Salts

What are Salts?

A salt is an ionic compound that consists of a cation (positive ion) and an anion (negative ion).

Reactions that produce salts

- acid + reactive metal → salt + hydrogen
- acid + carbonate → salt + water + carbon dioxide
- acid + base → salt + water
- base + ammonium salt → salt + water + ammonia gas

Solubility of Salts

Compound Containing	Solubility	Exceptions
Sodium, Potassium, Ammonium ions	All are soluble	-
Nitrate ions	All are soluble	-
Chloride ions	All are soluble	lead, silver insoluble
Sulfate ions	All are soluble	barium, calcium, lead insoluble. Silver sparingly soluble
Carbonate ions	All are insoluble	sodium, potassium, ammonium, Group 1 are soluble
Hydroxide ions	All are insoluble	sodium, potassium, Group 1, barium soluble. Calcium sparingly soluble.
Halides	All are soluble	silver, lead
Oxides	All are insoluble	-

Preparation of Salts

Uses of Salts

- Ammonium Phosphate
  - $\ce{(NH_4)_3 PO_4}$

    - A fertiliser used to provide plants with the elements nitrogen and phosphorus, essential for the plants' healthy growth.
- Monosodium Glutamate
    - $\ce{NaC_5H_8NO_4}
    - A sodium salt of glutamic acid which is used as a flavour enhancer in the food industry, and is especially used to enhance the taste of savoury foods.
- Sodium Fluoride
    - $\ce{NaF}$
    - A salt used to provide the fluoride ions in toothpaste. The fluoride ions prevent cavities and tooth decay.

Criteria for Preparation of Salts

- Solubility of the salt product
- Solubility of the reactants
- Method to achieve minimal contamination
- Ease of obtaining pure products
- Safety of procedure

Method 1: Reaction of acid with an excess insoluble substance, metal / carbonate / base

- To prepare a soluble salt from an acid
- Cation of the salt is provided by the insoluble substance, metal / carbonate / base
- Anion of the salt is provided by the acid.

Considerations

- Very reactive metals such as Group 1 metals are not reacted with acids due to safety as these metals react explosively with acids.
- Unreactive metals such as copper, silver, and gold do not react with acids.

Steps

1. Using a measuring cylinder, transfer $50 cm^3$ of a suitable acid into a beaker.
2. Add **excess** suitable insoluble metal / carbonate / base to the acid. Stir the mixture continuously until no more insoluble metal / carbonate / base can dissolve.
    - Excess of the insoluble substance can be seen at the bottom of the beaker.
    - **Rationale**
        - Insoluble substance is added in excess to ensure that all the acid has reacted. If not, the mixture at the end will contain excess acid and contaminate the salt produced.
3. Filter to remove excess insoluble substance (unreacted) as residue. Collect the filtrate, which is the desired salt solution
    - To remove excess insoluble substance
4. Heat the filtrate in an evaporating dish until saturated.
    - To obtain a saturated solution for crystallisation.
5. Cool the saturated solution to allow salt crystals to form.
    - Solubility decreases as solution cools.
6. Filter to collect the crystals. Wash the crystals with a little cold distilled water. Dry the

crystals between sheets of filter paper.
    - Use cold distilled water to minimise dissolving of the soluble salt crystals.

Method 2: Titration

- To prepare a soluble salt containing group 1 or ammonium cation
- Cation of the salt is provided by a soluble alkali or group 1 metal carbonate
- Anion of the salt is provided by the acid.

Considerations

- Titration is used to prepare group 1 salts as the metals of these salts are very reactive metals and group 1 carbonates and bases are soluble. Hence, method 1 was unsuitable.

Steps

1. Fill a burette with suitable dilute acid. Note the initial burette reading, $V_1 cm^3$
2. Pipette $25.0 cm^3$ of suitable aqueous alkali or aqueous carbonate into a conical flask.
3. Add a few drops of a suitable indicator to the solution in the conical flask.
4. Add the dilute acid from the burette slowly, swirling the conical flask, until the indicator changes colour permanently. Record the final burette reading, $V_2 cm^3$
5. Find the volume of dilute acid added for complete reaction, $V_2 - V_1 cm^3$
    - The colour change at the end point indicates that the reactant has been fully neutralised. The end point indicates the volume of alkali required to react completely with the acid.
6. Repeat the titration without adding the indicator. Add $V_2 - V_1 cm^3$ of the dilute acid to the aqueous alkali or aqueous carbonate into a conical flask, to obtain the desired salt solution.
    - Titration repeated without indicator so that the final salt produced is not contaminated by the indicator.
7. Heat the salt solution in an evaporating dish until saturated.
    - To obtain a saturated solution for crystallisation.
8. Cool the saturated solution to allow salt crystals to form.
    - Solubility decreases as solution cools
9. Filter to collect the crystals. Wash crystals with a little cold distilled water. Dry the crystals between sheets of filter paper.
    - Use cold distilled water to minimise dissolving of the soluble salt crystal.

Method 3: Ionic Precipitation

- To prepare an insoluble salt using 2 soluble solutions.
- Cation of the salt is provided by an aqueous salt solution, usually a nitrate of the desired cation as well as all nitrate salts are soluble.
- Anion of the salt is provided by another aqueous salt solution or acid, usually a sodium salt of the desired anion as all sodium salts are soluble.
- A precipitate is formed when two clear solutions react together to form an opaque solid product
- All solutions are clear but may be coloured, e.g. "blue solution of copper(II) sulfate".
- All precipitates are opaque and may be coloured, e.g. "yellow precipitate of lead(II) iodide".

- Note: There is no such thing as a clear precipitate!

Steps

1. Using a measuring cylinder, transfer $50 cm^3$ of a suitable salt solution AB into a beaker
2. Add the other suitable salt solution CD into the beaker and stir. Continue to add excess solution CD until no more precipitate AD forms.
    - Add excess CD so that all AB will be reacted.
3. Filter the mixture to obtain the insoluble salt, AD as the residue
    - The filtrate obtained is salt CB and excess CD
4. Wash the residue AD with distilled water. Dry the residue between sheets of filter paper.
    - The residue is washed to remove any excess soluble CD and soluble CB.