C3: Quantitative chemistry

What's the science story?

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.

Previous knowledge:

- Reactions
- Matter and reactions
- C1: Atomic structure and the periodic table
- C2: Chemical bonds

Next steps…

C4: Chemical changes
C8: Chemical analysis

Keywords

Reactants
Products
relative atomic mass
Formula
Relative formula mass
Mole
Compound
Element
-ide
-ate

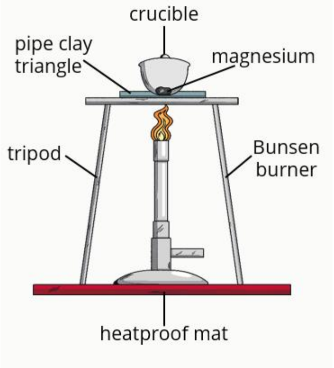
Mass
Gas
Oxidation
Decomposition
Balanced
Uncertainty
Measurement
Distribution
Estimation
Mean
range

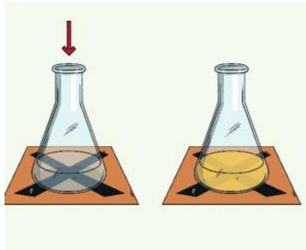
Concentration
Solution
Grams per dm^3
solute
volume
temperature
excess
limiting reactant

AQA GCSE Combined Science Trilogy (8464)

Working scientifically skills:	Assessments:
WS1: Scientific methods. How theories change over time, does the data support the theory or not **WS2:** Draw/Interpret diagrams. Use a model to make predictions **WS3:** Make predictions. Make prediction using a model **WS15:** Data. Calculate means, ranges and uncertainty **WS16:** Using equations. Use given equations correctly	End of unit test (summative) Exit tickets x 2/3 (formative) • **Mr Calculations**

Lesson No. and Title	Learning objectives	AQA Specification	Practical equipment
1. Relative formula mass and Moles for higher	4 – To calculate the relative formula mass for familiar compounds. 6 – To calculate the relative formula mass for unfamiliar compounds. **8 – To calculate the number of moles of a substance. (HT)**	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. **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 x 1023 per mole. Students should understand that the measurement of amounts in moles can apply to atoms, molecules, ions, electrons, formulae and equations, for example that in one mole of carbon (C) the number of atoms is the same as the number of molecules in one mole of carbon dioxide (CO2).**	

2. Writing chemical equations	4 – To write a word equation. 6 – To write a symbol equation. **6 – To explain why chemical equations must be balanced. (HT)** **8 – To interpret balanced symbol equations in terms of mole ratios. (HT)** **8 – To balance a symbol equation. (HT)**	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. Students should understand the use of the multipliers in equations in normal script before a formula and in subscript within a formula. **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. Students should be able to balance an equation given the masses of reactants and products. Students should be able to change the subject of a mathematical equation. 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 + 2HCI MgCI2 + H2 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. Students should be able to: • calculate the masses of substances shown in a balanced symbol equation • calculate the masses of reactants and products from the balanced symbol equation and the mass of a given reactant or product.**	
3. Conservation of mass	4 – To define conservation of mass 6 – To explain why the mass of a chemical reaction may increase or decrease 6 – To apply your knowledge of C of M to a practical investigation.	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. Students should understand the use of the multipliers in equations in normal script before a formula and in subscript within a formula.	crucible and lid, Bunsen burner, tripod, pipe clay triangle, heatproof mat, tongs, top pan balance, 2cm strip of magnesium. 

4. Uncertainty in chemical measurements	4 – To state the definition of uncertainty. 5 – To measure uncertainty using the range and mean from a set of results. 6 – To plot graphs of variation in results and explain why there is variation.	Whenever a measurement is made there is always some uncertainty about the result obtained. Students should be able to: • represent the distribution of results and make estimations of uncertainty • use the range of a set of measurements about the mean as a measure of uncertainty.	**0.1M sodium thiosulfate solution, 0.1M hydrochloric acid, conical flask, tile, whiteboard marker, stopwatch, measuring cylinder and safety goggles.** 
5. Concentration of solutions	4 – Explain what concentration of a solution means 5 – Calculate the mass of solute in a solution **8 – Explain the effect of the limiting reactant on the amount of products (higher)**	Many chemical reactions take place in solutions. The concentration of a solution can be measured in mass per given volume of solution, eg grams per dm3 (g/dm3). 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) explain how the mass of a solute and the volume of a solution is related to the concentration of the solution **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. Students should be able to explain the effect of a limiting quantity of a reactant on the amount of products it is possible to obtain in terms of amounts in moles or masses in grams.**	

6.			
7.			