

1. A single symbol means an uncombined **single atom** of the **element**,  or **Fe** 1 atom of iron,  
 or **S** 1 atom of sulphur (2Fe would mean two atoms, 5S would mean five sulphur atoms etc.)

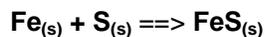
 or the formula **FeS** means one atom of iron is chemically combined with 1 atom of sulphur to form the **compound** called **iron sulphide**

**iron + sulphur ==> iron sulphide**



**on average one atom of iron chemically combines with one atom of iron forming one molecule of iron sulphide**

**two elements chemically combining to form a new compound**



**Atom balancing, sum left = sum right: 1Fe + 1S = (1Fe combined with 1S)**

All the reactants (what you start with) and all the products (what is formed) are all solids in this case.

When first learning symbol equations you probably won't use state symbols like <sub>(s)</sub> at first (see end note).

2.  or the formula **NaOH** means 1 atom of sodium is combined with 1 atom of oxygen and 1 atom of hydrogen to form the **compound** called **sodium hydroxide**

 or the formula **HCl** means 1 atom of hydrogen is combined with 1 atom of chlorine to form 1 molecule of the **compound** called **hydrochloric acid**

 or the formula **NaCl** means 1 atom of sodium are combined with 1 atom chlorine to form the **compound** called **sodium chloride**

 or the formula **H<sub>2</sub>O** means 2 atoms of hydrogen are chemically combined with 1 atom of oxygen to form the **compound** called **water**.

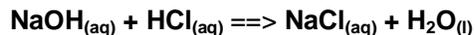
**sodium hydroxide + hydrochloric acid ==> sodium chloride + water**



the reactants are one molecule of sodium hydroxide and one molecule of hydrochloric acid

the products are one molecule of sodium chloride and one molecule of water

all chemicals involved are compounds



atom balancing, sum left = right: (1Na + 1O + 1H) + (1H + 1Cl) = (1Na + 1Cl) + (2H + 1O)

3.  or the symbol **Mg** means **1 atom** of the **element** called **magnesium**

 or **2HCl** means **two separate molecules** of the **compound** called **hydrochloric acid** (see example 2)

 or the formula **MgCl<sub>2</sub>** means **1 formula** of the **compound** called **magnesium chloride**, made of one atom of magnesium and two atoms of chlorine.

 or the formula **H<sub>2</sub>** means **1 molecule** of the **element** called **hydrogen** made up of two joined hydrogen atoms

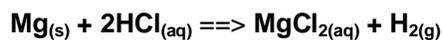
magnesium + hydrochloric acid ==> magnesium chloride + hydrogen



one atom of magnesium reacts with two molecules of hydrochloric acid

the products are one molecule of magnesium chloride and one molecule of hydrogen

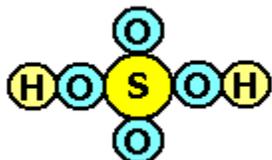
Mg and H-H are elements, H-Cl and Cl-Mg-Cl are compounds



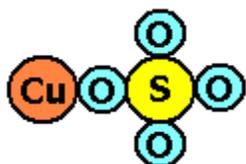
atom balancing, sum left = right:  $(1\text{Mg}) + 2 \times (1\text{H} + 1\text{Cl}) = (1\text{Mg} + 2\text{Cl}) + (2\text{H})$



4. or the formula  $\text{CuCO}_3$  means **one formula** of the **compound** called **copper carbonate**, made up of one atom of copper is combined with one atom of carbon and three atoms of oxygen to form the compound copper carbonate



or the formula  $\text{H}_2\text{SO}_4$  means **one formula** of the **compound** called sulphuric acid, which is made up of two atoms of hydrogen, one atom of sulphur and four atoms of oxygen



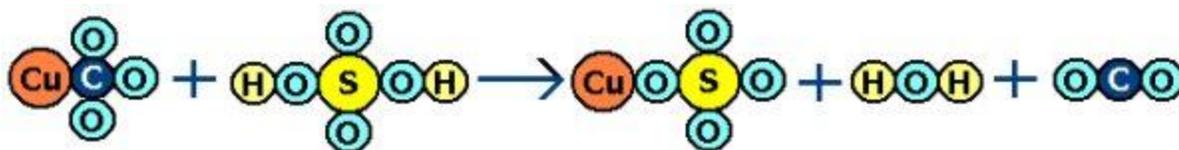
or the formula  $\text{CuSO}_4$  means **one formula** of the **compound** called copper sulphate which is made up of one atom of copper, one atom of sulphur and four atoms of oxygen

$\text{H}_2\text{O}$  (example 2)



or the formula  $\text{CO}_2$  means **one molecule** of the **compound** called **carbon dioxide** which is a chemical combination of one atom of carbon and two atoms of oxygen.

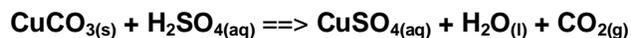
copper carbonate + sulphuric acid  $\implies$  copper sulphate + water + carbon dioxide



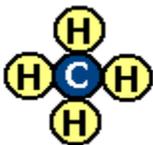
the reactants are one formula of copper carbonate and one molecule of sulphuric acid

the products are one formula of copper sulphate, one molecule of water and one molecule of carbon dioxide

all molecules are compounds in this reaction



balancing sum left = sum right:  $(1\text{Cu} + 1\text{C} + 3\text{O}) + (2\text{H} + 1\text{S} + 4\text{O}) = (1\text{Cu} + 1\text{S} + 4\text{O}) + (2\text{H} + 1\text{O}) + (1\text{C} + 2\text{O})$



5. or the formula  $\text{CH}_4$  means **one molecule** of the **compound** called **methane** which is made of one atom of carbon combined with four atoms of hydrogen



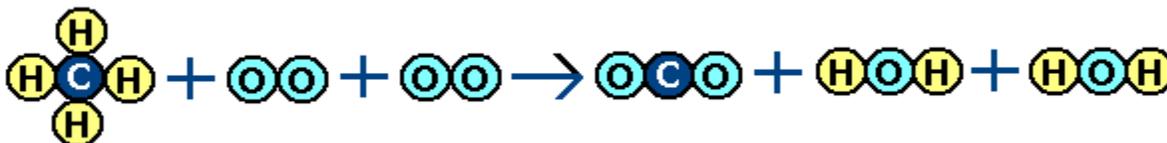
or  $2\text{O}_2$  means **two separate molecules** of the **element** called **oxygen**, and each oxygen molecule consists of two atoms of oxygen

$\text{CO}_2$  (see also example 4)

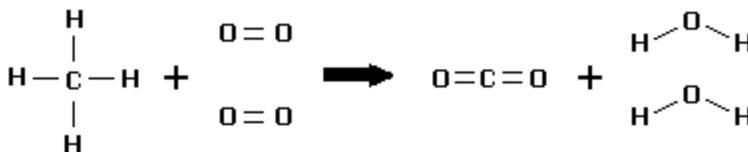


or  $2\text{H}_2\text{O}$  means **two separate molecules** of the **compound** called **water** (see also example 2)

methane + oxygen  $\implies$  carbon dioxide + water



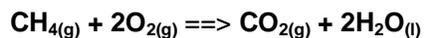
Using displayed formula the equation would look like this ...



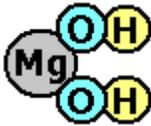
... in which every individual atom is shown and how it is bonded ('connected') with other atoms in the molecule. All the dashes represent the covalent bonds between the atoms in the molecules.

**one molecule of methane is completely burned by two molecules of oxygen**

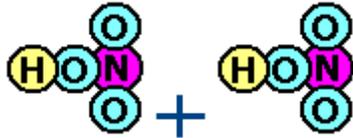
**to form one molecule of carbon dioxide and two molecules of water**



atom balancing, sum left = sum right:  $(1\text{C} + 4\text{H}) + 2 \times (2\text{O}) = (1\text{C} + 2\text{O}) + 2 \times (2\text{H} + 1\text{O})$



6. or the formula  $\text{Mg(OH)}_2$  is the **compound** magnesium hydroxide made up of one magnesium, two oxygen and two hydrogen atoms BUT the OH is a particular combination called hydroxide within a compound, so it is best to think of this compound as a combination of an Mg and two OH's, hence the use of the ( ). The subscripted 2 doubles everything in the brackets.



or  $2\text{HNO}_3$  means **two separate molecules** of the **compound nitric acid**, each molecule is made up of one hydrogen atom, one nitrogen atom and three oxygen atoms.

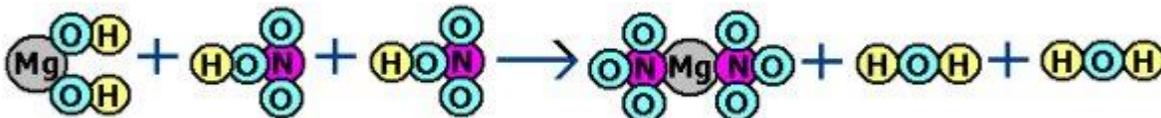


or the formula  $\text{Mg(NO}_3)_2$  is the **compound magnesium nitrate**, it consists of a magnesium (ion) and two 'nitrates' (ions), each nitrate consists of one nitrogen and three oxygen atoms, again the nitrate is a particular combination of atoms within a compound and hence the use of ( ) again.

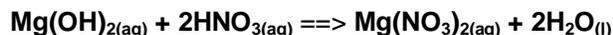


or  $2\text{H}_2\text{O}$  meaning **two molecules** of the **compound water** (see also examples 2 and 5)

magnesium hydroxide + nitric acid  $\implies$  magnesium nitrate + water

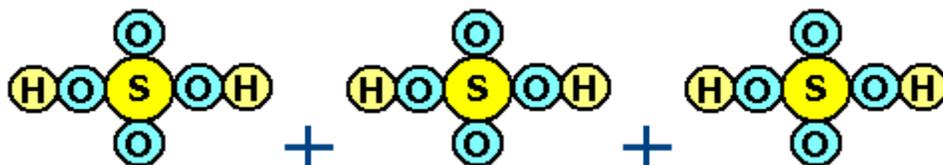


one formula of magnesium hydroxide reacts with two molecules of nitric acid to form one formula of magnesium nitrate and two molecules of water (all compounds)

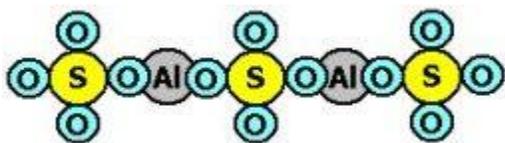


atom balancing, sum left = sum right:  $(1\text{Mg} + 2\text{O} + 2\text{H}) + 2 \times (1\text{H} + 1\text{N} + 3\text{O}) = (1\text{Mg} + 2\text{N} + 6\text{O}) + 2 \times (2\text{H} + 1\text{O})$

7.  or the formula  $\text{Al}_2\text{O}_3$  means **one formula** of the **compound** called **aluminium oxide**, made up of two atoms of aluminium Al and three atoms of oxygen O



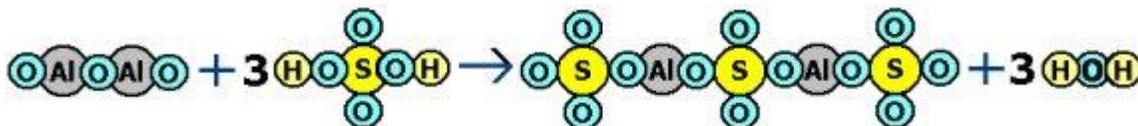
or  $3\text{H}_2\text{SO}_4$  meaning **three molecules** of the **compound** called **sulphuric acid** (see also example 4)



or the formula  $\text{Al}_2(\text{SO}_4)_3$  means **one formula** of the **compound** called **aluminium sulphate**, it consists of two aluminium, three sulphur and twelve oxygen atoms BUT the  $\text{SO}_4$  is a particular grouping called sulphate, so it is best to think of the compound as a combination of two Al's and three  $\text{SO}_4$ 's

 or  $3\text{H}_2\text{O}$  means **three separate molecules** of the **compound** called **water** (see also examples 2 and 5)

aluminium oxide + sulphuric acid  $\Rightarrow$  aluminium sulphate + water

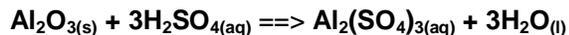


one formula of aluminium oxide reacts with three molecules of sulphuric acid

to form one formula of aluminium sulphate and three molecules of water

note the first use of numbers (3) for the sulphuric acid and water!

so picture three of them in your head, otherwise the picture gets a bit big!



atom balancing, sum left = sum right:  $(2\text{Al} + 3\text{O}) + 3 \times (2\text{H} + 1\text{S} + 4\text{O}) = (2\text{Al} + 3\text{S} + 12\text{O}) + 3 \times (2\text{H} + 1\text{O})$

GCSE-AS-A2-IB note: Aluminium sulfate is actually an ionic compound  $(\text{Al}^{3+})_2(\text{SO}_4^{2-})_3$