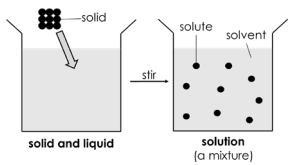
C3 Quantitative Chemistry
Combined Foundation

Keywords	
chemical formula	Represents chemicals with symbols and numbers
atom	The smallest particle of an element
element	A type of atom found on the periodic table
reactant	A chemical you start with in a reaction
product	A chemical made during a reaction
chemical equation	Uses chemical formulae in an equation to represent chemical reactions
solute	The solid that dissolved in a liquid
solvent	The liquid that dissolves a solid
solution	Formed when a solid is dissolved in a liquid
mean	The average of a set of numbers
range	The highest minus the lowest number
uncertainty	How close the highest and lowest numbers are to the mean in a set of numbers

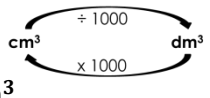
Concentrations of solutions



A solution is formed when a solid dissolves in a liquid. The concentration of the solution is the mass of solute in 1 dm^3 (≈1 litre) of solution.

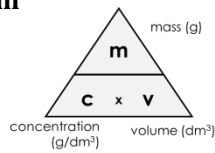
Example: Find the concentration of the solution formed when 2 g of HCl is dissolved in 400 cm^3 of H_2O.

Step 1: Convert cm^3 to dm^3



$$\textbf{volume in dm}^3 = \frac{400}{1000} = 0.4\ \textbf{dm}^3$$

Step 2: Use equation

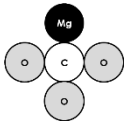


$$c = \frac{m}{v} = \frac{2}{0.4} = 0.05\ g/dm^3$$

Chemical formulae

In a chemical formula, each new symbol starts with a capital letter. The number after each symbol shows how many of that element are in the chemical. No number after the symbol means there is one.

Example: Magnesium carbonate

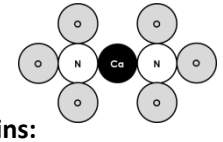


$MgCO_3$
- 3 x O (oxygen)
- 1 x C (carbon)
- 1 x Mg (magnesium)

$MgCO_3$ contains:
- 3 elements - Mg, C and O
- 5 atoms - 1 Mg, 1 C and 3 Os

Brackets are used to group elements - the number after the brackets shows how many of that group there are in the chemical.

Example: Calcium nitrate (has two lots of NO_3)

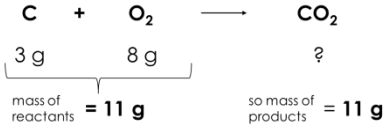


$Ca(NO_3)_2$
- 3 x 2 = 6 x O (oxygen)
- 1 x 2 = 2 x N (nitrogen)
- 1 x Ca (calcium)

$Ca(NO_3)_2$ contains:
- 3 elements - Ca, N and O
- 9 atoms - 1 Ca, 2 Ns and 6 Os

Conservation of mass

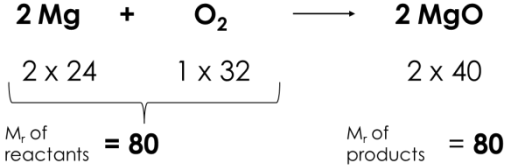
The law of conservation of mass states that no atoms are lost or made during a chemical reaction. Therefore:



mass of the products = mass of the reactants

Also **M_r products = M_r reactants**

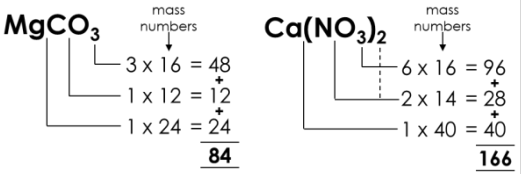
Example:



In an open system, the mass can change during an experiment involving gases as the gas can be 'added' or 'escape'.
- If a reactant is a gas, the mass increases (eg. 2 Ca + O_2 → 2 CaO).
- If a product is a gas, the mass decreases (eg. $ZnCO_3$ → ZnO + CO_2)

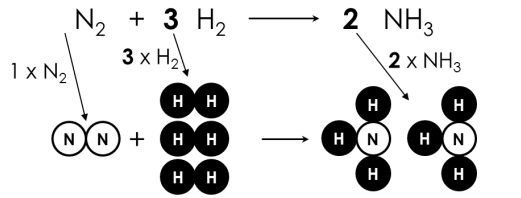
Relative formula mass (M_r)

The M_r is found by adding up the mass numbers of each atom in a chemical:



Balanced chemical equations

The 'balancing number' before each chemical shows how many of that chemical are used in the reaction. No number before the chemical means one.



Uncertainty in measurements

When we repeat an experiment, we can use the results to tell us how reliable the experiment was.

Example: A beaker containing 100 cm^3 water was heated by 20 °C. The experiment was repeated, and the times taken in seconds were **90**, **100**, **93, 95**.

1. Calculate the mean
(add numbers then divide by number of numbers)
$$\mathbf{90 + 100 + 93 + 95 = \frac{378}{4} = 94.5\ s}$$
2. Calculate the range (*highest – lowest*)
$$\mathbf{100 - 90 = 10\ s}$$
3. Calculate the uncertainty *(range ÷ 2)*
$$\mathbf{\frac{10}{2} = 5\ s}$$
4. Result is mean **±** uncertainty = **94.5 ± 5 s**