## Atomic Structure and the Periodic Table - Foundation and Higher (Separate)

#### **Atoms**

Contained in the nucleus are the protons and neutrons. Moving around the nucleus are the **electron** shells. They are negatively charged.

Particle	Relative Mass	Charge			
proton	1	+1			
neutron	1	0			
electron	Very small	-1			



Overall, atoms have no charge; they have the same number of protons as electrons. An ion is a charged particle - it does not have an equal number of protons to electrons.

#### Atomic Number and Mass Number



#### **Equations and Maths**

To calculate the relative atomic mass, use the following equation:

relative atomic mass  $(A_r)$  =

sum of (isotope abundance × isotope mass number) sum of abundances of all isotopes

#### **Balancing Symbol Equations**

There must be the same number of atoms on both sides of the equation:

$$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$$

 $C_{1} = 1$ 

0 = 4

H = 4

# heaker \_\_ ink spot.

Chromatography - to

separate out mixtures.

piece of wood

Evaporation - to separate a soluble salt from a solution: a quick way of separating out the salt. Filtration - to separate solids from liquids.

Mixtures, Chromatography and Separation

Mixtures – in a mixture there are no chemical

bonds, so the elements are easy to separate. Examples of mixtures are air and salt water.



Crystallisation - to separate a soluble salt from a solution: a slower method of separating out salt.





#### Separating out salt from rock salt:

- 1. Grind the mixture of rock salt.
- Add water and stir.
- Filter the mixture, leaving the sand in the filter paper
- 4. Evaporate the water from the salt, leaving the crystals.

#### **Elements**

Elements are made of atoms with the same atomic number. Atoms can be represented as symbols.

$$7n = 7inc$$

<b>Isotopes</b> – an isotope is an element
with the same number of protons
but a different number of neutrons.
They have the same atomic number,
but different mass number.

Isotope	Protons	Electrons	Neutrons			
<sup>1</sup> <sub>1</sub> H	1	1	1 - 1 = 0			
<sup>2</sup> <sub>1</sub> <b>H</b>	1	1	2 - 1 = 1			
<sup>3</sup> H	1	1	3 - 1 = 2			

**Compounds** – a compound is when two or more elements are chemically joined. Examples of compounds are carbon dioxide and magnesium oxide. Some examples of formulas are CO<sub>2</sub>, NaCl, HCl, H<sub>2</sub>O, Na<sub>2</sub>SO<sub>4</sub>. They are held together by chemical bonds and are difficult to separate.

#### **Chemical Equations**

A chemical reaction can be shown by using a word equation.

e.g. magnesium + oxygen → magnesium oxide On the left-hand side are the reactants, and the right-hand side are the products.

They can also be shown by a **symbol** equation.

e.g. 
$$2Mg + O_2 \rightarrow 2MgO$$

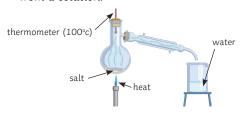
Equations need to be **balanced**, so the same number of atoms are on each side. To do this. numbers are put in front of the compounds.

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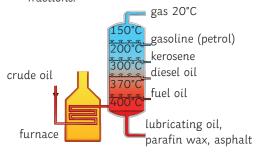
#### Distillation

To separate out mixtures of liquids.

1. **Simple distillation** – separating a liquid from a solution.



2. Fractional distillation – separating out a mixture of liquids. Fractional distillation can be used to separate out crude oil into fractions.



#### Metals and Non-metals

They are found at the **left** part of the periodic table. Non-metals are at the **right** of the table.

#### Metals

Are strong, malleable, good conductors of electricity and heat. They bond metallically.

#### Non-Metals

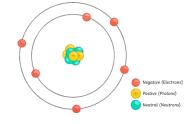
Are dull, brittle, and not always solids at room temperature.

#### History of the Atom

Scientist	Time	Discovery					
John Dalton	start of 19 <sup>th</sup> century	Atoms were first described as solid spheres.					
JJ Thomson	1897	Plum pudding model – the atom is a ball of charge with electrons scattered.					
Ernest Rutherford	1909	Alpha scattering experiment – mass concentrated at the centre; the nucleus is charged. Most of the mass is in the nucleus. Most atoms are empty space.					
Niels Bohr	around 1911	Electrons are in shells orbiting the nucleus.					
James Chadwick	around 1940	Discovered that there are neutrons in the nucleus.					

#### **Electronic Structure**

Electrons are found in shells. A maximum of two in the most inner shell, then eight in the 2<sup>nd</sup> and 3<sup>rd</sup> shell. The inner shell is filled first, then the 2<sup>nd</sup> then the 3<sup>rd</sup> shell.



## Group 7 Elements and Noble Gases

#### Halogens

The halogens are **non-metals**: fluorine, chlorine, bromine, iodine. As you go down the group they become less reactive. It is harder to gain an extra electron because its outer shell is further away from the nucleus. The melting and boiling points also become higher.

#### Noble Gases

The noble gases (group 0 elements) include: helium, neon and argon. They are un-reactive as they have full outer shells, which makes them very stable. They are all colourless gases at room temperature.

The boiling points all increase as they go down the group – they have greater intermolecular forces because of the increase in the number of electrons.

## Development of the Periodic Table

In the early 1800s, elements were arranged by atomic mass. The periodic table was not complete because some of the elements had not been found. Some elements were put in the wrong group.

Dimitri Mendeleev (1869) left gaps in the periodic table. He put them in order of **atomic mass**. The gaps show that he believed there was some undiscovered elements. He was right! Once found, they fitted in the pattern.

#### The Modern Periodic Table

Elements are in order of atomic mass/proton number. It shows where the metals and nonmetals are. Metals are on the left and non-metals on the right. The columns show the groups. The group number shows the number of electrons in the outer shell. The rows are periods – each period shows another full shell of electrons.

The periodic table can be used to predict the reactivity of elements.



#### Alkali Metals

The alkali metals (group 1 elements) are soft, very reactive metals. They all have one electron in their outer shell, making them very reactive. They are low density. As you go down the group, they become more reactive. They get bigger and it is easier to lose an electron that is further away from the nucleus.

They form ionic compounds with non-metals.

They react with water and produce hydrogen.

E.g.

lithium + water → lithium hydroxide + hydrogen

 $2Li + 2H_2O \rightarrow 2LiOH + H_2$ 

They react with chlorine and produce a metal salt.

E.g.

lithium + chlorine → lithium chloride

2Li + Cl₂ → 2LiCl

They react with oxygen to form metal oxides





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#### The Transition Metals

The transition metals are a block of elements found between groups 2 and 3 in the middle of the periodic table. Examples of transition metals include copper, nickel and iron with many more included. They have all the properties you would expect metals to have, such as being strong, shiny and conductors of electricity and heat. Transition metals make very good catalysts; this means they speed up a reaction without being used up themselves. Iron is used as a catalyst during the Haber process when making ammonia.

Transition metals can form more than one ion. For example, copper can take the form of  $Cu^+$ ,  $Cu^{2+}$  and iron can be  $Fe^{2+}$  and  $Fe^{3+}$ . The ions are often coloured and the compounds they are found in are also coloured.

																	He helium
<b>Li</b> lithium	Be beryllium	H hydrogen						B		N nitrogen			Ne neon				
Na sodium	Mg nagnesiun									Al		P			Ar argon		
<b>K</b> potassiu	Ca calcium	Sc scandium	Ti titanium	<b>V</b> vanadium	<b>Cr</b>	Mn manganese	Fe	Co	<b>Ni</b> nickel	Cu	Zn zinc	<b>Ga</b> gallium		As arsenic		Br bromine	Kr krypton
Rb	Sr strontium	Y yttrium	<b>Zr</b> zirconium	Nb niobium	Mo molybdenum	Tc technetium	Ru ruthenium	Rh	Pd palladium	Ag silver	Cd cadmium	In indium	Sn	Sb antimony			Xe
Cs caesium	Ba barium	La .anthanum	Hf hafnium	Ta tantalum	<b>W</b> tungsten	Re rhenium	Os osmium	lr iridium	Pt platinum	Au	Hg mercury		Pb lead	Bi bismuth	Po polonium	At astatine	Rn radon
Fr franciur	Ra radium	Ac actinium	Rf rutherfordium	Db dubnium	<b>Sg</b> seaborgium	Bh bohrium	Hs hassium	Mt meitnerium	<b>Ds</b> darmstadtium	Rg roentgenium							



