Year 9
Knowledge Organiser

B1 Cell Structure and Transport

Keywords

Cell	The unit of a living organism.
Eukaryotic cell	Animal, plant and fungus cells. Their DNA is confined to a nucleus.
Prokaryotic cell	Bacterium cell. Their DNA is not confined to a nucleus.
Diffusion	The spreading of particles from area of high to low concentration.
Osmosis	The diffusion of water through a partially permeable membrane from an area of high to low concentration of water.
Active transport	The movement of substances from a dilute solution to a more concentrated solution. Requires energy.
Partially permeable membrane	A membrane that only allows certain substances to go through.

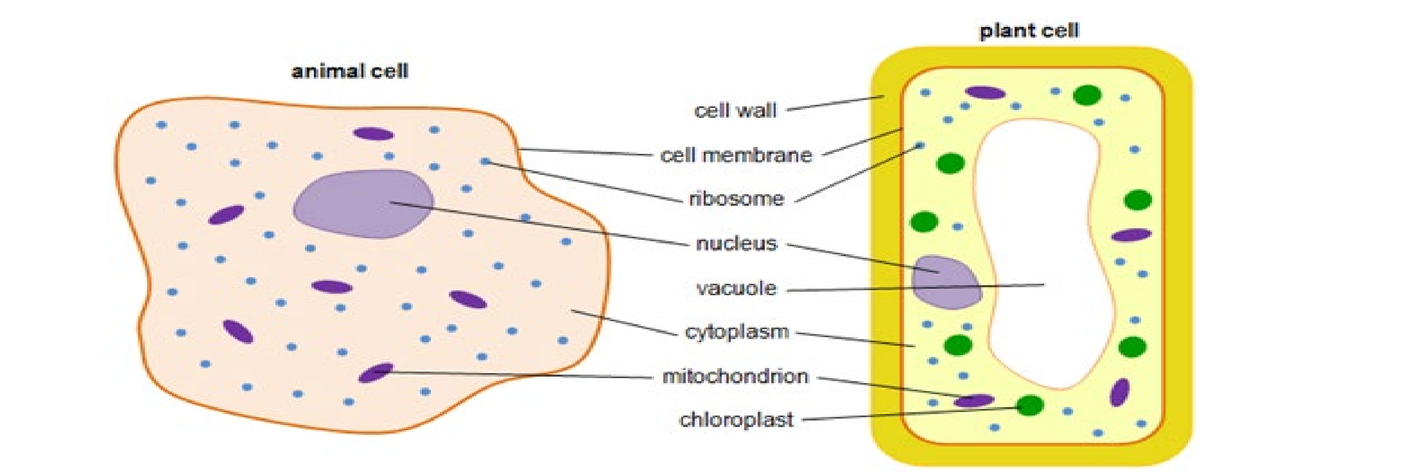
Factors Affecting the Rate of Diffusion

- Higher concentration gradient = faster rate of diffusion.
- Higher temperature = faster rate of diffusion.
- Larger surface area of the membrane = faster rate of diffusion.

Exchanging materials

Large surface area = faster rate of diffusion
Thin = short distance for diffusion
Good blood supply = maintains concentration gradient

Animal and Plant Cells



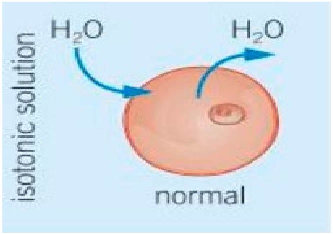
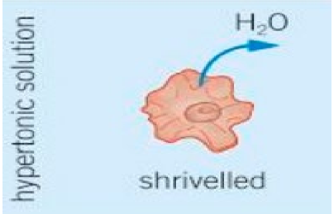
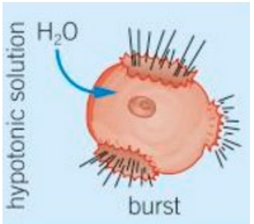
Unit Conversions

1km = 1000m
1m = 100cm
1cm = 10mm
1mm = 1000µm
1µm = 1000nm

Magnification Equation

$$\text{Magnification} = \frac{\text{Size of image}}{\text{Size of real object}}$$

Osmosis Key Terms

If the concentration of solutes in the solution outside the cell is the **same** as the internal concentration, the solution is **isotonic** to the cell.	
If the concentration of solutes in the solution outside the cell is **higher** than the internal concentration, the solution is **hypertonic** to the cell.	
If the concentration of solutes in the solution outside the cell is **lower** than the internal concentration, the solution is **hypotonic** to the cell.	

Keywords	
Cell cycle	The 3 stage process of cell division in a body cells.
Differentiate	The process where cells become specialised for a particular function.
Stem cells	Undifferentiated cells with the potential to form a range of different cell types.
Therapeutic cloning	Where an embryo is produced that is genetically identical to the patient so the cells are identical.
Mitosis	Cell division that results in two genetically identical daughter cells

Differentiation in animal cells

1. As an embryo, the cells are undifferentiated.
2. Cells are differentiated by turning some of their genes off and some of their genes on.
3. The combination of working or inactive genes decides what organelles the cell has and what the cell does.
4. The cell is now specialised for a particular function (for example, a muscle cell).
5. This does not change once the cell is mature.

Differentiation in plant cells

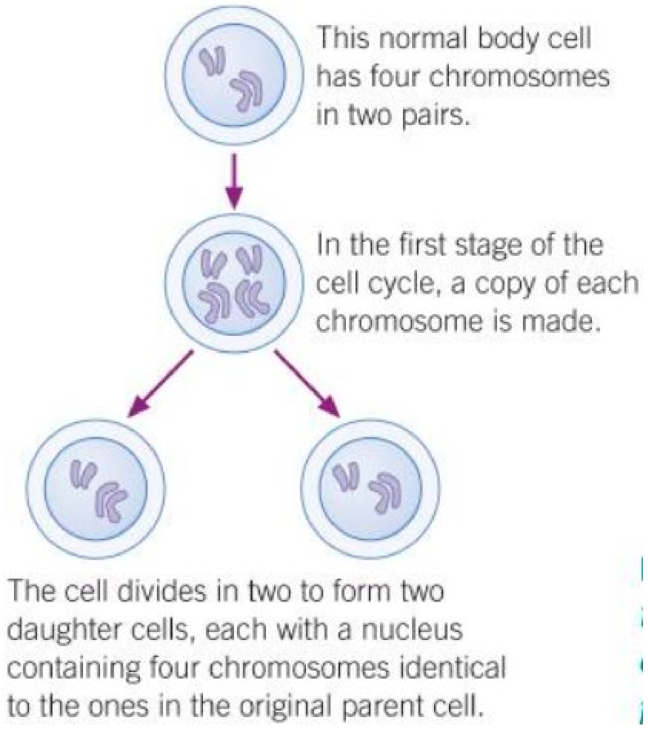
1. Undifferentiated cells are formed at active regions of the roots and shoots (meristems) through a plant's life.
2. These cells then differentiate into specialised cells.
3. This differentiation is not permanent. They are able to re-differentiate.
4. This means it is very easier to clone a plant.

The Cell Cycle

<u>Stage 1: Replication</u>
The longest stage.
DNA replicates to form two copies of each chromosome.
All of the organelles are also doubled.

<u>Stage 2: Mitosis</u>
The contents of the cell are rearranged.
One set of chromosomes is pulled to each end of the cell and the nucleus divides.

<u>Stage 3: Division</u>
The cytoplasm and cell membranes divide to form two identical daughter cells.

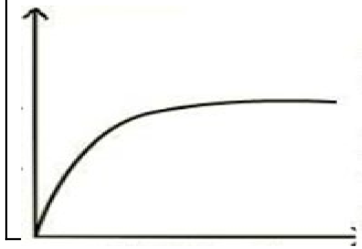
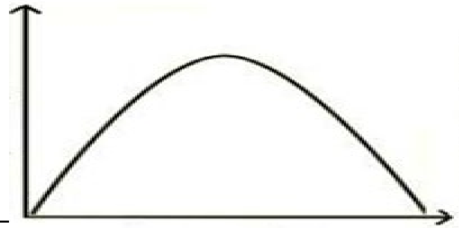
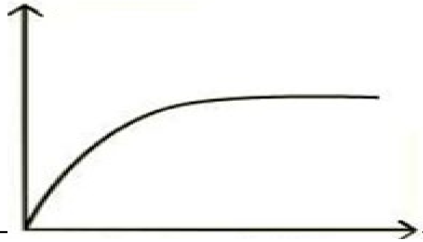


B1 Cell Division

Embryonic stem cells (animals)	Adult stem cells (animals)	Plant stem cells
Found in embryos in the early stages of life before the cells have differentiated. Can differentiate into most different types of cells.	Found in the bone marrow mostly and present in every adult. These can grow and replace similar damaged cells	Found in meristems and are capable of growing into any tissue throughout the life of the plan.. Allows plants to grow after they have been cut down.

B4 - Photosynthesis

Keywords	
Limiting Factors	Limits the rate of reaction
Photosynthesis	The process by which plants make food using carbon dioxide, water and light
Chloroplasts	The organelles where photosynthesis takes place
Chlorophyll	The green pigment contained in the chloroplasts

Light intensity	Temperature	Carbon dioxide levels
Lots of light = lots of photosynthesis. Not much light = not a lot of photosynthesis	Affects chemical reactions. The rate of photosynthesis will increase up to 40°C. After this, enzymes needed for photosynthesis are denatured.	CO_2 is the raw material for photosynthesis. There is only 0.04% CO_2 in the atmosphere. More CO_2 = photosynthesis increases
		

Photosynthesis

Plants and algae have evolved to harness the energy of sunlight and use it to make the sugar glucose in a process called **photosynthesis.** Chloroplasts are the organelles responsible for photosynthesis, they contain the green pigment chlorophyll.

Carbon dioxide + Water → Oxygen + Glucose

$$6CO_2 + 6H_2O \rightarrow 6O_2 + C_6H_{12}O_6$$

Algae

Algae are small photosynthesizing plants you find in water. They are adapted to photosynthesis in aquatic conditions. They absorb the CO_2 they need from the water around them

Leaf Adaptations

Large surface area: to absorb as much sunlight

Thin: short distance for diffusion

Chlorophyll: green pigment in chloroplasts necessary for photosynthesis

Stomata: allows the diffusion of gases into and out of the leaf.

Xylem: (plant veins) supply plenty of water to the leaf.

Using Glucose

Glucose: a small, simple, soluble sugar made during photosynthesis.

Starch: an insoluble polymer (chain) of glucose. Glucose must be converted to starch for storage.

Cellulose: a complex carbohydrate made from glucose to strengthen cell walls.

Amino acids: the building block of proteins, made by combining glucose with nitrate ions from the soil.

Fats & oils: made from glucose, used to strengthen cell walls and as an energy store.

B4 - Respiration

Keywords

Aerobic respiration	Breaking down glucose with oxygen to release energy and producing carbon dioxide and water.
Anaerobic respiration	Releasing energy from the breakdown of glucose without oxygen, producing lactic acid (in animals) and ethanol and carbon dioxide (in plants and microorganisms).
Breathing	The inflation and deflation of the lungs.
Fermentation	Yeast anaerobically respiring to produce ethanol and carbon dioxide.
Lactic acid	The mild poison made during anaerobic respiration.
Glycogen	A carbohydrate store in animals.
Oxygen debt	The extra oxygen that must be taken into the body after exercise has stopped to complete the aerobic respiration of lactic acid.

Aerobic Respiration

glucose + oxygen → carbon dioxide + water

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

Respiration is the chemical process of turning glucose and oxygen into carbon dioxide and water. It releases energy and is controlled by enzymes. Respiration is an exothermic process.

Anaerobic Respiration

glucose → lactic acid

$$C_6H_{12}O_6 \rightarrow C_3H_6O_3$$

Anaerobic respiration releases energy in the absence of oxygen. It is much less efficient than aerobic respiration. It produces a poisonous waste product called lactic acid, which can be removed by reacting it with oxygen.

Lactic acid + oxygen → carbon dioxide + water

Effect of Exercise

Heart rate: increases and the arteries to your muscles dilate. This has the effect of increasing oxygen and glucose supply and increasing carbon dioxide removal.

Breathing rate and volume: increases and you breathe more deeply. You breathe more often and also bring more air into your lungs in each breath. This increases the rate of oxygen uptake and carbon dioxide removal.

Temperature: increases. Respiration is an exothermic reaction and some energy is lost as heat.

Glycogen stores: decrease. Glycogen is converted back into glucose to supply the cells with the fuel they need for increasing cellular respiration.

Metabolism and the Liver

Metabolism is the sum of all the chemical reactions that take place in a cell or in the body.

The liver has many different roles:

1. Detoxifies substances such as the ethanol from alcoholic drinks.
2. Breaks down products into the blood so they can be excreted in urine via the kidneys.
3. Breaks down old, worn out blood cells and stores iron until it is needed.

Metabolism and the Liver

The liver also deals with the lactic acid produced in anaerobic respiration. The blood transports the lactic acid to the liver. Here, it is converted back into glucose, which is then broken down in aerobic respiration to form carbon dioxide and water. If the glucose isn’t needed, it can be stored as glycogen in the liver.

C1 Atomic Structure

Keywords

Atom	The smallest particle of an element.
Molecule	Two or more atoms chemically bonded together.
Element	A substance made up of only one type of atom.
Compound	Substance made from two or more elements chemically bonded together.
Mixture	Two or more substances mixed together, but do not react together. A mixture is not a pure substance.
Isotope	Atoms of the same element but with different numbers of neutrons
The law of conservation of mass	During a reaction, the atoms in the are rearranged into different compounds. Therefore, mass is never gained or lost in a chemical reaction.

Separating mixtures

1. Filtration: Using a filter to separate an insoluble solid from a liquid.

2. Crystallisation: The liquid (solvent) evaporates away leaving the soluble solid crystals (solute) behind.

3. Simple distillation: Separates a liquid from a solution. The solution is heated, it evaporates and then condenses for collection.

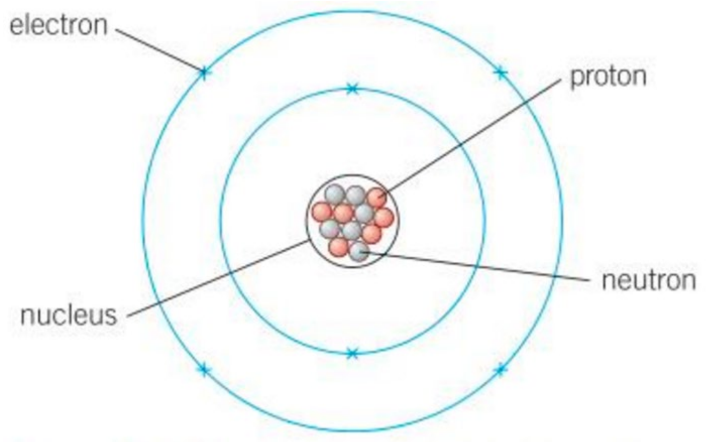
4. Fractional distillation: Separates multiple liquids from a solution, based on boiling points.

5. Chromatography: separating soluble substances from one another.

The history of the atom

- Atoms used to be thought as tiny spheres that could not be split.
- The discovery of the electron lead to the **plum-pudding model** of the atom, which suggested that the atom was a ball of positive charge with negative electrons embedded in it.
- The results from the alpha scattering experiments led to the plum-pudding model being replaced by the **nuclear model**, which suggested that a small, positively charged nucleus was surrounded by electrons orbiting in shells.
- Later experiments led to the discovery of protons and neutrons.

The structure of the atom



Sub-atomic particle	Relative charge	Relative mass
Proton	+1	1
Neutron	0	1
Electron	-1	Almost 0

C1 The Periodic Table

Keywords	
Alkali metals	Elements in group 1 of the periodic table.
Halogens	Elements in group 7 of the periodic table.
Noble gases	Elements in group 0 of the periodic table.
Displacement reaction	A reaction where a more reactive element takes the place of a less reactive element in a compound.
Transition elements	Elements from the central block of the periodic table.

The development of the periodic table

- Elements were first classified in order of their atomic weights.
- The early periodic tables were incomplete.
- Mendeleev changed this by leaving gaps for elements that he thought had not been discovered and changed the order based on chemical properties.
- Elements with properties predicted by Mendeleev were discovered and filled the gaps.

The arrangement of the periodic table

- The elements are ordered by atomic number.
- Elements in the same group have the same number of electrons in their outer shell and this gives them similar chemical properties.
- The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table. Non-metals are found towards the right and top of the periodic table.
- Metals react to form positive ions.
- Non-metals react to form negative ions.

Group 1 - The alkali metals

- Alkali metals have characteristic properties because of the single electron in their outer shell.
- Alkali metal + water → alkali metal hydroxide + hydrogen
- Alkali metal + chlorine → Alkali metal chloride
- Alkali metal + oxygen → Alkali metal oxide
- The reactivity increases going down the group.

Group 7 - The halogens

- The halogens have similar reactions because they all have 7 electrons in their outer shell.
- The halogens are non-metals and consist of molecules made of pairs of atoms. (diatomic molecules)
- The further down the group an element is the higher its relative molecular mass, melting point, and boiling point.
- The reactivity decreases going down the group.
- A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.

The transition elements

The transition elements are metals with similar properties which are different from those of the elements in Group 1. They are:

- Much less reactive than group 1 elements.
- Good conductors of electricity.
- Hard and strong.
- High density.
- High melting points (with the exception of mercury).

Many transition elements have ions with different charges, form coloured compounds and are useful as catalysts.

C2 Structure & Bonding

Keywords

Covalent bond	The attraction between two atoms that share one or more electrons
Ionic bond	The electrostatic force of attraction between positively and negatively charged ions.
Intermolecular forces	The attraction between the individual molecules in a covalently bonded substance.
Polymer	A substance made from very large molecules made up of many repeating units
Delocalised electrons	Bonding electron that is no longer associated with any one particular atom
Fullerene	Form of the element carbon that can exist as large cage-like structures, based on hexagonal rings of carbon atoms.
Metallic bonding	The electrostatic attraction between the positively charged atomic nuclei of metal atoms and the delocalized electrons in the metal.
Alloy	A mixture of two or more elements, at least one of which is a metal.

Structures and properties

Graphite: a form of carbon in which the atoms form layers. Layers can slide over each other, so graphite is much softer than diamond. It is used in pencils. Each carbon atom in a layer is joined to three other carbons. Conducts electricity.

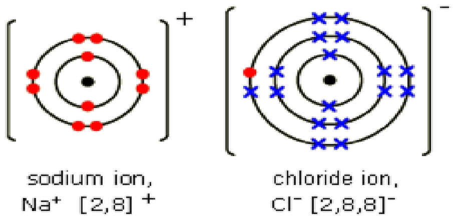
Diamond: a form of carbon where each carbon atom is joined to four other carbons. Diamond is very hard and has a high melting point. It does not conduct electricity.

Silica: similar structure to diamond. It is hard and has a high melting point. Contains silicon and oxygen atoms, instead of carbon atoms. It is a semiconductor, which makes it useful in the electronics industry.

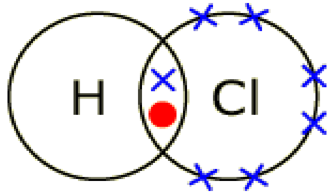
Ionic Bonding	Covalent Bonding
Electrons are transferred Ions are formed Between metals High melting/boiling points Conductive when liquid/molten	Electrons are shared No ions are formed Between non metals Low melting/boiling points Non conductive – no free electrons

Drawing dot and cross diagrams

When sodium and chlorine bond, one electron is transferred from the sodium atom to the chlorine atom. In the process, both gain a full outer shell and become ions. This is ionic bonding.



When hydrogen and chlorine bond, a pair of electrons is shared between the two atoms. In this way, they both gain the one electron they need to have a full outer shell.

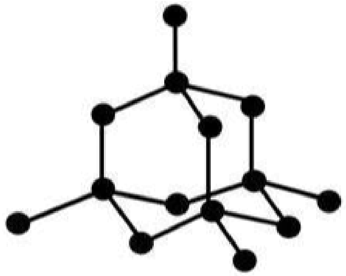


Metallic Bonding

Metallic bonding: Metallic bonding is the strong attraction between closely packed positive metal ions and a 'sea' of delocalized electrons.
High melting and boiling points: metallic bonds are strong and a lot of energy is needed to break them. This is why metals have high melting points and boiling points.
Conducting electricity: metals contain electrons that are free to move in the metal structure, carrying charge from place to place and allowing metals to conduct electricity well.

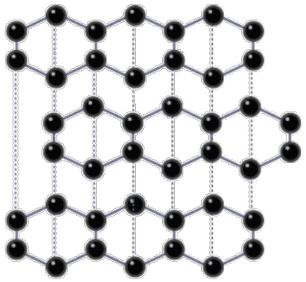
C3 Structure & Bonding

Allotrope	Different forms of the same element.
Giant covalent structure	Compounds formed of many atoms joined together by covalent bonds.
Simple covalent molecule	Compounds, or molecules that are formed from only a few atoms joined together by covalent bonds.
Fullerene	Allotropes of carbon that include bucky balls and carbon nanotubes.



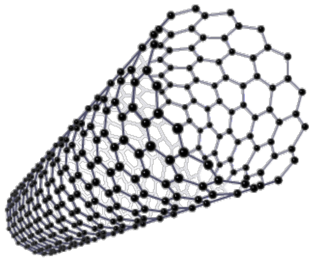
Diamond

Each carbon atom is bonded to **four** other carbon atoms by very strong covalent bonds and therefore has no free electrons. It cannot conduct electricity. The four strong covalent bonds give diamond a very high melting point.



Graphite

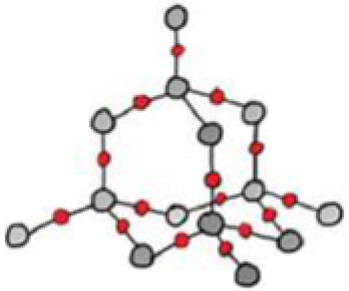
Each carbon is bonded to 3 carbon atoms with weak intermolecular forces between the layers, which allows the layers to easily slide over each other. They also have a delocalised electron which allows graphite to conduct electricity. Graphite is used in lubricants as the layers can slide.



Carbon nanotubes

Nanotubes are a type of fullerene and are molecular-scale tubes of carbon arranged similarly to the layers in graphite.

Carbon nanotubes have a very high melting point, as each carbon atom is joined to three other carbon atoms by strong covalent bonds. This also leaves each carbon atom with a spare electron, which forms a sea of delocalised electrons within the tube, meaning nanotubes can conduct electricity.



Silicon dioxide

Silicon dioxide has the same structure as diamond. It is made from many SiO_2 molecules joined together.
Silicon dioxide (silica) is the main component of sand.
It is often used to line kilns because it can withstand extremely high temperatures.

P3 - The Particle Model (Topic One)

Keywords

Keywords	
Density	The amount of mass per unit of volume. It tells us how tightly matter is packed together.
Chemical Change	The substance changes as the atoms are rearranged and new bonds have been formed.
Physical Change	The substance stays the same, the atoms are just in a different arrangement.
Temperature	The average kinetic energy of the particles in a substance.
Internal Energy	The total kinetic and potential energy of the particles within a system.
Specific Heat Capacity	The amount of energy required to raise the temperature of 1kg of the substance by 1°C.
Specific Latent heat of fusion	The amount of energy needed to change 1 kg of solid to 1 kg of liquid at its melting point
Specific Latent Heat of vaporization	The amount of energy needed to change 1 kg of liquid to 1 kg of gas at its boiling point.

State of matter	Arrangement of particles	Movement of particles	Can it flow?	Can it be compressed?
Solid	Close together regular pattern	Vibrate about a fixed position	No - has a fixed shape	No
Liquid	Close together random	Move around each other	Yes - they take the shape of the container	No
Gas	Far apart random	Move quickly in random directions	Yes - they completely fill the container	Yes

Specific Latent Heat

Latent heat is the energy needed for a substance to change state. When a change of state occurs, the energy supplied changes the internal energy but not the temperature. The energy need for a change of state to occur is affected by:

- Mass of substance
- Type of substance
- Size of forces that must be overcome

Specific latent heat can be calculated by using the following equation:

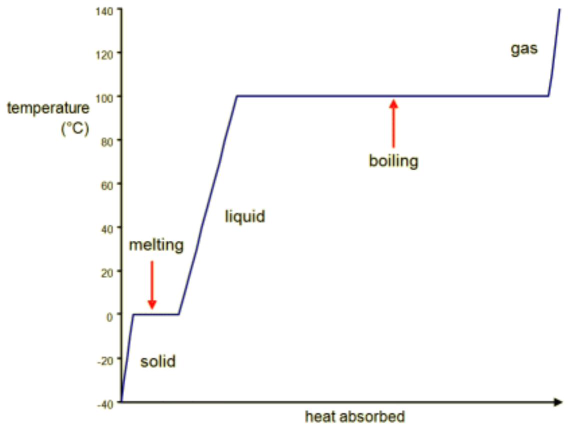
Energy = mass x latent heat

$$E = m \times L$$

Changing state

The picture shows a heating curve for ice. The two horizontal parts to the graph indicate a change in state.

When ice is heated, the first change in state is melting. This occurs at 0°C. At this point the solid block of ice turns into a liquid (water). The second change of state is boiling and occurs at 100°C. At this point, the liquid water evaporates to form water vapour.



When we heat a substance, the temperature remains constant during a change of state because the thermal energy added is used to break existing bonds between the molecules within the substance. When we cool a substance, the temperature remains constant during a change of state because thermal energy is released as new bonds are made.

P4 - Atomic Structure (Topic Two)

Keywords	
Ion	The charged particle produced when an atom gains or loses electrons.
Ionising power	The ability of a radiation to create ions.
Ionised	When atoms in a substance exposed to radiation lose electrons and become ions.
Penetrating power	The ability of radiation to pass through substances
Irradiated	A substance which has been exposed to radiation but is not made radioactive.
Radioactive contamination	When radioisotopes are transferred to an object making it radioactive

Type	What is it?	Charge	Relative Mass	What will stop it?	Where do we use it?
α	Helium nucleus	2+	4	A few cm of air or a sheet of paper	Fire Alarms
β	Fast moving electron	-	Almost zero	Aluminium foil or thin sheet of lead	Medical tracers
γ	EM wave	nil	zero	Very thick lead sheet or 2m of concrete	Killing bacteria Killing cancer cells

Type	Ionising Power	Range in air	Absorbed by	Effect of electric field
α	High	About 5cm	Paper	Attracted towards -ve plate
β	Medium	About 1m	5mm Aluminium 3mm Lead	Attracted to +ve plate
γ	Low	Infinite	Several cm of lead More than 1m of concrete	Unaffected

The Gold Foil Experiment

Ernest Rutherford fired positively charged alpha particles at a thin piece of gold foil in an experiment which lead to the rejection of the plum pudding model of the atom.

The three main conclusions were:

1) Because the majority of alpha particles passed through the foil, most of the atom is empty space.
2) Because some of the alpha particles deflected there must be a small positively charged region inside the atom.
3) Because alpha particles are fast moving, the positively charged region must have a large mass to stop and repel them.