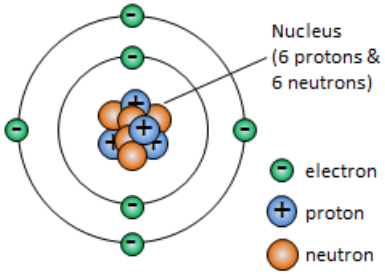
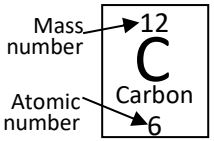
Atoms, Elements and Compounds

Atomic Structure



	Charge	Mass
Proton	1+	1
Neutron	0	1
Electron	1-	almost 0



Radius of an atom = 0.1nm (1×10^{-10}m)

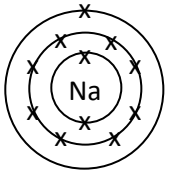
Radius of nucleus = 1×10^{-14}m (1/10,000 of an atom)

The **atomic number** is the number of **protons**.

The number of **electrons** = number of protons.

The number of **neutrons** = mass number – atomic number.

Electron Configuration



2,8,1

Atoms can have a **maximum** of **2** electrons in the first shell, **8** in the second and **8** in the third.

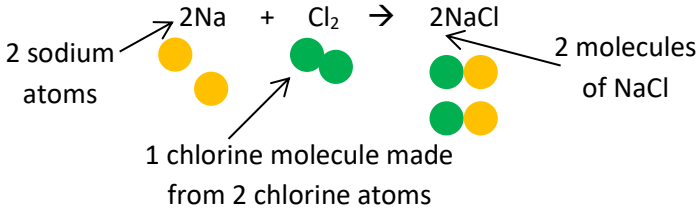
You must **fill each shell** before moving onto the next one.

Element – a group of the same type of atoms (ie. have the same atomic mass)

Compound – two or more different elements chemically joined.

Mixture – different types of molecules that are not chemically joined.

Chemical Equations



Isotopes

Different forms of the same element.

Have the **same number of protons** but **different number of neutrons**.

Have the same atomic number but different mass numbers

$$\text{Relative atomic mass} = \frac{\text{sum of (isotope abundance x isotope mass number)}}{\text{sum of abundances of all isotopes}}$$

Compounds

Elements are held together by **chemical bonds.**

Bonds are made by taking, giving or sharing electrons.

Properties usually **different** from the original elements. Difficult to separate the original elements.

Separation Techniques

REQUIRED PRACTICAL
SEE PRACTICAL SHEET FOR DETAIL

Chromatography – separates out different colours in ink. An Rf value can be calculated to compare inks.

Filtration – Separates a solid from a liquid.

Crystallisation – Separates out a solid that has dissolved in a liquid. The liquid evaporates leaving behind the solid.

Distillation – Separates out liquids that have different boiling points.

Balancing Equations

The same number of atoms of each element are needed on each side of an equation:

$H_2 + O_2 \rightarrow H_2O$ — 2 hydrogens on each side ✓; 2 oxygens on left, one on right ✗

$H_2 + O_2 \rightarrow 2H_2O$ — 2 hydrogens on left, four on right ✗; 2 oxygens on each side ✓

Multiply by the big number

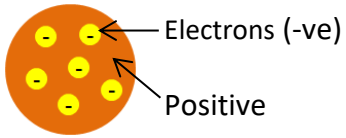
$2H_2 + O_2 \rightarrow 2H_2O$ — 4 hydrogens on each side ✓; 2 oxygens on each side ✓

History of the Atom and Periodic Table

History of the Atom

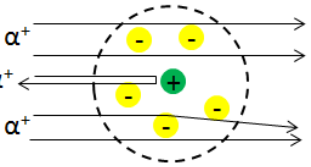
John Dalton
Atoms are solid spheres. Different spheres are made from different elements.

JJ Thomson
Measured charge and mass, showing atoms must contain electrons (-ve charges). Developed the **plum pudding model**.



Ernest Rutherford
He carried out **alpha particle scattering experiments**. If the plum pudding model was correct then the positive alpha particles should pass through or deflect slightly.

A few particles are deflected backwards. This must mean there is a **positive nucleus**.



Most particles pass through, a few are deflected.

Niels Bohr
Realised that if the electrons were in a cloud around a nucleus the atom would **collapse**. Suggested that the **electrons** orbit the nucleus in **fixed shells**. Experiments supported this.

Further experiments have shown the nucleus is made up of **protons and neutrons**.
James **Chadwick** carried out experiments to prove the existence of neutrons.

Development of the Periodic Table

Scientists used to not know about atomic structure, protons, neutrons and electrons. They arranged the atoms in **order of atomic mass**. There were lots of elements that had not been discovered so many elements were placed in the **wrong group**.

Dmitri Mendeleev improved the design of the periodic table:

- **Left gaps** for undiscovered elements. When they were discovered they fitted the pattern
- Changed the order of some elements so that they **matched the properties** of the rest of the group (eg. Te and I are not in order of atomic mass but they fit the properties of the rest of their group.

Group 1 Elements

React with **water** to form an **alkaline solution**: Lithium + water → lithium hydroxide + hydrogen
React vigorously when heated with **chlorine gas**: Sodium + chlorine → sodium chloride
React with **oxygen** to form **oxides**: Lithium forms lithium oxide (Li_2O), sodium forms sodium oxide and sodium peroxide (Na_2O_2) and potassium forms potassium peroxide and potassium superoxide (KO_3).
More reactive down the group – the outer electron is further from the nucleus so more easily lost.
Lower melting and boiling points down the group.

Group 7 Elements

Less reactive down the group – the outer shell is further from the nucleus so harder to gain an electron.
Higher melting and boiling points down the group. Exist as pairs of atoms – eg. Cl_2
A more reactive halogen will **displace** a less reactive halogen: $Cl_2 + KBr \rightarrow 2KCl + Br_2$

F = yellow gas
Cl = dense green gas
Br = red-brown volatile liquid
I = dark grey solid

Group 0 Elements

Full outer shells so are unreactive (inert).
Boiling point increases down the group - atoms have more electrons so stronger intermolecular forces form between molecules. Are colourless and non-flammable.

Transition Metals

Are typical metals (strong, dense, shiny, good conductors).
Have more than one ion (eg. CU^+ and CU^{2+}) and form coloured compounds.