QUALITATIVE ANALYSIS OF THE 3RD GROUP CATIONS AND FIFTH GROUP

Qualitative Analysis of the 3rd Group Cations

Definition of the 3rd Group Cations

These cations do not precipitate with the addition of hydrochloric acid (HCl) or hydrogen sulfide (H_2S) under acidic conditions (used for groups 1 and 2, respectively). Instead, they precipitate in basic conditions with hydrogen sulfide.

Key Cations in the 3rd Group:

1. Ferric ion (Fe^{3+})
2. Chromium ion (Cr^{3+})
3. Aluminum ion (Al^{3+})
4. Nickel ion (Ni^{2+})
5. Cobalt ion (Co^{2+})
6. Zinc ion (Zn^{2+})
7. Manganese ion (Mn^{2+})

SEPARATION AND ANALYSIS STEPS

1. Sample Preparation:

• Dissolve the sample in water or a dilute acid.

• Remove any precipitates formed from the cations of groups 1 and 2.

2. Addition of Basic Reagent:

• Add ammonia (NH_3) or ammonium sulfide .

• This leads to the precipitation of the 3rd group cations as sulfides or hydroxides (e.g., $Fe(OH)_3$, ZnS).

3. Separation of Cations:

• Separate the precipitates based on their solubility properties.

• For instance, ZnS dissolves in dilute acids, while $Fe(OH)_3$ does not.

4. Confirmatory Tests:

• Fe^{3+}: Reacts with potassium thiocyanate (KSCN) to produce a blood-red color.

• Zn^{2+}: Forms a colorless solution with excess ammonia.

• Cr^{3+}: Produces a green solution when heated with NaOH.

QUALITATIVE ANALYSIS OF THE 5TH GROUP CATIONS

Definition of the 5th Group Cations

These are the cations that remain in solution after the precipitation of the first four groups. They are also called "soluble group cations" as they do not react with the general group reagents.

KEY CATIONS IN THE 5TH GROUP:

1. Sodium (Na^+)
2. Potassium (K^+)
3. Ammonium (NH_4^+)
4. Magnesium (Mg^{2+})

STEPS FOR SEPARATION AND IDENTIFICATION

1. Detection of Ammonium Ion (NH_4^+):

- Heat the solution with sodium hydroxide (NaOH).
- If ammonia gas (NH_3) is released, the presence of NH_4^+ is confirmed.

2. Analysis of Potassium (K^+) and Sodium (Na^+):

- Perform a flame test:
- Na^+: Produces a bright yellow flame.
- K^+: Produces a violet flame (visible through a cobalt blue glass filter).

3. Detection of Magnesium Ion (Mg^{2+}):

- Use the magnesium reagent test or precipitate Mg^{2+} as $MgNH_4PO_4$ by adding NH_4OH, NH_4Cl, and HPO_4^{2-}.

Comparison of 3rd and 5th Group Cations

Property	3rd Group	5th Group
Reagents Used	H_2S in basic medium (NH_3 or)	NaOH, flame test
Nature of Cations	Transition metals (heavy elements)	Alkali and alkaline earth metals
Confirmatory Tests	Precipitation as sulfides or hydroxides	Flame test, ammonium detection

CONCLUSION

The qualitative analysis of 3rd and 5th group cations relies on a logical sequence of chemical reactions to separate and identify ions. Proper handling of reagents and following precise steps are essential for accurate results.