

C3 Quantitative Chemistry – Knowledge organiser

Higher Combined Science (Trilogy) GCSE

4.3.1	Chemical measurements
<p>Conservation of mass and balanced chemical equations</p>	<ul style="list-style-type: none"> - no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants. - This is why symbol equations must be balanced, so that there is the same number of atoms on both sides of the equation. e.g. $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ (now each side has 1 C, 4 H's and 4 O's)
<p>Relative formula mass (M_r)</p>	<ul style="list-style-type: none"> - This is the sum of all the atomic masses (A_r) of the atoms in a molecule/compound. e.g. M_r of $\text{H}_2\text{O} = 2 \times 1 + 1 \times 16 = 18$; M_r of $\text{CaCO}_3 = 1 \times 40 + 1 \times 12 + 3 \times 16 = 100$ - In a balanced symbol equation: M_r of the reactants = M_r of the products
<p>Explaining mass changes (when a reactant or product is a gas)</p>	<ul style="list-style-type: none"> - State symbols in an equation show the state of the substance: (s) solid; (l) liquid; (g) gas; (aq) aqueous (=dissolved in water) - If there appears to be a change in mass in a reaction this is usually because one of the reactants or products is a gas whose mass has not been included. e.g. $2\text{Mg}_{(s)} + \text{O}_{2(g)} \rightarrow 2\text{MgO}_{(s)}$: the mass will appear to increase, because the magnesium is gaining the atoms of oxygen gas. e.g. $\text{CaCO}_{3(s)} \rightarrow \text{CO}_{2(g)} + \text{CaO}_{(s)}$: the mass appears to decrease, because carbon dioxide gas is made and escapes into the air.
<p>Uncertainty in chemical measurements</p>	<ul style="list-style-type: none"> - Whenever a measurement is made there is always some uncertainty about the result obtained. This can be represented on a graph by plotting the range of repeats as well as the mean. The bigger the range around the mean, the more uncertainty there is about the results.
4.3.2	Moles, masses and concentrations
<p>Moles the symbol is 'mol'</p>	<ul style="list-style-type: none"> - 1 mole of a substance always contains the same number of atoms/molecules of that substance: this is the Avogadro constant = 6.02×10^{23} atoms/molecules per mole. - The mass of 1 mole of a substance in grams in the same number as its relative formula mass. e.g - the mass of 1 mole of carbon = 12g (because the A_r of carbon is 12) - the mass of 1 mole of H_2O = 18g (because the M_r of H_2O is 18) - number of moles = mass of a substance \div relative formula mass
<p>Using moles to balance equations</p> <p>Remember: moles = mass \div M_r</p>	<ul style="list-style-type: none"> - if you work out the number of moles of each reactant and product in a reaction (using moles = mass \div relative formula mass) this gives you the ratio of reactants and products, so you can write the balanced equation. e.g 48g of Mg reacts with 32g of O_2 to produce 80g of MgO so: $48 \div 24 = 2 \text{ mol of Mg}$; $32 \div (2 \times 16) = 1 \text{ mol of O}_2$; $80 \div (24 + 16) = 2 \text{ mol of MgO}$ this is a ratio of 2:1:2 (Mg: O_2: MgO)

	so the balanced equation is: $2\text{Mg} + (1)\text{O}_2 \rightarrow 2\text{MgO}$
Calculating masses of reactants and products Remember: moles = mass \div M_r	- The masses of reactants and products can be calculated from balanced symbol equations, because these give you the ratio of moles of each one. e.g $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$ this mean you have: 1mol of Mg that reacts with 2mol of HCl to produce 1mol of MgCl₂ and 1mol of H₂ : the ratio is 1:2:1:1 so if you have 48g of Mg ($48\text{g} \div 24 = 2\text{mol}$) this will react with: $4\text{mol} \times 36.5 =$ 146g of HCl to produce $2\text{mol} \times 95 =$ 190g of MgCl₂ and $2\text{mol} \times 2 =$ 4g of H₂
Limiting reactants	- In a reaction with with 2 reactants, it is common to use an excess of one reactant to make sure that all of the other reactant is used up. This reactant that is completely used up is called the limiting reactant , as it limits the amount of the products that can be made. - if you know that number of moles or the mass in grams of this limiting product, you can calculate the moles or mass of the products formed .
Concentrations of solutions	- The concentration of a solution (aq) can be measured in g/dm³ (mass/volume) <p style="text-align: center;">Concentration = mass \div volume</p> - The concentration of the solution depends on the mass of the solute and the volume of the solvent . Increasing mass increases concentration, increasing volume decreases concentration.