Subject: Chemistry	Topic: Amount of Substance 3.1.2	Year Group: 12

Calculating moles from mass

1	The number of moles (n) of a substance is related its mass (m) by the equation n = m/Mr where Mr is the relative molecular mass.

Calculations involving solutions

1	The number of moles (n) of a substance is related its concentration (c) by the equation n = cv/1000 where c is the concentration in moldm^{-3} and v is the volume in cm^3. If given the volume in dm^3, then convert to cm^3 by multiplying by 1000.

Avogadro's constant

1	To calculate the number of particles in a particular number of moles, use the following equation: Number of particles = L x n, where L is Avogadro's constant.

Conversions

1	1 litre = 1000 cm3 = 1 dm3 To convert from oC to Kelvin, add 273. To convert from cm3 to m3, divide by 1x106.

Combining equations

1	The mass of a substance can be related to the number of particles by the following equation: $\frac{m}{M_r} = n = \frac{\text{number of particles}}{L}$

Calculating moles of a gas

1	The number of moles (n) of a gas is related its volume (V) by the equation n = V/24000, where V is the volume in cm^3.

Ideal gas equation

1	The number of moles in a gas can be found using the equation: pV = nRT where p is the pressure in Pascals (Pa), V is the volume in m3, n is the number of moles, R is the gas constant (8.31 JK-1mol-1) and T is the temperature in Kelvin (K).

Finding molecular formulae

1	Divide the Mr of the compound by the Mr of the empirical formula. This value is the number of 'empirical formulae' present in the molecular formula. E.g. If Mr of molecule is 54 and Mr of empirical formula CH2 is 14, then 54/14 = 4. We then multiply CH2 by 4 to get the molecular formula of C4H8.

Key Vocabulary

1	Relative atomic mass (A_r)	The weighted average mass of an atom relative to 1/12th the mass of a carbon atom.
2	Relative molecular mass (M_r)	The weighted average mass of a molecule relative to 1/12th the mass of a carbon atom.
3	Avogradro constant (L) or (N_A)	The number of particles in one mole.
4	Mole	The amount of a substance that contains the number of particles equal to the Avogadro constant.
5	Empirical formula	The simplest whole number ratio of the atoms of each element in a compound.
6	Molecular formula	The actual number of the atoms of each element in a compound.

Calculating empirical formulae

1	Find the number of moles of each element using n=m/Mr Divide all the moles by the lowest number to give a whole number ratio If any of the values are not whole (e.g. 1:2.5), multiply all values by 2 (or 3 etc.). Note: if given % of each element (as opposed to mass), simply use the % as the mass value.

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Percentage Yield

1 Percentage yield = $\frac{\text{actual number of moles}}{\text{theoretical number of moles}}$ x100

'Actual number of moles' is sometimes known as 'theoretical number of moles'.
'Yield' is the amount of product obtained.

2 In a reaction involving multiple steps, the overall % yield is calculated by multiplying all of the % yield values from of each step. To do this, convert each % to a decimal, multiply together, and then convert back to a % by multiplying by 100.

Reasons for Low Percentage Yield

1 % yield is never 100 % i.e. we never get as much product as is theoretically possible to obtain from the mass of the products. Reasons for this are:

- Material lost when transferring from one vessel to another (mechanical transfer)
- Loss during a separating technique (e.g. on filter paper during a filtration)
- Side reactions
- Reaction not being complete
- Reaction being reversible

Atom Economy

1 Atom economy is calculated using the following:

Atom economy = $\frac{M_r \text{ of desired product}}{\text{Total } M_r \text{ of all products}}$ x100

2 The atom economy of a reaction is independent of the actual yield of products. The only way to increase the % atom economy is to change the reaction, or by making use of more of the products.

3 Addition reactions have an atom economy of 100% since they result in one product only.

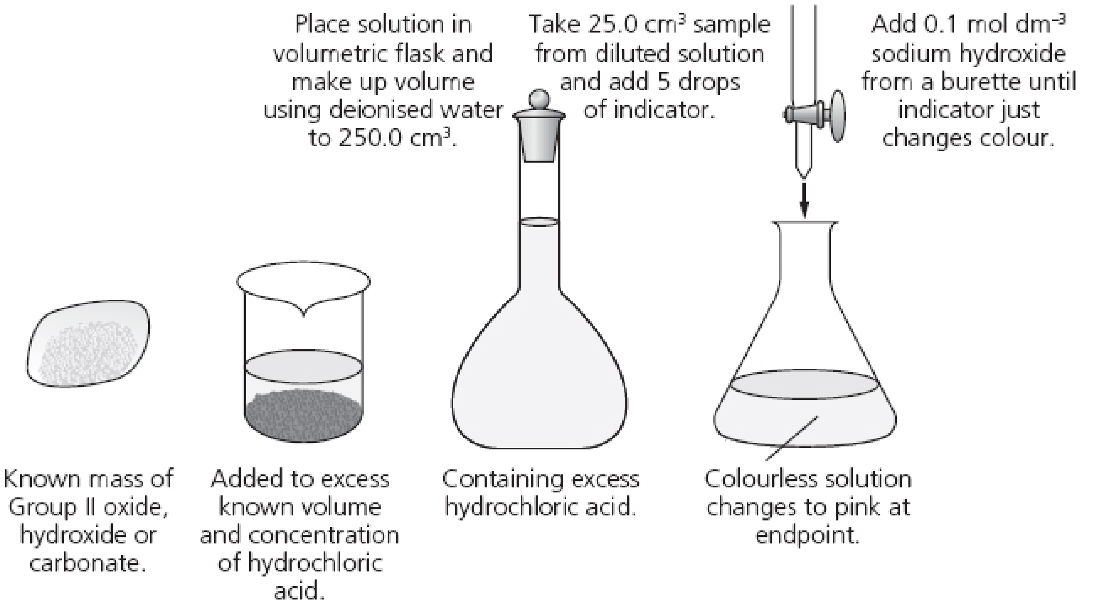
Determining degree of hydration

1

- Measure mass of hydrated compound.
- Heat to constant mass (thus removing the water).
- Measure mass of anhydrous product.
- Find mass of water by subtracting final mass from initial mass and divide by 18 to get moles of water.
- Use mass and Mr of anhydrous salt to find number of moles.
- Divide moles of water by moles of compound to find whole number ratio of compound: water and therefore the number

Making a Standard Solution

1



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Titration Calculations

1	Use n=cv/1000 to find number of moles of substance in burette.
2	Use balanced symbol equation to find number of moles of substance in conical flask.
3	Use c = 1000n/v to find concentration of substance in conical flask.

Percentage Error

1	The % error of a measured is calculated by: $\% \text{ error} = \frac{\text{error in equipment}}{\text{measured value}} \times 100$
2	If a burette is used, the value must be multiplied by 2, as a measurement will have been taken at the start, and again at the end.

Exam Tips

1	If you are ever given the mass of a known substance, immediately work out the number of moles using n=m/Mr. If you are ever given the concentration and volume of a solution, immediately work out the number of moles using n=cv/1000.

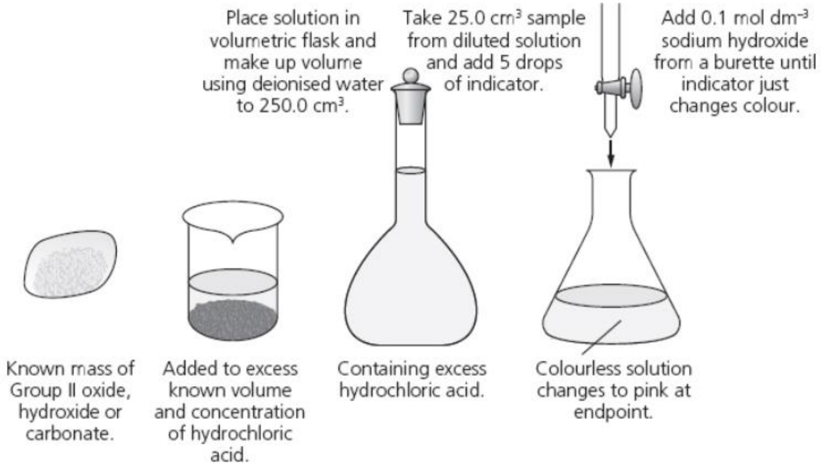
Indicators

1

Indicator	Phenolphthalein	Methyl orange
Colour in acidic solutions	colourless	red
Colour in neutral solutions	colourless	orange
Colour in alkaline solutions	pink	yellow
Titrations suitable for:	strong acid-strong base weak acid-strong base	strong acid-strong base strong acid-weak base

Back Titrations

1



Performing a Titration

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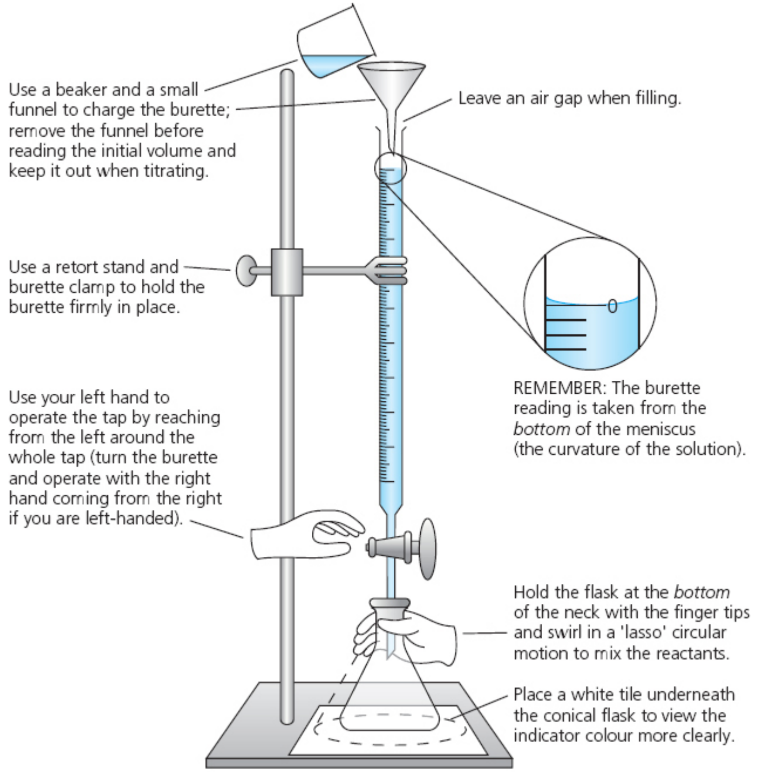

Back Titrations

1	Back titrations are used when a substance does not react easily with an acid or base. In this case, the substance being analysed is reaction with an excess of a strong acid (or base). The excess acid is then titrated as normal with a strong base and an indicator. By knowing how many moles of acid you reacted initially and the number of moles left over to react with the sodium hydroxide, you know how many moles reacted with the substance in question. The molar ratio will then allow the number of moles of the substance to be found.