

# Metals and non-metals

## Key words

word	definition
Metals	Shiny, good conductors of electricity and heat, malleable and ductile, and usually solid at room temperature.
Non-metals	Dull, poor conductors of electricity and heat, brittle and usually solid or gaseous at room temperature.
Displacement	Reaction where a more reactive metal takes the place of a less reactive metal in a compound.
Oxidation	Reaction in which a substance combines with oxygen.
Reactivity	The tendency of a substance to undergo a chemical reaction.

## Key diagram – The reactivity series

The **reactivity series** is the list of metals placed in order of their reactivity.

One way to remember this order is to learn this silly sentence:

increasing reactivity

potassium  
sodium  
calcium  
magnesium  
aluminium  
zinc  
iron  
lead  
copper  
silver  
gold

Please  
send  
Charlie's  
monkeys  
and  
zebras  
in  
lead  
cages  
securely  
guarded!

## Key knowledge

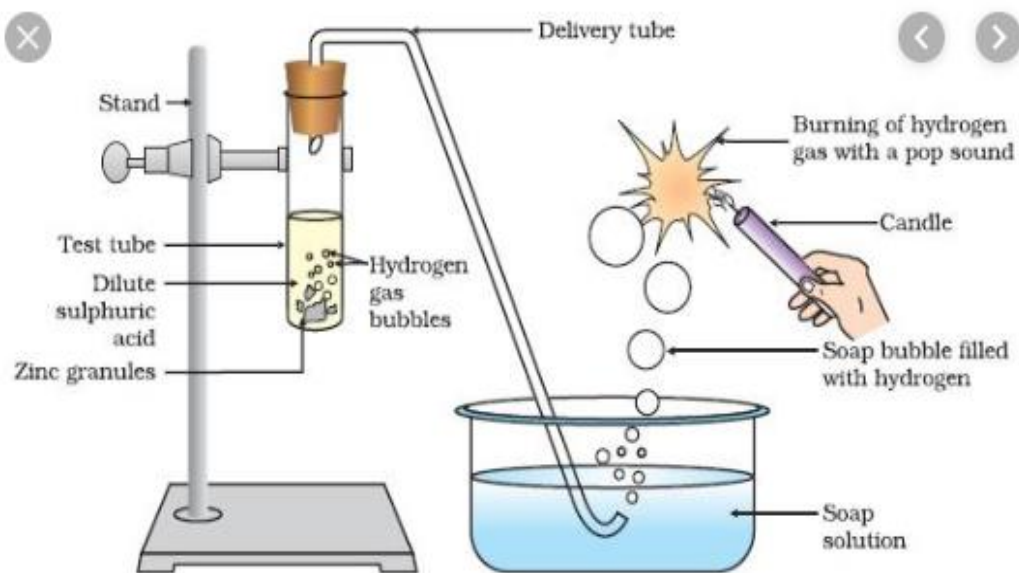
facts

Iron, nickel and cobalt are magnetic elements.

Mercury is a metal that is liquid at room temperature.

Bromine is a non-metal that is liquid at room temperature.

## Required practical – Acid and metal reactions



## Key process- Displacement reactions

The reactivity series can be used to predict if a metal will react with a metal compound. If the metal is **more reactive** than the metal in the compound, it pushes out, or **displaces**, the less reactive metal from its compound.



If the metal is **less reactive** than the metal in the compound, it will not compete and so there is no reaction.

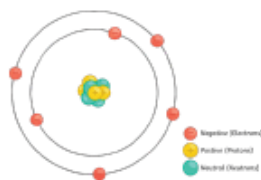


# Atomic Structure and the Periodic Table – Foundation and Higher

## 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 ( $A_r$ ) =

$$\frac{\text{sum of (isotope abundance} \times \text{isotope mass number)}}{\text{sum of abundances of all isotopes}}$$

## Balancing Symbol Equations

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



C - 1

O - 4

H - 4

## 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.

**Chromatography** – to separate out mixtures.



**Filtration** – to separate solids from liquids.



**Evaporation** – to separate a soluble salt from a solution; a quick way of separating out the salt.



**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.
2. Add water and stir.
3. 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.

N - nitrogen    F - fluorine    Zn - zinc    Ca - calcium

**Isotopes** – 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
${}^1_1\text{H}$	1	1	1 - 1 = 0
${}^2_1\text{H}$	1	1	2 - 1 = 1
${}^3_1\text{H}$	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  $\text{CO}_2$ ,  $\text{NaCl}$ ,  $\text{HCl}$ ,  $\text{H}_2\text{O}$ ,  $\text{Na}_2\text{SO}_4$ . 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  $\rightarrow$  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.  $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

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.

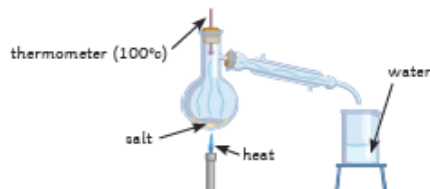


# Atomic Structure and the Periodic Table – Foundation and Higher

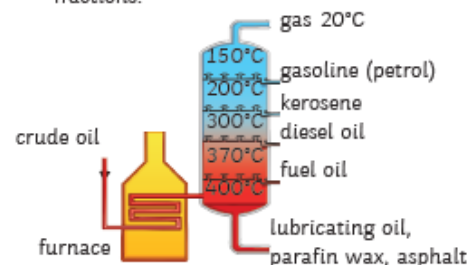
## Distillation

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 metallicly.

### Non-Metals

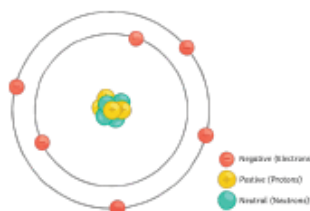
Are dull, brittle, and not always solids at room temperature.

## 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 non-metals 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.

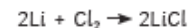
lithium + water → lithium hydroxide + hydrogen



They react with chlorine and produce a metal salt.

E.g.

lithium + chlorine → lithium chloride



They react with oxygen to form metal oxides.