

The separation of substances by precipitation

1. Execution of the exercise

1.1. Salt precipitation as a function of Ks

1.1.1. Mix an equal volume of $\text{Pb}(\text{NO}_3)_2$ and **1 M NaCl** in the test tube. Mix and observe the changes. Then add the Na_2SO_4 solution and centrifuge the resulting sediment (or wait until it falls to the bottom of the tube). Then add Na_3PO_4 solution to the supernatant. Observe phenomena occurring in the subsequent stages of the exercise.

1.1.2. Prepare 2 test tubes with 1-2 cm^3 of **0.1 M Ba²⁺** ion solution. Add 2-3 cm^3 of acetate buffer to the first tube, and then add **0.5 M K₂CrO₄**. Add only a potassium chromate solution to the second tube. Perform the same exercise for a **0.1 M Sr²⁺** salt solution.

1.1.3. Precipitation of aluminium hydroxide with a salt solution of weak acids. Add Na_2CO_3 solution to the test tube with 1-2 cm^3 Al^{3+} ions. Observe and note the results of the experiment.

1.2. Complexing reactions and precipitation reactions.

1.2.1. Ammonia complexes.

1.2.1.1. To approx. 1 cm^3 of the Fe^{3+} ion solution add the prepared (1:1) mixture: **2 M NH₃ aq** and **1 M NH₄Cl**. Repeat the experiment for the following cations: Al^{3+} , Mn^{2+} , Zn^{2+} , Co^{2+} . Observe and note the results of the experiment.

1.3. Amphotericity and precipitation reactions.

1.3.1. Add a few drops of Al^{3+} ion solution to the test tube. Then add dropwise a solution of **0.1 M NaOH**. Dissolve the precipitate by adding further portions of **0.1 M NaOH**.

Repeat the experiment for the following cations: Zn^{2+} , Pb^{2+} .

1.4. Change of the oxidation state in sediment precipitation reactions.

1.4.1. Precipitation of $\text{MnO}(\text{OH})_2$ deposits as a result of the redox reaction.

Add 1 cm^3 of Mn^{2+} salt solution to the test tube, then a few drops of **2 M NaOH** and 1-2 drops of H_2O_2 . Note the observations.



2. Development of results

- Salt precipitation as a function of Ks:
 - based on solubility equilibrium (Ks) value explain the effects observed in the 1.1. exercise. Calculate the salt solubility.
- The influence of pH on precipitation reactions:
 - explain why and in which test tubes in the exercise performed according to point 1.1.2. can the formation of sediments be observed? Give and write reactions for them.
 - find in the chemical tables the value of the solubility product for the BaCrO_4 and SrCrO_4 salts. What is the pH area in which the barium salt precipitates completely, and the strontium salt is not yet? Consider the course of reaction in point 1.1.2. without stabilizing the pH of the reaction medium with buffer.
 - why is there a precipitate in the exercise performed according to point 1.1.3.? Write a reaction.
- Complexing reactions and precipitation reactions.
 - which cations will remain in the solution in exercise 1.2.1. and in what form? Give patterns, reactions and stability constants of the complexes formed. Describe using chemical reactions, how the solution (analyzed in section 1.2.1.1) containing the Fe^{3+} , Al^{3+} , Mn^{2+} , Zn^{2+} , Co^{2+} cations would behave if treated with a 2 M NaOH solution.
- Amphotericity and precipitation reactions.
 - describe the phenomena occurring during the experiments in point 1.3.1. Does the pH at which the hydroxides precipitate coincide with the literature data?

Complete the table after completing the exercise:

Cation	pH of occurrence in the form		
	Me^{n+}	$\text{Me}(\text{OH})_n$	Hydroxo-complex
Al^{3+}			
Zn^{2+}			
Pb^{2+}			

- Change of the oxidation state in sediment precipitation reactions.
 - write reactions taking place in point 1.4.1. with an electronic balance. How can dissolve the resulting $\text{MnO}(\text{OH})_2$ precipitate? Give the reaction.



3. Conclusion

4. The scope of the material

- Solubility equilibrium and solubility (K_s and s)
- Salt effect, common ion effect.
- The influence of pH on the precipitation reaction.
- The effect of complexing reactions on precipitation
- Amphotericity and precipitation reactions.

5. Literature

- G. Charlot, *Quantitative inorganic analysis*, John Wiley & Sons inc. , London 1954
(<https://archive.org/details/in.ernet.dli.2015.151602>)

