Atoms, Elements and Compounds

All substances are made up of **atoms. Atoms** are the smallest part of an element that can possibly exist.

Atoms have a radius of around 1 nm ($1x10^{-10}$ m)

Atoms of each element are represented by a chemical symbol:

O for oxygen

Ca for calcium

If the symbol only contains 1 letter, this letter must be capital.

If the symbol contains 2 letters, the first must be capital and the second must be lower case.

An **element** is a substance made up of only **one type of atom.**

Compounds contain two more elements chemically combined in fixed proportions:

$CaCl_2$ for calcium chloride

No small number after Ca means there is 1 calcium atom in calcium chloride.

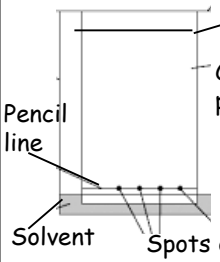
A small 2 after the Cl means there are 2 chlorine atoms in calcium chloride.

Compounds are not easily **separated.** They can only be separated by chemical reaction.
Compounds can be named using the following rules:

- The name of the metal goes first
- The name of the non-metal goes second
- Change the non-metal name ending from -ine to –ide

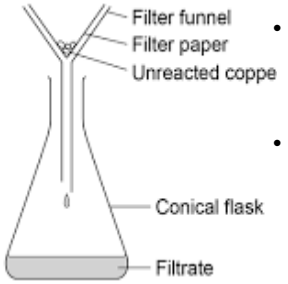
Word equation:
lithium + bromine → lithium bromide
Symbol equation:
Li + Br → LiBr

Chromatography – used to separate a mixture of substances dissolved in a solvent e.g. inks



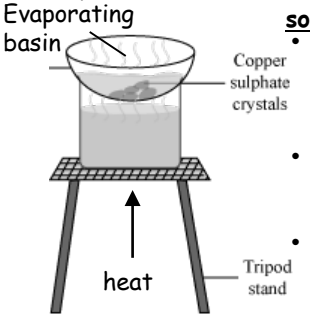
- Distance travelled by the spot depends on the **solubility** of the substance.
- Pencil line must be **above** solvent.
- Must be drawn in pencil as ink will dissolve and run up the paper.

Filtration – used to separate insoluble solids from a liquid or solution.



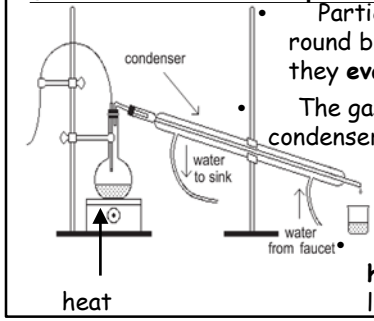
- Insoluble solid particles are too big to fit through holes in the filter paper.
- Soluble particles break up when they dissolve to they are small enough to pass through filter paper.

Crystallisation – used to obtain crystals from a solution



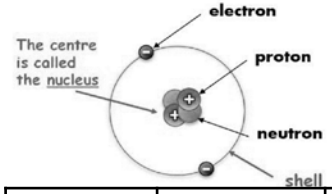
- **Evaporating** water from a solution on a water bath is gentler than heating directly.
- You should stop heating at the point of **crystallisation** – when crystals appear.
- The excess water can then be left on a window sill to evaporate.

Distillation – used to separate a mixture of liquids



- Particles are heated in the round bottomed flask until they **evaporate**.
- The gases travel down the condenser where they **condense**.
- The pure liquid is then collected.
- The liquid with the **higher boiling point** is left behind.

Structure of the atom:



*In an atom the number of **protons** is **equal** to the number of **electrons**.*

particle	mass	charge
electron	0.005	-1
proton	1	+1
neutron	1	0

Atoms have no overall charge

$^{12}_{6}C$

This is the **mass number**. It tells you how many **protons + neutrons** in the atom.
This is the chemical symbol.
This is the **atomic number**. It is the number of **protons** in the atom.

Electronic structure

Electrons are arranged around the nucleus in shells.
The shell closest to the nucleus (1st shell) is filled first and can hold up to 2 electrons.
The 2nd shell can hold up to 8 electrons.
The 3rd shell can hold up to 8 electrons.

e.g. Oxygen has 8 electrons in total. Its electron structure is 2,6.

Ions and isotopes

Atoms can lose or gain electrons to become charged.

Charged atoms are called **ions.**

They have charges because there are a different number of protons to electrons.

E.g. the Li^+ ion has 3 protons and 2 electrons.

Atoms with the same number of protons but different number of neutrons are called **isotopes.**

Isotopes are the same element but with different **masses.**

Periodic Table

The **periodic table** is a list of elements arranged according to their **atomic number**.

Elements in the same Group have the same number of outer shell electrons (e.g. group 1 all have 1 electron in their outer shell) and similar **properties** (e.g. the noble gases are all very unreactive gases). The number of **electrons** in an elements out shell determines its **chemical properties**.

Metals and non-metals

- **Metals** are found on the **left** side of the periodic table and **non-metals** are found on the **right**.
- **Metals** form **positive** ions (Li^+)
- **Non-metals** form **negative** ions (O^{2-})

History of the atom

Dalton: Indivisible spheres.
Thomson: Plum pudding- positive ball with embedded electrons.
Rutherford: Nuclear model. Experiment with gold foil shows most of an atom empty (helium nuclei pass through) with a positive nucleus (helium nuclei deflected).
Bohr: Planetary model- electrons in fixed orbits around the nucleus.
Protons discovered.
Chadwick: Discovered the neutron.

General physical properties	
Metals	**Non-Metals**
Lustrous (shiny)	Dull
Good conductor	Poor conductor
High density	Low density
Strong	Brittle
Malleable and ductile	
High melting point	Low melting point

Each Column is a **group**

- The group number tells you how many electrons are in the elements out shell.

Each row is a **period**

- The period number tells you how many shells an element has

1	2											3	4	5	6	7	0
																	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
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

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

Metals

Non- Metals

Elements with atomic numbers 112 – 116 have been reported but not fully authenticated

History of the Periodic Table

Before the discovery of subatomic particles (electrons, neutrons and protons) periodic tables were arranged based on atomic weight.

Mendeleev and Newlands both suggested different periodic tables.

Newlands	Mendeleev
Ordered elements by atomic weight	
Included only the elements known at the time	Left gaps for undiscovered elements
Arranged by atomic weight only	Arranged by atomic weight and adjusted for chemical properties
Every 8th element had similar properties (Newlands' Law Of Octaves)	Elements in groups had similar properties
Criticised for grouping elements with very different properties.	Not believed until the gaps he left for new elements proved to be correct.

Following the discovery of **protons** our modern periodic table is now arranged by **atomic number**.

The discovery of **isotopes** made it possible to explain why ordering elements by **atomic weight** was not always correct… as Mendeleev thought (look at Ar and K).