AQA Quantitative Chemistry Journey of Knowledge

Context and introduction to the unit:
Chemists use quantitative analysis to determine the formulae of compounds and the equations for reactions. Given this information, analysts can then use quantitative methods to determine the purity of chemical samples and to monitor the yield from chemical reactions. Chemical reactions can be classified in various ways. Identifying different types of chemical reaction allows chemists to make sense of how different chemicals react together, to establish patterns and to make predictions about the behaviour of other chemicals. Chemical equations provide a means of representing chemical reactions and are a key way for chemists to communicate chemical ideas.

KS3:
Chemical reactions, Energy transfers, The Periodic table, Displacement reactions, Oxidation and reduction.

CORE KNOWLEDGE

5.3.1.1 Conservation of mass and balanced chemical equations - The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants. This means that chemical reactions can be represented by symbol equations which are balanced in terms of the numbers of atoms of each element involved on both sides of the equation.

5.3.1.2 Relative formula mass - The relative formula mass (Mr) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula. In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown. Students should be able to calculate the percentage by mass in a compound given the relative formula mass and the relative atomic masses.

5.3.1.3 Mass changes when a reactant or product is a gas - Some reactions may appear to involve a change in mass but this can usually be explained because a reactant or product is a gas and its mass has not been taken into account. For example: when a metal reacts with oxygen the mass of the oxide produced is greater than the mass of the metal or in thermal decompositions of metal carbonates carbon dioxide is produced and escapes into the atmosphere leaving the metal oxide as the only solid product.

5.3.1.4 Chemical measurements - Whenever a measurement is made there is always some uncertainty about the result obtained.

5.3.2.1 Moles (HT only) - Chemical amounts are measured in moles. The symbol for the unit mole is mol. The mass of one mole of a substance in grams is numerically equal to its relative formula mass. One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance. The number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant. The value of the Avogadro constant is 6.02×10^{23} per mole.

5.3.2.2 Amounts of substances in equations (HT only) - The masses of reactants and products can be calculated from balanced symbol equations. Chemical equations can be interpreted in terms of moles. For example: $Mg + 2HCl \longrightarrow MgCl_2 + H_2$ shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas.

5.3.2.3 Using moles to balance equations (HT only) - The balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles to simple whole number ratios.

5.3.2.4 Limiting reactants (HT only) - In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used. The reactant that is completely used up is called the limiting reactant because it limits the amount of products.

5.3.2.5 Concentration of solutions - Many chemical reactions take place in solutions. The concentration of a solution can be measured in mass per given volume of solution, e.g. grams per dm^3 (g/dm^3). Students should be able to: • calculate the mass of solute in a given volume of solution of known concentration in terms of mass per given volume of solution • **(HT only) The mass of a solute and the volume of a solution is related to the concentration of the solution.**

Disciplinary knowledge
WS 1.2, 3.4, S 4.1, 4.2, 4.3, 4.5, 4.6

Vocabulary
Conservation, mass, moles, Avogadro, reactants, excess, concentration

Reading is Power
A mole of moles

Where next?
Chemical and Energy changes

AQA Quantitative Chemistry Journey of Knowledge – SEPS ONLY

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CORE KNOWLEDGE

4.3.3 Yield and atom economy of chemical reactions (chemistry only) - Even though no atoms are gained or lost in a chemical reaction, it is not always possible to obtain the calculated amount of a product because: • the reaction may not go to completion because it is reversible • some of the product may be lost when it is separated from the reaction mixture • some of the reactants may react in ways different to the expected reaction. The amount of a product obtained is known as the yield. When compared with the maximum theoretical amount as a percentage, it is called the percentage yield.

$$\%\ Yield = \frac{Mass\ of\ product\ actually\ made}{Maximum\ theoretical\ mass\ of\ product} \times 100$$

4.3.3.2 Atom economy - The atom economy (atom utilisation) is a measure of the amount of starting materials that end up as useful products. It is important for sustainable development and for economic reasons to use reactions with high atom economy. The percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows:

$$\frac{Relative\ formula\ mass\ of\ desired\ product\ from\ equation}{Sum\ of\ relative\ formula\ masses\ of\ all\ reactants\ from\ equation} \times 100$$

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only) - The concentration of a solution can be measured in mol/dm³. The amount in moles of solute or the mass in grams of solute in a given volume of solution can be calculated from its concentration in mol/dm³ . If the volumes of two solutions that react completely are known and the concentration of one solution is known, the concentration of the other solution can be calculated.

4.3.5 Use of amount of substance in relation to volumes of gases (chemistry only) (HT only) - Equal amounts in moles of gases occupy the same volume under the same conditions of temperature and pressure. The volume of one mole of any gas at room temperature and pressure (20°C and 1 atmosphere pressure) is 24 dm³ . The volumes of gaseous reactants and products can be calculated from the balanced equation for the reaction.

Disciplinary knowledge
WS 1.2, 3.4, S 4.1, 4.2, 4.3, 4.5, 4.6

Vocabulary
Yield, theoretical, atom economy, utilisation, moles

Reading is Power
A mole of moles

Where next?
Chemical and Energy changes