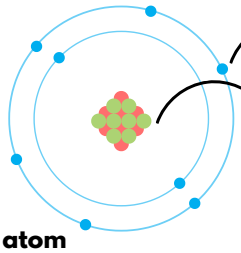
C1.1.1 Atoms, Elements and Compounds

An atom:

The smallest part of an element that can exist - the building blocks of all matter

Made up of **protons**, **neutrons** and **electrons**

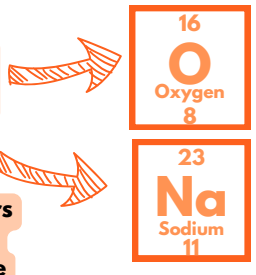


Electrons in orbit around the nucleus in 'shells'

The nucleus contains protons and neutrons

e.g. An oxygen atom

In the Periodic Table, elements are represented by a chemical symbol



Consist of 1 or 2 letters
1st letter - uppercase
2nd letter - lowercase

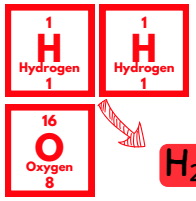
An element:

A substance made of one type of atom that all contain the same number of protons - there are about 100 different elements!

Compounds

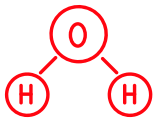
- A substance made up of two or more types of atoms in fixed proportions
- Formed from elements by chemical reactions, making them chemically combined together
- Cannot be separated by physical means and often have different properties to the original elements
- Ionic compounds - metal and non-metal joined as ions
  - The metal is the first part of the name
  - The non-metal is the second part of the name
    - Oxygen - suffix is most likely '-ate' e.g. sodium sulphate (Na_2SO_4)
    - Other non-metals - suffix is mostly likely '-ide' e.g. magnesium chloride ($MgCl_2$)
- Covalent compounds - non-metals chemically bonded together through covalent bonds

Compounds are represented by formulae, using the symbols from the atoms they were formed from



H_2O

Water contains 2 hydrogen and 1 oxygen atoms



Exam Tip: Know the names and symbols of the first 20 elements, plus those in Group 1 and Group 7.

H_2SO_4 - Sulfuric acid
CH_4 - Methane
C_2H_5OH - Ethanol
NH_3 - Ammonia
HCl - Hydrochloric acid
HNO_3 - Nitric acid

State symbols

State symbols represent what state each molecule is in during the reaction:

- Solid (s)
- Liquid (l)
- Gas (g)
- Aqueous (aq)

Dissolved in water

Exam Tip: Include state symbols only when instructed.

Chemical Reactions

Formation of one or more new substances → Atoms combine in fixed proportions which give them full outer shells → Often involve a detectable energy change

Can be represented by:

- Word equations: Magnesium + Hydrochloric Acid → Magnesium Chloride + Hydrogen

Reactants → Products

- Formulae: $Mg + 2HCl \rightarrow MgCl_2 + H_2$
- Chemical structures

Exam Tip: If there is a catalyst, you can write this above the arrow

Balancing Chemical Equations

Formulae is used to represent a balanced symbol equation - telling us what is happening to each atom in a reaction. According to the Law of Conservation of Mass, the number of atoms for each element must remain equal on both sides of the equation.

To balance a chemical reaction:

1. Count the atoms of each element in the reactants.
2. Count the atoms in the products.
3. Use trial and error to find what big numbers equalize the number of atoms for each element on both sides.

Exam Tip: You can change big numbers (e.g. $2Fe_2O_3$) but not small numbers (e.g. $2Fe_2O_3$)

Half & Ionic Equations

Half equations show electron behaviour in **redox** reactions, indicating one species gains electrons while another loses them.

$$Al^{3+} + 3e^- \rightarrow Al$$

$$2O^{2-} \rightarrow O_2 + 4e^-$$

Similarly, **ionic equations** represent on the behaviour of ions in reactions, simplifying complex processes by showing only the **reacting ions**. For example, in the neutralization of an acid and an alkali:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

is represented as:

$$H^+ + OH^- \rightarrow H_2O$$

Sodium and chloride ions remain unchanged and are known as **spectator ions**.

C1.1.2 Mixtures

Filtration:

Insoluble solids

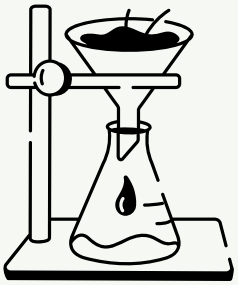
How it Works:

Used when a solid does not dissolve in a liquid.

- Example: Separating sand from water.

Method:

1. Place filter paper in a funnel over a beaker.
2. Pour the mixture through the funnel.
3. Liquid (filtrate) passes through, solid (residue) stays behind



Filtration does not create a new substance because no chemical bonds are broken or formed.

Crystallisation:

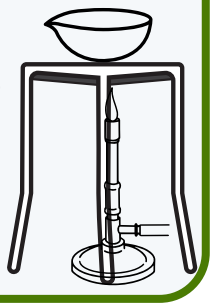
How it Works:

Used when a solid dissolves in a liquid and forms crystals upon evaporation.

- Example: Copper sulfate crystals from a solution.

Method:

1. Heat the solution to evaporate some of the solvent.
2. Allow the solution to cool slowly.
3. Crystals form as solubility decreases.
4. Filter out the crystals and dry them.



Use filter paper or a drying oven to dry crystals properly.

Mixtures are a combination of two or more substances that are not chemically bonded together.

Mixtures can consist of elements, compounds, or both, but they do not form new substances

The chemical properties of each substance in the mixture are unchanged.

Mixtures can be separated through physical processes.

Mixtures differ from pure substances, which consist of only one element or compound with identical particles that cannot be physically separated.

Simple Distillation

Liquid separation

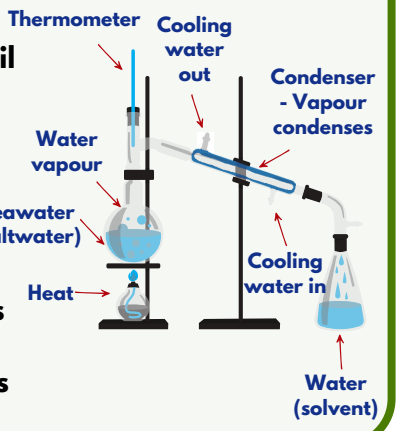
How it Works:

Used to separate a liquid from a dissolved solid.

Example: Separating water from seawater.

Method:

1. Heat the solution until the solvent evaporates.
2. The vapour is cooled in a condenser, turning back into liquid.
3. The solvent (liquid) is collected, and the solute (solid) remains behind.



Fractional Distillation

Liquid separation

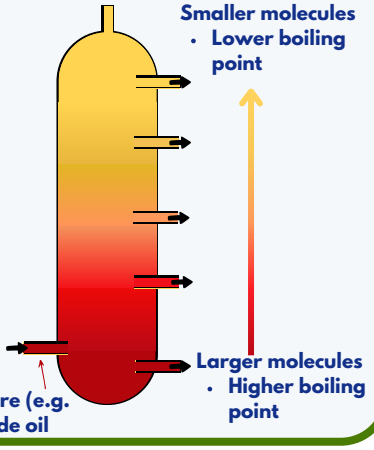
How it Works:

Used to separate two or more miscible liquids and works due to different boiling points.

Example: Crude oil

Method:

1. Heat the mixture; the liquid with the lowest boiling point evaporates first.
2. Vapour is cooled in a condenser and collected.
3. Continue heating to separate other components.



Chromatography

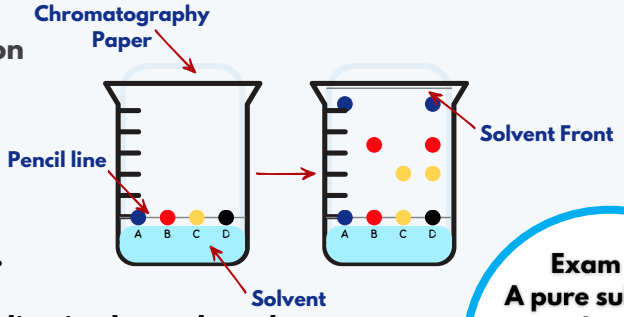
Soluble separation

How it Works:

Used to separate different dyes in ink based on solubility.

Method:

1. Draw a pencil line on chromatography paper.
2. Place spots of the samples on the line.
3. Dip the paper in a solvent, ensuring the pencil line is above the solvent.
4. The solvent carries the substances up the paper at different speeds.



Stationary phase: The paper.
Mobile phase: The solvent moving through the paper.

Exam Tip: Use a pencil for you start line - ink would affect results!

Exam Tip: A pure substance produces one spot, while a mixture produces multiple spots