C1 Atomic Structure

1. Atoms, elements and compounds

All substances are made of **atoms** that cannot be chemically broken down. It is the smallest part of an **element**.

Elements are made of only one type of atom. Each element has its own **symbol.**
e.g. Na is sodium.

Compounds contain more than one type of atom chemically joined.

Naming compounds-
Two elements =metal then non metal ending in - **ide**
e.g. Na_2S Sodium sulphide

Two or more including oxygen, the ending is - **ate**
e.g. Na_2SO_4 = sodium sulphate

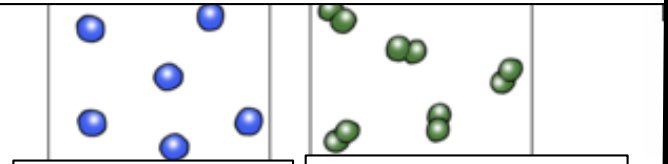
Compounds can be represented in symbols. There are two elements here: Magnesium and chlorine

$MgCl_2$

Magnesium chloride

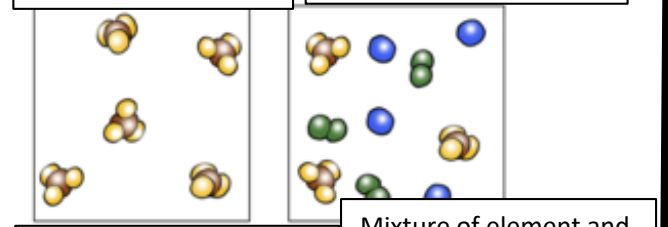
The numbers next to the symbols tells us that there are 3 atoms
1 x magnesium atom
2 x chlorine atoms

The small numbers tell you how many atoms there are of the element **before** the number.



Atoms of an element

molecules of an element



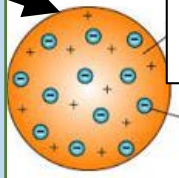
molecule of a compound

Mixture of element and a compound

2. Development of the Atomic Model

1. Dalton – believed that atoms could not be divided and are solid spheres.

2. The 'plum-pudding model' suggested that the atom was a ball of positive charge with negative electrons embedded in it. It was developed by J. J. Thomson who discovered the electron.

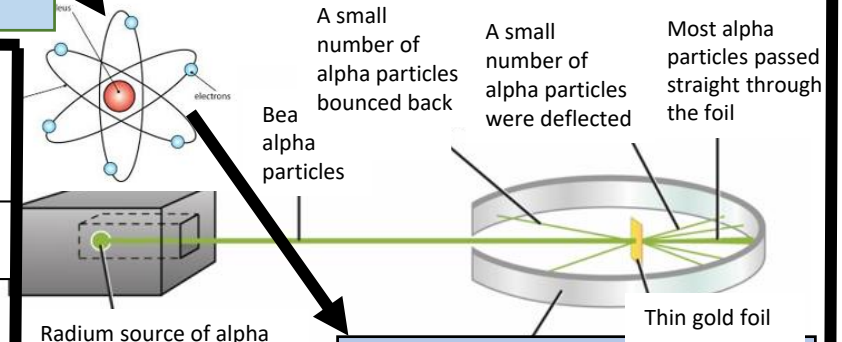


Spherical charge of positive charge

electron

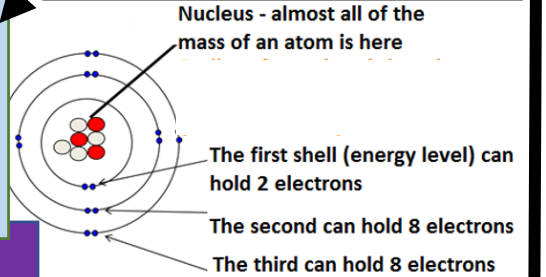
3. Rutherford-Marsden developed the Nuclear Model of the Atom

The results of Rutherford and Marsden's alpha scattering experiment led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged.

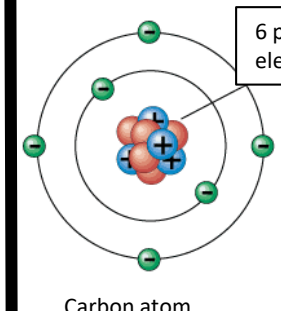


4. Chadwick discovered that there was a neutral particle found in the nucleus of an atom. These were added to the model.

5. Bohr – electrons in shells
Neils Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances in different shells that have different energy levels.



$1nm = 1x10^{-9}m$



3. Subatomic Particles

	Mass	Charge	Location
Proton	1	+	nucleus
Neutron	1	0	nucleus
Electron	Very small	-	shells

Mass number = Number of **protons** and **neutrons**

Atomic number = Number of protons

$^{7}_{3}Li$

Number of protons (+) = Number of electrons (-)

Number of neutrons = mass number – atomic number

$^{7}_{3}Li$

Protons = 3
Electrons = 3
Neutrons = 4

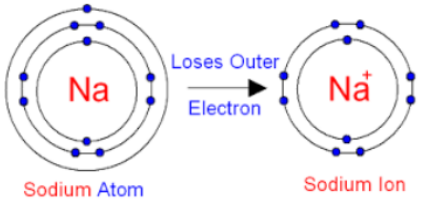
Isotopes — Different mass numbers

$^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$

Same atomic number

Isotopes have a **different number of neutrons** in the nucleus.

Atoms can lose or gain electrons to form ions

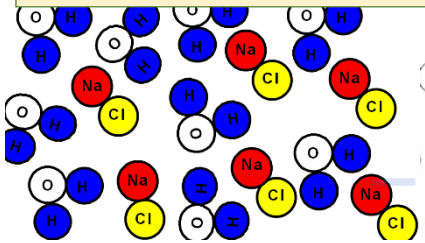


4. Separating mixtures

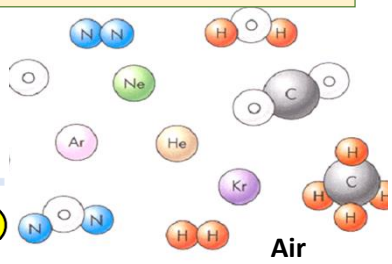
C1 Atomic Structure

A mixture consists of **two or more** elements or compounds **not** chemically combined together.
There are no chemical bonds holding the substances together so it means that they can be easily separated using physical methods called **separation techniques.**

Common examples of mixtures include crude oil, dyes, salt water and air.

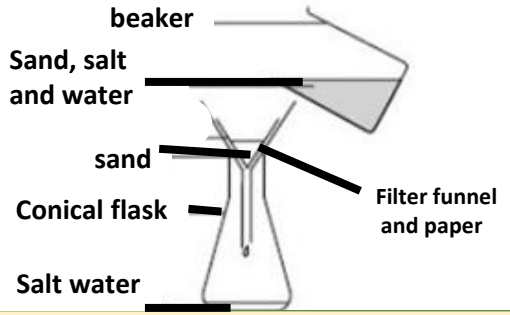


Salt water

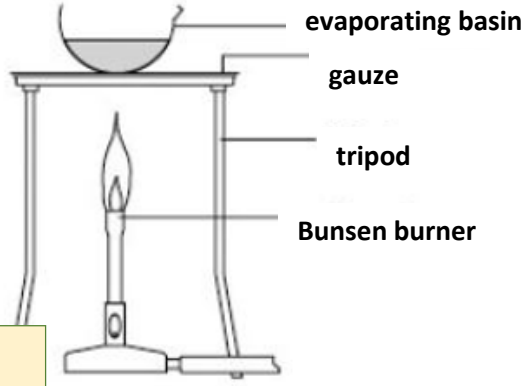


Air

Filtration
This method is used to separate insoluble solid from liquids.
The insoluble solid has large enough sized pieces to be come stuck in the filter paper, while the liquid e.g. water passes through the filter paper, into the flask/beaker.
This technique can be used to separate sand from salt water.

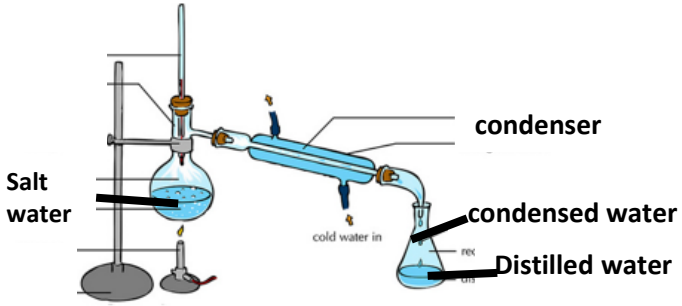


Evaporation and crystallisation
This method separates a soluble solute from its solvent by heating the resulting solution. Heat the solution and the solvent will evaporate. The solute is left behind as the water evaporates and slowly crystals are formed.
This technique can be used to separate soluble salts in solution.

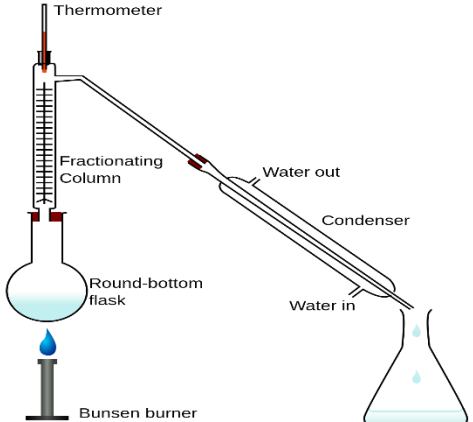


Simple distillation
The method is used to separate out a liquid and a soluble solid from a solution.

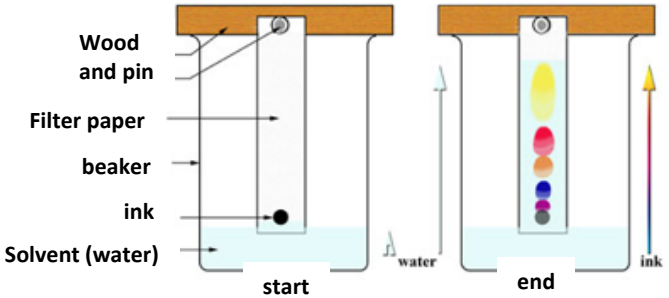
The solution is heated and the liquid evaporates.
The soluble solid if left in the round bottom flask.
The evaporated liquid (now a gas) enters the condenser, hits the cool surface and condenses back into a liquid. It forms droplets and drips into the beaker.
This method is used to separate salt water.



Fractional distillation
This method is used to separate several liquids mixed together e.g. crude oil.
If you place the mixture in a flask and heat it up, the different liquids will evaporate at different temperatures as they have different boiling points. Liquids with higher boiling points will evaporates last and liquids with the lowest boiling point will evaporate first and will go to the top of the fractionating column. As the column cools the different gases condense at different points (low boiling points at the top and high boiling points at the bottom), thus separating them.



Paper chromatography
Use to separate soluble solid compounds in a solution. A solvent is run up the filter paper and separates each dye compounds (as they move at different rates up the filter paper.
The end result is a pattern of spots called a chromatogram.
This technique can be used to separate different dyes in an ink.



C1 Periodic Table

5. History of the periodic table

Early periodic tables arranged in order of **atomic weight. Newlands proposed the law of octaves** as he noticed that every eighth elements had similar properties and so were grouped together.

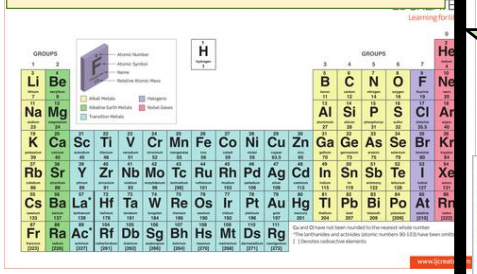
☹ Some elements were in the wrong groups so didn't follow the pattern because he assumed all elements had been discovered.

Mendeleev rearranged elements according to their properties and left gaps in to allow for new elements to be discovered. He predicted the atomic weights and properties of elements that had yet to be discovered

☺ The elements were discovered that filled the gaps and proved him right as his predictions were correct.

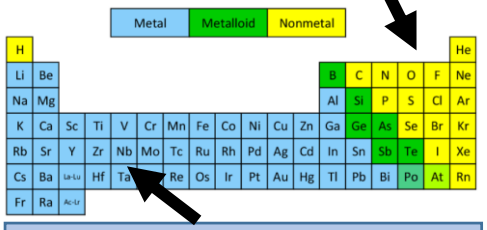
☺ **Isotopes were discovered** which explained why order based on weight didn't work.

Modern periodic table – order of **atomic (proton) number.**
Elements with similar properties in columns (**groups**).
Elements in same group have the same number of electrons in their outer shell and so have similar chemical properties.



6. Metals vs Non-metals

Non-metals: Many electrons in outer shell so form **negative ions**. Low melting and boiling points.

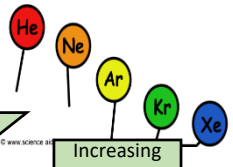


Metals: Few electrons in outer shell so form **positive ions**. Hard, high melting and boiling points.

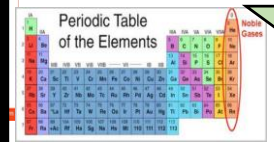
7. Group 0

Noble gases.
Unreactive (due to their full outer electron shell)

Increasing atomic mass as you go down the group.

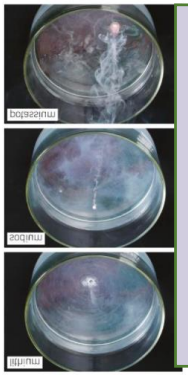


Increasing boiling point as you go down the group



8. Group 1

Alkali Metals
Very reactive (due to single electron in outer shell)

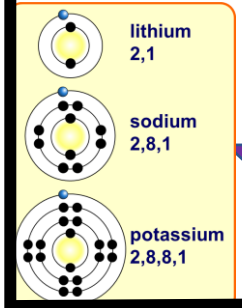


- **Properties:**
- React with oxygen to form **oxides**
- React with water to form a **hydroxide and hydrogen**
- React with chlorine to form **chlorides**
- **Are soft metals with a low density** (so these metals float on water)

sodium + oxygen → sodium oxide
$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$

sodium + water → sodium hydroxide + hydrogen
$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

sodium + chlorine → sodium chloride
$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

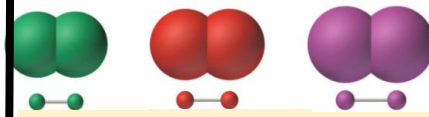


Alkali metals get MORE REACTIVE As you go down the group

9. Group 7

Halogens
Very reactive (due to having 7 electrons in their outer shell)

Properties:
- Are non- metals
- They exist as a diatomic molecules (two atoms joined together)

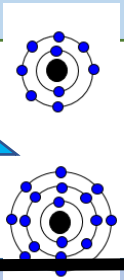


chlorine, Cl_2 | Bromine, Br_2 | Iodine, I_2

- The reactivity of the elements decreases going down the group.
- React with non-metals to form small molecules

A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.

Halogens get MORE reactive as you go up the group.



10. Transition metals

Are found between group 2 and 3 of the periodic table.

Properties:
- Are hard and strong metals
- Form coloured compounds
- Conduct electricity and heat (because they have delocalised electrons)
- Have a high melting and boiling point
- Are catalysts (speed up chemical reactions)