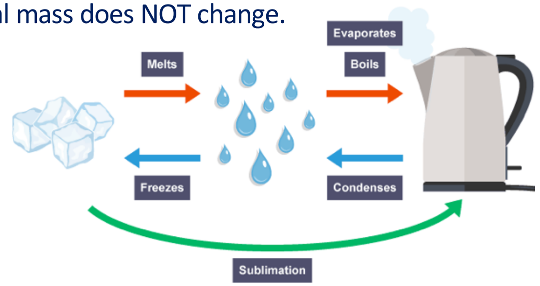
Method 2: Stone or other irregular shaped object

Displacement can

6.3.1.2 Changes of State

Conservation of mass

- The number of particles does not change during a change of state, only their spacing and arrangement.
- Total mass does NOT change.



- Change of state is **physical**.
- The material **recovers its original properties** if the change is reversed.

6.3.2.2 Temperature changes in a system and specific heat capacity

The change in temperature of a system depends on:

- the amount of **thermal energy** transferred to the system
- the mass of the substance
- the nature of the substance itself

change in thermal energy = mass × specific heat capacity x temperature change

$$\Delta E = mc\Delta\theta$$

- change in thermal energy, ΔE, in joules, J
- mass, m, in kilograms, kg
- specific heat capacity, c, in joules per kilogram per degree Celsius, J/kg °C
- temperature change, $\Delta\vartheta$, in degrees Celsius, °C.

Key Terms	Particle Model of Matter Definitions
condensation	A change of state in which gas becomes liquid by cooling.
energy	The capacity for doing work
evaporation	The process in which a liquid changes state and turns into a gas.
freeze	A change of state in which liquid becomes solid by cooling.
Internal energy	The total kinetic energy and potential energy of the particles in an object. Heating changes the energy stored within the object by increasing the energy of the particles that make up the system.
Kinetic energy	Energy which an object possesses by being in motion
Melting	The process that occurs when a solid turns into a liquid when it is heated
Specific heat capacity	The amount of energy needed to raise the temperature of 1 kg of substance by 1°C
Specific latent heat	The amount of energy needed to melt or vaporise 1 kg at its melting or boiling point
Sublimation	When a solid turns straight into a gas on heating, without becoming a liquid first, or when a gas turns straight into a solid, without becoming a liquid.
Temperature	How warm or cold something is
Thermal energy	Scientific term for heat energy

6.3.1.3 Internal Energy

- **Internal Energy:** Energy is stored inside a system by the particles that make up the system. Internal energy is the **total kinetic energy** and **potential energy** of **all the particles** that make up a system.
- Heating **increases** the energy of the particles
- Either **raises the temperature** of the system **or produces a change of state.**

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RPA Investigate Density

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6.3.2.2 Temp changes and specific heat capacity.

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Knowledge Organiser – 6.3 Particle model of matter

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6.3.2.2 Changes of heat and specific latent heat

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6.3.2.3 Changes of heat and specific latent heat

If a change of state happens:

- The energy needed for a substance to change state is called **latent heat**.
- When a change of state occurs, the energy supplied **changes the energy stored** (internal energy) but **does not change the temperature.**
- **specific latent heat** of a substance is the **amount of energy required to change the state of one kilogram of the substance** with no change in temperature.

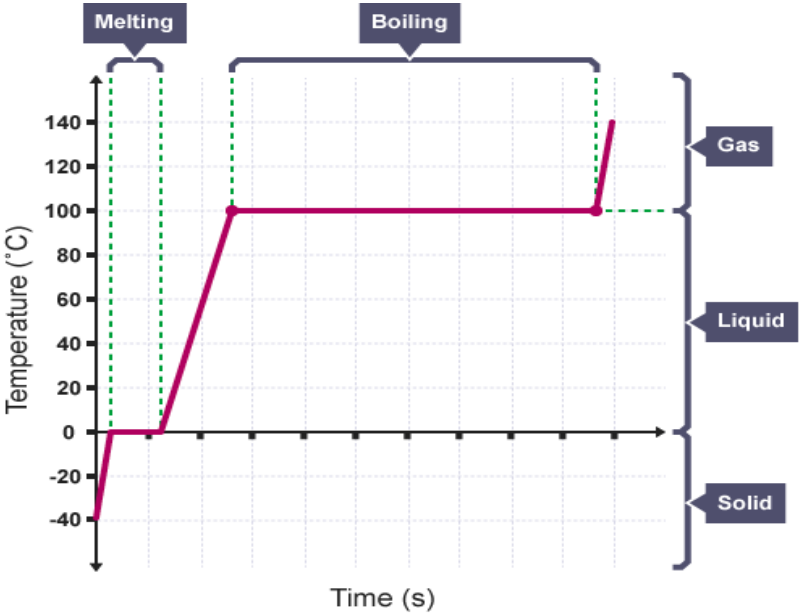
energy for a change of state = mass × specific latent heat

$E = mL$

- energy, E, in joules, J
- mass, m, in kilograms, kg
- specific latent heat, L, in joules per kilogram, J/kg
- **specific latent heat**, L, in joules per kilogram, J/kg

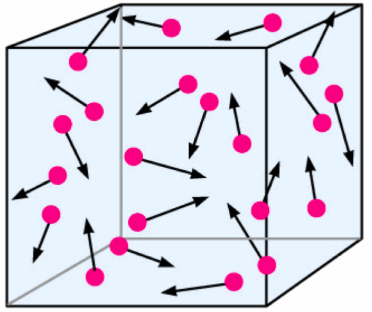
Specific latent heat of fusion – change of state from solid to liquid

Specific latent heat of vaporisation – change of state from liquid to vapour



6.3.3.1 Particle motion in gases

- Molecules of gas in **constant random motion**
- **Temperature** of gas **related to average kinetic energy of the molecules**
- **Changing the temperature** of a gas, held at constant volume, **changes the pressure** exerted by the gas



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6.3.3.1 Particle motion in gases

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