

11.3 Some reactions of the halide ions

Name: _____ Class: _____ Date: _____

Total: 24 marks

KEY WORDS reducing agent 还原剂 • precipitate 沉淀 • ammonia 氨 • halide ion 卤离子
• silver halide 卤化银

Objective

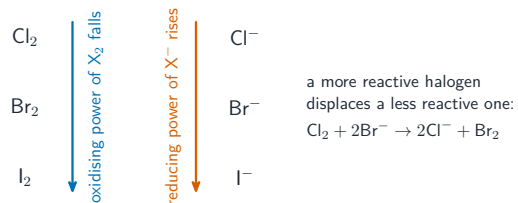
Build the skills to answer exam questions on **reactions of the halide ions** 卤离子 — halides as **reducing agents** 还原剂, the **silver halide** 卤化银 test, and the reaction with concentrated sulfuric acid.

You must be able to:

- describe the relative reactivity of the halide ions as reducing agents
- describe the test with aqueous silver ions followed by ammonia
- describe and write equations for the reactions with concentrated sulfuric acid

1 Worked examples

Halides as reducing agents

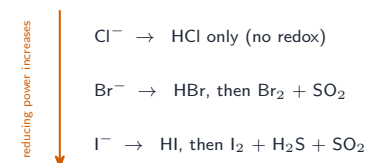


Reducing power of the halide ions increases down the group (a larger ion loses its electron more easily)

The silver halide test

Add AgNO₃ then ammonia: AgCl white (dissolves in dilute NH₃), AgBr cream (dissolves in conc. NH₃), AgI yellow (insoluble)

With concentrated sulfuric acid



The stronger reducing agents (Br⁻, I⁻) are oxidised to the halogen, reducing the sulfur

- Cl⁻: only HCl (no redox): $\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$.
- Br⁻: $\text{HBr} + \text{brown Br}_2 + \text{SO}_2$. I⁻: $\text{HI} + \text{I}_2 + \text{H}_2\text{S} + \text{SO}_2$ (I⁻ is the strongest reducing agent).

2 Practice

2.1 State the colour of the precipitate formed when silver nitrate is added to (a) chloride and (b) iodide ions. [2]

2.2 State the trend in reducing power of the halide ions down the group. [1]

3 Exam-style questions

3.1 A halide gives a cream precipitate with silver nitrate that dissolves only in concentrated ammonia. The halide is: [1]

- **A** chloride
- **B** bromide
- **C** iodide
- **D** fluoride

3.2 Which halide is oxidised to a coloured element by concentrated sulfuric acid, also producing H_2S ? [1]

- **A** chloride
- **B** bromide
- **C** iodide
- **D** none of them

3.3 (a) Describe how you would use silver nitrate and ammonia to distinguish between solutions of sodium chloride and sodium iodide. [3]

(b) Explain why iodide ions are oxidised by concentrated sulfuric acid but chloride ions are not. [2]

3.4 Write the equation for the reaction of solid sodium chloride with concentrated sulfuric acid. [1]

3.5 Separate samples of solid NaCl , NaBr and NaI are each warmed with concentrated sulfuric acid.

(a) State what is observed with each solid, naming the sulfur-containing product where one is formed. [5]

(b) Explain the pattern in (a) in terms of the reducing power of the halide ions. [3]

(c) Describe the test that distinguishes chloride, bromide and iodide ions **in solution**, giving the result in each case and the effect of adding aqueous ammonia. [4]

(d) State why dilute nitric acid is added before the silver nitrate. [1]

Solutions

2.1 (a) white; (b) yellow.

2.2 reducing power increases down the group.

3.1 B. A cream precipitate dissolving only in concentrated ammonia is bromide.

3.2 C. Iodide is the strongest reducing agent, reducing the acid to H_2S .

3.3 (a) add silver nitrate to each — both give a precipitate; chloride gives white, iodide gives yellow; add ammonia — the chloride (white) dissolves in dilute ammonia, the iodide (yellow) is insoluble.

(b) iodide ions are stronger reducing agents (lose their electron more easily), so they reduce the sulfuric acid; chloride ions are too weak a reducing agent.

3.4 $\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$.

3.5 (a) NaCl: steamy white fumes of HCl only — no redox occurs. NaBr: steamy fumes of HBr, plus orange-brown bromine vapour and a colourless choking gas, **sulfur dioxide**. NaI: purple-black iodine, a yellow solid (sulfur) and the smell of bad eggs — **hydrogen sulfide**.

(b) Reducing power increases down the group; the ion gets larger, so its outermost electron is further from the nucleus and better shielded and is lost more easily; iodide can therefore reduce sulfur from +6 all the way to -2, whereas chloride cannot reduce it at all.

(c) Acidify with dilute nitric acid, then add aqueous silver nitrate. White precipitate = chloride, cream = bromide, yellow = iodide. The white dissolves in **dilute** ammonia; the cream dissolves only in **concentrated** ammonia, and the yellow dissolves in neither.

(d) To remove carbonate and other ions that would themselves precipitate with silver nitrate and give a false positive.