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عنوان المحاضرة باللغة الانجليزية	Qualitative Analysis of Cations (Group I)
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Qualitative Analysis of Cations (Group I)

Separation of the Silver Group (Ag^+, Pb^{2+}, and Hg_2^{2+})

In this step, you will be given a single test tube with either one, two or all three ions. You will use the same tests that you did for each individual ion to separate the ions and confirm their identity. Add 5 drops of 3 M HCl to the solution to be analyzed. Stir. A white precipitate indicates that one or more of the ions Ag+, Pb2+, and Hg22+ is present. Centrifuge the solution and test to be sure that precipitation is complete by adding one more drop of 3M HCl. No additional precipitate should form. If more precipitate does form, continue adding 3M HCl until precipitation is complete. Centrifuge and decant (pour off) the clear liquid into a second test tube for step 5. Alternatively, you can just decant the supernatant. Wash the precipitate by adding 1 mL distilled water and stirring. Centrifuge and discard the wash water.

Separation and Confirmation of Lead

Lead chloride is considerably more soluble in hot water than cold water. Silver chloride and mercury(I) chloride are not very soluble at all in hot water.

$PbCl_2(s) \rightarrow Pb^{2+}(aq) + 2Cl^-(aq)$

The confirmatory test for lead is the formation of the yellow precipitate of PbCrO4 when K2CrO4 is added.

$Pb_2+(aq) + CrO_4^{2-}(aq) \rightarrow PbCrO_4(s)$

Add 1 mL of distilled water to the precipitate of AgCl, $PbCl_2$, and Hg_2Cl_2 and heat in a boiling water bath for about 3 minutes with occasional stirring. Centrifuge the hot solution, and quickly pour off the supernatant liquid. To the clear liquid, add 5 drops of K_2CrO_4. yellow precipitate of $PbCrO_4$ confirms the presence of lead. If lead ions are found to be present, check to be sure that all of the lead is removed from the AgCl and Hg_2Cl_2 precipitates by repeating the process of adding distilled water, heating, centrifuging and pouring off the clear liquid until the addition of K_2CrO_4 to the liquid no longer forms a precipitate.

Separation of Silver and Mercury; Confirmation of Mercury.

When 6M NH3 is added to AgCl, the Ag+ forms a colorless complex ion and goes into solution (meaning the precipitate dissolves):

$AgCl(s) + 2NH_3(aq) \leftrightarrow Ag(NH_3)_2+(aq) + CI^-(aq)$

The addition of the 6M NH_3 to the Hg_2Cl_2 causes the mercury(I) ion to undergo a disproportionation reaction. The appearance of the dark gray solid upon the addition of 6M NH_3 is confirmation of the presence of the mercury(I) ion.

$Hg_2Cl_2(s) + 2NH_3(aq) \rightarrow Hg(l) + HgNH_2Cl(s) + NH^{4+} + Cl^-(aq)$

To the precipitate from previous step, which is AgCl and Hg_2C_{l2}, add 1 mL 6M NH_3. The appearance of the dark gray precipitate confirms the presence of mercury (I). Stir, centrifuge, and transfer the solution to another test tube for step 4. Dispose of the mercury compounds in the container provided.

Confirmation of Silver

Addition of nitric acid (3M HNO3) to the [Ag(NH3)4] + complex ion (recall that this compound was formed when NH3 was added to the white precipitate of Ag+) breaks apart the ion. The NH3 combines with H+ to form NH4+, and the Ag^+ recombines with the Cl^- ion to precipitate as white AgCl.

$Ag(NH_3)_2$+(aq) + Cl^- (aq) + $2H^+$(aq) → AgCl(s) + $2NH_4$ + (aq)

Add 15 drops of 3M HNO3 to the solution. The solution will smoke and the reaction between the strong acid and the base will give off heat whether or not silver is present. The test tube may get very warm. Stir and test with pH indicator paper or litmus paper to be sure the solution is acidic. If it is not acidic, add more HNO3. The reappearance of the white AgCl precipitate in the acidic solution confirms the presence of silver.

Confirmation of Mercury

Addition of nitric acid (3M HNO_3) or (3HCl +HNO_3) for dissolve the black ppt (Hg + HgNH2Cl) and form HgCl2. This reaction involves oxidation reaction:

$Hg^0 \rightarrow Hg^{2+} + 2e$ Or $Hg^{1+} \rightarrow Hg^{2+} + e$

Addition of SnC_{l2} to convert HgC_{l2} to Hg_2C_{l2} and then addition of excess of SnC_{l2} to convert Hg_2C_{l2} to Hg. This reaction involves reduction reaction as shown in equations:

$2HgC_{l2} + SnC_{l2} \rightarrow Hg_2C_{l2} + SnC_{l4}$ White ppt

$Hg_2C_{l2} + SnC_{l2} \rightarrow 2Hg + SnC_{l4}$ Black ppt

The appearance of the dark precipitate confirms the presence of mercury (I).

Qualitative Analysis of Cations (Group I)

Analysis of Solutions Containing the Ions: