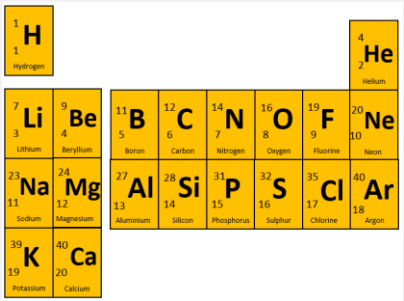
Atomic Structure

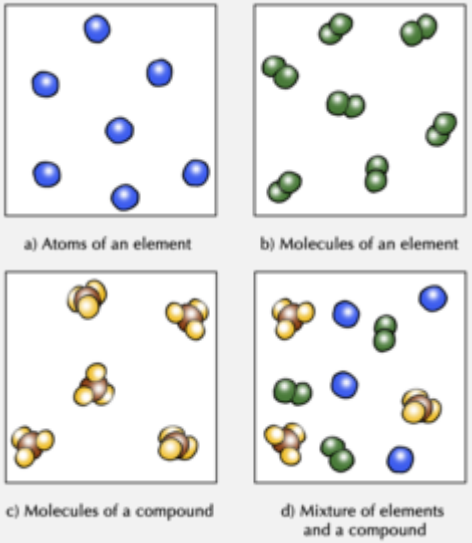
All the elements are listed in the **periodic table**.



Elements are made up of one type of atoms.

Compounds are formed If two or more different atoms bond together.

Mixtures are not chemically combined.



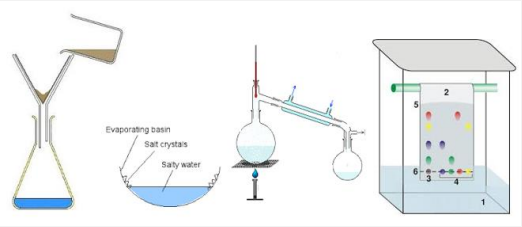
Compounds form when chemical reactions happen, for example:

Magnesium + Oxygen → Magnesium Oxide

The balanced symbol equation would be:

$$2Mg + O_2 \rightarrow MgO$$

Because compounds form chemical bonds they are difficult to separate however mixtures can be easily separated by **physical processes** – they do not require a chemical reaction.

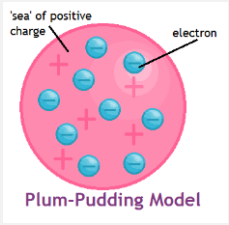


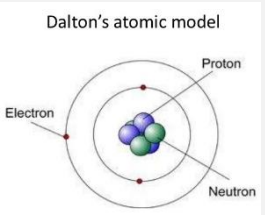
Filtration, crystallisation, distillation, chromatography (link here to paper 2)

We use models in Science to help us to explain what is going on. These models change over time as new technologies lead to new information.

Atomic theory has developed over time:

- 400BC – **Democritus** described materials as being made of small particles called 'atoms'
- 1803AD – **Dalton** said all matter is made of atoms and there are different types
- 1897AD – **J.J. Thomson** discovered the **electron**. Proposed the 'Plum Pudding' model where negative electrons were embedded in a ball of positive charge
- 1911AD – **Rutherford** suggested the atom has a positively charged nucleus and much of the atom was empty space
- 1913AD – **Neils Bohr** explained that electrons orbited the nucleus at specific distances.
- 1932AD – **James Chadwick** discovered the **neutron**





You need to be familiar with the plum pudding model and the model we use today.

Today we know that all atoms are made up of protons, neutrons and electrons (subatomic particles).

The structure of the atom		
	Relative Charge	Relative Mass
Electron	-1	0.0005
Proton	+1	1
Neutron	0	1

We can us the periodic table to find out how many of each of these subatomic particles an atom of any element has. The small number at the bottom of the elements square is the proton number, this tells us how many protons the atom has. It is the same as the number of electrons. The large number at the top of the elements square is the atomic mass, if we subtract the small number from the big number we get the number of neutrons in the atom.

C_{6}^{12}

Protons = 6
Electrons = 6
Neutrons = 12-6 = 6

Isotopes of an atom have the same number of protons and electrons, but a different number of neutrons

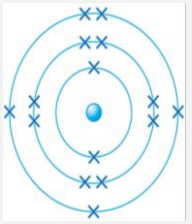
The **relative atomic mass** (A_r) is the mass of the different isotopes of an element.

$$A_r = \frac{\text{(Mass x \% of isotope 1)+ (Mass x \% of isotope 2)}}{100}$$

Electronic Structure

Electrons are arranged in shells orbiting the nucleus of the atom. These shells fill up from the inside out. The maximum number of electrons that each shell can hold is:

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

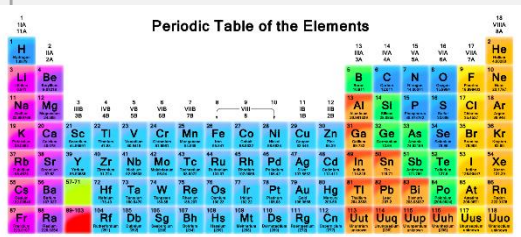


The electronic structure can be numbered. Eg. 2,8,2 = Mg

The History of the Periodic Table

The **periodic table** is arranged by the atomic (proton) number.

- The **groups go down** the periodic table. Elements in the same group have the same number of electrons in their outer shell, but a different number of shells.
- The **periods go across** the periodic table. Elements in the same period have the same number of shells, but a different number of electrons in their outer shell.



As with the model of the atom, the periodic table has developed over time. Changes have been made as more elements were discovered. The most important development in the history of the periodic table happened in1869AD when **Dmitri Mendeleev** ordered the known elements by atomic weights. He also put elements into groups if they had similar properties and reactivity's. His periodic table was better than all the previous versions because he left gaps for elements which hadn't been discovered yet. When new elements were discovered scientists found that they fit into these gaps.

Metals are found to the left of the periodic table. **Non-metals** are found to the right

Physical properties:

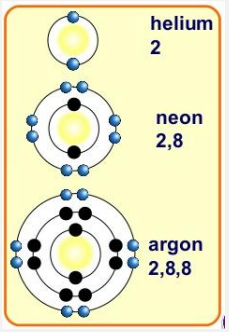
Metals	Non-metals
lustrous	dull
hard (with the exception of mercury which is a liquid at room temperature)	soft, brittle, liquids or gas (for most non-metals at room temperature)
high density	low density
high **tensile strength**	low or no tensile strength or gas
high melting point and boiling point	low melting point and boiling point
good conductors of heat	poor or no **thermal conductivity**
good **electrical conductivity**	poor or non conductors of electricity (with the exception of carbon)

Trends in the Periodic Table

Reactions happen between elements in the periodic table because all atoms want to gain a full outer shell. All of the trends that we see in the periodic table occur because the number of outer electrons is the same down a group and increases across a period.

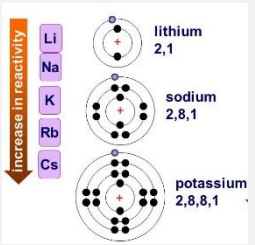
Group 0 (or group 8, Noble Gases):

- All of these elements are gases.
- They all have 8 electrons in their outer shell so…
- They are all unreactive
- The boiling points increase down the group because the atoms get bigger.



Group 1 (alkali metals):

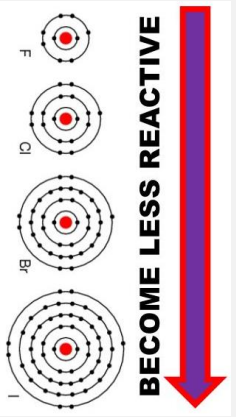
- These elements are all solid metals.
- All of these elements have 1 electron in their outer shell.
- All react vigorously with water to make hydrogen and a metal hydroxide **$2Na + 2H_2O \rightarrow 2NaOH + H_2$**
- All burn in oxygen to form oxides with a +1 charge.
- Elements gain a full outer shell by losing one.
- The reactivity of the elements increase down the group as the outer electron gets further away from the nucleus and so is easier to loose.



Potassium reacting with water

Group 7 (halogens)

- These elements are all non-metals
- All exist as pairs of atoms (F_2, Cl_2, Br_2 and I_2)
- These elements get a full outer shell by gaining one electron.



- The reactivity of the elements decreases down the group because the outer shell gets further away from the nucleus and so it is harder to attract an electron from another element.
- The atoms change from gases at the top of the group (F, Cl), to liquids (Br) and then solids (I) because the atoms get bigger as you go down the group.

Transition metals are found between groups 2 and 3.

- They have typical metal properties
- They are often used as **catalysts**
  - Iron is used in the Haber process to make ammonia
  - Nickel is used in the manufacture of margarine
- Compounds are often coloured

Triple Only

Properties of Transition Metals

All of the elements in the transition metals block are metallic elements. This means that they have similar properties to group 1 metals.

Transition metal ions can often have a variable charge number, unlike main group metal atoms which can only make one ion.