# AQA GCSE Chemistry (Combined Science) Unit 5.3: Quantitative Chemistry Knowledge Organiser - Higher

## Conservation of Mass

No atoms can be created or made during a chemical reaction, so the mass of the reactants will equal the mass of the product.

Reactions can be shown as a word or symbol equation.

magnesium + oxygen ➝ magnesium oxide

$Mg + O \rightarrow MgO$

Symbol equations should also be balanced; they should have the same number of atoms on each side.

$\mathbf{2Mg + O_2 \rightarrow 2MgO}$

## Relative Formula Mass

The relative formula mass ($M_r$) is the sum of all the relative atomic masses ($A_r$) of the atoms in the formula.

**Examples:**

**HCl**

$A_r$ of H = 1

$A_r$ of Cl = 35.5

$M_r$ of HCl = 1 + 35.5 = 36.5

**$H_2SO_4$**

$A_r$ of H = 1

$A_r$ of S = 32

$A_r$ of O = 16

$M_r$ of $H_2SO_4$ = (1 × 2) + 32 + (16 × 4)

$M_r$ of $H_2SO_4$ = 2 + 32 + 64

$M_r$ of $H_2SO_4$ = 98

## Concentration of Solutions

Concentration is the amount of a substance in a specific volume of a solution. The more substance that is dissolved, then the more concentrated the solution is.

It is possible to calculate the concentration of a solution with the following equation:

concentration ($g/dm^3$) = mass (g) ÷ volume of solvent ($dm^3$)

The equation can be rearranged to find the mass of the dissolved substance:

mass (g) = concentration ($g/dm^3$) × volume ($dm^3$)

## Calculating Percentage Mass of an Element in a Compound

percentage mass of an element in a compound =

$$A_r \times \frac{\text{number of atoms of that element}}{M_r \text{ of the compound}}$$

Find the percentage mass of oxygen in magnesium oxide.

$A_r$ of magnesium = 24 $A_r$ of oxygen = 16

$M_r$ of MgO = 24 + 16

= 40

$$\% \text{ mass} = \frac{A_r}{M_r} = \frac{16}{40} = 0.4 \quad 0.4 \times 100 = 40\%$$

## Conservation of Mass

Show that mass is conserved in a reaction.

$2Mg + O_2 \rightarrow 2MgO$

$(2 \times 24) + (2 \times 16) \rightarrow 2(24 + 16)$

$48 + 32 \rightarrow 2 \times 40$

$80 \rightarrow 80$

Total $M_r$ on the left-hand side of the equation is the same as the $M_r$ on the right-hand side.

Calculate the mass of the product.

6g of magnesium reacts with 4g of oxygen:

6 + 4 = 10g of magnesium oxide

During a reaction the mass can change. If one of the reactants is a gas, the mass can go up.

E.g.

magnesium + oxygen ➝ magnesium oxide

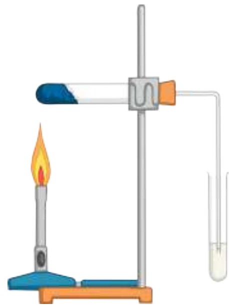
Oxygen from the air is added to the magnesium (making the product) which will be heavier in mass.

If one of the products is a gas, the mass can go down.

E.g.

sodium carbonate ➝ sodium oxide + carbon dioxide

When sodium carbonate is thermally decomposed, carbon dioxide gas is produced and released into the atmosphere.



## The Mole

The Avogadro constant, $6.02 \times 10^{23}$, is the number of molecules of a substance that make up one mole of that substance.

Iron has an $A_r$ of 56, so 1 mole of iron has a mass of 56g.

Oxygen ($O_2$) gas has an $M_r$ of 32, so 1 mole of oxygen has a mass of 32g.

Ammonia ($NH_3$) has an $M_r$ of 17, so 1 mole of ammonia has a mass of 17g.

$$\text{number of moles} = \frac{\text{mass in g (of an element or compound)}}{M_r \text{ (of the element or compound)}}$$

## Moles and Equations

Write a balanced symbol equation for the reaction in which 5.6g of iron reacts with 10.65g of chlorine to form iron chloride.

Work out the $M_r$ of all the substances.

$A_r$ of Fe = 56 and $A_r$ of Cl = 35.5

Divide the mass of each substance by its $M_r$ to calculate how many moles of each substance reacted or produced.

moles Fe = 5.6/56 = 0.1

moles Cl = 10.65/35.5 = 0.3

Divide by the smallest number of moles

$$Fe = \frac{0.1}{0.1} = 1 \qquad Cl = \frac{0.3}{0.1} = 3$$

Write down the balanced symbol equation.

Fe + 3Cl

Chlorine exists as $Cl_2$ so the whole thing must be multiplied by 2.

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$

## Limiting Reactions

If one reactant gets used up in a reaction before the other, then the reaction will stop. The reactant that has been used up is limiting.

If you halve the amount of reactant then the amount of product will also be halved.