6^{th} – 8^{th} WEEKs

Analysis of Cation Group 3:

- Cation group 3- Each student complete the procedure for their own UNKNOWN sample analysis
- Cation group 3 is the second largest group in qualitative analysis. It is studied in two subgroups named Subgroup 3A and Subgroup 3B to give the analyst a smaller number of cations to deal with at one time. Therefore, this experiment takes at least two-three weeks to be completed.
- First, the unknown cation group 3 sample is precipitated and then separated into two subgroups.

  Subgroup 3A: Mn^{2+} - Fe^{2+} - Fe^{3+} - Ni^{2+}- Co^{2+}

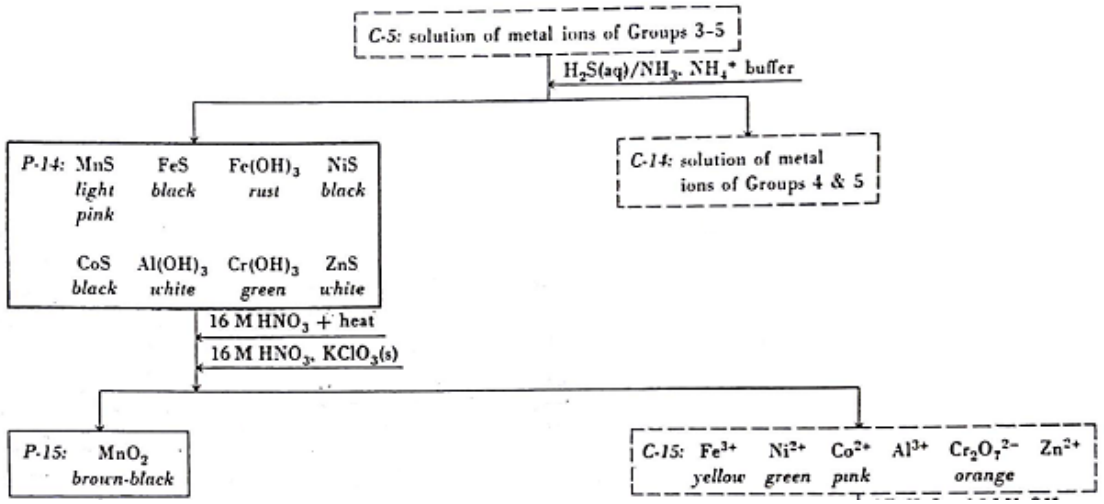
  Subgroup 3B: Al^{3+}- Cr^{3+}- CrO_4^{2-}- Zn^{2+}
- After the separation of subgroups, different procedures are applied to each subgroup.
- Three analysis schemes are given below.

In all analysis schemes, precipitates are enclosed in boxes with solid lines, solutions are contained in boxes with dashed lines.

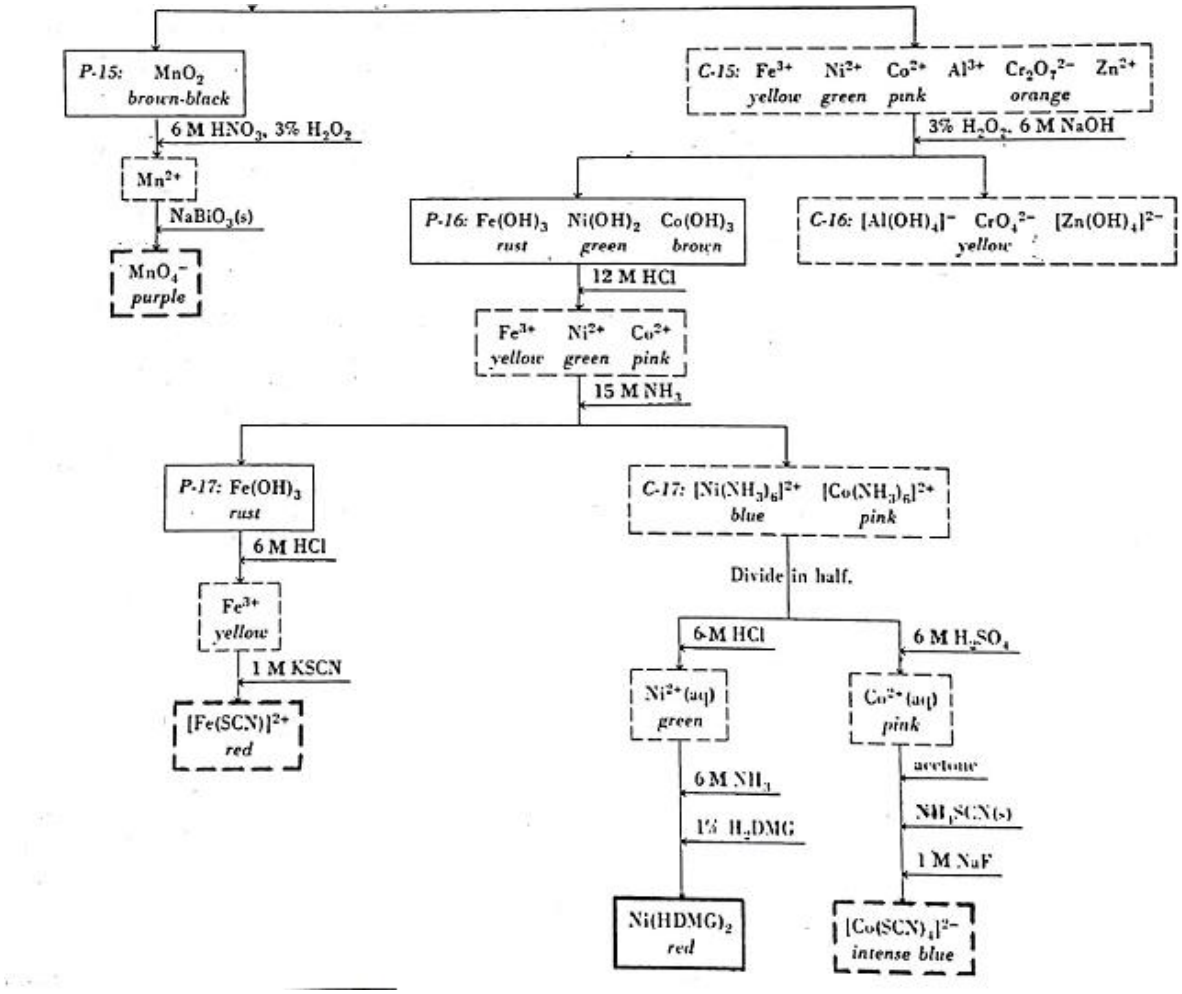
Cation Group 3: The Ammonium Sulfide Group-

Mn^{2+} - Fe^{2+} - Fe^{3+} - Ni^{2+}- Co^{2+}- Al^{3+}- Cr^{3+}- CrO_4^{2-}- Zn^{2+}

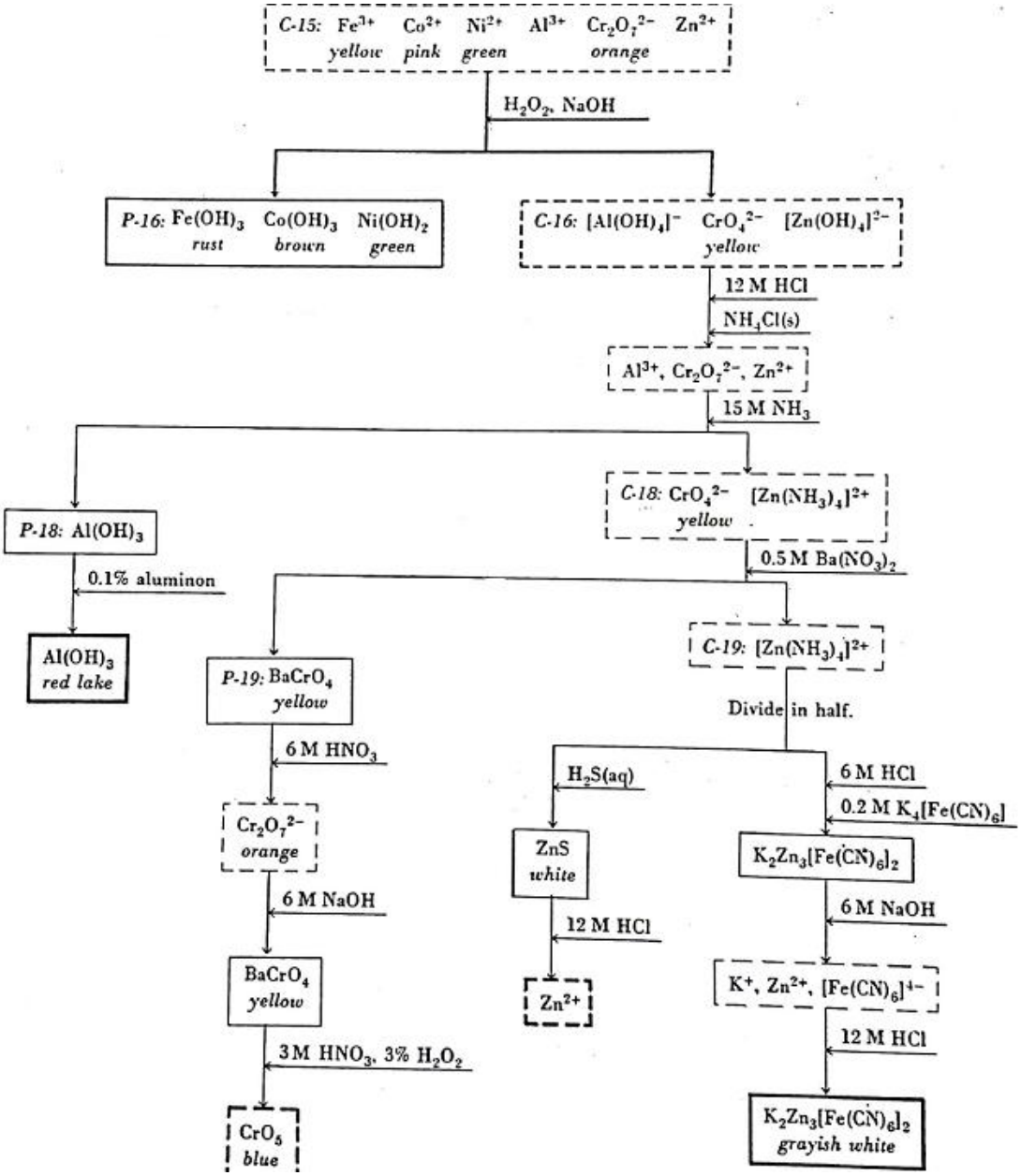
The cations of the ammonium sulfide group are precipitated as hydroxides and sulfides from an alkaline solution of hydrogen sulfide.



Qualitative analysis flowchart for The Ammonium Sulfide Group: Precipitation and separation into two subgroups



Qualitative analysis flowchart for The Ammonium Sulfide Subgroup 3A



Qualitative analysis flowchart for The Ammonium Sulfide Subgroup 3B

Some examples for precipitation reactions

$Fe^{3+}(aq) + 3\,NH_3(aq) + 3\,H_2O \longrightarrow Fe(OH)_3(s) + 3\,NH_4^+(aq)$

$Al^{3+}(aq) + 3\,NH_3(aq) + 3\,H_2O \longrightarrow Al(OH)_3(s) + 3\,NH_4^+(aq)$

$Cr^{3+}(aq) + 3\,NH_3(aq) + 3\,H_2O \longrightarrow Cr(OH)_3(s) + 3\,NH_4^+(aq)$

$Mn^{2+}(aq) + 2\,NH_3(aq) + H_2S(aq) \longrightarrow MnS(s) + 2\,NH_4^+(aq)$

$Fe^{2+}(aq) + 2\,NH_3(aq) + H_2S(aq) \longrightarrow FeS(s) + 2\,NH_4^+(aq)$

$Co^{2+}(aq) + 2\,NH_3(aq) + H_2S(aq) \longrightarrow CoS(s) + 2\,NH_4^+(aq)$

$Ni^{2+}(aq) + 2\,NH_3(aq) + H_2S(aq) \longrightarrow NiS(s) + 2\,NH_4^+(aq)$

$Zn^{2+}(aq) + 2\,NH_3(aq) + H_2S(aq) \longrightarrow ZnS(s) + 2\,NH_4^+(aq)$

Some examples for the separation of subgroups

$Fe(OH)_3(s) + 3H^+(aq) \longrightarrow Fe^{3+}(aq) + 3H_2O$

$Al(OH)_3(s) + 3\,H^+(aq) \longrightarrow Al^{3+}(aq) + 3\,H_2O$

$Cr(OH)_3(s) + 3\,H^+(aq) \longrightarrow Cr^{3+}(aq) + 3\,H_2O$

$3\,ZnS(s) + 2\,NO_3^-(aq) + 8\,H^+(aq) \longrightarrow 3\,Zn^{2+}(aq) + 2\,NO(g) + 3\,S(s) + 4\,H_2O$

$3\,MnS(s) + 2\,NO_3^-(aq) + 8\,H^+(aq) \longrightarrow 3\,Mn^{2+}(aq) + 2\,NO(g) + 3\,S(s) + 4\,H_2O$

$Fe(OH)_3(s) + 3\,H^+(aq) \longrightarrow Fe^{3+}(aq) + 3\,H_2O$

$FeS(s) + NO_3^-(aq) + 4\,H^+(aq) \longrightarrow Fe^{3+}(aq) + NO(g) + S(s) + 2\,H_2O$

$3\,CoS(s) + 2\,NO_3^-(aq) + 8\,H^+(aq) \longrightarrow 3\,Co^{2+}(aq) + 2\,NO(g) + 3\,S(s) + 4\,H_2O$

$3\,NiS(s) + 2\,NO_3^-(aq) + 8\,H^+(aq) \longrightarrow 3\,Ni^{2+}(aq) + 2\,NO(g) + 3\,S(s) + 4\,H_2O$

Some examples for identification reactions

$2Mn^{2+}(aq) + 5NaBiO_3(s) + 14H^+ \longrightarrow 2MnO_4^-(aq) + 5Bi^{3+}(aq) + 5Na^+(aq) + 7H_2O$

$Fe^{3+}(aq) + SCN^-(aq) \longrightarrow FeSCN^{2+}(aq)$

$Co^{2+}(aq) + 4SCN^-(aq) \longrightarrow Co(SCN)_4^{2-}(aq)$

$4CrO_5(aq) + 12\,H^+(aq) \longrightarrow 4Cr^{3+} + 7O_2(g) + 6H_2O$

$Zn(NH_3)_4^{2+}(aq) + H_2S(aq) \longrightarrow ZnS(s) + 2NH_3(aq) + 2NH_4^+(aq)$

REPORT FOR QUALITATIVE ANALYSIS

Name-Surname:		**Number:**	
Sample No	**3**	**Date**	
Sample Name	**Cation group 3**		
Ions expected to be observed	**To be filled by the assistant**		
Analysis of ion under study	**Procedure and Observation**	**Precipitation-Identification reactions for the ion**	
Result			

List of some reagents used in experiments are given below:

Ammonia/ammonium chloride buffer solution (NH_3/NH_4Cl)
2 M thioacetamide (CH_3CSNH_2)
6 M Ammonia solution (NH_3)
12 M Hydrochloride (HCl)
6 M Nitric acid solution (HNO_3)
4 M Potassium hydroxide (KOH)
0.5 M Barium nitrate ($Ba(NO_3)_2$)
0.1% Aluminon
3% Hydrogen peroxide(H_2O_2)