2.2 Salt Preparation Including Titration Calculations

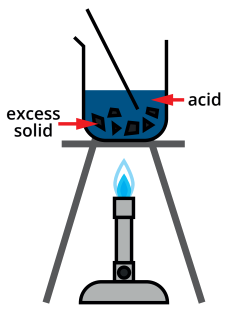
Introduction:

- Acids react with metals, bases and carbonates to form **salts**.
- The **method** of **preparation of salt crystals** from acids depends on whether the substances they are reacting with are **soluble** or **insoluble**.

Preparation of a salt from a metal or insoluble base/carbonate:

- Metals, bases and certain metal carbonates, are **insoluble** in water.
- There are **three stages** in the preparation.

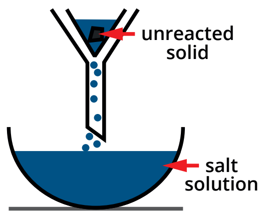
Stage 1:



- **Excess** metal/base/carbonate is added to the acid to make sure all **the acid has reacted and been used up**.
- Heating and stirring help the process.
- For metals and metal carbonates, the fizzing stops when all the acid has been used up.

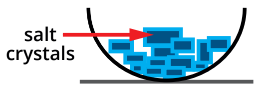
Stage 2:

- The mixture is **filtered** using a filter funnel and filter paper.
- The **excess solid remains in the filter paper**. The salt solution passes through into the evaporating basin.



Stage 3:

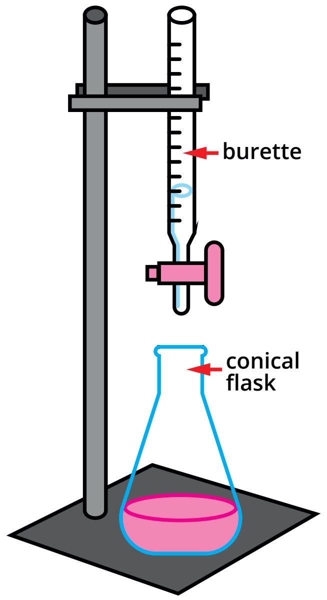
- The **salt crystals are collected** from the solution by **evaporation**.



- The solution is **heated to evaporate the water**. The size of the crystals produced depends on the rate of evaporation.
  - » **Large crystals – evaporate water slowly** near a radiator or window ledge.
  - » **Small crystals** – use a Bunsen to evaporate $^{2}/_{3}$ of the water quickly, before allowing to crystallise naturally.

Preparation of a salt from an alkali or soluble carbonate:

- An alkali is a soluble base.
- A **titration** is used to produce a salt from an acid and alkali.
- This is an outline method for carrying out a titration in which an acid is added to an alkali.



1. Measure exactly 25 cm³ of alkali into a clean conical flask.
2. Add a **few drops of indicator** to the flask.
3. Place the flask onto a white tile.
4. Fill the burette with acid.
5. Slowly add the acid from the burette to the alkali until the **indicator changes colour***. This is the **endpoint** of the reaction.
6. Record the volume of acid added to the flask.
7. Repeat steps 1-6 **without using the indicator** and adding the **same volume of acid** from the burette.

****The colour change will depend on which indicator is used to carry out the titration.***

The **salt crystals** are collected from the solution by **evaporation**.

Note - the same method works for adding an alkali to an acid - just swap around the solutions that go into the flask and burette.

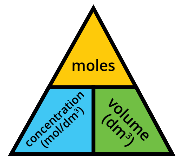
Preparing Insoluble Salts (SS only):

- An insoluble salt is made when solutions of two soluble salts react in a **precipitation reaction**.
- There are **three stages** in the method.
  Stage 1 – Mixing The two soluble salt solutions are mixed.
  Stage 2 – Filtration The insoluble precipitate is separated from the mixture by filtration. The precipitate stays behind in the filter paper, while the solution passes through.
  Stage 3 – Washing and drying Water cannot dissolve the precipitate - it is insoluble - but it can wash off any remaining impurities. The filter paper is then removed, opened out and the precipitate dried in an oven.

Titration Calculations (SS only):

- The concentration of a solution is the **number of moles per dm³**.
- The following equation is used to calculate the concentration of a solution:

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



Note – divide a volume in cm³ by 1,000 to convert to dm³.

Titration Calculation:

- The results of a titration can be used to calculate the concentration of an acid/alkali.

1:1 Mole Ratio

15.0 cm³ of 0.1 mol/dm³ hydrochloric acid was needed to neutralise 25.0 cm³ of sodium hydroxide solution. What is the **concentration** of the sodium hydroxide solution?

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Step 1: Convert all volumes to dm³

HCl 15.0 cm³ = 15.0 ÷ 1000 = **0.015 dm³**
NaOH 25.0 cm³ = 25.0 ÷ 1000 = **0.025 dm³**

Step 2: Calculate the number of moles of the substance where the volume and concentration are known

number of moles HCl = concentration × volume
number of moles of HCl = 0.1 × 0.015 = **0.0015 mol**

Step 3: Calculate the unknown concentration

This is a **1:1 reaction**, i.e. 1 part of HCl reacts with 1 part of NaOH. We can say that 0.0015 mol of acid reacts with 0.0015 mol of alkali.
concentration of NaOH = number of moles ÷ volume
concentration of NaOH = moles ÷ volume = 0.0015 ÷ 0.025 = 0.06 mol/dm³

2:1 Mole Ratio

20.0 cm of 0.5 mol/dm³ sulfuric acid was needed to neutralise 25.0 cm³ of sodium hydroxide solution. What is the **concentration** of the sodium hydroxide solution?

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Step 1: Convert all volumes to dm³

H_2SO_4 20.0 cm³ = 20.0 ÷ 1000 = **0.020 dm³**
NaOH 30.0 cm³ = 30.0 ÷ 1000 = **0.030 dm³**

Step 2: Calculate the number of moles of the substance where the volume and concentration are known

number of moles H_2SO_4 = concentration × volume
number of moles of H_2SO_4 = 0.5 × 0.020 = **0.01 mol**

Step 3: Calculate the unknown concentration

This is a **2:1 reaction**, i.e. 2 parts of NaOH react with 1 part of H_2SO_4. We can say that 0.01 mol of acid will react with 0.02 mol of alkali.
concentration of NaOH = number of moles ÷ volume
concentration of NaOH = moles ÷ volume = 0.02 ÷ 0.025 = 0.8 mol/dm³