Molar calculations

The golden rule in these calculations is to **keep track of the moles**!
Remember that a mole is simply a certain number of particles (6.02×10^{23})
The molecular weight is the mass of that number of molecules

Balanced equations

The balanced equation allows us to work out how many of each kind of species (molecule, atom or ion) take part in a chemical reaction.

$$2H_2 + O_2 \rightarrow 2H_2O$$

Each oxygen molecule reacts with two hydrogen molecule to form 2 molecules of water.

Concentration of Solutions

$$\text{Concentration (mol / dm}^3) = \frac{\text{amount of substance (mol)}}{\text{volume (dm}^3)}$$

$$[\ ] = \frac{n}{V}$$

e.g. Dissolving exactly 28.0 g of sodium hydroxide to make 250 cm^3 of solution.

$M_r(NaOH) = 23 + 16 + 1 = 40$ g (i.e. one mole of NaOH has a mass of 40 g). Since we have 28.0 g, this is $\frac{28.0\ g}{40\ g\ /\ mol} = 0.70$ mol. Now we have the number of moles and the volume these are dissolved in, we can work out the concentration as $\frac{0.70\ mol}{0.25\ dm^3} = 2.8$ mol / dm^3 or 2.8 M.

Neutralization Titrations

1. Keep track of the moles! Work out the number of moles in the solution of known strength
2. Write out the balanced equation for the neutralization (ACID + ALKALI = SALT + WATER)
3. Use this to work out the number of moles of the unknown strength substance which were neutralized
4. Then work out the (unknown) concentration of this solution

e.g. A student put 25.0 cm^3 of sodium hydroxide solution with an unknown concentration into a conical flask using a pipette. The sodium hydroxide reacted with exactly 20.0 cm^3 of 0.50 mol / dm^3 hydrochloric acid added from a burette. What was the concentration of the sodium hydroxide solution?

1. 20.0 cm^3 of 0.5 M HCl was used. This is $\frac{20}{1000}$ $dm^3 \times 0.5$ mol / dm^3 =0.01 mol.
2. $NaOH + HCl \rightarrow NaCl + H_2O$

3. Each molecule of HCl reacts with one of NaOH. Therefore, 0.01 mol of NaOH are neutralized by 0.01 mol of HCl.

4. 25.0 cm^3 of the NaOH solution contained 0.01 mol of NaOH. 1 dm^3 would contain 0.01 mol $\times \frac{1000}{25}$ /dm^3 = 0.40 mol / dm^3 or 0.4 M.

Masses in equations

1. First write the equation for the reaction

2. Keep track of the moles! Find the number of moles of one of the substances in the equation for which you know the mass

3. Use the equation to work out the number of moles of the substance you're interested in

4. Now use its molecular mass to work out the mass of it which reacted / was formed

e.g. When a solution of sodium hydroxide is added to one of copper sulphate, a white precipitate of copper hydroxide forms (this is a test for Cu^{2+} ions). If NaOH is added until there is an excess of alkali in the solution, and the precipitate is collected and found to weigh 2.65 g, what mass of copper sulphate was there in the original solution?

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