Atomic Structure

Atoms are very small, having a radius of about 0.1 nm (1 x 10^{-10} m). NANOMETRES! The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 x 10^{-14} m). **Almost all of the mass of an atom is in the nucleus.**

Atoms are the basic building blocks of all matter. They have sub atomic particles.

Sub atomic particle name	Position in atom	Relative charge	Relative mass
Proton (p)	nucleus	+	1
Neutron	nucleus	0	1
Electron (e)	shell	-	VERY small

Atomic Number = the number of protons in atom = number of electrons in atom
The atomic number defines the element.

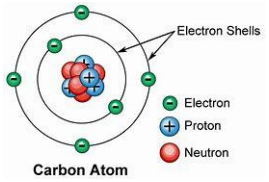
Mass Number: the **Σ** (protons + neutrons) in the nucleus. This is relative to the abundance of...

Isotopes: Atoms of the **same element** with different **numbers of neutrons**.

Electron Arrangement:
Electrons orbit the nucleus in **shells** or energy levels.

1st shell = 2 electrons
2nd shell = 8 electrons
3rd shell = 8 electrons

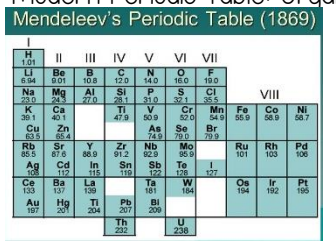
Eg. Carbon's **electronic structure**: 2,4
(2 e^- in 1st shell, 4 e^- in 2nd shell)



The electrons in an atom occupy the lowest available energy levels (innermost available shells)

History of the Periodic Table

Dmitri Mendeleev: Created the first Periodic Table, organizing elements by **atomic mass** but **leaving gaps for undiscovered elements**.
Modern Periodic Table: Organized by **atomic number**.



Elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic mass was not always correct.

The Periodic Table

Periods (Rows): Show the number of electron shells in the atoms of the elements.

Group 1 form 1+ ions
Group 2 form 2+ ions
Group 6 form 2- ions
Group 7 form 1- ions

Key: relative atomic mass / atomic symbol / name / atomic (proton) number

PERIODIC table because similar properties occur at regular intervals.

Group 1	Group 2											Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
1 H hydrogen 1																	4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86

Non-Metals:

Found on the right of the periodic table.
Poor conductors (insulators), brittle, and dull.
Tend to gain electrons to form negative ions.
OR share electrons in covalent bonding.

Group 0: Noble Gases

(Full outer shell, very unreactive INERT).

Group 1: Alkali Metals

Increasing reactivity ↓ Decreasing m.p + b.p

(1 electron in outer shell, highly reactive). As you **go down the group**, there are **more shells (shielding)**, so the **outer shell is further from the nucleus**, so the **force of attraction is weaker**, so the outer **electron is easily lost**.

Metals:

Good conductors of heat and electricity.
Malleable, ductile, and shiny.
Lose electrons to form positive ions.

Group 7: Halogens

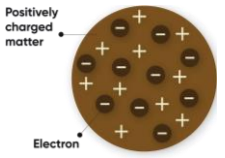
Decreasing reactivity ↓ Increasing m.p + b.p

DIATOMIC (2 atoms in each molecule)
More reactive will displace less reactive!
Kill microorganisms (do NOT clean).
(7 electrons in outer shell). As you **go down the group**, there are **more shells (shielding)**, so the **outer shell is further from the nucleus**, so the **force of attraction is weaker**, so the last **electron is NOT so easily gained**.

Elements **like having full shells (stable)** so their **ability to lose or gain electrons** is reflected in their **reactivity**

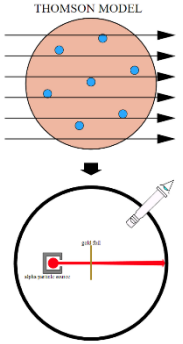
Development of the Atomic Model

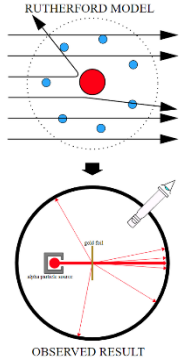
John Dalton (1803): Atoms as solid spheres.



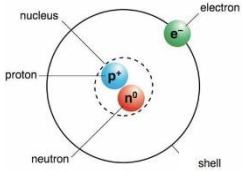
J.J. Thomson (1897): Discovery of the electron; "**Plum Pudding Model**" (negative electrons in a positively charged 'soup').

Ernest Rutherford (1909): Gold foil experiment; atoms mostly empty space with a **dense, positively** charged nucleus. (the positive alpha particles were **deflected and even bounced directly back**! This meant there was dense positive section - A nucleus!)





Niels Bohr (1913): Electrons orbit in shells/energy levels.



...**Later experiments** led to the idea that the positive charge of any **nucleus could be subdivided into a whole number of smaller particles**, each particle having the same amount of **positive charge**. The name **proton** was given to these particles.
The experimental work of **James Chadwick provided the evidence** to show the **existence of neutrons** within the nucleus. This was about 20 years after the nucleus became an accepted scientific idea.

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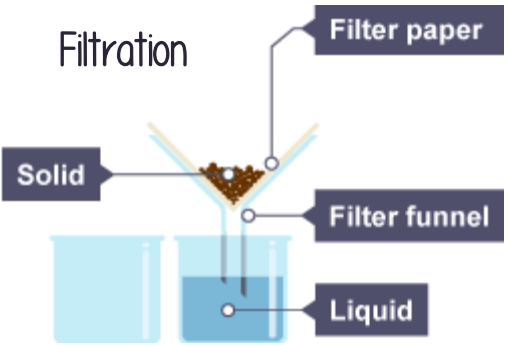
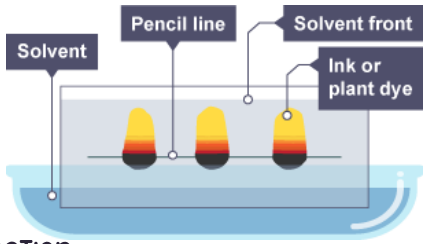
Key models, methods and equipment

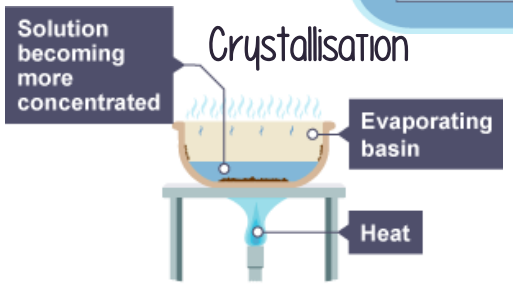
Filtration



Chromatography

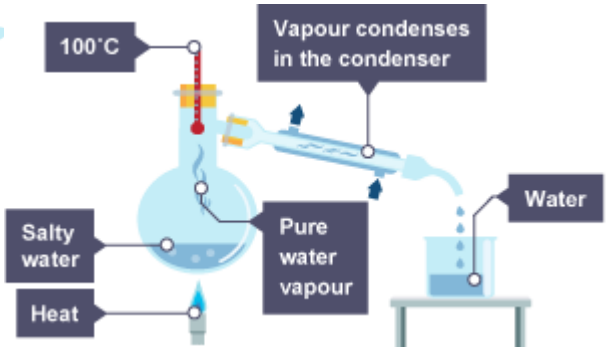


Crystallisation

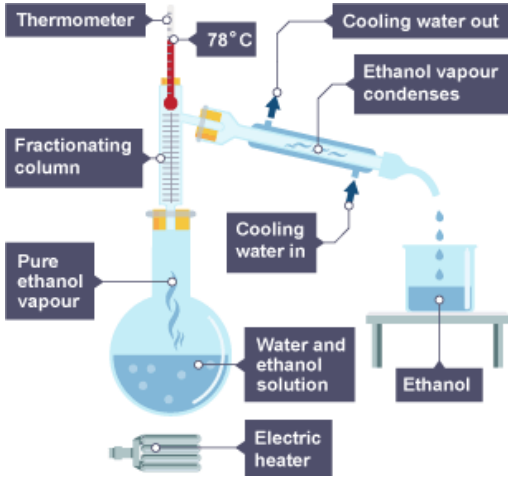


Separating mixtures:

Distillation - simple:



Distillation - fractional:



Key Terms to Remember:

- **Atom**: The smallest part of an element that can exist.
- **Element**: Made of only 1 type of atom
- **Compound**: Two or more types of element chemically joined.
- **Mixture**: Two or more elements or compounds not chemically joined. They can be separated.
- **Atomic Number**: Number of protons.
- **Mass Number**: Number of protons + neutrons.
- **Charge**: Subatomic particles CAN have a charge – these are **+ positive, - negative** or otherwise - **none – 0**.
- **Mass**: **Protons and neutrons** have the most mass, a mass of **1** each – the nucleus is dense. **Electrons** have a mass of **NEARLY 0**.
- **Isotope**: Atom with the same number of protons but different neutrons.
- **Group**: Vertical column in the Periodic Table, the number of electrons in the outer shell.
- **Period**: Horizontal row, same as the number of electron shells (in the electronic configuration).
- **Mixture**: A mixture consists of **two or more elements or compounds not chemically combined together**. The chemical properties of each substance in the mixture are unchanged.
- **Filtration**: Separation by **particle size**, using filter paper and a funnel. Small particles can pass through to the filtrate, large particles cannot.
- **Crystallisation**: Separation through heating a substance on a water bath and leaving it somewhere to warm for the **SOLVENT** molecules to **evaporate** – leaving crystals to form.
- **Distillation (simple and fractional)**: Separation of **PURE liquids by boiling point**. Liquids with lower boiling points can be collected first – the first distillate.
- **Chromatography**: Separation by **solubility**. More soluble compounds will travel furthest up the chromatogram.

Key Formulae:

- **Number of Neutrons** = Mass Number – Atomic Number

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