MINISTRY OF HEALTH OF UKRAINE
BOGOMOLETS NATIONAL MEDICAL UNIVERSITY

Department of Medical and General Chemistry

INORGANIC CHEMISTRY

Student notebook for experimental chemistry

(Module 2 «Chemical Elements»)

Student _____

Group _____

Kyiv 2016

Approved by Methodical Commission of Physicochemical Disciplines of
Bogomolets National Medical University,
Record of Proceedings № 3 dated 07.12.2015

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This Student Notebook for Experimental Chemistry allows you to keep a written record or report of the mandatory laboratory and practical works that you will carry out as part of the Inorganic Chemistry course. The Student Laboratory Notebook includes laboratory and practical works in 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 / practical work,and best of luck with it!

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 1. General characteristics of the p-elements. Hydrogen and its compounds.

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 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 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 equation:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 2. p-elements of the VIIA group. Halogens. Halogens compounds in negative oxidation states.

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 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,

Observation:

Write the molecular equation:

in the second – about 1 g of KBr,

Observation:

Write the molecular equation:

in the third – about 1 g of KI

Observation:

Write the molecular 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).

Observation:

Write the molecular equation:

in the second – 5 drops of potassium iodide solution (KI).

Observation:

Write the molecular equation:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 3. p-elements of the VIIA group. Halogens. Halogens compounds in positive oxidation states.

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 molecular equation:

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 molecular equation:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 4. p -elements of the VIA group. Oxygen, Sulfur, Selenium, Tellurium.

Laboratory work N 4

Experiment 1. Reduction properties of sulfites.

Place 2–3 mL of potassium dichromate solution ($K_2Cr_2O_7$) 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 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 ($Na_2S_2O_3$) to discoloration.

Observation:

Write the molecular equation:

b) Transfer 3–4 drops of sodium thiosulfate solution ($Na_2S_2O_3$) into clean test tube and add 3–4 drops of hydrochloric acid solution (HCl).

Observation:

Write the molecular 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 equation:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 5. p-elements of the VA group. Nitrogen. Compounds of nitrogen in negative oxidation states.

Laboratory work N 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 equation:

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

Observation:

Write the molecular 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 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 phenolphtalein indicator. Note the color of solutions. In the first test tube add 1–2 microspattles of ammonium chloride. Compare the colors of solutions in the first and second test tubes. Make conclusion about equilibrium shift.

Observation:

Write the molecular equation:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 6. p-elements of the VA group. Nitrogen. Compounds of nitrogen in positive oxidation states.

Laboratory work N 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 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 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 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 equation:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 7. p-elements of the VA group. Phosphorus and its compounds.

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 $Al_2(SO_4)_3$ 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 equation:

Observation:

Write the molecular equation:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 8. p-elements of the VA group. Arsen subgroup (Arsen, Antimony, Bismuth).

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 (HNO_3) into the first test tube; 3–4 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation:

Write the molecular 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 $K[Sb(OH)_6]$ solution into clean test tube, add 2–3 drops of sulfuric acid solution
Observation:
Write the molecular equation:

Experiment *3. Preparation of bismuth (III) iodide.*

Transfer 3–4 drops of bismuth nitrate solution ($Bi(NO_3)_3$) into clean test tube, add some drops of potassium iodide solution (KI) until precipitate formation. Add again potassium iodide solution (KI) until precipitate
Observation:
Write the molecular equation:

Date _____

Teacher`s signature _____

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 9. p-elements of the IVA group. Carbon and Silicum.

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:

Observation:

Write the molecular and ionic equations:

And 5–6 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation:

Write the molecular and ionic equations:

Experiment 2. Interaction salts of chromium with soluble carbonates.

Transfer 2–3 drops of chromium (III) sulfate solution ($Cr_2(SO_4)_3$) into clean test tube, add 2–3 drops of sodium carbonate solution (Na_2CO_3).

Observation:

Write the molecular and ionic equations:

To the resulting precipitate chromium (III) hydroxide add 5–10 drops of sodium hydroxide solution (NaOH):

Observation:
Write the molecular and ionic equations:

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 and ionic equations:

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 and ionic equations:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 10. p-elements of the IVA group. Germanium subgroup (Germanium, Stannum, Lead).

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:

Observation:

Write the molecular and ionic equations:

Add 3–5 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation:

Write the molecular and ionic 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 and ionic equations:

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 $K_3[Fe(CN)_6]$ 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.
Observation:
Write the molecular reaction equations for

a) reducing of iron (III) chloride by stannum (II) chloride;

b) interaction of iron (II) chloride with $K_3[Fe(CN)_6]$

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

Take two clean test tubes. Transfer 2–3 drops of lead (II) nitrate solution ($Pb(NO_3)_2$) 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:

Observation:

Write the molecular and ionic equations:

and 4–5 drops of sodium hydroxide solution (NaOH) into the second test tube:

Observation:

Write the molecular and ionic equations:

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

Take two clean test tubes. Transfer 4–5 drops of lead (II) nitrate solution ($Pb(NO_3)_2$) in each one.

Add into the first test tube some drops of potassium iodide solution (KI) until precipitate form:

Observation:

Then to the precipitate formed 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).

Write the molecular and ionic equations:

Add into the second test tube 5–6 drops of potassium chromate solution (K_2CrO_4).

Observation:

Write the molecular and ionic equations:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 5. p - Elements of the III-VIII groups of the periodic table of elements

Topic 11. p-elements of the IIIA group. Boron and Aluminium

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:

Observation:
Write the molecular and ionic equations:

Add sodium hydroxide solution (NaOH) into the second test tube until precipitate dissolve.

Observation:
Write the molecular and ionic 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 and ionic equations:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 6. s-Elements (typical metals)

Topic 12. s-elements of the I group. Alkali metals

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 hexacianocobaltate

Place 1–2 drops of KCl solution on the slide plate. Near place 1–2 drops of sodium hexacianocobaltate solution ($Na_3[Co(CN)_6]$). Mix drops of KCl solution and sodium hexacianocobaltate solution using glass stick.

Observation:

Write the molecular and ionic equations:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 6. s-Elements (typical metals)

Topic 13. Elements of the II group. Beryllium, magnesium and alkali-earth metals

Laboratory work N 13

Experiment 1. Interaction $CaCl_2$ with $(NH_4)_2C_2O_4$.

Place 0,5–1 mL of $CaCl_2$ solution into clean test tube and add 0,5–1 mL of $(NH_4)_2C_2O_4$ solution. Resulting precipitation divide into two test tubes.

Add CH_3COOH solution into the first test tube:

Observation:
Write the molecular and ionic equations:

and HCl solution into the second test tube:

Observation:
Write the molecular and ionic 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:

Observation:
Write the molecular and ionic equations:

Add HNO_3 solution into the second test tube:

Observation:

Write the molecular and ionic 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:

Observation:

Write the molecular equation:

Add NaOH solution into the second test tube:

Observation:

Write the molecular equation:

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:

Observation:

Write the molecular and ionic equations:

Add NH_4Cl solution into the second test tube:

Observation:

Write the molecular and ionic equations:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 7. d-Elements of the I - VIII groups of the periodic table of elements

Topic 14. General characteristics of d-elements. d-elements of the IB group. Copper, Argentum, Aurum.

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 and ionic equations:

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 and ionic 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:

Observation:
Write the molecular and ionic equations:

Add 2–3 mL of sodium hydroxide solution (NaOH) into the second test tube:

Observation:
Write the molecular and ionic equations:

Third test tube carefully heat:

Observation:
Write the molecular and ionic equations:

b) Place some drops of sodium hydroxide solution (NaOH) into clean test tube and add 1–2 drops of argentum nitrate solution ($AgNO_3$). Resulting precipitation divide into two test tubes.

Add 5-6 drops of hydrochloric acid solution (HCl) into the first test tube:
Observation:
Write the molecular and ionic equations:

Add 5-6 drops of ammonia solution (NH_4OH) into the second test tube.

Observation:
Write the molecular and ionic equations:

Experiment 3. Preparation of complex compounds of copper and argentum

a) Place 2–3 drops of copper sulfate solution ($CuSO_4$) into clean test tube and add 1–2 drops of ammonia solution (NH_4OH) until precipitate is formed. Then add ammonia solution (NH_4OH) until precipitate is dissolved.

Observation:
Write the molecular and ionic equations:

b) Transfer 3–4 drops of argentum nitrate solution ($AgNO_3$) 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 (NH_4OH).

Observation:

Write the molecular and ionic 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:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 7. d-Elements of the I - VIII groups of the periodic table of elements

Topic 15. d-elements of the IIB group. Zinc, Cadmium, Mercury.

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 molecular and ionic equations:

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.

Observation:
Write the molecular and ionic equations:

Then add an excess of ammonium hydroxide solution to dissolve the precipitate.

Observation:
Write the molecular and ionic equations:

Experiment 3. Hydrolysis of salts of zinc

On a strip of universal indicator paper, apply a drop of solution of zinc chloride.

Observation:

Estimate the pH of salt solution:

Write the hydrolysis reactions in molecular and ionic forms:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 7. d-Elements of the I - VIII groups of the periodic table of elements

Topic 16. d-elements of the VIA group. Chromium subgroup.

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

Observation:
Write the molecular and ionic equations:

Add some drops of sodium hydroxide solution (NaOH) into the second test tube:

Observation:
Write the molecular and ionic equations:

Experiment 2. Oxidizing properties of potassium dichromate

Transfer 5 drops of potassium dichromate solution ($K_2Cr_2O_7$) 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 molecular and ionic equations:

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 molecular and ionic equations:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 7. d-Elements of the I - VIII groups of the periodic table of elements

Topic 17. d-elements of the VIIA group. Manganese subgroup.

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 precipitate formed with glass stick.

Observation:

Write the molecular and ionic equations:

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 molecular and ionic equations:

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 molecular and ionic equations:

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 molecular and ionic equations:

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:

Observation:
Write the molecular and ionic equations:

Add 3−4 drops of sodium sulfite solution (Na_2SO_3) into the second test tube:

Observation:
Write the molecular and ionic equations:

Add 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 molecular and ionic equations:

Date _____

Teacher`s signature _____

Module 2. «Chemical elements»

Semantic Module 7. d-Elements of the I - VIII groups of the periodic table of elements

Topic 18. d-elements of the VIIIA group. Iron and its compounds.Cobalt and Nicole compounds. Platinum metals.

Laboratory work N 18

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

Transfer 3−4 drops of Mohr's salt solution ($(NH_4)_2Fe(SO_4)_2$) 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 molecular and ionic equations:

Experiment 2. Reducing properties of iron (II) compounds

Transfer 3−4 drops of Mohr's salt solution ($(NH_4)_2Fe(SO_4)_2$) 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 molecular and ionic equations:

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:

Observation:
Write the molecular and ionic equations:

Add 3−4 drops of sodium hydroxide solution (NaOH) into the second test tube.

Observation:
Write the molecular and ionic equations:

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 molecular and ionic equations:

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

a) transfer 3−4 drops of Mohr's salt solution $(NH_4)_2Fe(SO_4)_2$) into clean test tube and add 5−10 drops of potassium ferricyanide solution $K_3[Fe(CN)_6]$.

Note the color of resulting precipitate:

Write the molecular and ionic equations:

b) transfer 3−4 drops of iron (III) salt solution into clean test tube and add 5−10 drops of potassium ferrocyanide solution $K_4[Fe(CN)_6]$.

Note the color of resulting precipitate:

Write the molecular and ionic equations:

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 solution:

Write the molecular and ionic equations:

Experiment 5. 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).

Observation:
Write the molecular and ionic equations:

Transfer 3−4 drops of cobalt (II) nitrate solution ($Co(NO_3)_2$) 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 molecular and ionic equations:

Experiment 6. Preparation of ammonia complexes of cobalt (II) and nickel (II)

a) 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.

Observation:

Write the molecular and ionic equations:

b) Transfer 3−4 drops of cobalt (II) nitrate solution ($Co(NO_3)_2$) into the second clean test tube and add ammonium hydroxide solution (NH_4OH) to precipitate formation, then add an excess of ammonium.

Observation:

Write the molecular equation:

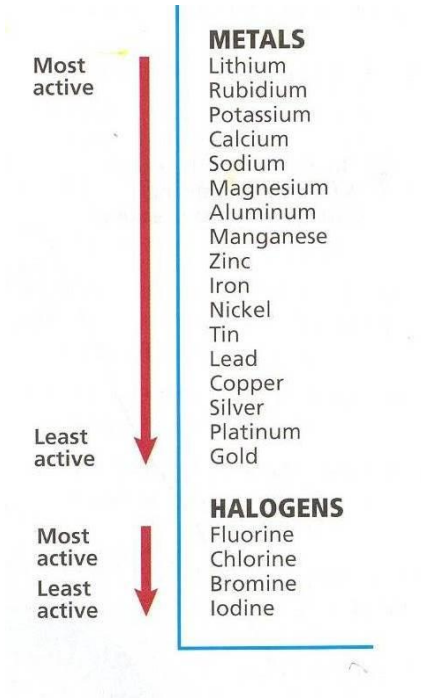
Add 2−3 drops of hydrogen peroxide solution (H_2O_2) to the precipitate formed.

Observe the color changing of precipitate:

Write the molecular and ionic equations:

Date _____

Teacher`s signature _____

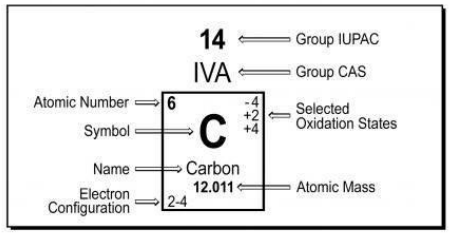


Solubility of Ionic Compounds in Water

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

Cation / Anion	Al 3+	NH_4 1+	Ba 2+	Cd 2+	Ca 2+	Cr 3+	Co 2+	Cu 2+	Fe 3+	Fe 2+	H 1+	Pb 2+	Mg 2+	Hg 1+	Ni 2+	K 1+	Ag 1+	Na 1+	Sr 2+	Zn 2+
$C_2H_3O_2^-$	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_2O	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_2O	I	I	I	I	D	I	D	I	I
$C_2O_4^{2-}$	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 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 **H** +1 -1 Hydrogen 1.0079 1																	2 **He** 0 Helium 4.0026 2
3 **Li** +1 Lithium 6.941 2-1	4 **Be** +2 Beryllium 9.0122 2-2											5 **B** +3 Boron 10.811 2-3	6 **C** -4 +2 +4 Carbon 12.011 2-4	7 **N** -3 -2 -1 +1 +2 +3 +4 +5 Nitrogen 14.007 2-5	8 **O** -2 Oxygen 15.999 2-6	9 **F** -1 Fluorine 18.998 2-7	10 **Ne** 0 Neon 20.179 2-8
11 **Na** +1 Sodium 22.990 2-8-1	12 **Mg** +2 Magnesium 24.305 2-8-2											13 **Al** +3 Aluminium 26.982 2-8-3	14 **Si** -4 +2 +4 Silicon 28.086 2-8-4	15 **P** -3 +3 +5 Phosphorus 30.974 2-8-5	16 **S** -2 +4 +6 Sulphur 32.065 2-8-6	17 **Cl** -1 +1 +3 +5 +7 Chlorine 35.453 2-8-7	18 **Ar** 0 Argon 39.948 2-8-8
19 **K** +1 Potassium 39.098 2-8-8-1	20 **Ca** +2 Calcium 40.078 2-8-8-2	21 **Sc** +3 Scandium 44.956 2-8-9-2	22 **Ti** +2 +3 +4 Titanium 47.867 2-8-10-2	23 **V** +2 +3 +4 +5 Vanadium 50.942 2-8-11-2	24 **Cr** +2 +3 +6 Chromium 51.996 2-8-13-1	25 **Mn** +2 +3 +4 +6 +7 Manganese 54.938 2-8-13-2	26 **Fe** +2 +3 Iron 55.845 2-8-14-2	27 **Co** +2 +3 Cobalt 58.933 2-8-15-2	28 **Ni** +2 +3 Nickel 58.693 2-8-16-2	29 **Cu** +1 +2 Copper 63.546 2-8-18-1	30 **Zn** +2 Zinc 65.39 2-8-18-2	31 **Ga** +3 Gallium 69.723 2-8-18-3	32 **Ge** -4 +2 +4 Germanium 72.64 2-8-18-4	33 **As** -3 +3 +5 Arsenic 74.922 2-8-18-5	34 **Se** -2 +4 +6 Selenium 78.96 2-8-18-6	35 **Br** -1 +1 +5 Bromine 79.904 2-8-18-7	36 **Kr** 0 +2 Krypton 83.80 2-8-18-8
37 **Rb** +1 Rubidium 85.468 2-8-18-8-1	38 **Sr** +2 Strontium 87.62 2-8-18-8-2	39 **Y** +3 Yttrium 88.906 2-8-18-9-2	40 **Zr** +4 Zirconium 91.224 2-8-18-10-2	41 **Nb** +3 +5 Niobium 92.906 2-8-18-12-1	42 **Mo** +3 +6 Molybdenum 95.94 2-8-18-13-1	43 **Tc** +4 +6 +7 Technetium (98) 2-8-18-14-1	44 **Ru** +3 Ruthenium 101.07 2-8-18-15-1	45 **Rh** +3 Rhodium 102.91 2-8-18-16-1	46 **Pd** +2 +4 Palladium 106.42 2-8-18-18	47 **Ag** +1 Silver 107.87 2-8-18-18-1	48 **Cd** +2 Cadmium 112.41 2-8-18-18-2	49 **In** +3 Indium 114.82 2-8-18-18-3	50 **Sn** +2 +4 Tin 118.71 2-8-18-18-4	51 **Sb** -3 +3 +5 Antimony 121.76 2-8-18-18-5	52 **Te** -2 +4 +6 Tellurium 127.60 2-8-18-18-6	53 **I** -1 +1 +5 +7 Iodine 126.90 2-8-18-18-7	54 **Xe** 0 +2 +4 +6 Xenon 131.29 2-8-18-18-8
55 **Cs** +1 Cesium 132.91 2-8-18-18-8-1	56 **Ba** +2 Barium 137.33 2-8-18-18-8-2	57-71 **La** Lanthanide	72 **Hf** +4 Hafnium 178.49 2-8-18-32-10-2	73 **Ta** +5 Tantalum 180.95 2-8-18-32-11-2	74 **W** +6 Tungsten 183.84 2-8-18-32-12-2	75 **Re** +4 +6 +7 Rhenium 186.21 2-8-18-32-13-2	76 **Os** +3 +4 Osmium 190.23 2-8-18-32-14-2	77 **Ir** +3 +4 Iridium 192.22 2-8-18-32-15-2	78 **Pt** +2 +4 Platinum 195.08 2-8-18-32-17-1	79 **Au** +1 +3 Gold 196.97 2-8-18-32-18-1	80 **Hg** +1 +2 Mercury 200.59 2-8-18-32-18-2	81 **Tl** +1 +3 Thallium 204.38 2-8-18-32-18-3	82 **Pb** +2 +4 Lead 207.2 2-8-18-32-18-4	83 **Bi** +3 +5 Bismuth 208.98 2-8-18-32-18-5	84 **Po** +2 +4 Polonium (209) 2-8-18-32-18-6	85 **At** Astatine (210) 2-8-18-32-18-7	86 **Rn** 0 Radon (222) 2-8-18-32-18-8
87 **Fr** +1 Francium (223) -18-32-18-8-1	88 **Ra** +2 Radium (226) -18-32-18-8-2	89-103 **Ac** Actinide	104 **Rf** Rutherfordium (261) -18-32-32-10-2	105 **Db** Dubnium (262) -18-32-32-11-2	106 **Sg** Seaborgium (266) -18-32-32-12-2	107 **Bh** Bohrium (264) -18-32-32-13-2	108 **Hs** Hassium (277) -18-32-32-14-2	109 **Mt** Meitnerium (268) -18-32-32-15-2	110 **Uun** +2 +4 Ununnilium (281) -18-32-32-17-1	111 **Uuu** Unununium (272) -18-32-32-18-1	112 **Uub** Ununbium (285) -18-32-32-18-2	113 **Uut** Ununtrium (284)	114 **Uuq** Ununquadium (289)	115 **Uup** Ununpentium (288)	116 **Uuh** Ununhexium (291)	117 **Uus** Ununseptium	118 **Uuo** Ununoctium (294)

Electron Shells

			S	P	D	F
1	K	2	2			
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 **La** +3 Lanthanum 138.91 2-8-18-18-9-2	58 **Ce** +3 +4 Cerium 140.12 2-8-18-20-8-2	59 **Pr** +3 Praseodymium 140.91 2-8-18-21-8-2	60 **Nd** +3 Neodymium 144.24 2-8-18-22-8-2	61 **Pm** +3 Promethium (145) 2-8-18-23-8-2	62 **Sm** +2 +3 Samarium 150.36 2-8-18-24-8-2	63 **Eu** +2 +3 Europium 151.96 2-8-18-25-8-2	64 **Gd** +3 Gadolinium 157.25 2-8-18-25-9-2	65 **Tb** +3 Terbium 158.93 2-8-18-27-8-2	66 **Dy** +3 Dysprosium 162.50 2-8-18-28-8-2	67 **Ho** +3 Holmium 164.93 2-8-18-29-8-2	68 **Er** +3 Erbium 167.26 2-8-18-30-8-2	69 **Tm** +3 Thulium 168.93 2-8-18-31-8-2	70 **Yb** +2 +3 Ytterbium 173.04 2-8-18-32-8-2	71 **Lu** +3 Lutetium 174.97 2-8-18-32-9-2

Actinide

89 **Ac** +3 Actinium (227) -18-32-18-9-2	90 **Th** +4 Thorium 232.04 -18-32-18-10-2	91 **Pa** +4 +5 Protactinium 231.04 -18-32-20-9-2	92 **U** +3 +4 +5 +6 Uranium 238.03 -18-32-21-9-2	93 **Np** +3 +4 +5 +6 Neptunium (237) -18-32-23-8-2	94 **Pu** +3 +4 +5 +6 Plutonium (244) -18-32-24-8-2	95 **Am** +3 +4 +5 +6 Americium (243) -18-32-25-8-2	96 **Cm** +3 Curium (247) -18-32-25-9-2	97 **Bk** +3 +4 Berkelium (247) -18-32-27-8-2	98 **Cf** +3 Californium (251) -18-32-28-8-2	99 **Es** Einsteinium (252) -18-32-29-8-2	100 **Fm** Fermium (257) -18-32-30-8-2	101 **Md** Mendelevium (258) -18-32-31-8-2	102 **No** Nobelium (259) -18-32-32-8-2	103 **Lr** Lawrencium (262) -18-32-32-9-2