

7.3 Preparation of salts

Name: _____ Class: _____ Date: _____

Total: 30 marks

KEY WORDS insoluble 不溶 • filter 过滤 • crystallise 结晶 • excess 过量 • evaporate 蒸发

Objective

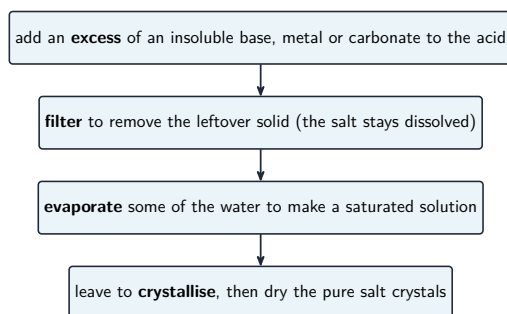
Build the skills to answer exam questions on the **preparation of salts** 盐的制备 — **solubility rules** 溶解性规则, making **soluble salts** 可溶盐, and making **insoluble salts** 不溶盐 by **precipitation** 沉淀.

You must be able to:

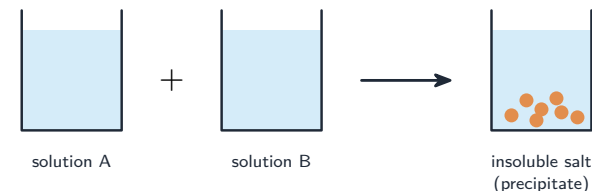
- use the solubility rules
- describe making a soluble salt (excess solid, filter, evaporate, crystallise)
- describe making an insoluble salt by precipitation

1 Worked examples

■ Two salt-making routes



Soluble salt from an insoluble solid: react with excess, filter, evaporate, crystallise



Insoluble salt: mix two solutions each carrying one needed ion → filter, wash, dry

- **soluble:** all Na/K/ammonium and nitrates; most chlorides/sulfates.

■ Choosing the route, and writing the equation

Decide from the solubility rules first. **Soluble:** all sodium, potassium and ammonium salts, all nitrates, most chlorides (not silver or lead) and most sulfates (not barium, calcium or lead). **Insoluble:** most carbonates and hydroxides (except sodium, potassium and ammonium).

Route 1, a soluble salt from an insoluble base or carbonate. Warm the acid, add the solid in **excess** so all the acid is used up, **filter** off the leftover solid, **evaporate** the filtrate until crystals begin to form, then leave it to **crystallise** and dry the crystals between filter papers. Use this when one reactant is insoluble, which is what makes “add in excess and filter” possible.

Route 2, a soluble salt from a soluble base (titration). Both reactants are in solution, so nothing can be filtered off. Find the exact volume of acid that neutralises the alkali by titration with an indicator, then repeat with the same volumes **without** the indicator, and evaporate and crystallise.

Route 3, an insoluble salt (precipitation). Mix solutions that each carry one of the needed ions, then **filter**, **wash** the residue with distilled water, and **dry** it.

Worked example. Describe how to prepare pure, dry copper(II) sulfate crystals from copper(II) oxide.

1. Warm dilute sulfuric acid in a beaker.
2. Add copper(II) oxide a little at a time, stirring, until some remains unreacted: this shows the acid has all reacted.
3. Filter to remove the excess copper(II) oxide.
4. Evaporate the blue filtrate until crystals just start to appear at the edge.
5. Leave the solution to cool and crystallise, then dry the crystals between filter papers.

The equation is $\text{CuO} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$. For a precipitation, an **ionic equation** shows only the ions that change: $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$.

2 Practice

2.1 State whether silver chloride is soluble or insoluble. [1]

2.2 Name the method used to make an insoluble salt. [1]

2.3 Identify which of these salts is insoluble: sodium chloride, barium sulfate, potassium nitrate. [1]

2.4 Write the ionic equation for the formation of silver chloride from silver nitrate and sodium chloride solutions. [2]

2.5 Explain why the solid is added in excess in the filtration route. [2]

3 Exam-style questions

3.1 A soluble salt is best made from an acid and an **excess** of an insoluble base by, in order: [1]

- A filter, react, crystallise
- B react, filter, evaporate, crystallise
- C evaporate, react, filter
- D precipitate, wash, dry

3.2 Describe how to make pure, dry copper(II) sulfate crystals from copper(II) oxide and dilute sulfuric acid. [4]

3.3 Barium sulfate is insoluble. Name two solutions that could be mixed to make it, and state what you would do after mixing. [3]

3.4 A student prepares two salts: zinc sulfate crystals from zinc carbonate, and lead(II) iodide.

(a) Write the equation for the reaction of zinc carbonate with dilute sulfuric acid. [2]

(b) Describe how the student obtains pure, dry crystals of zinc sulfate, giving the practical steps in order. [5]

(c) Explain how the student knows when enough zinc carbonate has been added. [2]

(d) Lead(II) iodide is insoluble. Identify two solutions that could be mixed to prepare it, and write the ionic equation. [3]

(e) State the three steps needed to obtain the dry lead(II) iodide from the mixture, and state why the residue is washed. [3]

Solutions

2.1 insoluble.

2.2 precipitation.

2.3 Barium sulfate.

2.4 $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$.

2.5 So that all of the acid is used up; the excess solid can then be filtered off, leaving a solution containing only the salt.

3.1 B. React (excess base), filter off the excess, evaporate, then crystallise.

3.2 add excess copper(II) oxide to warm dilute sulfuric acid until no more reacts; filter to remove the excess solid; evaporate some water from the filtrate; leave to crystallise, then dry the crystals.

3.3 mix a solution of a soluble barium salt (e.g. barium chloride) with a soluble sulfate (e.g. sodium sulfate); then filter, wash and dry the precipitate.

3.4 (a) $\text{ZnCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O} + \text{CO}_2$.

(b) Warm the dilute sulfuric acid; add zinc carbonate a little at a time, with stirring, until it is in excess; filter to remove the excess solid; evaporate the filtrate until crystals begin to form at the edge; leave it to cool and crystallise, then dry the crystals between filter papers.

(c) Solid stays at the bottom of the beaker and no more bubbles of carbon dioxide are produced; this shows all the acid has reacted.

(d) Any soluble lead salt, such as lead(II) nitrate, with any soluble iodide, such as potassium iodide; $\text{Pb}^{2+}(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow \text{PbI}_2(\text{s})$.

(e) Filter the mixture, wash the residue with distilled water and dry it; it is washed to remove the soluble salt solution left on the crystals, which would otherwise contaminate the product.