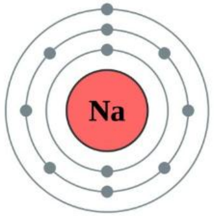
Chemistry 1: Atomic Structure and the Periodic Table

Section 1: Key Terms

Atom	The **smallest part of an element** that can exist. All substances are made of atoms. **No** overall **electrical charge**. **Very small**, radius of 0.1nm.
Element	An element **contains only one type of atom**. Found on the Periodic Table. There are about 100 elements.
Compound	**Two or more elements chemically bonded** with each other. Can only be separated into the elements through chemical reactions.
Mixture	**Contains two or more elements or compounds not chemically bonded**. Can be separated using physical methods e.g. by filtration, crystallisation, distillation and chromatography.
Filtration	A process that **separates** mixtures of **insoluble solids and liquids**.
Crystallisation	A process that **separates dissolved solids from liquids** by **evaporating** the liquid to leave crystals.
Distillation	A process that **separates a mixture of liquids** based on their **boiling points**.
Chromatography	A process that **separates mixtures** by **how quickly they move through a stationary phase** (e.g. paper)
Isotope	An atom of the **same element** with **different numbers of neutrons**.
Relative atomic mass	An **average value of mass** that takes account of the **abundance of the isotopes** of the element.

Section 2: Properties of Sub-Atomic Particles

Sub-atomic particle	Mass	Charge	Position in Atom
Proton	1	+1	Nucleus
Neutron	1	0	Nucleus
Electron	Very small	-1	Orbiting in shells



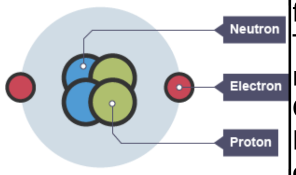
Mass number – the total number of **protons** and **neutrons** →

$$^{23}_{11}\text{Na}$$

Atomic number – the **number of protons** (the number of electrons is the same in an atom)

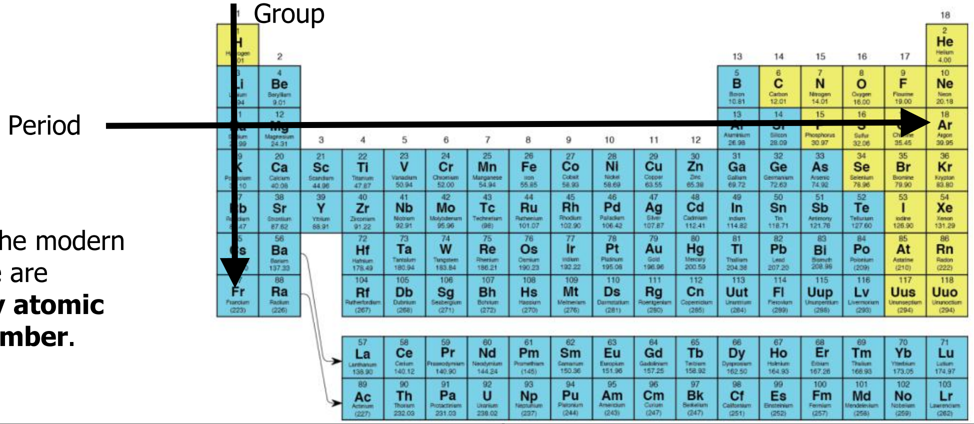
Electron configuration– Electrons fill the first energy level (shell) first.
Maximum electrons:
2 in first shell
8 electrons in other shells

Section 3: Development of Atomic Model

Plum Pudding 	The plum pudding model thought that the atom is a **ball of positive charge** with **negative electrons embedded** in it. Was **incorrect**.	Nuclear Model 	**Rutherford's** scattering experiment found a central area of positive charge. The nuclear model has a **positive nucleus** and **electrons in shells**. **Chadwick** later discovered **neutrons**. **Bohr** discovered the arrangement of **electrons in shells**.

Section 4: Periodic Table

Group	Elements in the **same vertical column** are in the same group. Elements in the same group have the **same number of electrons in their outer shell**, and therefore **similar properties**.
Period	Elements in the **same horizontal row**. The atomic number increases by one moving across the period.
Metal	Elements that react to form positive ions. Left and centre of periodic table (except H).
Non-Metal	Elements that react to form negative ions. Right of periodic table.
Mendeleev	Made the modern periodic table by **leaving gaps for undiscovered elements** and **re-arranging some elements** (Mendeleev could only measure relative atomic mass, not atomic number).



Elements in the modern periodic table are **arranged by atomic (proton) number.**

Section 3: Groups of the Periodic Table

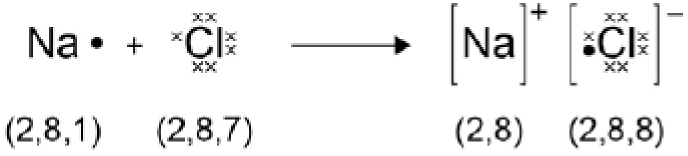
Group	Properties	Trends	Reactions
Group 0 Noble Gases	**Unreactive** and **do not form molecules.**	**Boiling point increases** going **down the group.**	Very unreactive as they **have full outer shells.**
Group 1 Alkali Metals	**Reactive** because they can easily lose one electron.	**Reactivity increases** going **down the group.**	With **water**: Metal + water → Metal hydroxide + hydrogen With **oxygen**: Metal + oxygen → Metal oxide With **chlorine**: Metal + chlorine → Metal chloride
Group 7 Halogens	Non-metals. Form **molecules** with pairs of atoms	**Reactivity decreases** going **down the group. Boiling point** and **melting point increase** going **down the group.**	A **more reactive** halogen can **displace** a **less reactive** halogen from a solution of its salt.

Chemistry 2: Bonding, Structure and the Properties of Matter

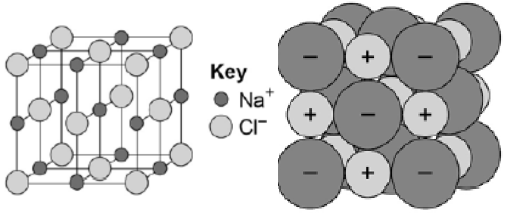
Section 1: Bonding Key Terms

Ion	An atom that is **charged** because it has **gained** or **lost electrons**.
Ionic bond	The **bond** between two **oppositely charged ions** (**metal** and **non-metal**). Occurs because of **electrostatic** attraction.
Electrostatic attraction	The **force** that **holds two oppositely charged ions** together. A **strong** force.
Metals	In ionic bonding, **metals lose electrons** to become **positively-charged** ions.
Non-metals	In ionic bonding, **non-metals gain electrons** to become **negatively-charged** ions.
Giant lattice	A **large 3D structure** that contains a **lot of bonds**.
Covalent bond	A bond formed when **non-metals share electrons**. A **strong** bond.
Molecule	A **small group of atoms** held together with **covalent bonds**. **Not charged.**
Polymer	**Very large covalent compounds** with **many repeating units**.
Metallic bonding	The **electrons** in the **outer shell** of metal atoms are **delocalised** and so are **free to move** through the whole structure. The **sharing of delocalised electrons** gives rise to **strong metallic bonds**.
Alloy	A mixture of **two or more elements**, **at least one of which is a metal**. E.g. steel

Section 2: Ionic Bonding



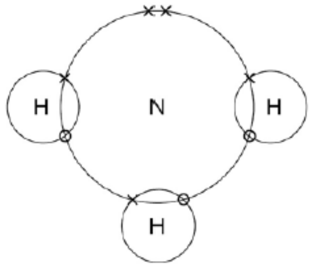
In ionic bonding, metals lose electrons to become positively-charged ions. Non-metals gain these electrons to become negatively-charged ions.

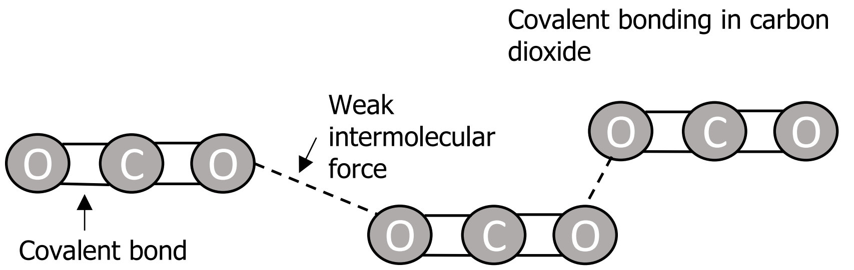


Two representations of a **giant ionic lattice**. The lines represent ionic bonds.

Property of ionic compounds	Reason
High melting point	There is a **strong electrostatic force** between the **positive and negative ions** in the **giant lattice**. A **large amount of energy** is **needed to overcome this force**.
Conduct electricity when liquid/ molten	**Ions are able to move** so there is a **flow of charged ions** (current).
Do not conduct electricity when solid	**Ions are in fixed positions** so cannot flow**.**

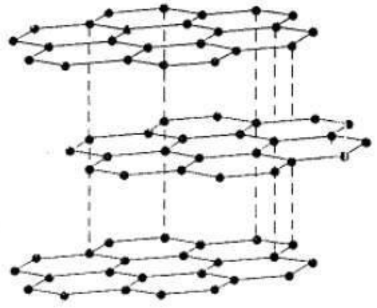
Section 3: Simple Covalent Molecules





Property of covalent molecules	Reason
Low melting and boiling points (usually gases or liquids)	There are only **weak intermolecular forces between the molecules**. **Not much energy** is needed to overcome these forces.
Do not conduct electricity	Covalent molecules are **not charged**.

Section 4: Giant Covalent Structures Made of Carbon

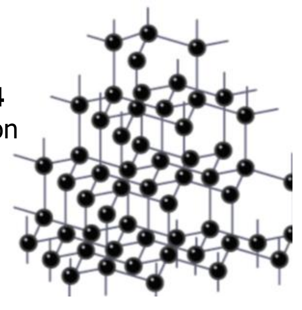


Graphite

Each **carbon** forms **3 bonds** to other carbon atoms. Arranged in **layers** with **weak intermolecular forces between layers**.

Diamond

Each **carbon** forms **4 bonds** to other carbon atoms.



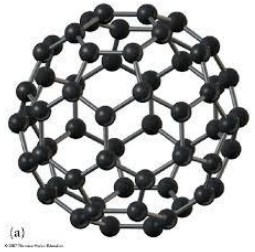
Section 4a: Properties of Graphite

Property	Reason
Conducts electricity	Each carbon only **forms 3 bonds** so **one electron is delocalised**. These electrons are **free to move** and **carry charge** through the structure.
Soft and slippery	Only **weak intermolecular forces** exist **between layers**, so layers can easily be rubbed off.

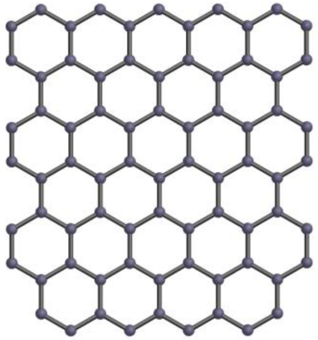
Section 4b: Properties of Diamond

Property	Reason
Doesn't conduct electricity	Diamond **doesn't contain delocalised electrons or ions**.
Very hard	Each carbon bonds to **4 other carbon atoms** with **strong covalent bonds** to form a **lattice**.
High melting point	Each carbon bonds to 4 other carbon atoms with strong covalent bonds to form a lattice. A **large amount of energy** is needed to overcome all these bonds.

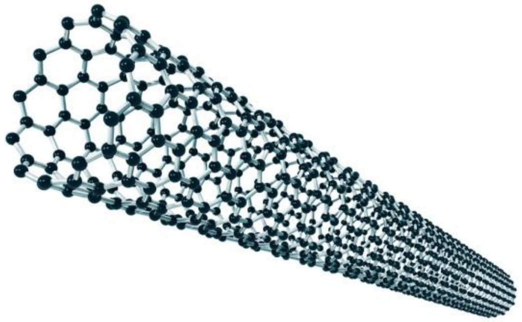
Section 5: Small Carbon-Based Structures



Fullerene



Graphene



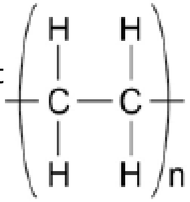
Carbon nanotube

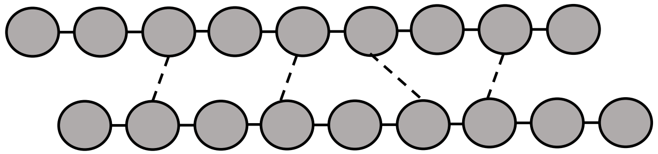
Section 1: Properties of Metals

	Structure	Properties	Uses
Fullerene	**Hollow-shaped**. Usually **hexagonal rings of carbon** atoms. E.g. Buckminsterfullerene (C_{60})	Very **strong**. Hollow so can contain other chemicals within it.	**Drug delivery, lubricants**.
Graphene	A **single layer of graphite**.	Very **strong**. **Has delocalised electrons** so it is able to **conduct electricity**.	**Electronics, composites.**
Carbon nanotube	**Cylindrical tubes** of carbon atoms that are **very long** compared to their diameter.	Very **strong, light** and **flexible**. Has **delocalised electrons** so it is able to **conduct electricity**.	**Nanotechnology, electronics, reinforcing (e.g. tennis rackets).**

Section 6: Polymers

A polymer. The lines show covalent bonds. 'n' is a large number.

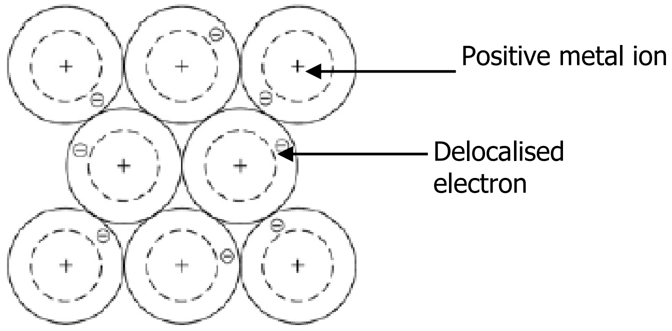




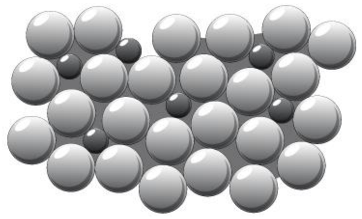
Polymers are held together by intermolecular forces (dashed lines)

Property	Reason
Solid	Usually solid because the **intermolecular forces between polymer molecules** are **relatively strong**.

Section 7: Metallic Bonding



A pure metal. It consists of metal ions in layers with delocalised electrons.



An alloy. The layers have been distorted by the presence of other elements

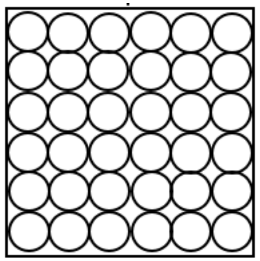
7a Properties of Pure Metals

Property	Reason
High melting points	**Strong electrostatic forces** between the **positive ions** and **delocalised electrons**. Requires a **large amount of energy** to overcome.
Conduct electricity	Metals have **delocalised electrons**. These electrons are **able to move** through the structure and carry charge.
Conduct heat	The **delocalised electrons** are able to **move and transfer thermal energy** through the structure.
Malleable	The **layers** are able to **slide over each other** so the metal can be bent and shaped. The attraction between the positive ions and delocalised electrons prevents the metal from shattering.

7b Properties of Alloys

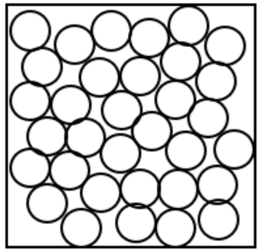
Property	Reason
Harder than metals	The **layers are distorted** by the presence of other elements. This **prevents the layers from being able to slide over each other**.

Section 8: States of Matter



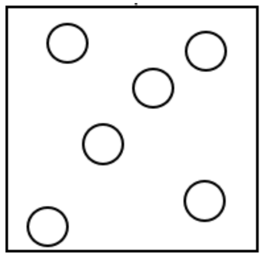
Solid

State symbol – (s)



Liquid

State symbol – (l)



Gas

State symbol – (g)

Chemistry 3: Quantitative Chemistry

Section 1: Bonding Key Terms	
Law of conservation of mass	**No atoms** are **lost** or **gained** during a **chemical reaction**. The mass of the products is the same as the mass of the reactants. Some reactions **appear to give a change in mass**, but this is because a **gas may have escaped** from the reaction container.
Relative atomic mass (A_r)	The **average mass** of an **atom of an element** compared to Carbon-12.
Relative formula mass (M_r)	The **sum** of **all the atomic masses** of the atoms in a **formula** (e.g. H_2O).
Uncertainty	The **interval** within which the **true value** can be **expected to lie**. E.g. 25°C $\pm$ 2°C – the true value lies between 23°C and 27°C.
Balanced Symbol Equations	Symbol equations should be balanced – they should have the same number of atoms of each element on each side. e.g. $Mg + O_2 \rightarrow MgO$ This is **NOT** balanced (more Oxygen atoms on the left hand side) **2**$Mg + O_2 \rightarrow$ **2**MgO This is a **balanced symbol equation**
Concentration	A measure of the **number of particles** of a chemical in a **volume**. Can be measured in **g/dm^3**.
Decimetre^3 (dm^3)	A **measurement of volume**. Contains **1000cm^3**.
Mole (HT)	A measurement for the amount of a chemical. It is the **mass** (in grams) of **6.02 x 10^{23}** (the Avogadro constant) **atoms of an element**. Symbol: mol.
Balanced equation (HT)	Balanced symbol equations show **the number of moles that react**. e.g. $Mg + 2HCl \rightarrow MgCl_2 + H_2$ Shows one mole of magnesium reacting with two moles of hydrochloric acid to form one mole of magnesium chloride and one mole of hydrogen.
Limiting reactant (HT)	The **reactant** that is **completely used up** in a chemical reaction. It **limits the amount of product** formed.
Excess reactant (HT)	The reactant that is **not completely used up** in a chemical reaction. There is some reactant left at the end.

Section 2: Calculations and Examples	
Calculating relative formula mass (M_r)	Add up all the atomic masses in a formula. e.g. H_2O. Mass of hydrogen = 1. Mass of oxygen = 16. (2x1) + 16 = 18, so M_r of H_2O = 18
Percentage by mass in a compound	Percentage by mass in a compound = $\frac{\text{Mass of element}}{M_r \text{ of compound}}$ x100 e.g. What is the percentage by mass of hydrogen in water? Percentage mass of hydrogen in water = $\frac{2}{18}$ x100 = 11.1%
Percentage uncertainty	Percentage uncertainty = $\frac{\text{Uncertainty}}{\text{Quantity being measured}}$ x100 e.g. What is the percentage uncertainty of a 50cm^3 measuring cylinder accurate to $\pm$2cm^3? Percentage uncertainty = $\frac{2}{50}$ x 100 = 4%
Volume in dm^3	Volume in dm^3 = $\frac{\text{volume of liquid in cm}^3}{1000\text{cm}^3}$ e.g. What is the volume in dm^3 of 500cm^3 of hydrochloric acid? Volume in dm^3 = $\frac{500}{1000}$ = 0.5dm^3
Number of moles (HT)	Number of moles = $\frac{\text{Mass of chemical}}{\text{Relative formula mass}}$ e.g. How many moles of water are there in 36g of H_2O? Number of moles = $\frac{36}{18}$ = 2 moles
Concentration of a solution (HT)	Concentration = $\frac{\text{Mass of solute}}{\text{Volume (in dm}^3\text{)}}$ e.g. What is the concentration of a solution of hydrochloric acid which contains 100g of hydrochloric acid in 500cm^3? Concentration = $\frac{100}{0.5}$ = 200g/dm^3

Chemistry 4: Chemical Changes

Section 1: Key Terms

Metal oxide	Metals react with oxygen to produce metal oxides. This is an oxidation reaction.
Displacement reaction	A **more reactive** metal can **displace** a **less reactive** metal from a compound.
Oxidation	Chemicals are oxidised if they **gain oxygen** in a reaction. Also, chemicals are oxidised if they **lose electrons** in a reaction. (HT)
Reduction	Chemicals are oxidised if they **lose oxygen** in a reaction. Also, chemicals are oxidised if they **gain electrons** in a reaction. (HT)
Acid	A chemical that **dissolves in water** to produce **H^+ ions**.
Base	A chemical that **reacts with acids** and **neutralises** them. E.g. **metal oxides**, **metal hydroxides**, **metal carbonate**
Alkali	A **base** that **dissolves in water**. It produces **OH- ions** in solution.
Neutralisation	When a **neutral solution** is formed from reacting an **acid** and **alkali**. General equation: **$H^+ + OH^- \rightarrow H_2O$**
pH	A scale to **measure acidity/ alkalinity**. A **decrease of one pH** unit causes a **10x increase in H^+ ions**. (HT)
Strong acid (HT)	A strong acid is **completely ionised** in solution. E.g. **hydrochloric**, **nitric** and **sulfuric** acids.
Weak acid (HT)	A weak acid is **only partially ionised** in solution. E.g. **ethanoic**, **citric** and **carbonic** acids.

Section 2: Making a Soluble Salt

1	**Add solid** metal, metal carbonate, metal oxide or metal hydroxide **to an acid**.
2	Add solid **until no more reacts**.
3	**Filter** off excess solid.
4	**Evaporate** to remove some of the water.
5	Leave to **crystallise**.
6	Remove all water in a **desiccator/ oven**.

The pH Scale – can be measured using universal indicator or a pH probe

Acidic pH 0-6	Neutral pH 7	Alkaline pH 8-14

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Section 3: Reactivity

Element	Reaction	Reactivity
Potassium	When potassium is added to **water**, the metal **melts** and floats. It moves around very quickly. The metal is also **set on fire**, with sparks and a **lilac flame**.	↑
Sodium	When sodium is added to **water**, it **melts** to form a ball that moves around on the surface. It **fizzes rapidly**.	
Lithium	When lithium is added to **water**, it floats. It **fizzes steadily** and becomes smaller.	
Calcium	**Fizzes quickly** with dilute **acid**.	
Magnesium	**Fizzes quickly** with dilute **acid**.	
(Carbon)		
Zinc	**Bubbles slowly** with dilute **acid**.	
Iron	**Very slow reaction** with dilute **acid**.	
(Hydrogen)		
Copper	**No reaction** with dilute **acid**.	

Section 4: Extracting Metals

Very unreactive metals e.g. Gold	Found **naturally** in the ground. **Don't need extracting**.
Metals less reactive than carbon	Extracted by **reduction with carbon**.
Metals more reactive than carbon	Extracted by **electrolysis**.

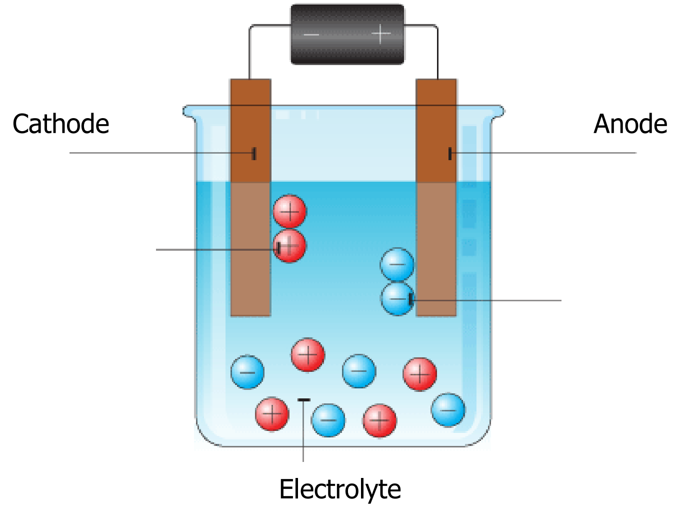
Section 5a: Reactions of Acids

With metal	Acid + Metal → Salt + Hydrogen	
With alkali	Acid + Metal Hydroxide → Salt + Water	(Neutralisation reaction)
With metal oxide	Acid + Metal Oxide → Salt + Water	(Neutralisation reaction)
With carbonate	Acid + Metal Carbonate → Salt + Water + Carbon Dioxide	(Neutralisation reaction)

Section 5b: Salts

Salts	• Hydro**chlor**ic Acid forms **chlor**ide salts e.g. Hydrochloric acid + Zinc → Zinc Chloride + Hydrogen • **Sulf**uric Acid forms **sulf**ate salts • **Nitr**ic Acids forms **nitr**ate salts

Chemistry 4: Chemical Changes



- **P**ositive
- **A**node
- **N**egative
- **I**s
- **C**athode

Section 7 Electrolysis key terms	
Electrolysis	The process of **splitting an ionic compound** by passing **electricity** through it.
Electrolyte	An **ionic compound** that is **molten** (melted) or **dissolved in water**. The **ions** are **free to move**.
Electrode	An **electrical conductor** that is placed in the **electrolyte** and connected to the **power supply**.
Cathode	The **electrode** attached to the **negative** terminal of the **power supply**.
Anode	The **electrode** attached to the **positive** terminal of the **power supply**.

Section 8: What is discharged in electrolysis?

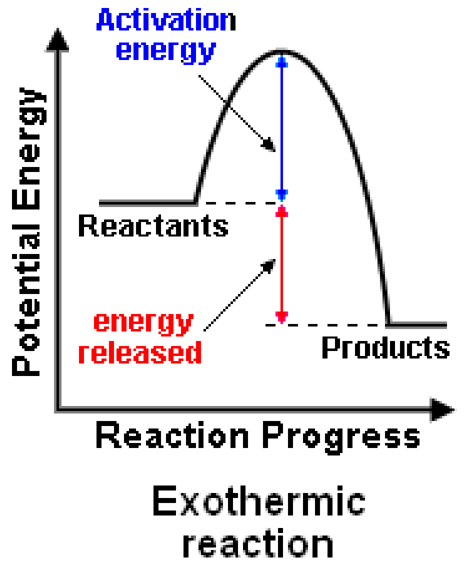
Electrolyte	Cathode	Anode
Molten Compound	Metal	Non-metal
Dissolved compound (aqueous solution)	The **metal** if the metal is **less reactive than hydrogen**. **Hydrogen** is produced if the **metal is more reactive than hydrogen**.	**Oxygen** is produced **unless the solution contains halide ions** (chloride, bromide, iodide) when the **halogen** (chlorine, bromine, iodine) is produced.

Section 9: Aluminium Electrolysis	
Cryolite	**Aluminium oxide** is **dissolved in cryolite** to **lower its melting point**. This **saves money on energy costs.**
Cathode	Positive **Al^{3+} ions move to the cathode.** Aluminium is produced. **$Al^{3+} + 3e^- \rightarrow Al$**
Anode	Negative **O^{2-} ions move to the anode.** Oxygen is made. **$2O^{2-} \rightarrow O_2 + 4e^-$** **Wears away** as the **carbon anode reacts with oxygen to form carbon dioxide.**

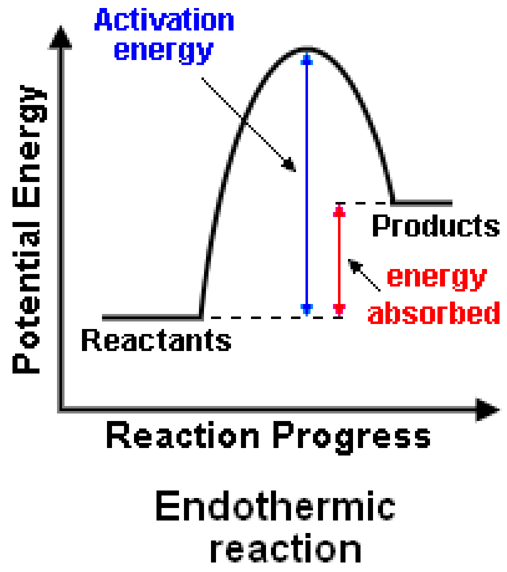
Chemistry 5: Energy Changes

Section 7 Energy Changes Key Terms	
Conservation of energy	Energy is **not created or destroyed**, only **transferred from one store to another**
Exothermic	A reaction that **transfers energy to the surroundings** so the **temperature of the surroundings increases**, e.g. **combustion** and **neutralisation** reactions. Used in **self-heating cans** and **hand warmers.**
Endothermic	A reaction that **takes in energy from the surroundings** so the **temperature of the surroundings decreases**, e.g. **thermal decomposition**. Used in **sports injury packs.**
Activation energy	The **energy needed** for **particles to successfully react**.
Breaking bonds	**Energy is needed** to break bonds.
Forming bonds	**Energy is released** when bonds are formed.

Exothermic Energy Profile



Endothermic Energy Profile



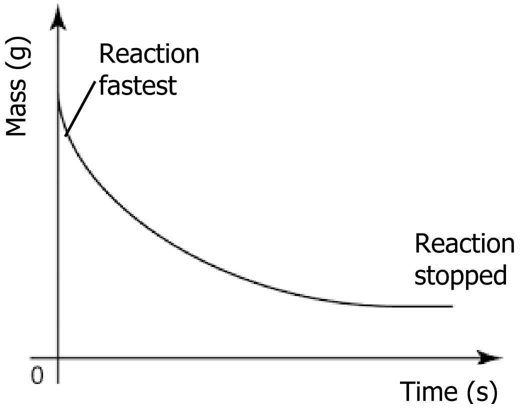
Energy released from forming bonds is **greater than** the energy needed to break bonds. (HT)

Energy released from forming bonds is **less than** the energy needed to break bonds. (HT)

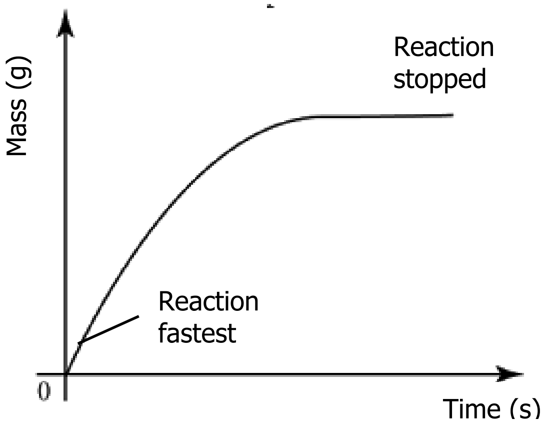
Chemistry 6: Rate and Extent of Chemical Change

Calculating rate of reaction:

$$\text{Mean rate} = \frac{\text{amount of reactant used}}{\text{time taken}} \quad \textit{or} \quad \text{Mean rate} = \frac{\text{amount of product formed}}{\text{time taken}}$$



Typical graph when measuring **reactants used**



Typical graph when measuring **products formed**

Section 1: Key terms

Collision theory	**Reactions occur** only when **particles collide with enough energy**.
Activation energy	The amount of **energy particles** need in order **to react**.
Catalyst	A chemical (or **enzyme**) that **increases the rate of reaction without being used itself** (therefore they are not included in an equation). They **provide an alternative pathway** for the reaction with a **lower activation energy**.
Concentration	The **number of particles** in a certain **volume.**

Section 2: Factors Affecting Rate

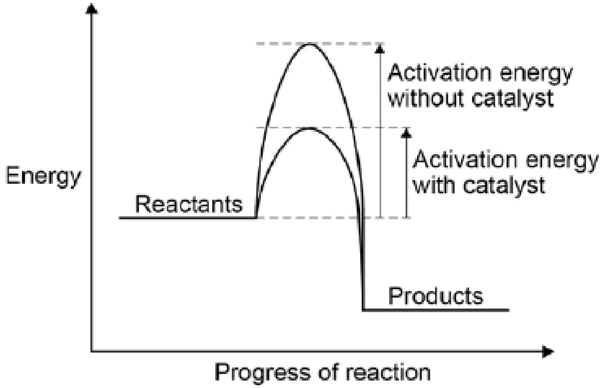
Factor	Effect on Rate	Explanation
Concentration of reactants	Increasing the concentration **increases** the rate of reaction.	**Increases** the **chance of a collision** as there are more particles.
Pressure of gases	Increasing the pressure **increases** the rate of reaction.	**Increases** the **chance of a collision** as there are more particles.
Surface area of solid reactants	Increasing the surface area **increases** the rate of reaction.	**Exposes more of the solid** so that there is a **greater chance of collisions** occurring.
Temperature	Increasing the temperature **increases** the rate of reaction.	**Increases speed** at which particles move and makes **collisions more energetic**.
Catalyst	Catalysts **increase** the rate of reaction.	**Lowers** the **activation energy**.

Section 3: Reversible Reactions

Reversible reaction	A reaction in which the **products can also form the reactants**. Shown as: $A + B \rightleftharpoons C + D$
Exothermic	A reaction that **releases energy** to the environment.
Endothermic	A reaction that **takes in energy** from the environment.
Equilibrium (HT)	Equilibrium is reached when the **forward and reverse reactions occur at exactly the same rate**. Needs a **sealed container**.
Le Chatelier's Principle (HT)	If a system is at equilibrium and a change is made to any of the conditions, then the **system responds to counteract the change**.

Section 4: Changing conditions at equilibrium

Changing temperature (HT)	If the temperature of a system at equilibrium is increased: • the amount of products at equilibrium increases for an endothermic reaction • the amount of products at equilibrium decreases for an exothermic reaction. If the temperature of a system at equilibrium is decreased: • the amount of products at equilibrium decreases for an endothermic reaction • the amount of products at equilibrium increases for an exothermic reaction.
Changing concentration (HT)	• If the concentration of a reactant is increased, more products will be formed. • If the concentration of a product is decreased, more products will be formed.
Changing pressure (HT)	For reactions of gases: • an increase in pressure causes the reaction to favour the side with the smaller number of molecules (as shown by the symbol equation for that reaction). • A decrease in pressure causes the reaction to favour the side with the larger number of molecules (as shown by the symbol equation for that reaction).

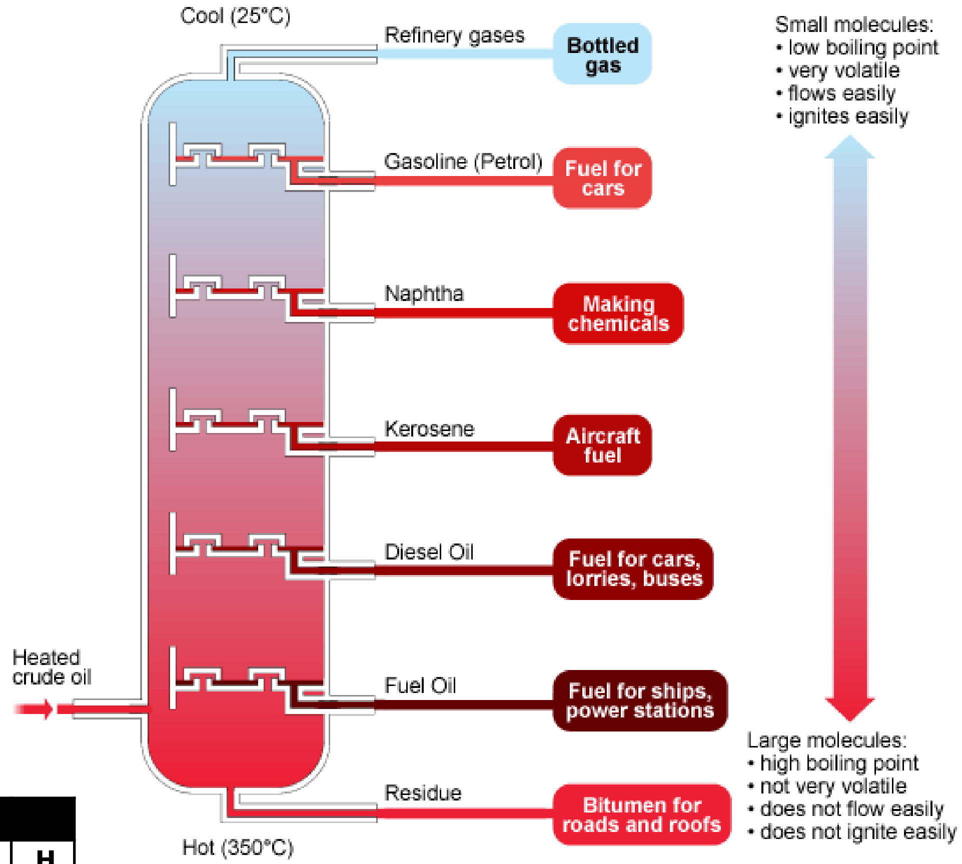


Energy profile diagram for a reaction with/ without a catalyst.

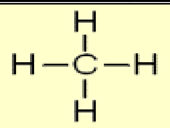
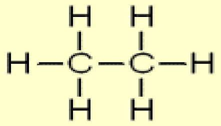
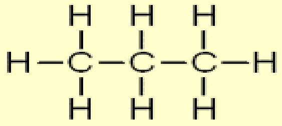
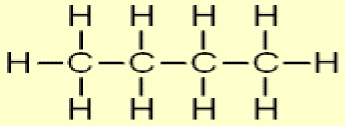
Chemistry 7: Hydrocarbons

Section 1: Key terms

Crude oil	A **mixture** of **hydrocarbons** formed over **millions of years** from dead **plankton** subjected to **pressure**.
Hydrocarbon	A molecule containing **hydrogen** and **carbon** atoms **only**.
Alkane	A **hydrocarbon** containing only **single bonds**. Follows the formula C_nH_{2n+2}.
Fractional distillation	The method of **separating hydrocarbons** based on their **boiling point**.
Intermolecular force	**Weak forces of attraction** that exist between **molecules**.
Boiling point	The temperature at which a **liquid** turns into a **gas**.
Viscosity	The ability of a substance to **flow**.
Flammability	The ability of a substance to **burn** or **ignite**.
Combustion	A **reaction** between a **fuel** and **oxygen** that produces **heat**.
Alkene	A **hydrocarbon** containing at least one **double bond**. Alkenes are more reactive than alkanes and are used to make **polymers**.
Bromine water	A chemical that is **brown/ orange** in colour. If added to an **alkene** it reacts and changes to **colourless**. Alkanes do not produce a change in colour.
Cracking	The process by which less-useful **long-chain hydrocarbons** are **split** to produce smaller, more useful molecules (an **alkane** and an **alkene**)
Fraction	A fraction contains **similar length hydrocarbons** with a **small range of boiling points**.



Section 2: Alkanes

methane CH_4	
ethane C_2H_6	
propane C_3H_8	
butane C_4H_{10}	

Section 3: Fractional Distillation

1	The crude oil is **heated** to 400°C.	**H**
2	Most fractions **evaporate** and become **vapours**. The residue doesn't boil and flows to the bottom of the column.	**E**
3	Hot vapours **rise** up the column and **cool down**.	**R**
4	When the vapours **cool** to their **boiling point** they **condense** and flow out of the column.	**C**
5	Those with **lower boiling points rise further** before cooling down.	
6	Refinery gases do not cool down to their boiling point so **remain as gases**.	

Section 4: Cracking

Cracking Method	Process	Temperature
Catalytic Cracking	Fraction is **heated** in the presence of a **zeolite catalyst**.	**500°C.**
Steam Cracking	Fraction is diluted with **steam** and **heated**.	**850°C.**

Complete Combustion of Alkanes Equations: Note – the equation is balanced

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Propane + Oxygen → Carbon Dioxide + Water

Cracking Equations: Note – the equation is balanced

decane –> heptane + propene

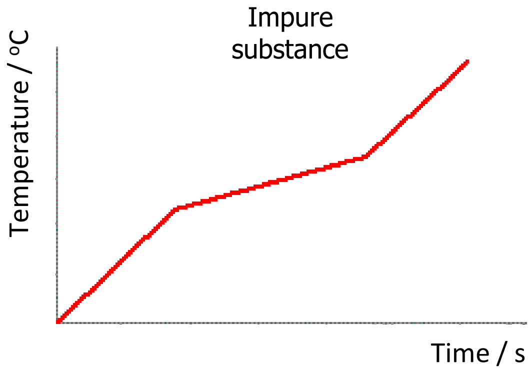
$$C_{10}H_{22} \rightarrow C_7H_{16} + C_3H_6$$

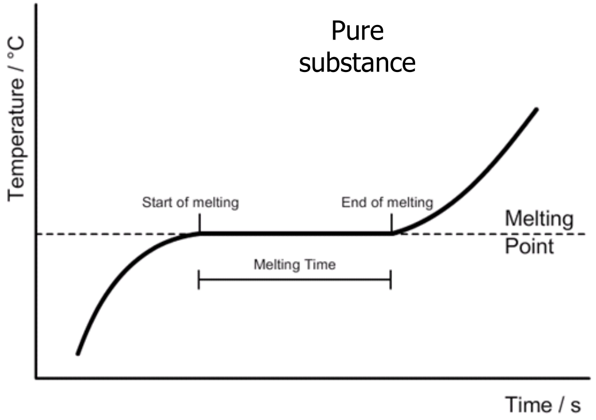
Large, less-useful alkane | Smaller, useful alkane | Useful alkene

Chemistry 8: Chemical Analysis

Section 1: Key terms	
Pure	A pure substance is a single **element** or **compound**, **not mixed** with any other substance.
Formulation	A **mixture** that has been designed as a useful product. Formulations are made by mixing the components in **carefully measured quantities**. Formulations include **fuels**, **cleaning agents**, **paints**, **medicines**, **alloys**, **fertilisers** and **foods**.
Melting point	The **temperature** at which a substance turns from a solid to a liquid.

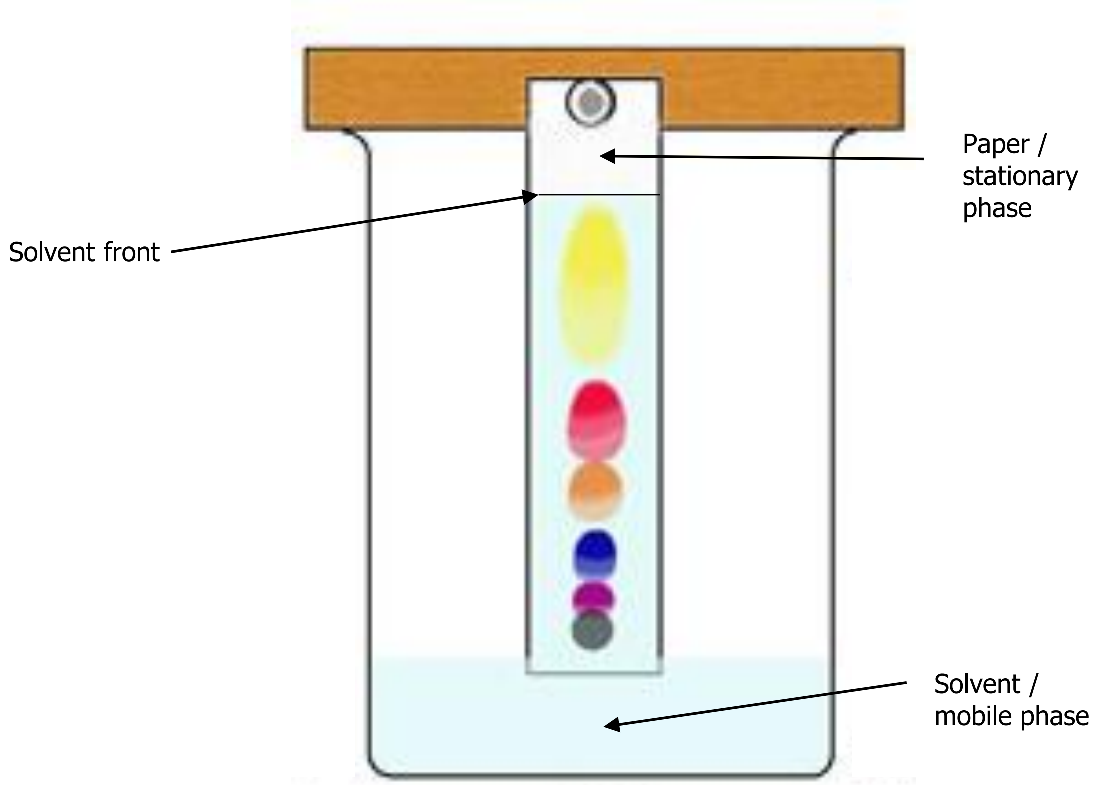
Section 2: Impure and Pure Graphs
Impure substances do not melt at specific temperatures.
Pure substances do melt at specific temperatures (a horizontal line is produced).





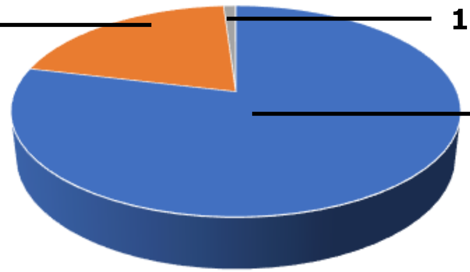
Section 4: Testing for Gases		
Gas	**Procedure**	**Positive Result**
Hydrogen	Hold a **lit splint** at the end of a test tube producing gas.	Hydrogen burns with a **pop** noise.
Oxygen	Hold a **glowing splint** in a test tube of the gas.	The splint **relights** if oxygen is present.
Carbon dioxide	Bubble gas through a solution of **limewater**.	Carbon dioxide causes the limewater to turn **milky**.
Chlorine	Place **damp litmus paper** in the gas.	The litmus is **bleached white** if chlorine is present.

Section 3: Chromatography	
Chromatography	A method used to **separate mixtures** into their different chemicals.
Solvent	The chemical that **dissolves the sample** in chromatography.
Solvent front	The **maximum distance** the **solvent moves** up the paper.
Stationary phase	The **medium** (e.g. paper) through which the **mobile phase passes** in **chromatography**.
Mobile phase	The **solvent** (e.g. water) that carries the sample (e.g. ink) in **chromatography**.
R_f value	A value (always less than 1) that shows how far the substance has moved compared to the solvent. Equation: $R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$



Chemistry 9: Chemistry of the Atmosphere

Section 1: The Atmosphere



Air also contains **0.04% carbon dioxide** and variable amounts of **water vapour**

Section 2: Formation of the Atmosphere

Early Atmosphere
Atmosphere is **mainly carbon dioxide** with **no oxygen**.

4.6 – 3.6 Billion Years Ago
Volcanoes erupt releasing **nitrogen** and **water vapour**. **Water vapour condenses** and forms the oceans. Some **carbon dioxide dissolves** in the **oceans**. **Carbon dioxide** is also locked in **fossil fuels** and **sedimentary rocks**.

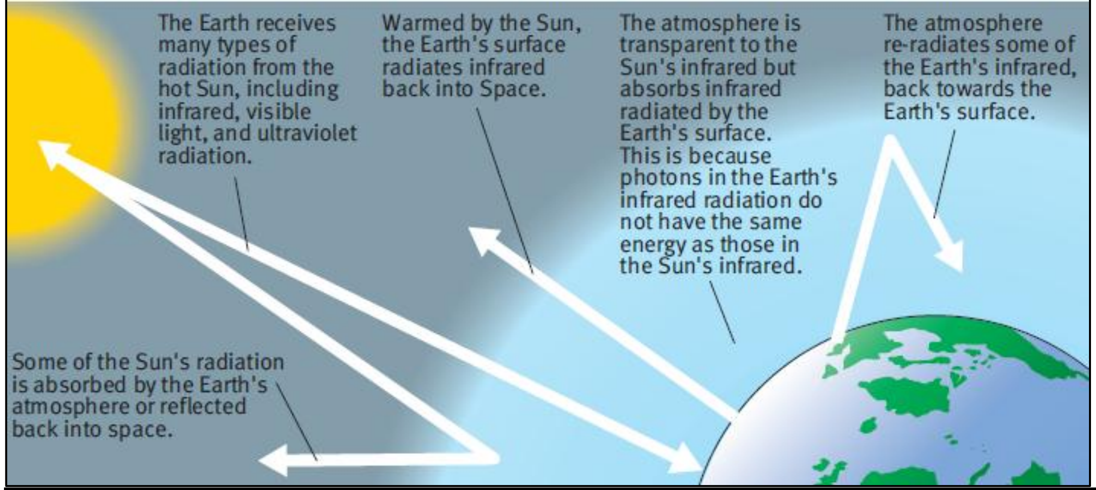
2.7-1.7 Billion Years Ago
Plants evolve and release **oxygen** through **photosynthesis**. They take in more carbon dioxide.

Section 2a: Reduction of CO_2 by formation of deposits

Coal	**Plants absorbed CO_2.** They **died and decayed.** This layer of decaying plants was **compressed to form coal.**
Oil and natural gas	**Plankton absorbed CO_2.** Plankton died and were **deposited in muds on the sea floor.** They were covered over and **compressed over millions of years.**
Limestone	**Shelled animals absorbed CO_2** to make their **calcium carbonate shells.** The remains of these animals were **compressed to form limestone.**

Section 3: Greenhouse Effect and Global Warming

Greenhouse effect	The process by which the **temperature** on **Earth** is kept **high enough to support life** by greenhouse gases absorbing radiation radiated by the Earth.
Greenhouse gas	Greenhouse gases keep temperatures on Earth high enough to support life. **Water vapour**, **methane** and **carbon dioxide** are greenhouse gases.
Short wavelength radiation	The **radiation** from the **Sun**. Is able to **pass through** the Earth's atmosphere and **warm the surface** of the Earth **without being absorbed** by greenhouse gases.
Long wavelength radiation	The **radiation from the Earth's surface.** Some is **absorbed** by greenhouse gases and **doesn't escape the atmosphere.**
Carbon footprint	The **total amount** of **carbon dioxide** and other **greenhouse gases** emitted over the **full life cycle** of a product or event.
Global warming	The **increase** of the **average temperature** of the **Earth.**



Greenhouse Effect

How humans increase carbon dioxide in the atmosphere	How humans increase methane in the atmosphere
Combustion of **fossil fuels**	Increased **animal farming**
Deforestation	Decomposition of **rubbish in landfill**
How humans can decrease carbon dioxide concentration	**How humans can decrease methane concentration**
Use **alternative forms of energy** e.g. wind turbines	**Alternative foods – non-animal based**
Energy efficiency e.g. more efficient cars	Increased **recycling**
Carbon capture – capturing CO_2 from power stations	
Carbon off-setting – planting **more trees**	

Effects of global warming
Some regions will **not** be able to produce **enough food** because of **drought.**
Changes to distribution of species and migration patterns.
Increase in sea levels because of melting of polar ice caps.
Reduction of water supplies in some regions.

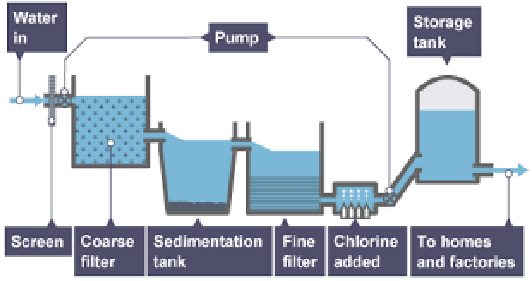
Section 4: Common Pollutants

Pollutant	Formula	Cause	Effect
Carbon monoxide	CO	**Incomplete combustion** of a **hydrocarbon** fuel.	**Toxic** gas. Colourless and odourless so hard to detect.
Sulfur dioxide	SO_2	**Burning coal or petrol.** Both contain sulfur which reacts with oxygen in the air.	Cause **respiratory problems** (e.g. for those with asthma). Combine with water vapour to cause **acid rain.**
Nitrogen oxides	NO_x	In **car engines.** **N_2** and **O_2 from air** react at **high temperatures.**	
Particulates	CO_2	**Incomplete combustion** of a hydrocarbon fuel.	**Global dimming** (reduction in sunlight reaching Earth).

Chemistry 10: Using Resources

Section 1: Key Terms	
Finite resource	A resource used by humans that has a **limited supply** e.g. coal.
Renewable resources	A resource used by humans that can be **replenished** e.g. trees. If not managed correctly, the resource may decrease.
Potable water	Water that is **safe to drink**. Has **low levels of dissolved salts** and **microbes**.
Fresh water	Water that has **low levels of dissolved salts**. Sea water is not fresh water.
Pure water	**Only** contains **water molecules**, nothing else.
Desalination	A process that **removes salt from sea water** to create potable water. **Expensive** as it **requires a lot of energy**. Only necessary in areas with small amounts of fresh water e.g. Spain.
Sewage	**Wastewater produced by people**. Contains potentially dangerous **chemicals** and large numbers of **bacteria**.

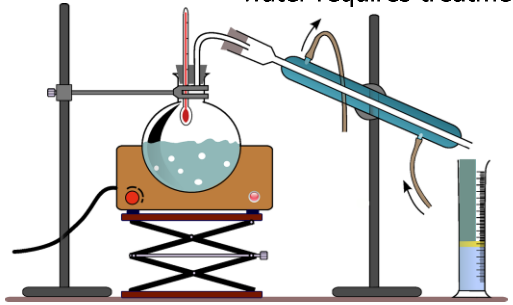
Section 2: Potable Water

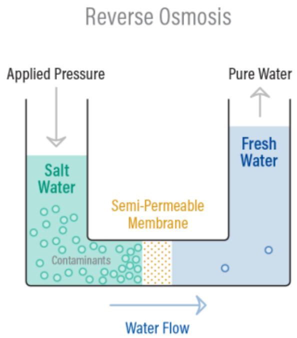


Obtaining potable water in countries with plentiful fresh water e.g. the UK

- Find a suitable source of fresh water (e.g. a **reservoir**).
- Pass through **filter beds to remove particles**.
- **Sterilise** to kill microbes e.g. by using **chlorine**, **ozone** or **ultraviolet light**.

Obtaining potable water in countries with limited fresh water requires treatment of sea water:





Distillation:

- Water is heated to **100ºC**.
- It **evaporates**, leaving the salt behind.
- A **condenser cools** the water to return it to the liquid state.

Reverse osmosis:

- **Pressure** is applied to the water.
- The **water molecules** move through the **partially-permeable membrane**.
- **Other particles are too large** and are not able to move through.

Section 3: Sewage Treatment	
Screening and grit removal	**Removes rags, paper, plastics** etc. that may block pipes.
Sedimentation	**Suspended particles settle out** of the water an fall to the bottom of a sedimentation tank to **form the sewage sludge**.
Anaerobic digestion of sewage sludge	**Bacteria digest the sludge** in the **absence of oxygen**. This breaks it down. **Methane and carbon dioxide are produced** by the bacteria.
Aerobic biological treatment of sewage effluent	**Aerobic bacteria digest** more of the **organic matter in the effluent** (the treated waste water).

Section 4: Alternative Methods of Metal Extraction	
Bioleaching	**Bacteria** grow on **low-grade copper ores**. They produce a **leachate** (liquid) that **contains copper compounds**.
Phytomining	**Plants** are grown on **low-grade copper ores**. The plants **absorb the copper** and are then **burned**. The **ash contains copper compounds**.
Displacement using scrap iron	A method of **obtaining pure copper** from the copper compounds produced in phytomining and bioleaching. **Iron displaces copper** from its compounds as **iron is more reactive**. **Cheap**.
Electrolysis	A method of **obtaining pure copper** from the copper compounds produced in phytomining and bioleaching. **Copper compounds can be dissolved** and then the **positive copper ions would be attracted to the negative electrode** in electrolysis.

Section 5: Life Cycle Assessment	
Life Cycle Assessment	Life cycle assessments **assess the environmental impact of products**. A LCA assesses the use of **water, resources, energy sources** and **production of some wastes** during the following stages: • **extracting** and **processing raw materials** • **manufacturing** and **packaging** • **use** and operation during its lifetime • **disposal** at the end of its useful life, including transport and distribution at each stage.
Reuse	The **environmental impact** of products can be **reduced** by reusing the product. Only **suitable for some products e.g. glass bottles**.
Recycling	Some materials can be recycled e.g. metals. Metals can be **recycled by melting and recasting** or **reforming into different products**.