

MINISTRY OF HEALTH OF UKRAINE
BOGOMOLET'S NATIONAL MEDICAL UNIVERSITY

Department of Medical and General Chemistry

**GENERAL AND INORGANIC
CHEMISTRY**

Student notebook for experimental chemistry

(II semester “Chemistry of elements”)

Student _____

Group _____

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This Student Notebook for Experimental Chemistry allows you to keep a written record or report of the mandatory laboratory that you will carry out as part of the General and Inorganic Chemistry course. The Student Laboratory Notebook includes laboratory works and also questions in all basic topics in General and Inorganic Chemistry. Chemistry is a practical subject, and, by developing your practical skills in the laboratory, you will increase your understanding and appreciation of chemistry.

The notebook is for first year foreign students of Pharmaceutical Faculty.

Have fun, enjoy your laboratory works, and best of luck with it!

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LABORATORY SAFETY RULES

Take care of yourself.

Acquire good lab habits from the word go.

- ✓ Report all accidents, injuries, and breakage of glass or equipment to teacher immediately.
- ✓ Lab coats should be worn in laboratory.
- ✓ Long hair (chin-length or longer) must be tied back to avoid catching fire.
- ✓ Work quietly – know what you are doing by **reading** the assigned experiment **before** you start to work. Pay close attention to any **cautions** described in the laboratory exercises.
- ✓ Do not taste or smell chemicals.
- ✓ Never return chemicals to their bottles.
- ✓ **Never** point a test tube being heated at another student or yourself. Never look into a test tube while you are heating it.
- ✓ Unauthorized experiments or procedures **must not** be attempted.
- ✓ Leave your work station clean and in good order before leaving the laboratory.
- ✓ Do not leave your assigned laboratory station without permission of the teacher.
- ✓ Follow all instructions given by your teacher.
- ✓ Do not mouth pipette.
- ✓ Do not waste chemicals; do not take more than what is required
- ✓ Wash your hands before leaving the lab.
- ✓ Absolutely no noise or disruptive behavior in the lab. No fooling around.
- ✓ **No eating or drinking in the lab at any time!**



Exothermic Dangers

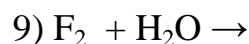
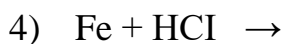
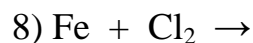
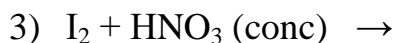
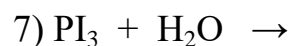
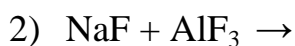
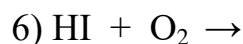
When you make up a solution using a concentrated or solid strong acid or base, always gradually add the acid or base to the water, not vice versa. If you add water to the strong acid or base, the solution may boil almost instantly, ejecting the chemical forcefully from the container.

Topic 1. General characteristics of the p-elements. Hydrogen and its compounds. p-elements of the VIIA group. Halogens. Halogens compounds in positive and negative oxidation states.

Questions for admission to the implementation of laboratory works:

1. What oxidation states (numbers) are characteristic for hydrogen and its compounds?
2. What types of chemical bonds form hydrogen in binary compounds with other elements? Give examples of binary compounds of hydrogen with various types of chemical bonds.
3. What is a hydrogen bond?
4. Which of the metals can be used to produce H_2 from hydrochloric acid (HCl): Cu, Al, Fe, Mg, Au, Ag, Hg, Zn, Pb?
5. Assign the oxidation number of hydrogen in following compounds: H_2O , H_2O_2 , NaH, PH_3 , H_2 , CH_4 , C_2H_4 , H_2S , HCl?
6. Describe the chemical properties of hydrogen.
7. What substances – S, P, N, Cl, Cu, Zn, Al, Au, Pt, H_2O , SO_2 , P_2O_5 , $Cu(OH)_2$, FeO – interact with H_2 ? Write reactions.
8. Explain, why the water molecule is polar.
9. Name the physiological solution in which water acts as a solvent.
10. What substances – Na, Ca, Mg, Al, Cu, Fe, S, Cl_2 , N_2 , H_2S , K_2S , $Cu(NO_3)_2$, $Ba(NO_2)_2$ – interact with H_2O ? Write reactions.
11. Describe the acid-base nature of the hydrogen peroxide.
12. Why hydrogen peroxide exhibits oxidizing and reducing properties?
13. What is the electronic configuration of halogen atoms? What oxidation numbers are characteristic for halogens in compounds? Explain speciality of fluorine.
14. Describe the chemical properties of halogens.
15. Write the mechanism of chain reaction between chlorine and hydrogen.
16. Hydrogen halides: write formulas and characterize their reducing properties.
17. Preparation of hydrochloric, hydrobromic, hydroiodic and hydrofluoric acids.
18. Which of the hydrogen halides (HF, HCl, HBr, HI) react with sulfuric acid? Write reactions.

19. Complete and balance equations for the following reactions:



20. Iodine is practically insoluble in water but soluble in a solution of KI. Why?

21. Explain the high reactivity of the mixture of nitric and hydrochloric acids.

22. What substances – Cu, Fe, Al, Na_2SO_4 , AgNO_3 , SiO_2 , Cr_2O_3 , MnO_2 , KClO_3 , KMnO_4 – interact with HCl? Write reactions.

23. Why hydroiodic acid in air turns brown?

24. Oxidizing property of OF_2 . Write the reaction equation of OF_2 with dilute sodium hydroxide solution.

25. Explain inability of fluorine to exhibit any oxidation state other than -1 in its compounds.

26. Write the reaction for preparation of chlorine water, bleaching powder.

27. Write the reaction for preparation of chloric acid, hypochlorous acid.

28. Write the reaction for decomposition of potassium chlorate, potassium bromate, potassium iodate.

29. Write the reaction for preparation of Cl_2O_7 .

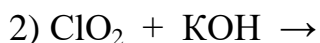
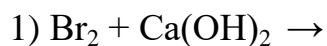
30. Explain a change of stability, oxidizing and acidic properties in a following row: $\text{HClO} \rightarrow \text{HClO}_2 \rightarrow \text{HClO}_3 \rightarrow \text{HClO}_4$.

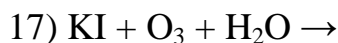
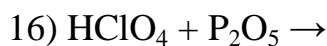
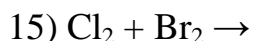
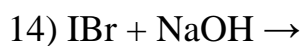
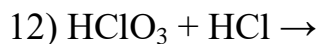
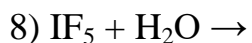
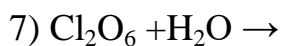
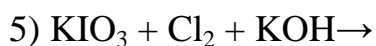
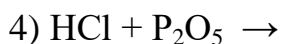
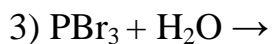
32. Explain a change of stability, oxidizing and acidic properties in a following row: $\text{HClO} \rightarrow \text{HBrO} \rightarrow \text{HIO}$.

33. Explain a change of acidic, oxidizing and reducing properties in a following row: $\text{HClO}_3 \rightarrow \text{HBrO}_3 \rightarrow \text{HIO}_3$.

34. Which of the oxyacids is most stable?

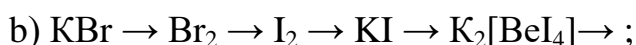
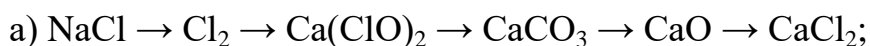
35. Complete and balance equations for the following reactions:





36. What mass of Berthollet salt can be prepared from 168 g of potassium hydroxide?

37. Make the reactions necessary for the following transformations:



Laboratory work N 1

Experiment 1. Preparing hydrogen.

Place small amount of crystalline zinc (Zn) into clean test tube and add 10 drops of hydrochloric acid solution (HCl).

Observation _____

Write the molecular reaction equation _____

Experiment 2. Reducing properties of hydrogen peroxide

Transfer 10 drops of potassium permanganate solution (KMnO_4) into clean test tube, add 3-5 drops of sulphuric acid solution (H_2SO_4) and 3-5 drops of hydrogen peroxide (H_2O_2).

Observation _____

Write the molecular reaction equation _____

Experiment 3. Oxidizing properties of hydrogen peroxide

Transfer 10 drops of potassium iodide solution (KI) into clean test tube, add 3-5 drops of sulphuric acid solution (H_2SO_4) and 3-5 drops of hydrogen peroxide (H_2O_2). Then add 2 drops of starch solution.

Observation _____

Write the molecular reaction equation _____

Laboratory work N 2

Experiment 1. Preparation of chlorine.

Transfer 10 drops of concentrated hydrogen chloride solution (HCl) into clean test tube and add dropwise potassium permanganate solution (KMnO_4) until the solution is colored in pink. Immerse starch iodide paper in test tube (*starch iodide paper can quickly detect the presence of strong oxidizing agents such as chlorine, nitrous acid and hydrogen peroxide*). Note the change of color of starch iodide paper.

Observation _____

Write the molecular reaction equation _____

Experiment 2. Comparison of reducing properties of hydrogen halides

Transfer 10 drops of concentrated sulfuric acid solution (H_2SO_4) into three test tubes and add: in the first test tube – about 1 g of KCl, in the second – about 1 g of KBr, in the third – about 1 g of KI.

Observation _____

Write the molecular reaction equation _____

Experiment 3. The reactions of the qualitative determination of bromide and iodide ions

Transfer 2 drops of silver nitrate solution (AgNO_3) into two clean test tubes and add: in the first test tube – 5 drops of potassium bromide solution (KBr), in the second – 5 drops of potassium iodide solution (KI).

Observation _____

Write the reaction equation in the molecular and ionic forms _____

Laboratory work N 3

Experiment 1. Properties of chlorine water.

a) reaction with potassium bromide and potassium iodide

Transfer 5 drops of benzene into two clean test tubes and add: in the first test tube – 10 drops of potassium bromide solution (KBr), in the second – 10 drops of potassium iodide solution (KI). Shake the contents of test tubes. Add 5 drops of chlorine water into each test tube. Shake the contents of test tubes again. Note the color of benzene layer.

Observation _____

Write the reaction equation in the molecular and ionic forms _____

b) oxidation of manganese sulfate

Transfer 10 drops of manganese sulfate solution (MnSO_4) into clean test tubes, add 5 drops of chlorine water and 5 drops of sodium hydroxide solution (NaOH).

Observation_____

Write the reaction equation in the molecular and ionic forms_____

Topic 2. p-elements of the VIA group. Oxygen, Sulfur, Selenium, Tellurium.

Questions for admission to the implementation of laboratory works:

1. Allotropic modification of sulfur.
2. Write the hydrolysis reactions for salts which undergo hydrolysis in the ionic and molecular forms and notice the pH of aqueous solution of these salts (acidic, basic or neutral): sodium sulfide (Na_2S), sodium sulfite (Na_2SO_3), aluminum sulfate ($\text{Al}_2(\text{SO}_4)_3$).
3. Chemical properties of sulfur.
4. Oxidizing and reducing properties of sulfur (IV) oxide.
5. Preparation of sulfur (IV) oxide.
6. What substances – CuCl_2 , MgCl_2 , $\text{Al}_2(\text{SO}_4)_3$, $\text{Pb}(\text{NO}_3)_2$, CaCl_2 – interact with H_2S ? Write reactions.
7. Chemical properties of selenium (interaction with O_2 , Fe, concentrated HNO_3).
8. Interaction of dilute sulfuric acid with metals.

9. What mass of sulfur can be prepared as a result of reaction between HCl and 1 mole of $\text{Na}_2\text{S}_2\text{O}_3$?
10. Make the reactions necessary for the following transformations:
 $\text{S} \rightarrow \text{FeS} \rightarrow \text{H}_2\text{S} \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{SO}_2 \rightarrow \text{S}$
11. Give examples of pharmaceutical preparations containing sulfur.

Laboratory work N 4

Experiment 1. Reduction properties of sulfites.

Place 2–3 mL of potassium dichromate solution ($\text{K}_2\text{Cr}_2\text{O}_7$) into clean test tube, add 3–4 drops of sulfuric acid solution (H_2SO_4) and add 3–4 drops of sodium sulfite (Na_2SO_3).

Observation _____

Write the molecular reaction equation _____

Experiment 2. Properties of sodium thiosulfate.

a) Place 1–2 mL of iodine solution (I_2) into clean test tube, add 1–2 drops of starch solution (solution is colored in dark blue). Dropwise add sodium thiosulfate solution ($\text{Na}_2\text{S}_2\text{O}_3$) to discoloration.

Write the molecular reaction equation _____

b) Transfer 3–4 drops of sodium thiosulfate solution ($\text{Na}_2\text{S}_2\text{O}_3$) into clean test tube and add 3–4 drops of hydrochloric acid solution (HCl).

Observation _____

Write the molecular reaction equation _____

Experiment 3. The reaction for detection of sulfate ion

Place 1–2 mL of sulfuric acid solution (H_2SO_4) into clean test tube and add 1–2 drops of barium chloride solution (BaCl_2).

Observation: _____

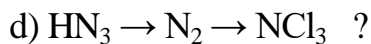
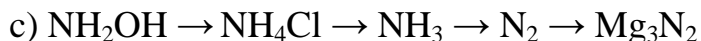
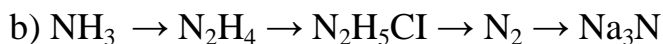
Write the molecular reaction equation _____

Topic 3. p-elements of the VA group. Nitrogen. Nitrogen compounds in negative oxidation state.

Questions for admission to the implementation of laboratory works:

1. Electron configuration for Nitrogen atom.
2. Preparation of Nitrogen.
3. Chemical properties of Nitrogen.
4. Describe the structure of a molecule of ammonia.
5. Chemical properties of ammonia.
6. Decomposition of ammonium salts on heating.
7. Write the hydrolysis reactions for following salts in the ionic and molecular forms and notice the pH of aqueous solution of these salts (acidic, basic or neutral): $(\text{NH}_4)_2\text{SO}_4$, $\text{CH}_3\text{COONH}_4$.
8. What compounds are formed by passing through aqueous solution of ammonia CO_2 , NO_2 , SO_2 , Cl_2 ? Write the reactions.
9. Preparation of hydrazine. Describe the structure of a molecule of hydrazine.
10. Balance the following redox reactions:
 - a) $\text{NH}_2\text{OH} + \text{I}_2 + \text{KOH} \rightarrow \text{N}_2 + \text{KI} + \text{H}_2\text{O}$
 - b) $\text{NH}_2\text{OH} + \text{FeSO}_4 + \text{H}_2\text{SO}_4 \rightarrow \text{Fe}_2(\text{SO}_4)_3 + (\text{NH}_4)_2\text{SO}_4 + \text{H}_2\text{O}$
11. Complete and balance equations for the following reactions:
 - a) $\text{HN}_3 + \text{HI} \rightarrow$
 - b) $\text{HN}_3 + \text{KMnO}_4 + \text{H}_2\text{SO}_4 \rightarrow$

12. Make the reactions necessary for the following transformations:



Laboratory work 5

Experiment 1. Preparation and properties of ammonia.

a) Transfer 4–5 drops of ammonium chloride solution (NH_4Cl) into clean test tube and add 2–3 drops of sodium hydroxide (NaOH). Carefully heat the test tube using Bunsen's burner. Through the test tube opening do as follow: put a wet strip of red litmus paper.

Observation _____

Write the molecular reaction equation _____

b) Transfer 3–4 drops of sodium chloride solution (NaCl) into clean test tube and add 1–2 drops of argentic nitrate (AgNO_3). Dropwise add ammonia solution to resulting precipitate to its dissolving.

Observation _____

Write the molecular reaction equation _____

c) Transfer 3–4 drops of potassium permanganate solution (KMnO_4) into clean test tube and add 3–4 drops of ammonia solution. Carefully heat the test tube using Bunsen's burner.

Observation _____

Write the molecular reaction equation _____

Experiment 2. Equilibrium in aqueous ammonia solution and its shift.

Transfer 7–8 drops of ammonia solution into two clean test tubes and add in each one: 8–10 drops of distilled water and 1–2 drops of phenolphthalein indicator. Note the color of solutions.

In the first test tube add 1–2 microspatulas of ammonium chloride. Compare the colors of solutions in the first and second test tubes. Make conclusion about equilibrium shift.

Observation _____

Write the molecular reaction equation _____

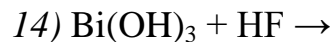
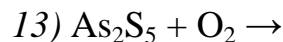
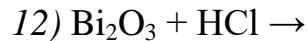
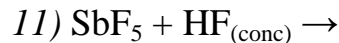
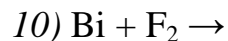
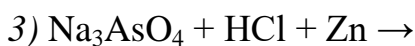
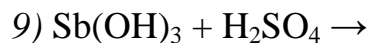
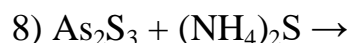
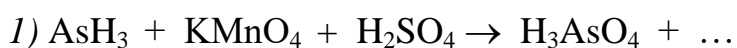
Topic 4. p-elements of the VA group. Nitrogen compounds in positive oxidation state. Phosphorus and its compounds. Arsen subgroup (Arsen, Antimony, Bismuth).

Questions for admission to the implementation of laboratory works:

1. Write formulas of all nitrogen oxides. Which of them react with $\text{Ca}(\text{OH})_2$ solution? Write reactions.
2. Preparation of N_2O , NO , NO_2 .
3. Write decomposition reactions for following salts: a) NaNO_3 ; b) AgNO_3 ; c) $\text{Al}(\text{NO}_3)_3$; d) $\text{Pb}(\text{NO}_3)_2$.
4. What substances – P_2O_5 ; HCl ; C ; I_2 ; CaO ; Cu ; Al ; CO_2 – interact with concentrated nitric acid? Write reactions.
5. Complete and balance equations for the following reactions:
 - a) $\text{Ag} + \text{HNO}_3 \text{ dilute} \rightarrow \dots$
 - b) $\text{Fe} + \text{HNO}_3 \text{ dilute} \rightarrow \dots$
6. Complete and balance equations for the following reactions:
 - a) $\text{HNO}_2 + \text{Br}_2 + \text{H}_2\text{O} \rightarrow \dots$
 - b) $\text{HNO}_2 + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \rightarrow \dots$
 - c) $\text{KNO}_2 + \text{KI} + \text{H}_2\text{SO}_4 \rightarrow \dots$
 - d) $\text{KNO}_2 + \text{KMnO}_4 + \text{H}_2\text{SO}_4 \rightarrow \dots$
7. What volume of NO_2 can be prepared as a result of reaction between 300 g HNO_3 ($\omega(\text{HNO}_3)$ 40%) and copper?

8. Identify the simplest formula of the substance, using mass fractions of elements: $\omega(\text{O}) = 56,47\%$, $\omega(\text{N}) = 16,47\%$, $\omega(\text{Na}) = 27,06\%$.
9. Make the reactions necessary for the following transformations:
- $\text{NO}_2 \rightarrow \text{HNO}_3 \rightarrow \text{Ba}(\text{NO}_3)_2 \rightarrow \text{KNO}_3$
 - $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2\text{O} \rightarrow \text{N}_2 \rightarrow \text{NH}_3 \rightarrow \text{NO} \rightarrow \text{N}_2$
 - $\text{N}_2 \rightarrow \text{NO} \rightarrow \text{NO}_2 \rightarrow \text{HNO}_3 \rightarrow \text{NO}_2 \rightarrow \text{N}_2$
10. Electron configuration for phosphorus atom.
11. What are the main differences in the chemical properties of nitrogen and phosphorus?
12. Which of allotropic modifications of phosphorus is the most stable?
13. Which of allotropic modifications of phosphorus is poisonous?
14. Preparation of phosphine.
15. Give examples of compounds containing phosphorus atom with the oxidation state +1. Describe their redox properties.
16. Write formulas of phosphorus oxides.
17. Chemical properties of phosphorus oxides. Write reactions.
18. Describe the acidic properties of phosphoric acids. Write reactions.
19. Write the hydrolysis reactions for following salts in the ionic and molecular forms and notice the pH of aqueous solution of these salts (acidic, basic or neutral): Na_3PO_4 , $(\text{NH}_4)_3\text{PO}_4$, $\text{K}_2(\text{PHO}_3)$.
20. Complete and balance equations for the following reactions:
- | | |
|---|--|
| 1) $\text{PH}_3 + \text{KMnO}_4 + \text{H}_2\text{SO}_4 \rightarrow$ | 6) $\text{PCl}_3 + \text{NaOH} \rightarrow$ |
| 2) $\text{H}_3\text{PO}_3 + \text{AgNO}_3 + \text{H}_2\text{O} \rightarrow$ | 7) $\text{P}_2\text{O}_3 + \text{KOH} \rightarrow$ |
| 3) $\text{H}_3\text{PO}_3 + \text{Zn} + \text{H}_2\text{SO}_4 \rightarrow$ | 8) $\text{PH}_3 + \text{O}_2 \rightarrow$ |
| 4) $\text{P} + \text{Ca} \rightarrow$ | 9) $\text{P} + \text{HNO}_3 \rightarrow$ |
| 5) $\text{H}_3\text{PO}_3 + \text{Cl}_2 + \text{H}_2\text{O} \rightarrow$ | 10) $\text{Ca}(\text{OH})_2 + \text{H}_3\text{PO}_3 \rightarrow$ |
21. Make the reactions necessary for the following transformations:
- calcium phosphate \rightarrow phosphorus \rightarrow phosphorus (V) oxide \rightarrow phosphoric acid \rightarrow sodium phosphate \rightarrow sodium hydrogen phosphate \rightarrow barium phosphate
 - phosphorus \rightarrow phosphine \rightarrow phosphorus (V) oxide \rightarrow phosphoric acid \rightarrow potassium phosphate \rightarrow calcium phosphate

22. Describe electron configuration of Arsen, Antimony and Bismuth.
23. Oxidation numbers of Arsen, Antimony and Bismuth.
24. How change nonmetallic and metallic properties in a following row: As→Sb→Bi?
Write reactions.
25. Give examples of compounds in which Arsen, Antimony and Bismuth have oxidation number -3.
26. Preparation of compounds of Arsen, Antimony and Bismuth with Hydrogen. Compare stability of these compounds.
27. Oxides of Arsen. Describe chemical properties of these oxides.
28. Oxides of Antimony. Describe chemical properties of these oxides.
29. Describe redox properties of compounds in which Arsen, Antimony and Bismuth have oxidation number +5.
30. Complete and balance equations for the following reactions:



31. Make the reactions necessary for the following transformations:



Laboratory work 6

Experiment 1. Nitrous acid, nitrites and their properties.

- a) Transfer 3–4 drops of sodium nitrite solution (KNO_2) into clean test tube and add 2 drops of concentrated sulfuric acid solution (H_2SO_4).

Observation _____

Write the molecular reaction equation _____

b) Transfer 3–4 drops of potassium permanganate solution (KMnO_4) into clean test tube, add 2–3 drops of sulfuric acid solution (H_2SO_4) and add 2–3 drops of sodium nitrite solution (KNO_2).

Observation _____

Write the molecular reaction equation _____

c) Transfer 3–4 drops of sodium nitrite solution (KNO_2) into clean test tube, add 2–3 drops of sulfuric acid solution (H_2SO_4), 3–4 drops of potassium iodide solution (KI) and 3–4 drops of benzene. Shake contents of test tube.

Observation _____

Write the molecular reaction equation _____

Experiment 2. Oxidizing properties of nitric acid.

Place a small piece of copper shavings into two clean test tubes and add: 3–4 drops of concentrated nitric acid solution (HNO_3) to the first test tube, 3–4 drops of dilute nitric acid solution (HNO_3) to the second test tube. Carefully heat using Bunsen's burner the last one.

Observation _____

Write the molecular reaction equation _____

Laboratory work N 7

Experiment 1. Solubility of phosphorus salts.

Take two clean test tubes and add: 4–5 drops of FeCl_3 solution in first test tube, 4–5 drops of $\text{Al}_2(\text{SO}_4)_3$ in second test tube. Add 10 drops of CH_3COONa solution and 2–3 drops of Na_2HPO_4 solution in each one (precipitates are not formed in absence of CH_3COONa). Check

precipitates solubility in hydrochloric acid (dropwise add hydrochloric acid to resulting precipitates).

Observation _____

Write the molecular reaction equations _____

Laboratory work N 8

Experiment 1. Preparation and properties of bismuth hydroxide.

Take two clean test tubes and transfer in each one: 3–4 drops of salt of bismuth (III) and some drops of sodium hydroxide solution (NaOH) until precipitate formation. Then add 3–4 drops of nitric acid solution (HNO₃) into the first test tube; 3–4 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation _____

Write the molecular reaction equation _____

Conclusion about chemical character of Bi(OH)₃ _____

Experiment 2. Redox properties of hexahydroxoantimony acid (V) and its salts.

Transfer 3–4 drops of $\text{K}[\text{Sb}(\text{OH})_6]$ solution into clean test tube, add 2–3 drops of sulfuric acid solution (H_2SO_4) and add 2–3 drops of potassium iodide solution (KI).

Observation _____

Write the molecular reaction equation _____

Experiment 3. Preparation of bismuth (III) iodide.

Transfer 3–4 drops of bismuth nitrate solution ($\text{Bi}(\text{NO}_3)_3$) into clean test tube, add some drops of potassium iodide solution (KI) until precipitate formation. Add again potassium iodide solution (KI) until precipitate dissolve.

Observation _____

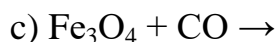
Write the molecular reaction equation _____

Topic 5. p-elements of the IVA group. Carbon and Silicium.

Germanium subgroup (Germanium, Stanum, Lead). p-elements of the IIIA group. Boron and Aluminium.

Questions for admission to the implementation of laboratory works:

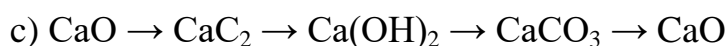
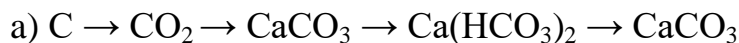
1. Describe electron configuration of Carbon and Silicium.
2. Describe types of hybridization for Carbon and Silicium.
3. Explain the high firmness and infusibility of Silicium (IV) oxide.
4. Oxidizing or reducing properties are characterized for Carbon and Silicium?
5. Explain complexing ability of CO.
6. Explain mechanism of poisonous action of CO.
7. Complete and balance equations for the following reactions:
 - a) $\text{CO} + \text{Cl}_2 \rightarrow$
 - b) $\text{HCOOH} \rightarrow$



8. What substances – H_2O , CaO , BaCO_3 , NaOH , CO , C , P_2O_5 – interact with CO_2 ? Write reactions.

9. What substances – CaO , Mg , HCl , NaOH , HF , H_2O , Na_2CO_3 – interact with SiO_2 ? Write reactions.

10. Make the reactions necessary for the following transformations:



11. Describe electron configuration of Germanium, Stannum, Lead.

12. What is the difference between the electronic structures of Germanium, Stannum and Lead from the electronic structures of Carbon and Silicon?

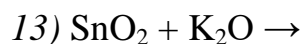
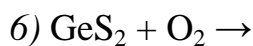
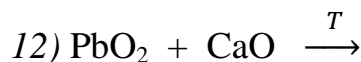
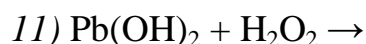
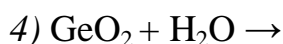
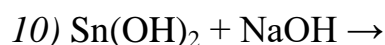
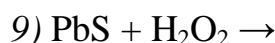
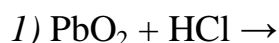
13. In which acids can dissolve Germanium, Stannum and Lead? Write reactions.

14. Write the reactions of Stannum and Lead with alkalis.

15. Describe amphoteric properties of SnO and PbO .

16. Preparation of $\text{Pb}(\text{OH})_2$, $\text{Ge}(\text{OH})_2$, $\text{Sn}(\text{OH})_2$. Write reactions.

17. Complete and balance equations for the following reactions:



19. Describe type of hybridization AO of Boron in molecule BCl_3 .

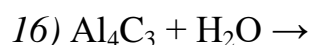
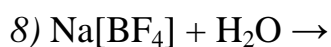
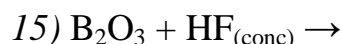
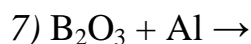
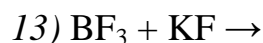
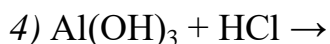
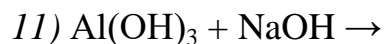
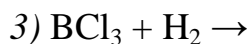
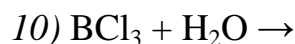
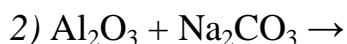
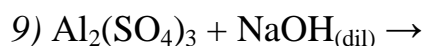
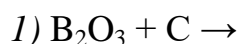
20. Explain paramagnetism B_2 using method MO.

21. What coordination numbers are typical for coordination compounds of Aluminium?

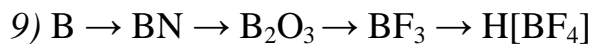
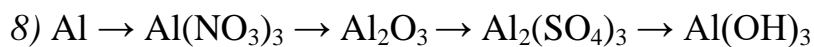
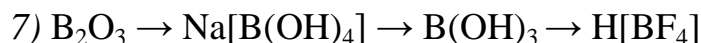
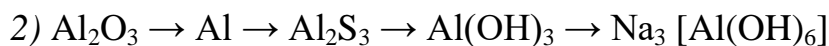
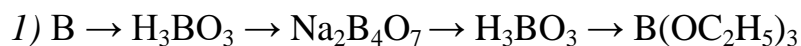
22. Write reactions of Aluminium with O_2 , N_2 , C , S , F_2 .

23. Write hydrolysis reactions for following salts: $\text{Al}_2(\text{SO}_4)_3$, $\text{Al}(\text{CH}_3\text{COO})_3$, BF_3 , BCl_3 .

24. Complete and balance equations for the following reactions:



25. Make the reactions necessary for the following transformations:



Laboratory work N 9

Experiment 1. Preparation and properties of insoluble carbonates.

Transfer 2–3 drops of calcium chloride solution ($CaCl_2$) into clean test tube, add 2–3 drops of sodium carbonate solution (Na_2CO_3). Divide resulting precipitate into two parts in two test

tubes. Then add 5–6 drops of hydrochloric acid solution (HCl) into the first test tube; 5–6 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation_____

Write the reaction equations in the molecular and ionic forms

Experiment 2. Interaction salts of chromium with soluble carbonates.

Transfer 2–3 drops of chromium (III) sulfate solution ($\text{Cr}_2(\text{SO}_4)_3$) into clean test tube, add 2–3 drops of sodium carbonate solution (Na_2CO_3). Show that resulting precipitate is chromium (III) hydroxide by adding 5–10 drops of sodium hydroxide solution (NaOH).

Observation_____

Write the molecular reaction equation in the molecular and ionic forms

Experiment 3. Preparation of insoluble silicate.

Transfer 3–4 drops of calcium chloride solution (CaCl_2) into clean test tube and add 1–2 drops of sodium silicate solution (Na_2SiO_3).

Observation_____

Write the molecular reaction equation in the molecular and ionic forms

Experiment 4. Hydrolysis of sodium silicate.

Transfer 4–5 drops of sodium silicate solution (Na_2SiO_3) into clean test tube and add 2–3 drops of phenolphthalein indicator solution.

Observation _____

Write the hydrolysis reaction in the molecular and ionic forms

Experiment 5. Hydrolysis of sodium silicate in the presence of ammonium chloride.

Transfer 3–4 drops of sodium silicate solution (Na_2SiO_3) into clean test tube and add 3–4 drops of ammonium chloride solution (NH_4Cl).

Observation _____

Write the molecular reaction equation

Laboratory work N 10

Experiment 1. Preparation and properties of stannum (II) hydroxide.

Take two clean test tubes. Transfer 3–5 drops of stannum (II) chloride solution (SnCl_2) and 5–6 drops of sodium hydroxide solution (NaOH) in each one. Then add 3–5 drops of hydrochloric acid solution (HCl) into the first test tube, and 3–5 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation _____

Write the reaction equations

Experiment 2. Impress of stannum from its salt solution

Transfer 5–10 drops of stannum (II) chloride solution (SnCl_2) into clean test tube and add small granule of zinc (Zn).

Observation _____

Write the molecular reaction equation

Experiment 3. Reducing properties of Sn^{2+}

Take two clean test tubes. Transfer 1–3 drops of iron (III) chloride solution (FeCl_3), 1–3 drops of $\text{K}_3[\text{Fe}(\text{CN})_6]$ solution, 5–6 drops of distilled water in each one. Notice color of prepared solutions. The first test tube keep for comparison. Add 2–4 drops stannum (II) chloride solution (SnCl_2) into the second test tube. Notice the change of solution color.

Observation _____

Write the molecular reaction equations for

- reducing of iron (III) chloride by stannum (II) chloride;
- interaction of iron (II) chloride with $\text{K}_3[\text{Fe}(\text{CN})_6]$

Experiment 4. Preparation and properties of lead (II) hydroxide.

Take two clean test tubes. Transfer 2–3 drops of lead (II) nitrate solution ($\text{Pb}(\text{NO}_3)_2$) and some drops of sodium hydroxide solution (NaOH) in each one (until precipitate form). Then add 4–5

drops of acetic acid solution (CH_3COOH) into the first test tube, and 4–5 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation_____

Write the molecular reaction equations

Experiment 5. Preparation of slightly soluble lead (II) salts.

Take two clean test tubes. Transfer 4–5 drops of lead (II) nitrate solution ($\text{Pb}(\text{NO}_3)_2$) in each one. Add into the first test tube some drops of potassium iodide solution (KI) until precipitate form; then add 3–5 drops of acetic acid solution (CH_3COOH) and carefully heat until precipitate dissolve. After cooling you can see formation of crystals of lead iodide (PbI_2). Add into the second test tube 5–6 drops of potassium chromate solution (K_2CrO_4).

Observation_____

Write the molecular reaction equations

Laboratory work N 11

Experiment 1. Preparation and properties of aluminium hydroxide.

Transfer 3–5 drops of aluminium salt solution into clean test tube and add 2–3 drops of sodium hydroxide solution (NaOH). Resulting precipitate divide into two clean test tubes. Then add 3–5 drops of hydrochloric acid solution (HCl) into the first test tube, and sodium hydroxide solution (NaOH) into the second test tube until precipitate dissolve.

Observation_____

Write the reaction equations

Experiment 2. Preparation of slightly soluble salts of aluminium

Transfer 3–5 drops of aluminium salt solution into clean test tube and add sodium phosphate solution (Na_3PO_4).

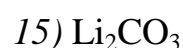
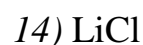
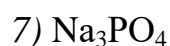
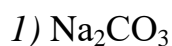
Observation

Write the molecular reaction equation

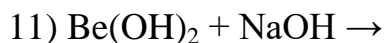
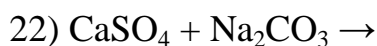
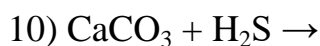
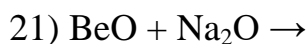
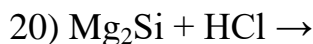
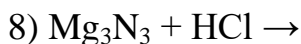
Topic 6. s-elements of the I group. Alkali metals. s-elements of the II group. Beryllium, Magnesium and alkaline earth metals.

Questions for admission to the implementation of laboratory works:

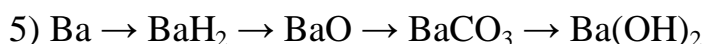
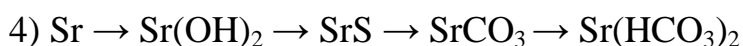
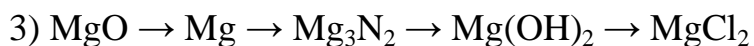
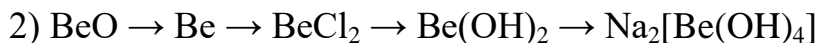
1. Describe electron configurations and energy diagrams of elements of the I group: lithium, sodium, potassium, rubidium, caesium.
2. Which of the following salts undergo hydrolysis? Write hydrolysis reactions in the molecular and ionic forms.



3. Which of the following formulas belonging to alkalis: $\text{Be}(\text{OH})_2$, $\text{Mg}(\text{OH})_2$, $\text{Cu}(\text{OH})_2$, NaOH , $\text{Ba}(\text{OH})_2$?
4. Complete and balance equations for the following reactions:
- | | |
|---|--|
| 1) $\text{Li} + \text{H}_2 \rightarrow$ | 9) $\text{Cs} + \text{S} \rightarrow$ |
| 2) $\text{K} + \text{NH}_3 \rightarrow$ | 10) $\text{KO}_2 + \text{NO}_2 \rightarrow$ |
| 3) $\text{Li} + \text{S} \rightarrow$ | 11) $\text{NaH} + \text{Cl}_2 \rightarrow$ |
| 4) $\text{Na} + \text{H}_2\text{O}$ | 12) $\text{K} + \text{NH}_3 \rightarrow$ |
| 5) $\text{Rb}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2 \rightarrow$ | 13) $\text{Na}_2\text{O}_2 + \text{S} \rightarrow$ |
| 6) $\text{K}_2\text{O}_2 + \text{HCl}_{(\text{pозб})} \rightarrow$ | 14) $\text{K} + \text{H}_2\text{O} \rightarrow$ |
| 7) $\text{Na}_2\text{O}_2 + \text{H}_2\text{O}_{(\text{хол.})} \rightarrow$ | 15) $\text{CsO}_2 + \text{CO} \rightarrow$ |
| 8) $\text{NaNO}_3 \xrightarrow{T}$ | 16) $\text{Cs} + \text{I}_2 \rightarrow$ |
5. Make the reactions necessary for the following transformations:
- $\text{Li} \rightarrow \text{LiH} \rightarrow \text{LiCl} \rightarrow \text{LiOH} \rightarrow \text{Li}_2\text{CO}_3$
 - $\text{Na} \rightarrow \text{NaNH}_2 \rightarrow \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 \rightarrow \text{NaCl}$
 - $\text{K} \rightarrow \text{KO}_2 \rightarrow \text{K}_2\text{CO}_3 \rightarrow \text{KHCO}_3 \rightarrow \text{KCl}$
 - $\text{Rb} \rightarrow \text{Rb}_2\text{O}_2 \rightarrow \text{RbCl} \rightarrow \text{Rb}_2\text{SO}_4 \rightarrow \text{RbOH}$
 - $\text{Cs} \rightarrow \text{Cs}_2\text{S} \rightarrow \text{Cs}_2\text{SO}_4 \rightarrow \text{CsOH} \rightarrow \text{CsCl}$
6. Describe electron configurations and energy diagrams of elements of the II group: magnesium, calcium, barium and beryllium.
7. What volume of CO_2 , measured under normal conditions, formed by the thermal decomposition of 10 g CaCO_3 .
8. Complete and balance equations for the following reactions:
- | | |
|--|--|
| 1) $\text{CaH}_2 + \text{H}_2\text{O} \rightarrow$ | 12) $\text{MgCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \rightarrow$ |
| 2) $\text{Be} + \text{HCl} \rightarrow$ | 13) $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow$ |
| 3) $\text{Sr} + \text{H}_2 \rightarrow$ | 14) $\text{Ca} + \text{N}_2 \rightarrow$ |
| 4) $\text{BaO} + \text{H}_2\text{O} \rightarrow$ | 15) $\text{CaC}_2 + \text{H}_2\text{O} \rightarrow$ |
| 5) $\text{Ba}(\text{NO}_3)_2 \xrightarrow{T}$ | 16) $\text{Mg} + \text{SiO}_2 \rightarrow$ |
| 6) $\text{Be}_2\text{C} + \text{H}_2 \xrightarrow{T}$ | 17) $\text{MgSO}_4 + \text{NaOH} \rightarrow$ |
| 7) $\text{SrS} + \text{CO}_2 + \text{H}_2\text{O} \rightarrow$ | 18) $\text{Mg} + \text{NH}_3 \rightarrow$ |
| | 19) $\text{MgO} + \text{Al}_2\text{O}_3 \rightarrow$ |



9. Make the reactions necessary for the following transformations:



Laboratory work N 12

Experiment 1. The characteristic yellow-color of the flame for sodium ions.

Nichrome wire immersed in a NaCl solution. Then nichrome wire put into the flame.

Observation _____

Experiment 2. Interaction of potassium salts with sodium hexacyanocobaltate

Place 1–2 drops of KCl solution on the glass slide. Near place 1–2 drops of sodium hexacyanocobaltate solution ($\text{Na}_3[\text{Co}(\text{CN})_6]$). Mix drops of KCl solution and sodium hexacyanocobaltate solution using glass stick.

Observation _____

Write the molecular reaction equation

Laboratory work N 13

Experiment 1. Interaction CaCl_2 with $(\text{NH}_4)_2\text{C}_2\text{O}_4$.

Place 0,5–1 mL of CaCl_2 solution into clean test tube and add 0,5–1 mL of $(\text{NH}_4)_2\text{C}_2\text{O}_4$ solution. Resulting precipitation divide into two test tubes. Add CH_3COOH solution into the first test tube and HCl solution into the second test tube.

Observation_____

Write the molecular reaction equations

Experiment 2. Interaction BaCl_2 with H_2SO_4

Place 0,5–1 mL of BaCl_2 solution into clean test tube and add 0,5–1 mL of H_2SO_4 solution. Resulting precipitation divide into two test tubes. Add HCl solution into the first test tube and HNO_3 solution into the second test tube.

Observation_____

Write the molecular reaction equations

Experiment 3. Interaction BaCl_2 with Na_2CO_3

Place 0,5–1 mL of BaCl_2 solution into clean test tube and add some drops of Na_2CO_3 solution. Resulting precipitation divide into two test tubes. Add HCl solution into the first test tube and NaOH solution into the second test tube.

Observation_____

Write the molecular reaction equations

Experiment 4. Interaction $MgCl_2$ with $NaOH$

Place 0,5–1 mL of $MgCl_2$ solution into clean test tube and add 0,5–1 mL of $NaOH$ solution. Resulting precipitation divide into two test tubes. Add HCl solution into the first test tube and NH_4Cl solution into the second test tube.

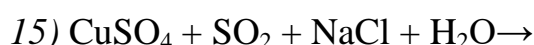
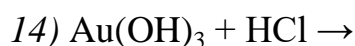
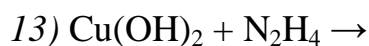
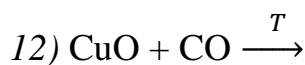
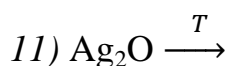
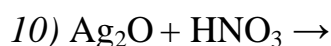
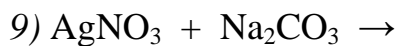
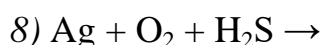
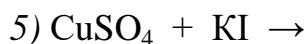
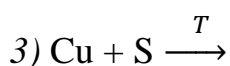
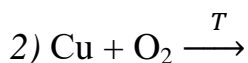
Observation _____

Write the molecular reaction equations

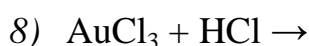
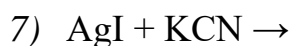
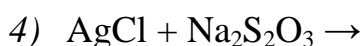
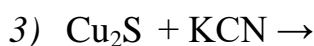
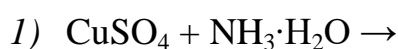
Topic 7. General characteristics of d-elements. d-elements of the IB group. Copper, Argentum, Aurum. d-elements of the IIB group. Zinc, Cadmium, Mercury.

Questions for admission to the implementation of laboratory works:

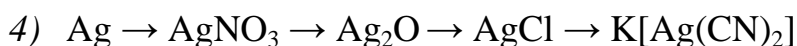
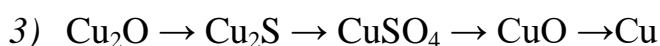
1. Describe electron configurations of d-elements of the IB group: copper, argentum, aurum.
2. In which of acids one can dissolve copper, argentum and aurum? Write the corresponding chemical reactions.
3. Explain the process of dissolution of gold (aurum) in the "aqua regis" (nitrohydrochloric acid) and write reaction equation.
4. Complete and balance equations for the following reactions:



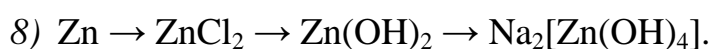
5. Write the complexation reactions. Give the name for each complex compound.



6. Make the reactions necessary for the following transformations:



7. Make the reactions necessary for the following transformation:



8. Write reactions between zinc and concentrated sulfuric acid, zinc oxide and sodium hydroxide.

9. Describe chemical properties of zinc hydroxide.
10. Write reaction between cadmium sulfite and ammonia solution.
11. Write reaction between mercury and concentrated nitric acid.

Laboratory work N 14

Experiment 1. Oxidizing properties of copper (II) substances.

- a) Place granule of zinc (or iron) into copper (II) salt solution.

Observation _____

Write the molecular reaction equation

- b) Transfer 2 drops of copper (II) sulfate solution (CuSO_4) into clean test tube and add 2 drops of potassium iodide solution (KI). Note the color of resulting precipitate. Then add some drops of sodium sulfite solution (Na_2SO_3).

Observation _____

Write the molecular reaction equations

Experiment 2. Preparation and properties of copper hydroxide and argentum hydroxide

- a) Place 2–3 mL of copper sulfate solution (CuSO_4) into clean test tube and add sodium hydroxide solution (NaOH). Resulting precipitation divide into three test tubes. Add 2–3 mL of hydrochloric acid solution (HCl) into the first test tube, 2–3 mL of sodium hydroxide solution (NaOH) into the second test tube, third test tube carefully heat.

Observation _____

Write the molecular reaction equations

b) Place some drops of sodium hydroxide solution (NaOH) into clean test tube and add 1–2 drops of argentic nitrate solution (AgNO₃). Resulting precipitation divide into two test tubes. Add some drops of hydrochloric acid solution (HCl) into the first test tube, some drops of ammonia solution (NH₄OH) into the second test tube.

Observation_____

Write the molecular reaction equations

Experiment 3. Preparation of complex compounds of copper and argentic

a) Place 2–3 drops of copper sulfate solution (CuSO₄) into clean test tube and add 1–2 drops of ammonia solution (NH₄OH) until precipitate is formed. Then add ammonia solution (NH₄OH) until precipitate is dissolved.

Observation_____

Write the molecular reaction equations

b) Transfer 3–4 drops of argentic nitrate solution (AgNO₃) into clean test tube and add 4–5 drops of hydrochloric acid solution (HCl). Note the color of resulting precipitate. Then add 8–10 drops of ammonia solution (NH₄OH).

Observation_____

Write the molecular reaction equations

Experiment 4. Hydrolysis of copper (II) and argentum (I) salts

Put into copper sulfate solution (CuSO_4) and argentum nitrate solution (AgNO_3) litmus paper and note the color.

Observation_____

Write the reactions of hydrolysis in molecular and ionic forms

Laboratory work N 15

Experiment 1. Preparation and properties of zinc hydroxide.

Transfer some drops of zinc (II) chloride solution (ZnCl_2) into clean test tube and add sodium hydroxide solution (NaOH) to precipitate formation. Then add an excess of sodium hydroxide solution.

Observation_____

Write the reaction equations in the molecular and ionic forms

Experiment 2. Complex compounds of zinc

Transfer some drops of zinc (II) chloride solution (ZnCl_2) into clean test tube and add ammonium hydroxide solution (NH_4OH) to precipitate formation. Then add an excess of ammonium hydroxide solution to dissolve the precipitate.

Observation _____

Write the reaction equations in the molecular and ionic forms

Experiment 3. Hydrolysis of salts of zinc

On a strip of universal indicator paper, apply a drop of solution of zinc chloride. Determine the pH of salt solution.

Observation _____

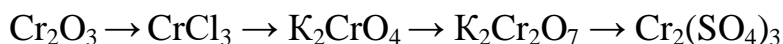
Write the hydrolysis reactions in molecular and ionic forms

Topic 8. d-elements of the VIB group. Chromium subgroup.

Questions for admission to the implementation of laboratory works:

1. Preparation of chromium from chromium (III) oxide. Write reactions.
2. What oxides are formed as result of burning chromium, molybdenum and wolfram?
Write reaction equation.

3. Make the reactions necessary for the following transformation:



4. What volume of chlorine is formed as result of reaction between one mole of potassium dichromate and hydrochloric acid?

5. Write reaction equation between chromium (III) sulfate and sodium carbonate.

6. Write the reaction equation:



7. What is the biological role of chromium and molybdenum as trace elements?

Laboratory work N 16

Experiment 1. Preparation and properties of chromium (III) hydroxide.

Take two clean test tubes. Transfer 5 drops of chromium salt solution and 5 drops of ammonia solution into each one. Then add some drops of sulfuric acid solution (H_2SO_4) into the first test tube and some drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation _____

Write the reaction equations in the molecular and ionic forms

Experiment 2. Oxidizing properties of potassium dichromate

Transfer 5 drops of potassium dichromate solution ($\text{K}_2\text{Cr}_2\text{O}_7$) into clean test tube, add 5 drops of sulfuric acid solution (H_2SO_4) and 5 drops of potassium iodide solution (KI). Then add 2–3 drops of organic solvent and mix contents of test tube.

Observation _____

Write the reaction equation

Experiment 3. Conversion of the chromate into the dichromate and vice versa

Transfer 5–6 drops of potassium chromate solution (K_2CrO_4) into clean test tube and add 3–4 drops of sulfuric acid solution (H_2SO_4). Note the color of the resulting solution. Then add some drops of potassium hydroxide solution (KOH) until color is changed.

Observation _____

Write the reaction equation

Topic 9. d-elements of the VIIB group. Manganese subgroup.

Questions for admission to the implementation of laboratory works:

1. Write reaction equation between manganese sulfate and potassium hydroxide (in the air), manganese sulfate and ammonia sulfide, manganese sulfate and potassium permanganate (neutral medium).
2. Write reaction equation of preparation from manganese sulfate the following substances:
 - a) manganese (II) hydroxide;
 - b) manganese (IV) oxide;
 - c) potassium manganate.
3. Write reaction equation of preparation from potassium permanganate the following substances:
 - a) manganese (II) sulfate;

b) manganese (IV) oxide;

c) potassium manganate.

4. Write reaction equation which characterized oxidizing properties, reducing properties and redox properties of potassium manganate.

5. Write reaction equation of preparation of potassium manganate.

Laboratory work N 17

Experiment 1. Preparation and properties of manganese (II) hydroxide.

Transfer 3–4 drops of manganese (II) salt solution into clean test tube and 2–3 drops of alkali solution. Stir resulting precipitate with glass stick until browning of precipitate.

Observation_____

Write the reaction equation

Experiment 2. Oxidizing and reducing properties of manganese (IV) oxide

a) oxidizing properties

Place 1 microspatula of manganese (IV) oxide (MnO_2) into clean test tube and add 2–3 drops of concentrated hydrochloric acid solution (HCl).

Observation_____

Write the reaction equation

b) reducing properties

Place 1 microspatula of manganese (IV) oxide (MnO_2) into clean test tube, add 2–3 drops of concentrated potassium hydroxide solution (KOH) and add 1 microspatula of potassium nitrate solution (KNO_3). Carefully heat.

Observation_____

Write the reaction equation

Experiment 3. Decomposition of potassium permanganate

Place 3–4 crystals of potassium permanganate (KMnO_4) into clean test tube. Carefully heat. After cooling add 5–6 drops of water. Note the color of the resulting solution.

Observation _____

Write the reaction equation

Experiment 4. Reducing of potassium permanganate by sodium sulfite in different medium

Take three test tubes. Transfer 3–5 drops of potassium permanganate solution (KMnO_4) in each one. Then add 2–3 drops of sulfuric acid solution (H_2SO_4) and 3–4 drops of sodium sulfite solution (Na_2SO_3) into the first test tube; sodium sulfite solution (Na_2SO_3) into the second test tube; 3–4 drops of sodium hydroxide solution (NaOH) and 3–4 drops of sodium sulfite solution (Na_2SO_3) into the third test tube.

Observation _____

Write the reaction equation

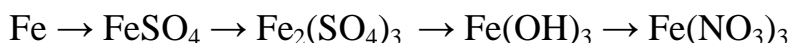
Topic 10. d-elements of the VIIB group. Iron and its compounds.

Cobalt and Nickel. Platinum metals.

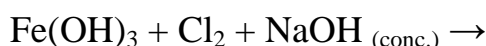
Questions for admission to the implementation of practical and laboratory works:

1. What substances – H_2S , HCl , Mg , Sn , BaCl_2 , NaCl , CuCl_2 , KMnO_4 (in the presence of H_2SO_4), NaOH – interact with iron (II) sulfate? Write chemical equations for corresponding reactions.

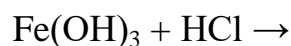
2. Make the reactions necessary for the following transformation:



3. What is ferrate (IV)? Write the equation reaction:



4. Write the equation reaction:



5. Write coordination compounds using the following data:

a) central ion – Fe^{3+} ;

b) coordination number – 6;

c) ligands – NH_3 ;

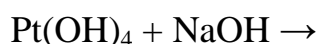
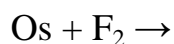
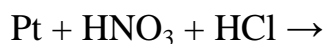
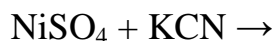
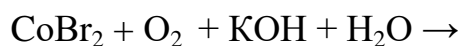
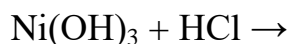
d) outer sphere – ions Cl^- .

6. Write reaction equation of oxidation of iron (II) hydroxide employing sodium hypochlorite (NaClO).

7. Write reaction equation between iron and dilute sulfuric acid (in the cold), between iron and concentrated sulfuric acid (upon heating).

8. What substances – H_2S , HCl , Mg , Sn , BaCl_2 , NaCl , CuCl_2 , KMnO_4 (in the presence of H_2SO_4), NaOH – interact with cobalt (II) sulfate? Write chemical equations for corresponding reactions.

9. Write the equation reaction:



10. Write coordination compounds using the following data:

a) central ion – Co^{3+} , Ni^{2+} ;

b) coordination number – 6;

c) ligands – NH_3 ;

d) outer sphere – ions Cl^- .

11. Write reaction equation between platinum (IV) hydroxide and potassium hydroxide, platinum (IV) hydroxide and hydrochloric acid.

12. Write reaction equation of oxidation of cobalt (II) hydroxide and nickel (II) hydroxide employing sodium hypochlorite (NaClO).

Laboratory work N 18

Experiment 1. Preparation and properties of iron (II) hydroxide.

Transfer 3–4 drops of Mohr's salt solution ($\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$) into clean test tube and add 2–3 drops of sodium hydroxide solution (NaOH). Observe the color changing of precipitate over time.

Observation _____

Write the reaction equation

Experiment 2. Reducing properties of iron (II) compounds

Transfer 3–4 drops of Mohr’s salt solution ($(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$) into clean test tube, add 2–3 drops of dilute sulfuric acid (H_2SO_4) and 3–4 drops of potassium permanganate solution (KMnO_4).

Observation_____

Write the reaction equation

Experiment 3. Preparation and properties of iron (III) hydroxide.

Take two clean test tubes. Transfer 2–3 drops of iron (III) salt solution and add 5–10 drops of sodium hydroxide solution (NaOH) into each one. Note the color of the resulting precipitate. Then add 3–4 drops of hydrochloric acid solution (HCl) into the first test tube and 3–4 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation_____

Write the reaction equation

Experiment 4. Oxidizing properties of iron (III) compounds

Transfer 3–4 drops of iron (III) salt solution into clean test tube and add 3–4 drops of potassium iodide solution (KI).

Observation_____

Write the reaction equation

Experiment 5. Qualitative reactions on Fe^{2+} and Fe^{3+} ions.

a) transfer 3–4 drops of Mohr’s salt solution ($(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$) into clean test tube and add 5–10 drops of potassium ferricyanide solution $\text{K}_3[\text{Fe}(\text{CN})_6]$. Note the color of resulting precipitate.

Observation_____

Write the reaction equation

b) transfer 3–4 drops of iron (III) salt solution into clean test tube and add 5–10 drops of potassium ferrocyanide solution $\text{K}_4[\text{Fe}(\text{CN})_6]$. Note the color of resulting precipitate.

Observation_____

Write the reaction equation

c) transfer 3–4 drops of iron (III) salt solution into clean test tube and add 5–10 drops of potassium thiocyanate solution (KSCN) or ammonium thiocyanate solution (NH_4SCN). Note the color of resulting precipitate.

Observation_____

Write the reaction equation

Laboratory work N 19

Experiment 1. Preparation and properties of cobalt (II) hydroxide and nickel (II) hydroxide.

Take two clean test tubes. Transfer 3–4 drops of nickel (II) chloride solution (NiCl_2) into the first clean test tube and add 5–6 drops of sodium hydroxide solution (NaOH).

Transfer 3–4 drops of cobalt (II) nitrate solution ($\text{Co}(\text{NO}_3)_2$) into the second clean test tube, add 5–6 drops of sodium hydroxide solution (NaOH) and then add 5–10 drops of hydrogen peroxide solution (H_2O_2).

Observation _____

Write the reaction equation

Experiment 2. Preparation of ammonia complexes of cobalt (II) and nickel (II)

Take two clean test tubes. Transfer 3–4 drops of nickel (II) chloride solution (NiCl_2) into the first clean test tube and add ammonium hydroxide solution (NH_4OH) to precipitate formation, then add an excess of ammonium hydroxide solution to dissolve the precipitate.

Transfer 3–4 drops of cobalt (II) nitrate solution ($\text{Co}(\text{NO}_3)_2$) into the second clean test tube and add ammonium hydroxide solution (NH_4OH) to precipitate formation, then add an excess of ammonium hydroxide solution to dissolve the precipitate.

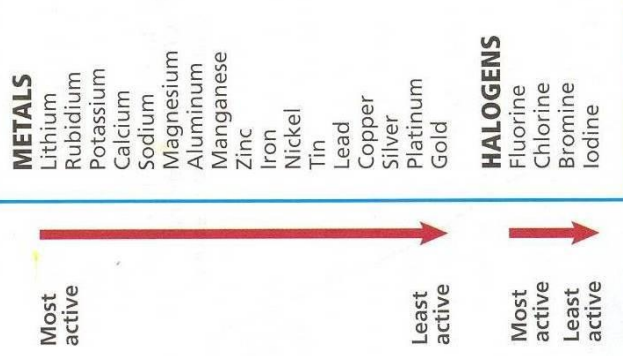
Observation _____

Write the reaction equation

Add 2–3 drops of hydrogen peroxide solution (H_2O_2) to the second test tube. Observe the color changing of precipitate.

Observation _____

Write the reaction equation



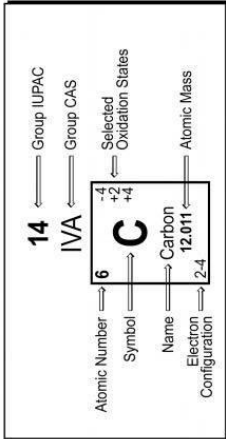
Solubility of Ionic Compounds in Water

Key: S = soluble; I = insoluble; D = decomposes in water; U = compound does not exist

Cation	Al ³⁺	NH ₄ ⁺	Ba ²⁺	Cd ²⁺	Ca ²⁺	Cr ³⁺	Co ²⁺	Cu ²⁺	Fe ³⁺	Fe ²⁺	H ⁺	Pb ²⁺	Mg ²⁺	Hg ¹⁺	Ni ²⁺	K ¹⁺	Ag ¹⁺	Na ¹⁺	Sr ²⁺	Zn ²⁺
Anion																				
C ₂ H ₃ O ₂ ⁻	S	S	S	S	S	S	S	S	S	S	S	S	S	I	S	S	I	S	S	S
Br ⁻	S	S	S	S	S	S	S	S	S	S	S	S	S	I	S	S	I	S	S	S
CO ₃ ²⁻	U	S	I	I	I	U	I	I	U	I	S	I	I	I	I	S	I	S	I	I
ClO ₃ ⁻	S	S	S	S	S	U	S	S	U	U	S	S	S	S	I	S	S	S	S	S
Cl ⁻	S	S	S	S	S	S	S	S	S	S	S	S	S	I	S	S	I	S	S	S
CrO ₄ ²⁻	U	S	I	I	S	U	I	S	I	I	S	I	I	I	U	S	I	S	I	I
OH ⁻	I	I	S	I	I	I	I	I	I	I	H ₂ O	I	I	U	I	S	U	S	I	I
I ⁻	S	S	S	S	S	S	S	S	S	S	S	I	S	I	S	S	I	S	S	S
NO ₃ ⁻	S	S	S	S	S	S	S	S	S	S	S	S	S	D	S	S	S	S	S	S
O ²⁻	I	U	S	I	I	I	I	I	I	I	H ₂ O	I	I	I	I	D	I	D	I	I
C ₂ O ₄ ²⁻	I	I	I	I	I	S	I	I	S	I	S	I	I	I	I	S	I	S	I	I
PO ₄ ³⁻	I	S	I	I	I	I	I	I	I	I	S	I	I	U	I	S	I	S	I	I
SiO ₃ ²⁻	I	U	S	I	I	U	I	U	U	I	I	I	I	U	U	S	U	S	I	I
SO ₄ ²⁻	S	S	I	S	I	S	S	S	S	S	S	I	S	I	S	S	I	S	I	S
S ²⁻	D	S	D	I	I	I	I	I	I	I	S	I	D	I	I	S	I	S	I	I
SO ₃ ²⁻	U	S	I	I	I	I	I	U	U	I	S	I	U	U	I	S	I	S	I	I

PERIODIC TABLE OF THE ELEMENTS

1 1 H Hydrogen 1.0079 2-1	2 2 He Helium 4.0026 2-0											16 16 O Oxygen 15.999 2-2	17 17 F Fluorine 18.998 2-1	18 18 Ne Neon 20.179 2-8			
3 3 Li Lithium 6.941 2-1	4 4 Be Beryllium 9.0122 2-2											15 15 N Nitrogen 14.007 2-3	16 16 O Oxygen 15.999 2-2	17 17 F Fluorine 18.998 2-1	18 18 Ne Neon 20.179 2-8		
11 11 Na Sodium 22.990 2-8-1	12 12 Mg Magnesium 24.305 2-8-2											14 14 C Carbon 12.011 2-4	15 15 N Nitrogen 14.007 2-3	16 16 O Oxygen 15.999 2-2	17 17 F Fluorine 18.998 2-1	18 18 Ar Argon 39.948 2-8-8	
19 19 K Potassium 39.098 2-8-8-1	20 20 Ca Calcium 40.078 2-8-8-2	21 21 Sc Scandium 44.956 2-8-9-2	22 22 Ti Titanium 47.887 2-8-10-2	23 23 V Vanadium 50.942 2-8-11-2	24 24 Cr Chromium 51.996 2-8-13-1	25 25 Mn Manganese 54.938 2-8-13-2	26 26 Fe Iron 55.845 2-8-14-2	27 27 Co Cobalt 58.933 2-8-15-2	28 28 Ni Nickel 58.693 2-8-16-2	29 29 Cu Copper 63.546 2-8-18-1	30 30 Zn Zinc 65.39 2-8-18-2	31 31 Ga Gallium 69.723 2-8-18-3	32 32 Ge Germanium 72.64 2-8-18-4	33 33 As Arsenic 74.922 2-8-18-5	34 34 Se Selenium 78.96 2-8-18-6	35 35 Br Bromine 79.904 2-8-18-7	36 36 Kr Krypton 83.80 2-8-18-8
37 37 Rb Rubidium 85.468 2-8-18-8-1	38 38 Sr Strontium 87.62 2-8-18-8-2	39 39 Y Yttrium 88.906 2-8-18-9-2	40 40 Zr Zirconium 91.224 2-8-18-10-2	41 41 Nb Niobium 92.906 2-8-18-12-1	42 42 Mo Molybdenum 95.94 2-8-18-13-1	43 43 Tc Technetium (98) 2-8-18-14-1	44 44 Ru Ruthenium 101.07 2-8-18-15-1	45 45 Rh Rhodium 102.91 2-8-18-16-1	46 46 Pd Palladium 106.42 2-8-18-18	47 47 Ag Silver 107.87 2-8-18-18-1	48 48 Cd Cadmium 112.41 2-8-18-18-2	49 49 In Indium 114.82 2-8-18-18-3	50 50 Sn Tin 118.71 2-8-18-18-4	51 51 Sb Antimony 121.76 2-8-18-18-5	52 52 Te Tellurium 127.60 2-8-18-18-6	53 53 I Iodine 126.90 2-8-18-18-7	54 54 Xe Xenon 131.29 2-8-18-18-8
55 55 Cs Cesium 132.91 2-8-18-18-8-1	56 56 Ba Barium 137.33 2-8-18-18-8-2	57-71 57-71 La Lanthanide	72 72 Hf Hafnium 178.49 2-8-18-32-10-2	73 73 Ta Tantalum 180.95 2-8-18-32-11-2	74 74 W Tungsten 183.84 2-8-18-32-12-2	75 75 Re Rhenium 186.21 2-8-18-32-13-2	76 76 Os Osmium 190.23 2-8-18-32-14-2	77 77 Ir Iridium 192.22 2-8-18-32-15-2	78 78 Pt Platinum 195.08 2-8-18-32-17-1	79 79 Au Gold 196.97 2-8-18-32-18-1	80 80 Hg Mercury 200.59 2-8-18-32-18-2	81 81 Tl Thallium 204.38 2-8-18-32-18-3	82 82 Pb Lead 207.2 2-8-18-32-18-4	83 83 Bi Bismuth 208.98 2-8-18-32-18-5	84 84 Po Polonium (209) 2-8-18-32-18-6	85 85 At Astatine (210) 2-8-18-32-18-7	86 86 Rn Radon (222) 2-8-18-32-18-8
87 87 Fr Francium (223) -18-32-18-8-1	88 88 Ra Radium (226) -18-32-18-8-2	89-103 89-103 Ac Actinide	104 104 Rf Rutherfordium (261) -18-32-32-10-2	105 105 Db Dubnium (262) -18-32-32-11-2	106 106 Sg Seaborgium (266) -18-32-32-12-2	107 107 Bh Bohrium (264) -18-32-32-13-2	108 108 Hs Hassium (277) -18-32-32-14-2	109 109 Mt Meitnerium (268) -18-32-32-15-2	110 110 Uun Ununnilium (281) -18-32-32-17-1	111 111 Uuu Unununium (272) -18-32-32-18-1	112 112 Uub Unubium (285) -18-32-32-18-2	113 113 Uut Ununtrium (284) -18-32-32-18-3	114 114 Uuq Ununquadium (289) -18-32-32-18-4	115 115 Uup Ununpentium (288) -18-32-32-18-5	116 116 Uuh Ununhexium (291) -18-32-32-18-6	117 117 Uus Ununseptium -18-32-32-18-7	118 118 Uuo Ununoctium (294) -18-32-32-18-8



Electron Shells						
	1	2	s ₂	p	d	f
1	K	2	2	6		
2	L	8	2	6		
3	M	18	2	6	10	
4	N	32	2	6	10	14
5	O	32	2	6	10	14
6	P	18	2	6	10	
7	Q	8	2	6		
8	R	2	2			

Lanthanide

57 57 La Lanthanum 138.91 2-8-18-18-9-2	58 58 Ce Cerium 140.12 2-8-18-20-9-2	59 59 Pr Praseodymium 140.91 2-8-18-21-8-2	60 60 Nd Neodymium 144.24 2-8-18-22-8-2	61 61 Pm Promethium (145) 2-8-18-23-8-2	62 62 Sm Samarium 150.36 2-8-18-24-9-2	63 63 Eu Europium 151.96 2-8-18-25-8-2	64 64 Gd Gadolinium 157.25 2-8-18-25-9-2	65 65 Tb Terbium 158.93 2-8-18-27-8-2	66 66 Dy Dysprosium 162.50 2-8-18-28-8-2	67 67 Ho Holmium 164.93 2-8-18-29-8-2	68 68 Er Erbium 167.26 2-8-18-30-8-2	69 69 Tm Thulium 168.93 2-8-18-31-8-2	70 70 Yb Ytterbium 173.04 2-8-18-32-8-2	71 71 Lu Lutetium 174.97 2-8-18-32-9-2
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Actinide

89 89 Ac Actinium (227) -18-32-18-9-2	90 90 Th Thorium 232.04 -18-32-18-10-2	91 91 Pa Protactinium 231.04 -18-32-20-9-2	92 92 U Uranium 238.03 -18-32-21-9-2	93 93 Np Neptunium (237) -18-32-25-8-2	94 94 Pu Plutonium (244) -18-32-24-9-2	95 95 Am Americium (243) -18-32-25-8-2	96 96 Cm Curium (247) -18-32-25-9-2	97 97 Bk Berkelium (247) -18-32-28-8-2	98 98 Cf Californium (251) -18-32-28-8-2	99 99 Es Einsteinium (252) -18-32-28-8-2	100 100 Fm Fermium (257) -18-32-30-8-2	101 101 Md Mendelevium (258) -18-32-31-8-2	102 102 No Nobelium (259) -18-32-31-8-2	103 103 Lr Lawrencium (262) -18-32-32-8-2
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