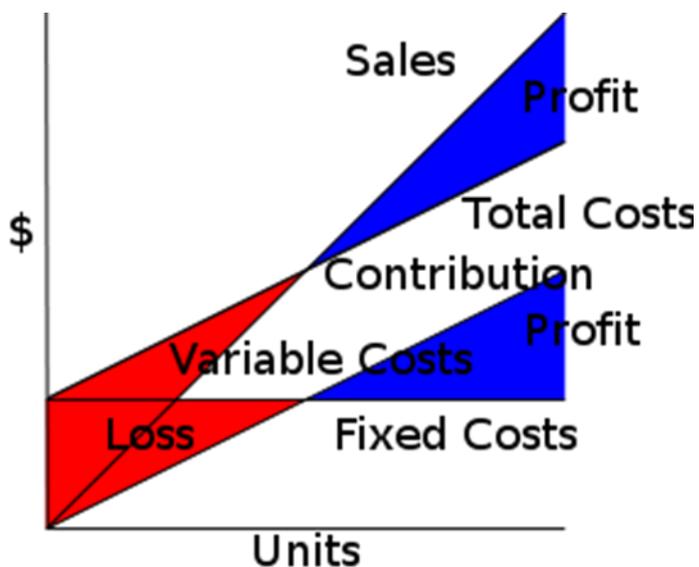


Nat 4/5 Chemistry - Topic 4



Moles and Equations



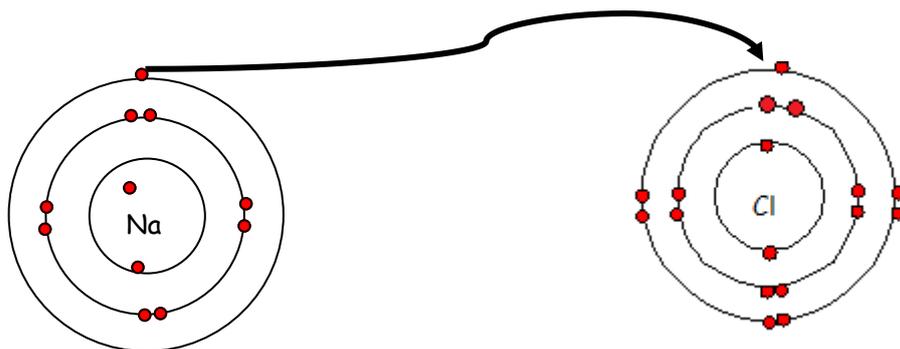
Topic 4 Moles and Equations

Nat 4 outcomes Nat 5 outcomes
By the end of this unit you should know the following:

- A chemical reaction which can be described using word equations, can also be described using chemical symbol equations.
- How to use balanced chemical equations to work out the mass of product formed.
- Chemical and ionic formulae including compounds containing group ions are used.
- The chemical formula of a covalent molecular substance gives the number of atoms present in the molecule.
- The formula of a covalent network or ionic compound gives the simplest ratio of atoms/ions in the substance.
- The gram formula mass is defined as the mass of one mole of a substance.
- Using the chemical formula of any substance the gram formula mass can be calculated using relative atomic masses of its constituent elements.

Ionic Chemical Formulae

You will remember from the previous topic on bonding that atoms join together in order to form a complete outer shell. In ionic bonding they do this by **transferring their unpaired outer (valence) electrons from the metal atoms to the non-metal atoms**, as shown in the example below of sodium chloride.



The valency of the elements is the same as the size of their charge on the resulting ion; metals in **group 1 having a 1+ charge**, non-metals in **group 6 having a 2- charge**, etc.

In the same way as with covalent compounds we can work out the chemical formula by using the crossing over the valency method.

- | | | | |
|--------|---|------|----|
| Step 1 | Write down the symbols: | Na | Cl |
| Step 2 | Write the valency | Na | Cl |
| Step 3 | Cross over the valency using arrows | Na | Cl |
| Step 4 | Simplify the numbers
No need to write the 1. | NaCl | |

Chemical Equations

Word Equations

During a chemical reaction **reactants** are turned into new substances called **products**. This can be shown by a word equation where the chemicals reacting are shown on the left hand side and the products formed on the right. For example, in the reaction between **magnesium** ribbon and **oxygen** gas, a white powder **magnesium oxide** is produced.

The word equation for this is:



Notice that only the chemical names are used in the equation and not descriptions.

NOTES

Work out the word equations from the following descriptions of chemical reactions:



1. Sodium metal reacts violently with water producing hydrogen gas and a solution of sodium hydroxide.
2. Carbon dioxide gas and black copper oxide powder are formed when green copper carbonate powder is heated in a test tube.
3. When iron is produced in a blast furnace from iron ore, the iron(III) oxide in the ore reacts with carbon monoxide gas. Carbon dioxide is also formed in the reaction.

Chemical Equations

Chemists often use shorthand to write chemical equations. They do this by using the chemical formula of each reactant and product and then simply swap them for the words in a word equation. Extra information can also be included by using state symbols.

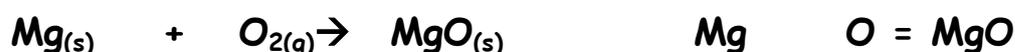
Solid = (s)

Liquid = (l)

Gas = (g)

Aqueous solution = (aq)

E.g. magnesium + oxygen → magnesium oxide



Remember which elements are diatomic gases

(H₂, N₂, O₂, F₂, Cl₂, Br₂ & I₂)

For compounds you will need to correctly work out their formula using the crossing over the valency method, unless they have a prefix like mono or di in their name.

NOTES

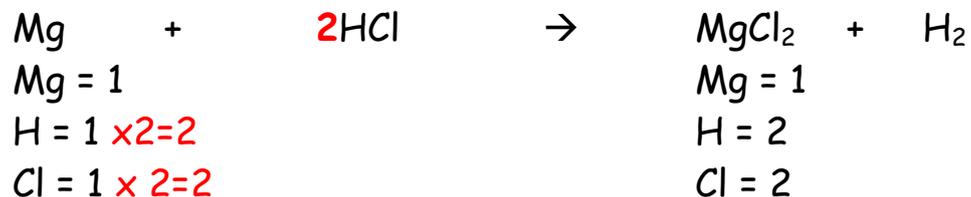
Convert the following word equations into chemical equations.



Your teacher may get you to try some extra questions on this.

Balanced Chemical Equations

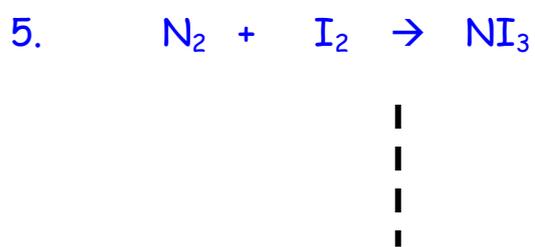
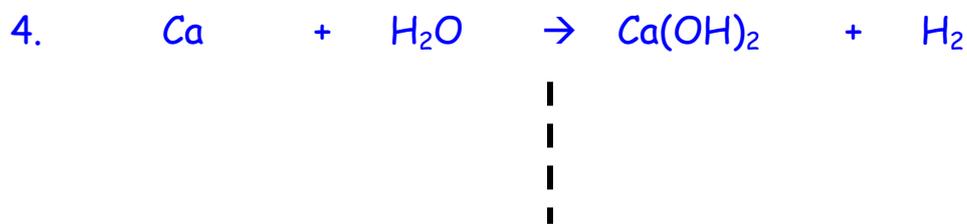
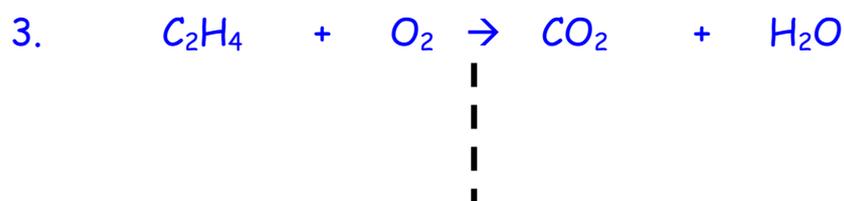
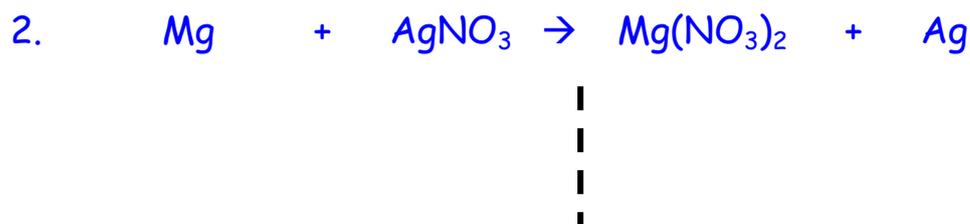
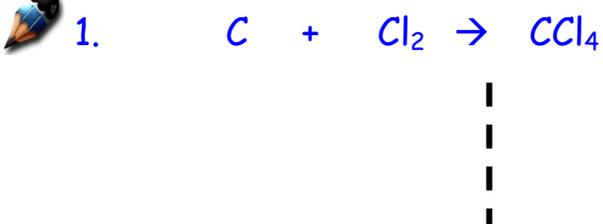
An easy way to help you balance chemical equations is to use the following accountancy method where you count the number of atoms of each element on both sides of the equation:



By having 2 HCl molecules the equation is balanced.

NOTES

Balance the following chemical equations:



Your teacher may get you to try some extra questions on this.



Quick Test 3

- Write word equations for the following reactions:
 - When lithium metal is added to water, a gas is given off, called hydrogen. A solution is also formed called lithium hydroxide.
 - Carbon dioxide gas and black copper oxide are formed when green copper carbonate powder is heated.
 - Hydrogen peroxide is an unstable liquid that spontaneously decomposes to form water and oxygen gas.
- Convert the following into balanced chemical equations:
 - $C + S \rightarrow CS_2$
 - $Li + ZnSO_4 \rightarrow Zn + Li_2SO_4$
 - sulfur dioxide + oxygen \rightarrow sulfur trioxide
 - nitrogen + hydrogen \rightarrow nitrogen hydride

A Chemical Measure

In chemistry we use a fixed amount called a **mole**, like a dozen it is a fixed number it just happens to be very large 602,000,000,000,000,000,000! This is because atoms and molecules are so small we need a colossal number of them to be able to weigh them. When we are looking at compounds we need to add up the masses of all the atoms in the chemical formula. This gives us the **gram formula mass or GFM, where the GFM is the mass of one mole of a substance expressed in grams.**

Calculating Mass from Moles

e.g. 1

Calculate the mass of 0.1 mol calcium carbonate?

Steps to success

1. Write down the formula of calcium carbonate
2. Calculate the formula mass of calcium carbonate (formula mass is 1 mol)
3. Write the ratio format with moles on left side and mass on right side.
4. Work out the ratio for the given mass.

NOTES

Work out the following, showing your working out:



1. What is the GFM of the following substance?

- a. NaCl b. CaF₂ c. CuSO₄ d. (NH₄)₂CO₃

2. What is the mass of the following?

- a. 2 moles of NaCl b. 0.2 moles of CaF₂

- c. 3 moles of CuSO₄ d. 0.5 moles of (NH₄)₂CO₃

3. What is the number of moles in the following?

- a. 5.85g of NaCl b. 380g of CaF₂

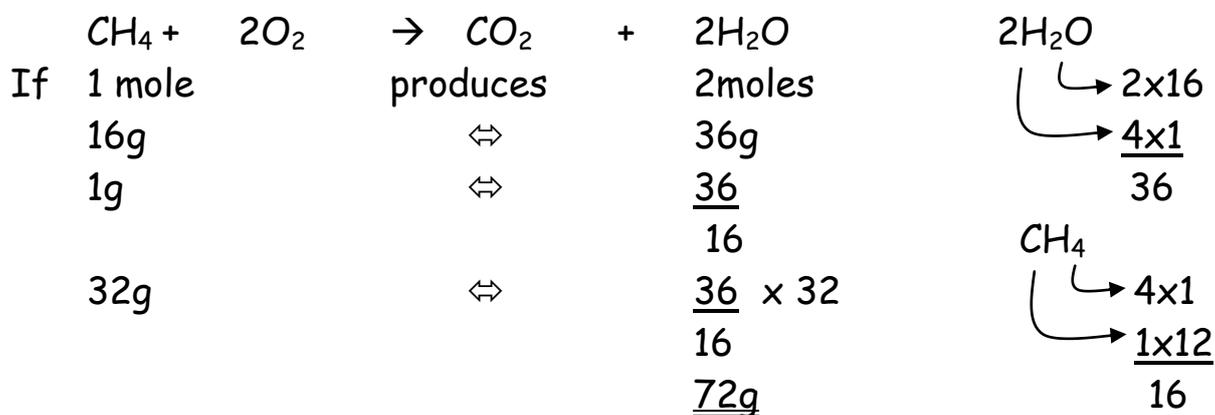
- c. 1.6g of CuSO₄ d. 192g of (NH₄)₂CO₃

Your teacher may get you to try some extra questions on this.

Using Balanced Chemical Equations:

It is possible to use a balanced chemical equation to work out how much product is produced during a chemical reaction or how much reactant is needed to produce a certain amount of product.

If 32g of methane (CH₄) is burnt, how much water is formed?



Another way of tackling this question is to use mole calculations:



NOTES

Work out the following, showing your working out:

- a. What mass of water is produced when 8g of hydrogen burns in oxygen?



- b. What mass of carbon dioxide is formed when 64g of ethene (C_2H_4) burns in oxygen?



- c. What mass of oxygen is required to burn 32g of methane (CH_4) completely?



Your teacher may get you to try some extra questions on this.