Classical qualitative analysis. 7. Amphoteric properties of hydroxides

Amphoterism – the ability of chemical to react with both acids and bases. Otherwise, it is the ability of chemicals to act in some reactions as acids and in other as bases. Amphoteric compounds are sometimes called **ampholytes**. Among the inorganic compounds these ones which contain the elements from the central groups of the periodic table exhibit the best amphoteric properties. This is typical behavior for the metal hydroxides with an average electronegativity, such as aluminum and zinc. The tendency of elements to form amphoteric compounds is associated with the ability to form by their compounds in aqueous solution both cations and anions. Amphoteric properties of hydroxides are often used in qualitative analysis for the separation of ions. For example, the amphoteric properties of the sparingly soluble aluminum hydroxide allow to separate it from the sparingly soluble iron hydroxide (III), which exhibits basic character. Most of the sparingly soluble in water hydroxide will dissolve in dilute non-oxidizing acids: $Fe(OH)_3 + H_3O^+ \rightarrow Fe^{3+} + 6H_2O$. However, in dilute solutions of strong bases only amphoteric hydroxides will dissolve: $Al(OH)_3 + OH^- \rightarrow Al(OH)_4^-$

Experimental procedure:

I.

1. Pour approximately 0.5 cm^3 of a) Fe^{3+} ions solution b) Al^{3+} ions solution into two glass test tubes.
2. Into each of these tubes pour approximately 0.5 cm^3 2 M/l $NH_3.H_2O$ solution
3. In both tubes hydroxides will precipitate, in a) brown in b) white gelatinous. Write the appropriate precipitation reactions.
4. Into both tubes with precipitates pour approximately 0.5 cm^3 2 M/l HCl solution. Precipitates should be dissolved. Write the appropriate dissolving reactions.

II.

1. Pour approximately 0.5 cm^3 of Fe^{3+} ions solution and Al^{3+}ions solution into one test tube .
2. Into test tube containing the mixture of Fe^{3+} and Al^{3+} ions pour approximately 1 cm^3 2 M/l $NH_3.H_2O$ solution. Precipitate should be formed. Observe the color of sediment. Write the appropriate precipitation reactions.
3. Separate hydroxides precipitates from the solution by centrifuging it in plastic tubes in centrifuges and decanting the solution.
4. To centrifuged precipitate add about 0.5 cm^3 of 2M/l NaOH solution. Part of the precipitate should be dissolved and this solution should be poured into a glass test tube: solution A.
5. Perform identification reaction for Al^{3+} ion in solution A using spot test analysis (see Exercise 3). Observe the color of the stain on the blogging paper. Write the reaction equation for dissolving of aluminum hydroxide in NaOH solution.
6. To the remaining precipitate (from point 4) add approximately 0.5 cm^3 of a 2 mol/l HCl solution. Precipitate should be dissolved. Obtained solution pour to glass test tube: solution B.
7. Perform the identification of Fe^{3+} ions in solution B using the complex formation reaction (see Exercise 2, point 2): $Fe^{3+} + SCN^- \leftrightarrow [Fe(SCN)]^{2+}$ ..... (the last step): $Fe^{3+} + 6SCN^- \leftrightarrow [Fe(SCN)_6]^{3-}$. Observe the color of the solution in a test tube.

III.

Specify one reagent which may be applied to separate $Al(OH)_3$ from $Fe(OH)_3$. Write appropriate reaction equations.