1.1 The nature of substances

Elements:

Elements are substances that cannot be broken down into simpler substances by chemical means. They are the basic building blocks of all substances. Elements are made up of only one type of atom.

Compounds:

Compounds are substances made of two or more different types of atom that are chemically joined. They have completely different properties to the elements from which they are made.

Diagrams of molecules:

A molecule can be represented in a diagram by using a key. Here is an example of a key:

Methane, CH4

In a methane molecule, the four hydrogen atoms surround a central carbon atom, rather than all being joined together in a row.

Ammonia, NH_3

In ammonia, the three hydrogen atoms surround a central nitrogen atom.

Hydrogen, H_2

Hydrogen gas is made of molecules where two hydrogen atoms are joined together.

Positive Ions		Negative Ions	
Name	**Formula**	**Name**	**Formula**
Aluminium	Al^{3+}	Bromide	Br^-
Ammonium	NH_4^+	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^-
Calcium	Ca^{2+}	Fluoride	F^-
Copper(II)	Cu^{2+}	Hydroxide	OH^-
Hydrogen	H^+	Iodide	I^-
Iron(II)	Fe^{2+}	Nitrate	NO_3^-
Iron(III)	Fe^{3+}	Oxide	O^{2-}
Lithium	Li^+	Sulfate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^+		
Silver	Ag^+		
Sodium	Na^+		
Zinc	Zn^{2+}		

Formulae of ionic compounds:

Many compounds contain ions. Ions are particles with a charge. Metal ions carry a positive charge and non-metal ions carry a negative charge. In any compound, the positive and negative charges are balanced to create a neutral compound.

e.g. lithium chloride

Li^+ Cl^-

LiCl

magnesium oxide

Mg^{2+} O^{2-}

MgO

calcium bromide

Ca^{2+} Br^-

$CaBr_2$

calcium hydroxide

Ca2+ OH-

Ca(OH)2

A_r and M_r:

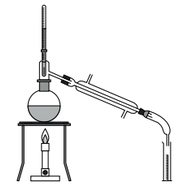
The Ar values of elements are given in the Periodic Table. We can use these to calculate the M_r values of compounds.

e.g. $A_r(C) = 12$, $A_r(H) = 1$, $A_r(O) = 16$, $A_r(Ca) = 40$

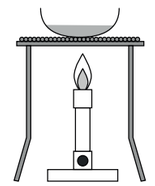
Chemical formula	Calculation	M_r value
CO_2	12 + (16 x 2)	44
CH_4	12 + (1 x 4)	16
$Ca(OH)_2$	40 + (16 x 2) + (1 x 2)	74

Mixtures:

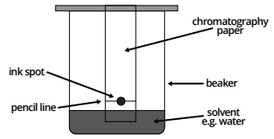
In mixtures, atoms/molecules are not chemically joined. Mixtures are easily separated by physical processes, such as:



distillation



evaporation



chromatography

filtration

Chromatography:

To separate mixtures of soluble substances, such as inks, dyes and food colourings, we can use paper chromatography.

In paper chromatography, a drop of the mixture is placed on chromatography paper and the paper is then placed in a beaker of solvent (e.g. water), with the level of the solvent just below the level of the spot.

The solvent soaks into and then moves up the paper. Any soluble substance in the pigment dissolves in the solvent and travels up the paper with it. The most soluble substances travel the furthest. The substances can be identified by how far they have travelled. To measure this, we calculate the R_f value.

$$R_f = \frac{\textbf{distance travelled by pigment}}{\textbf{distance travelled by solvent front}}$$