Cambridge IGCSE Chemistry

Topic 4: Stoichiometry

The mole concept

Notes

(Extended only) Define the mole and the Avogadro constant

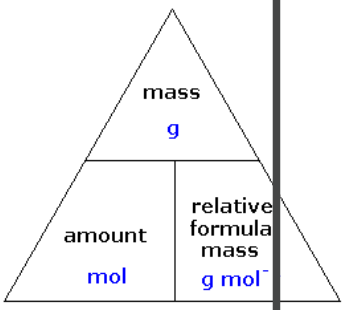
- Chemical amounts are measured in moles (therefore it is the amount of substance). The symbol for the unit mole is mol.
    - Mole = amount of substance
- The number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant: 6.02×10^{23} per mole.

(Extended only) Use the molar gas volume, taken as 24dm^3 at room temperature and pressure

- Equal amounts in mol. of gases occupy the same volume under the same conditions of temperature and pressure (e.g. RTP)
- Volume of 1 mol. of any gas at RTP (room temperature and pressure: 20˚C and 1 atmosphere pressure) is 24 dm^3
- This sets up the equation:

  Volume (dm^3) of gas at RTP = Mol. x 24
- Use this equation to calculate the volumes of gaseous reactants and products at RTP

(Extended only) Calculate stoichiometric reacting masses, volumes of gases and solutions, and concentrations of solutions expressed in g/dm^3 and mol/dm^3 (Calculations involving the idea of limiting reactants may be set.)



- You can convert between moles and grams by using this triangle:
    - moles = mass ÷ formula mass
- You can work out the moles or volume of a gas at RTP using the equation:
    - volume = moles x 24
    - rearranged to: moles = volume ÷ 24
- You can work out concentrations of solutions in g/dm^3 using the equation:
    - concentration = mass of solute ÷ volume
- you can work out concentrations of solutions in mol/dm^3 using the equation:
    - concentration = moles of solute ÷ volume
- to convert between concentration in mol/dm^3 and g/dm^3:
    - mol/dm^3 → g/dm^3 multiply by Mr
    - g/dm^3 → mol/dm^3 divide by Mr
- if you are given a reacting mass/volume/concentration and are asked to work out the mass/volume/concentration of another reactant or a product:
    - calculate the number of moles (use the appropriate equation from above)

- use the large numbers in the balanced equation to work out the mole ratio (e.g. for the equation $H_2 + Cl_2 \rightarrow 2HCl$, one mole of H_2 reacts to form 2 moles of HCl, so the mole ratio is 1:2)
- use the mole ratio to work out how many moles of the other reactant or product you have (in the example above, if you had 2 moles of H_2, you would make 4 moles of HCl)
- using the number of moles and the appropriate equation above, calculate the mass/volume/concentration

- limiting reagents:
  - in a reaction, often one of the reactants will be a limiting reagent. This means that this reactant will be used up first and will cause the reaction to stop.
  - in calculations, if given the mass/volume of a limiting reagent and another reagent, you must use the mass/volume of the limiting reagent.

(Extended only) Calculate empirical formulae and molecular formulae

- empirical formula from molecular formula:
  - if there is a common multiple in the number of different elements in your molecular formula, then divide by this number to give you the simplest whole number ratio
  - e.g. Fe_2O_4, common multiple is 2, empirical formula is FeO_2
- Molecular formula from empirical formula and relative molecular mass:
  - Find relative molecular mass of the empirical formula
  - Divide relative molecular mass of compound by that of the empirical formula
  - If answer was 2 and the empirical formula was Fe_2O_3 then the molecular formula would be empirical formula x 2 = Fe_4O_6

(Extended only) Calculate percentage yield and percentage purity

$$\text{Percentage yield} = \frac{\text{Amount of product produced}}{\text{Maximum amount of product possible}} \times 100$$

- It is not always possible to obtain the calculated amount of a product for 3 reasons...
  - 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
- Amount of product obtained is known as yield
- Percentage purity calculation
  - Divide the mass of the pure substance by the mass of the sample, then multiply this by 100 (you may have to use moles to find masses)