THE MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY
"DNIPROVSKA POLYTECHNIC"

FACULTY OF GEOLOGICAL PROSPECTING
Departament of Chemestry

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CHEMISTRY

METHODICAL INSTRUCTIONS AND TASKS
FOR SELF-WORK
ON THE DISCIPLINE

for students of all specialties
Part 1

Dnipro
NTU “DP”
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Затверджено до видання методичною комісією з галузі знань 10. Природничі науки (протокол № 3 від 15.03.2018) за поданням кафедри хімії (протокол № 9 від 14.02.2018).

The methodical instructions contain individual tasks in the course of chemistry, which are compiled on the topics of the theoretical course.

Методичні рекомендації містять індивідуальні завдання відповідно до тем теоретичного курсу хімії.

Відповідальна за випуск завідувач кафедри хімії, д-р техн. наук, проф. О.Ю. Свєткіна.

INTRODUCTION

The current methodological guidelines include the tasks on conducting ongoing student knowledge check of the chemistry course.

Part one contains tasks on the topic of the theoretical part of the course. Each topic has a number: 1, 2, 3, etc. Inside the topics there are sections and subsections, which are numbered by adding one or two numbers respectively to the topic number. Thus, in topic 2 there are sections 2.1, 2.2, 2.3, etc. and subsections 2.1.1, 2.1.2, 2.1.3, etc.

One section (subsection) there is 30 tasks. If there are no tasks in the middle of the section, it is indicated that particular examples should be taken from one of the previous sections. For example, to complete the task 10 of section 1.2 means: to compile empirical and graphic formulas for possible oxides of an element which are specified in section 1.1 under No. 10, that is manganese.

Each student of the group performs assignments on various topics during the semester, indicated by numbers from 01 to 30.

1. CLASSES OF INORGANIC COMPOUNDS

1.1. List the stable oxidation steps of the element:

01 – Nitrogen; 02 – Magnesium; 03 – Sodium; 04 – Chlorine; 05 – Sulfur; 06 – Titanium; 07 – Carbon; 08 – Zinc; 09 – Copper; 10 – Manganese; 11 – Chromium; 12 – Bromine; 13 – Calcium; 14 – Aluminum; 15 – Potassium; 16 – Silver; 17 – Barium; 18 – Silicon; 19 – Cadmium; 20 – Lithium; 21 – Nickel; 22 – Hydrogen; 23 – Lithium; 24 – Tin; 25 – Phosphorus; 26 – Antimony; 27 – Boron; 28 – Iron; 29 – Mercury; 30 – Iodine.

1.2. Make empirical and graphical formulas for possible oxides of the element given in section 1.1 and name these oxides.

1.3. Determine the type of oxide (solvent, non–soluble, basic, acid or amphoteric) specified in section 1.2.

1.4. Write the equation of the salt formation reactions, proving the nature of the oxides (basic, acid or amphoteric), defined in section 1.3.

1.5. Write the empirical, graphic formulas and the name of the hydroxides of oxides, compiled in section 1.2.

1.6. Name the compounds in the international nomenclature:

01 – $KHCO_3$; 02 – $Ca(HCO_3)_2$; 03 – $Fe(OH)_2NO_3$; 04 – $CaOHNO_2$; 05 – $CaSiO_3$; 06 – $Ba_3(PO_4)_2$; 07 – $CaHPO_4$; 08 – $Ba(HSO_4)_2$; 09 – Li_2SO_4;

10 – $KHSO_4$; 11 – Na_2SO_3; 12 – PbS; 13 – $Ca(HSO_4)_2$; 14 – $BiOHCl_2$; 15 – $CaCrO_4$; 16 – $K_2Cr_2O_7$; 17 – $NaMnO_4$; 18 – $MnSO_4$; 19 – $FeOHCl_2$; 20 – $CdOHCl$; 21 – $MgOHCl$; 22 – $(MgOH)_2CO_3$; 23 – $AlOHSO_4$; 24 – $[Al(OH)_2]_2SO_4$; 25 – $CaOHCl$; 26 – $(NiOH)_2CO_3$; 27 – $CoOHBr$; 28 – $LiHCO_3$; 29 – $AgNO_3$; 30 – Na_2ZnO_2.

1.7. Determine the degree of oxidation of the elements forming the compounds specified in section 1.6

1.8. Write the empirical and graphic formulas for acids:

01 – boric; 02 – carbonic; 03 – nitrous ; 04 – phosphoric; 05 – sulphuric; 06 – nitric; 07 – hydrosulphuric; 08 – acetic; 09 –silicic; 10 – sulphuric; 11 – hydrochloric acid; 12 – nitric; 13 – phosphoric; 14 – silicic; 15 – carbonic; 16 – hydrobromic; 17 – hydrofluoric acid; 18 – chromic; 19 – boric; 20 – permanganic; 21 – sulphuric; 22 – phosphoric; 23 – hydrobromic; 24 – sulphurous; 25 – nitrous; 26 – hydroiodic; 27 – chromic; 28 – nitric; 29 – acetic; 30 – permanganic.

1.9. Write the empirical and graphic base formulas:

01 – aluminum(III) hydroxide; 02 – calcium hydroxide; 03 – iron(III) hydroxide; 04 – strontium hydroxide; 05 – sodium hydroxide; 06 – iron(II) hydroxide; 07 – bismuth(III) hydroxide; 08 – copper(I) hydroxide; 09 – nickel(III) hydroxide; 10 – cobalt(III) hydroxide; 11 – potassium hydroxide; 12 – cesium hydroxide; 13 – barium hydroxide; 14 – cadmium hydroxide; 15 – magnesium hydroxide; 16 – manganese(II) hydroxide; 17–francium hydroxide; 18 – copper(II) hydroxide; 19 – bismuth(III) hydroxide; 20 – nickel(III) hydroxide; 21– mercury(II) hydroxide; 22 – lithium hydroxide; 23 – barium hydroxide; 24 – radium hydroxide; 25 – zirconium(III) hydroxide; 26 – copper(II) hydroxide; 27 – chromium(II) hydroxide; 28 – yttrium(III) hydroxide; 29 – rubidium hydroxide; 30 – thallium(III) hydroxide.

1.10. Write the empirical and graphic salt formulas:

01 – lithium nitrate; 02 – calcium carbonate; 03 – potassium sulphate; 04 – sodium nitrate; 05 – zinc sulfite; 06 – lithium chloride; 07 – sodium silicate; 08 – beryllium fluoride; 09 – barium sulfide; 10 – sodium dichromate; 11 – magnesium hydrogen sulfide; 12 – calcium dihydrogenphosphate; 13 – iron(III) hydrogen sulfate; 14 – aluminum hydroxosulfate; 15 – chromium(III) dihydroxonitrate; 16 – potassium zincate; 17 – aluminum dihydrogenphosphate; 18 – strontium dichromate; 19 – aluminum dihydroxosulphate; 20 – potassium hydrogencarbonate; 21 – iron(III) hydroxychloride; 22 – calcium hydrogenphosphate; 23 – aluminum dihydroxychloride; 24 – sodium hydrogenphosphate; 25 – cadmium carbonate;

26 – strontium hydrogensulfate; 27 – mercury(II) nitrate; 28 – barium chloride; 29 – tin(II) sulfate; 30 – silver chromate.

2. MAIN CONCEPTS AND LAWS OF CHEMISTRY

2.1. Atomic mass, molecular weight, mole, molar mass

2.1.1. Determine the mass in g and in a.m.u of an atom of the element:

01 – Titanium; 02 – Carbon; 03 – Zinc; 04 – Copper; 05 – Manganese; 06 – Chromium; 07 – Bromine; 08 – Calcium; 09 – Aluminum; 10 – Potassium; 11 – Silver; 12 – Barium; 13 – Silicon; 14 – Lithium; 15 – Nickel; 16 – Mercury; 17 – Iodine; 18 – Hydrogen; 19 – Lithium; 20 – Tin; 21 – Phosphorus; 22 – Antimony; 23 – Boron; 24 – Iron; 25 – Nitrogen; 26 – Magnesium; 27 – Sodium; 28 – Chlorine; 29 – Sulfur; 30 – Cadmium.

2.1.2.Determine the mass in g and in a.m.u of a molecule of the substance:

01 – carbonic acid; 02 – sulphuric acid; 03 – nitrous acid; 04 – ammonium hydroxide; 05 – zinc hydroxide; 06 – potassium sulfate; 07 – lithium sulfate; 08 – nitric acid ; 09 – barium sulfide; 10 – calcium hydrogensulfate; 11 – aluminum hydrogensulfate; 12 – sodium hydrogencarbonate; 13 – silver hydroxide; 14 – sulfurous acid; 15 – hydrosulphuric acid; 16 – barium hydroxide; 17 – copper(II) hydroxide; 18 – sodium silicate; 19 – magnesium hydrogensulfide; 20 – silver chromate; 21 – sodium chloride; 22 calcium nitrate; 23 – potassium sulfite; 24 – iron(III) hydrogensulfate; 25 – ammonium nitrite; 26 – aluminum phosphate; 27 – chromium(III) dihydroxochloride; 28 – sodium chromate; 29 – aluminum sulfate; 30 – calcium carbonate.

2.1.3. Calculate how many atoms fit into

01 – 15 g of titanium; 02 – 0,3 g of carbon; 03 – 17 g of zinc; 04 – 24 g of copper; 05 – 0,01 g manganese; 06 – 7 g of chromium; 07 – 5 g of bromine; 08 – 10 g of calcium; 09 – 50 g of aluminum; 10 – 15 g of potassium; 11 – 24 g of silver; 12 – 22 g of barium; 13 – 16 g of silicon; 14 – 0,9 g of lithium; 15 – 27 g of nickel; 16 – 41,2 g mercury; 17 – 12,7 g of iodine; 18 – 25,7 g of hydrogen; 19 – 24,3 g of lithium; 20 – 16,8 g of tin; 21 – 35,1 g of phosphorus; 22 – 33,5 g of stibium; 23 – 20,6 g boron; 24 – 33,9 g of iron; 25 – 36,8 g of nitrogen; 26 – 43,6 g of magnesium; 27 – 0,66 g of sodium; 28 – 1,23 g of chlorine; 29 – 2,27 g of sulfur; 30 – 23 g of cadmium.

2.1.4. Calculate how many molecules are contained in:

01 – 100 g of calcium carbonate; 02 – 54 g of chromium(III) dihydroxychloride; 03 – 22 g sodium chromate; 04 – 82 g aluminum sulfate; 05 – 4,8 g of iron(III) hydrogensulfate; 06 – 30 g of ammonium nitrite; 07 – 58 g of aluminum phosphate; 08 – 0,64 g of sodium chloride; 09 – 53 g of calcium nitrate; 10 – 21 g of potassium sulfite; 11 – 87 g of silver chromate; 12 – 5,21 g copper(II) hydroxide; 13 – 15,8 g sodium silicate; 14 – 5,4 g of magnesium hydrogensulfide; 15 – 73 g of sulphurous acid; 16 – 10,2 g of hydrosulphuric acid; 17 – 16,7 g barium hydroxide; 18 – 22,5 g aluminum hydrogensulfate; 19 – 36,2 g sodium hydrogencarbonate; 20 – 42,8 g of silver hydroxide; 21 – 51,3 g of nitric acid; 22 – 66,3 g barium sulfide; 23 – 72,2 g of calcium hydrogensulfate; 24 – 23,6 g of ammonium hydroxide; 25 – 44,6 g zinc hydroxide; 26 – 85,3 g of potassium sulfate; 27 – 44,9 g of lithium hydroxide; 28 – 1,3 g of carbonic acid; 29 – 0,66 g of sulphuric acid; 30 – 36,8 g of nitrite acid.

2.1.5. How many moles are the amount of substance specified in the section 2.1.4.

2.1.6. Determine the mass in g:

01 – 2 mol. of sodium chromate; 02 – 0,3 mol. of aluminum sulfate; 03 – 3,4 mol. of calcium carbonate; 04 – 6,3 mol. of aluminum phosphate; 05 – 5,1 mol. of chromium(III) dihydroxochloride; 06 – 3 mol. of potassium sulfite; 07 – 2,5 mol. of iron(III) hydrogensulfate; 08 – 3,2 mol. of ammonium nitrite; 09 – 6 mol. of sodium chloride; 10 – 2,8 mol. of calcium nitrate; 11 – 10 mol. of silver chromate; 12 – 7,3 mol. of copper(II) hydroxide; 13 – 0,43 mol. of sodium silicate; 14 – 3,8 mol. of magnesium hydrogensulfide; 15 – 11,5 mol. of sulfite acid; 16 – 6,22 mol. of hydrosulphuric acid; 17 – 0,7 mol. of barium hydroxide; 18 – 3 mol of aluminum hydrogensulfate; 19 – 1,4 mol. of sodium hydrogencarbonate; 20 – 22 mol. of silver hydroxides; 21 – 1,8 mol. of – nitrous acid; 22 – 2,27 mol. barium sulfide; 23 – 1,3 mol. of calcium hydrogensulfate; 24 – 2,9 mol. of ammonium hydroxide; 25 – 0,22 mol. of zinc hydroxide; 26 – 112 mol. of potassium sulfate; 27 – 44 mol. of lithium sulfate; 28 – 39 mol. of carbonic acid; 29 – 0,88 mol. of sulphuric acid; 30 – 5 mol. of – nitrous acid.

2.2. Equivalent, molar mass of equivalent of a substance

2.2.1. Calculate the equivalent and molar mass of the equivalent of the element specified in section 1.1.

2.2.2. Calculate the equivalent and molar mass of the oxide equivalent in section 1.2.

2.2.3. Calculate the equivalent and molar mass of the acid equivalent given in section 1.8.

2.2.4. Calculate the equivalent and molar mass of the base equivalent given in section 1.9.

2.2.5. Calculate the equivalent and the molar mass of the salt equivalent given in section 1.10.

2.2.6. Determine the mass in g of the specified number of equivalents of the substance:

01 – 3,0 – sulphuric acid; 02 – 0,4 – barium hydroxide; 03 – 6,0 – sodium hydroxide; 04 – 0,8 – hydrochloric acid; 05 – 5,1 – sodium carbonate; 06 – 2,1 – tin(IV) chloride; 07 – 1,4 – water; 08 – 6,2 – aluminum chloride; 09 – 18 –2,9 – phosphoric acid; 10 – 10,2 – calcium chloride; 11 – 5,0 – zinc oxide; 12 – 6,2 – nitrous acid; 13 – 0,41 – strontium hydroxide; 14 – 4,5 – ammonium nitrate; 15 – 5,5 – potassium chromate; 16 – 0,28 – sodium sulfite; 17 – 0,38 – barium sulfide; 18 – 2,9 – potassium sulfate; 19 – 3,6 – lead(II) bromide; 20 – 2,2 – lead(II) sulfate; 21 – 8,2 – silver carbonate; 22 – 1,3 – nickel(II) iodide; 23 – 0,84 – sodium sulfide; 24 – 11,5 – iron(III) hydroxide; 25 – 0,2 – zinc hydroxide; 26 – 7,2 – aluminum sulfate; 27 – 5,2 – zinc nitrite; 28 – 3,2 – magnesium chloride; 29 – 0,7 – sulfur trioxide; 30 – 0,5 – nitrogen dioxide.

2.2.7. How many equivalents are contained:

01 – 10 g of iron(III) hydroxide; 02 – 20,3 g of zinc hydroxide; 03 – 3,6 g of lead(II) bromide; 04 – 22,8 g of lead (II) sulfate; 05 – 13 g of sulphuric acid; 06 – 24 g of barium hydroxide; 07 – 6,5 g of sodium hydroxide; 08 – 28,6 g of chloride acid; 09 – 52,1 g of sodium carbonate; 10 – 21,2 g of the tin(IV) chloride; 11 – 1,4 g of water; 12 – 16,2 g of aluminum chloride; 13 – 11,8 g of – phosphoric acid; 14 – 1,2 g of calcium chloride; 15 – 15,3 g of zinc oxide;16 – 6,2 g of nitrite acid; 17 – 2,41 g of strontium hydroxide; 18 – 14,5 g of ammonium nitrate; 19 – 25,5 g of potassium chromate; 20 – 22,9 g of sodium sulfite; 21 – 3,38 g of barium sulfide; 22 – 12,9 g of potassium sulfate; 23 – 28,2 g of silver carbonate; 24 – 8,6 g of nickel(II) iodide; 25 – 84 g of sodium sulfide; 26 – 7,9 g of aluminum sulfate; 27 – 25,2 g of zinc nitrite; 28 – 13,2 g of magnesium chloride; 29 – 2,7 g of sulfur trioxide; 30 – 3,5 g nitrogen dioxide.

2.3. The law of equivalents

2.3.1. Determine the molar mass of the equivalent and the atomic mass of metal trivalent, when combustion $\mathbf{m_1}$ g, to which $\mathbf{m_2}$ g of metal oxide is formed. The values of $\mathbf{m_1}$ and $\mathbf{m_2}$ are respectively equal to:

01	– 7,50; 14,2	11	– 2,25; 4,25	21	– 7,75; 14,60
02	– 3,50; 6,60	12	– 3,75; 7,08	22	– 8,25; 15,58
03	– 3,00; 5,66	13	– 3,25; 6,14	23	– 8,75; 16,52
04	– 1,50; 2,83	14	– 1,75; 3,30	24	– 11,0; 20,77
05	– 8,00; 15,1	15	– 1,10; 2,08	25	– 12,0; 22,66
06	– 5,00; 9,44	16	– 1,60; 3,02	26	– 0,60; 1,13
07	– 1,00; 1,88	17	– 2,60; 4,90	27	– 13,0; 24,54
08	– 4,50; 8,50	18	– 2,10; 3,96	28	– 4,10; 7,74
09	– 6,50; 12,3	19	– 3,60; 6,80	29	– 14,0; 26,43
10	– 1,25; 2,36	20	– 3,10; 5,85	30	– 15,0; 28,32

2.3.2. Determine the molar mass of the equivalent and the atomic mass of the metal (II), if $\mathbf{m_2}$ g of salt was obtained when $\mathbf{m_1}$ g of metal and chlorine were connected, The molar mass of chlorine equivalent is 35,45 g/mol, The values of $\mathbf{m_1}$ and $\mathbf{m_2}$ are respectively:

01	– 2,16; 8,46	11	– 19,44; 76,14	21	– 24,48; 95,88
02	– 0,72; 2,86	12	– 20,88; 81,78	22	– 22,32; 87,42
03	– 25,2; 98,7	13	– 21,60; 84,60	23	– 18,72; 73,32
04	– 23,04; 90,24	14	– 9,36; 36,66	24	– 16,56; 64,86
05	– 17,28; 67,68	15	– 7,92; 31,02	25	– 13,68; 53,58
06	– 12,96; 50,76	16	– 10,08; 39,48	26	– 5,76; 22,56
07	– 7,20; 28,20	17	– 8,64; 33,84	27	– 6,48; 25,38
08	– 3,60; 14,10	18	– 14,40; 56,40	28	– 5,04; 19,74
09	– 20,16; 78,96	19	– 15,84; 62,04	29	– 4,32; 16,92
10	– 8,35; 32,46	20	– 15,12; 59,22	30	– 2,88; 11,28

2.3.3. Determine the molar mass of the equivalent and the atomic mass of the metal (II) if it is displaced from the sulfate acid of **V** l of hydrogen measured under normal conditions. The mass of the metal **m** and the volume of hydrogen **V** respectively are:

01	– 4,90; 1,68	11	– 9,48; 3,25	21	– 7,52; 2,58
02	– 5,23; 1,79	12	– 9,15; 3,14	22	– 7,19; 2,46
03	– 5,66; 1,90	13	– 8,82; 3,02	23	– 6,86; 2,36
04	– 1,96; 0,67	14	– 4,58; 1,57	24	– 6,54; 2,24
05	– 2,29; 0,78	15	– 4,25; 1,46	25	– 6,20; 2,13

06 – 2,61; 0,90	16 – 3,92; 1,34	26 – 5,88; 2,02
07 – 7,84; 2,69	17 – 3,59; 1,25	27 – 3,27; 1,12
08 – 8,17; 2,80	18 – 0,98; 0,34	28 – 2,94; 1,01
09 – 8,50; 2,91	19 – 0,65; 0,22	29 – 1,63; 0,56
10 – 9,80; 3,36	20 – 0,33; 0,11	30 – 1,31; 0,45

2.3.4. Determine the molar mass of the metal equivalent that is in contact with the element if it is known that this compound contains **A** % of the element, the molar mass equivalent of which is $\mathbf{M_e}$ g/mol, The values of **A** and $\mathbf{M_e}$ for the corresponding elements are:

01 – 06 – Sulfur; 48,04; 16,00
07 – 12 – Chlorine; 79,78; 35,45
13 – 18 – Florine; 45,24; 19,00
19 – 24 – Bromine; 80,00; 80,00
25 – 30 – Iodine; 94,84; 126,90

2.4. Avogadro's Law

2.4.1. Determine the mass of a substance that fits under normal conditions in:

01 – 3 l of ammonia; 02 – 3,8 l of a neon; 03 – 3 l of oxygen; 04 – 0,9 l of sulfur dioxide; 05 – 0,4 l of carbon dioxide; 06 – 112 l of oxygen; 07 – 0,5 l nitrogen dioxide; 08 – 1 l of nitrogen(IV) oxide; 09 – 0,6 l carbon(IV) oxide; 10 – 3,2 l of fluorine; 11 – 1,8 l of hydrogen; 12 – in 2,9 l of nitrogen(II) oxide; 13 – 1,4 l of helium; 14 – 1,5 l of nitrogen; 15 – 2,5 l of methane; 16 – 6,72 l of argon; 17 – 21,5 l of a neon; 18 – 2,8 l of hydrogen fluoride; 19 – 3,7 l of xenon; 20 – 2,3 l of chlorine; 21 – 2,5 l of hydrogen chloride; 22 – 0,6 l of sulfur dioxide; 23 – 2,6 l of hydrogen sulphide; 24 – 2,8 l of methane; 25 – 5 l of nitrogen dioxide; 26 – 15 l of hydrogen; 27 – 10,7 l of ammonia; 28 – 20 l of oxygen; 29 – 15 l of helium; 30 – 0,8 l of neon.

2.4.2. Determine the volume occupied under normal conditions:

01 – 36 g of nitrogen dioxide; 02 – 4,9 g of hydrogen sulphide; 03 – 42 g carbon(II) oxide; 04 – 5 g of hydrogen; 05 – 2,3 g of hydrogen fluoride; 06 – 3,4 g of oxygen; 07 – 6,8 g of nitrogen; 08 – 5,2 g of nitrogen(II) oxide; 09 – 7,3 g of helium; 10 – 8,6 g of argon; 11 – 72 g of sulfur trioxide; 12 – 9,2 g of hydrogen sulphide; 13 – 78 g of ammonia; 14–5,4 g of carbon dioxide; 15 – 5,8 g of hydrogen; 16–68 g of hydrogen sulphide; 17 – 98 g helium; 18 – 12 g of nitrogen dioxide; 19–25 g of hydrogen iodide; 20–67 g of hydrogen bromide; 21 – 8 g of sulfur dioxide; 22 – 16 g of acetylene; 23 – 15 g of nitrogen; 24 – 20 g of oxygen; 25 – 11,6 chlorine; 26 – 18 g of methane; 27 – 17 g of nitrogen oxide; 28 – 25 g of xenon; 29 – 0,7 g of nitrogen(I) oxide; 30 – 5 g of carbon(II) oxide.

3. CHEMICAL EQUILIBRIUM

3.1. Calculate the equilibrium constant and the initial concentrations of the reactants in the system (equilibrium concentrations, mol/l of substances indicated by the corresponding formula in the equation of reaction; the initial concentrations of the reaction products are 0):

3.1.1. $2NO + O_2 \Leftrightarrow 2NO_2$

01	0,2	0,1	0,1
02	0,3	0,2	0,1
03	0,4	0,1	0,2
04	1,5	0,7	0,6
05	2,0	1,4	1,6

3.1.2. $CO + Cl_2 \Leftrightarrow COCl_2$

06	1,0	1,5	1,4
07	0,3	0,4	0,2
08	2,0	1,8	1,6
09	3,0	2,0	2,0
10	0,5	0,4	0,1

3.1.3. $N_2O_4 \Leftrightarrow 2NO_2$

11	2,0	6,0
12	0,3	0,4
13	0,5	0,7
14	1,2	1,4
15	2,5	1,6

3.1.4. $H_2 + I_2 \Leftrightarrow 2HI$

16	2,4	1,6	0,8
17	0,04	0,02	0,01
18	1,5	1,2	1,1
19	0,1	0,2	0,3
20	3,2	1,6	1,8

3.1.5. $2CO + O_2 \Leftrightarrow 2CO_2$

21	1,2	1,4	1,4
22	0,3	0,5	0,7
23	0,01	0,02	0,03
23	2,2	1,8	1,4
25	1,6	0,3	0,4

3.1.6. $2NO + Cl_2 \Leftrightarrow 2NOCl$

26	0,03	0,02	0,01
27	0,4	0,6	0,6
28	0,6	0,2	0,1
29	2,6	1,8	1,6
30	4,0	2,2	2,6

3.2. Calculate the equilibrium concentrations of all substances and the constant of the equilibrium of the reaction (initial concentrations, mol/l, reactants and equilibrium concentration, mol/l of one of the products indicated by the corresponding formulas):

3.2.1. $2NO_2 \Leftrightarrow 2NO + O_2$.

01	0,5	0,1
02	0,4	0,01
03	2,5	1,4
04	2,8	0,6
05	0,08	0,02

3.2.2. $2SO_2 + O_2 \Leftrightarrow 2SO_3$.

06	0,8	0,6	0,2
07	2,4	1,8	0,6
08	0,8	0,4	0,1
09	1,2	0,8	0,4
10	3,6	2,2	0,8

3.2.3. $2\,NO_2 \Leftrightarrow N_2O_4$.

11	2,2	0,4
12	1,8	0,2
13	0,08	0,01
14	1,6	0,3
15	2,8	1,4

3.2.4. $CO + Cl_2 \Leftrightarrow 2COCl_2$.

16	4,8	2,2	1,2
17	0,08	0,04	0,01
18	1,3	0,8	0,3
19	6,2	4,4	2,8
20	0,2	0,08	0,04

3.2.5. $2HI \Leftrightarrow H_2 + I_2$.

21	0,8	–	0,2
22	0,4	0,1	–
23	1,5	0,8	–
23	2,6	–	1,2
25	3,6	2,2	–

3.2.6. $2CO + O_2 \Leftrightarrow 2CO_2$.

26	1,4	0,6	0,2
27	2,7	0,5	0,1
28	0,8	0,3	0,1
29	4,2	2,2	1,6
30	3,4	2,1	1,8

3.3. Calculate the equilibrium concentrations of the reactants (initial concentrations, mol/l of substances indicated by the corresponding formulas in the equation of reaction):

3.3.1. $A + B \Leftrightarrow AB$.

01	0,6	0,2	
02	2,2	0,8	
03	1,6	1,2	($K_p = 1$)
04	1,4	0,6	
05	1,2	0,8	

3.3.2. $H_2 + I_2 \Leftrightarrow 2HI$.

06	1,5	0,7	
07	2,4	1,6	
08	1,6	0,6	($K_p = 2$)
09	1,4	0,4	
10	1,6	0,2	

3.3.3. $2HCl \Leftrightarrow H_2 + Cl_2$.

11	0,6	
12	0,8	
13	1,4	($K_p = 0,1$)
14	0,2	
15	1,8	

3.3.4. $CO + Cl_2 \Leftrightarrow 2COCl_2$.

16	1,4	8,8	
17	0,4	0,1	
18	1,2	0,4	($K_p = 0,02$)
19	1,8	1,6	
20	2,4	3,2	

3.3.5. $A + B \Leftrightarrow C + D$.

21	2,0	4,0	
22	3,0	6,2	
23	4,2	4,4	($K_p = 3$)
24	1,2	1,0	
25	6,0	2,2	

3.3.6. $2NO + O_2 \Leftrightarrow 2NO_2$.

26	1,2	0,8	
27	0,6	0,4	
28	3,8	2,2	($K_p = 4$)
29	4,6	1,2	
30	2,6	0,2	

3.4. Shift of chemical equilibrium

In what direction the equilibrium is shifted at the specified pressure changes (**P**), concentration (**C**) of one of the reactants, temperature (**T**°) for the following reciprocal reactions:

3.4.1. **$2SO_2 + O_2 \Leftrightarrow 2SO_3$;** **$H^o_{298}$ =** – 196,6 кДж.

01	P	will rise,	[SO_3]	will decrease
02	P	will decrease,	[SO_2]	will rise
03	[O_2]	will increase,	T^o	will rise
04	[O_2]	will decrease,	T^o	will decrease
05	[SO_3]	will increase,	[SO_2]	will decrease

3.4.2. **$N_2 + O_2 \Leftrightarrow 2NO$;** **$H^o_{298}$ =** – 180,6 кДж.

06	[N_2]	will increase,	T^o	will decrease
07	[NO]	will decrease,	T^o	will rise
08	[O_2]	will increase,	P	will rise
09	[O_2]	will decrease,	P	will decrease
10	[NO]	will increase,	[N_2]	will decrease

3.4.3. **$COCl_2 \Leftrightarrow CO + Cl_2$;** **$H^o_{298}$ =** – 112,5 кДж/

11	[$COCl_2$]	will increase,	T^o	will rise
12	[$COCl_2$]	will decrease,	T^o	will decrease
13	[CO]	will increase,	P	will decrease
14	[Cl_2]	will decrease,	P	will rise
15	[CO]	will decrease,	[Cl_2]	will increase

3.4.4. **$2H_2 + O_2 \Leftrightarrow 2H_2O$;** **$H^o_{298}$ =** – 483,6 кДж.

16	[H_2]	will decrease,	T^o	will rise
17	[O_2]	will increase,	T^o	will decrease
18	[H_2]	will increase,	[H_2O]	will decrease
19	[O_2]	will decrease,	P	will rise
20	[H_2O]	will increase,	P	will decrease

3.4.5. **$2CO + O_2 \Leftrightarrow 2CO_2$;** **$H^o_{298}$ =** – 566 кДж.

21	[CO]	will increase,	[CO_2]	will decrease
22	[CO]	will decrease,	T^o	will rise
23	[O_2]	will decrease,	T^o	will decrease
24	[CO_2]	will decrease,	P	will decrease
25	[O_2]	will increase,	P	will rise

3.4.6. **$N_2 + 3H_2 \Leftrightarrow 2NH_3$;** **$H^o_{298}$ =** – 92,4 кДж.

26	$[N_2]$	will increase,	P	will decrease
27	$[H_2]$	will decrease,	T^o	will rise
28	$[N_2]$	will decrease,	P	will rise
29	$[NH_3]$	will increase,	T^o	will decrease
30	$[H_2]$	will increase,	$[NH_3]$	will decrease

4. CONCENTRATION OF SOLUTIONS

4.1. How many grams, moles, and equivalents of the dissolved substance are contained in:

01 – 250 g 8 % solution of potassium carbonate; 02 – 200 g 20 % solution of sulphuric acid; 03 – 150 g 15 % solution of hydrochloric acid; 04 – 180 g 17,5 % solution of potassium hydroxide; 05 – 100 g 3 % solution of silver nitrate; 06 – 270 g 10 % solution of sodium dichromate; 07 – 50 g of 5 % potassium permanganate solution; 08 – 300 g 10 % solution of lithium chloride; 09 – 120 g 7 % solution of manganese(II) sulfate; 10 – 400 g of 12 % sodium chloride solution; 11 – 160 g 20 % solution of ammonium hydroxide; 12 – 170 g 2 % solution of barium nitrate; 13 – 210 g 11 % solution of sodium nitrate; 14 – 180 g 5 % solution of sodium hydroxide; 15 – 190 g of 11 % potassium iodide solution; 16 – 110 g 30 % solution of hydrochloric acid; 17 – 75 g of 5 % potassium permanganate solution; 18 – 210 g 27 % solution of sulphuric acid; 19 – 700 g 3 % solution of phosphate acid; 20 – 90 g 45 % solution of hydrobromic acid; 21 – 40 g 32 % solution of iodide acid; 22 – 70 g 90 % solution of sulfate acid; 23 – 170 g 11 % solution of potassium carbonate; 24 – 400g of 53 % hydrochloric acid solution; 25 – 160 g 3 % solution of hydrosulphuric acid; 26 – 30 g 5 % solution of nitric acid; 27 – 180 g 3% solution of bismuth(III) nitrite; 28 – 145 g 8 % solution of magnesium chloride; 29 – 250 g of 1 % – boric acid solution; 30 – 115 g 3 % solution of sodium sulfate.

4.2. How many grams, moles, and equivalents of the dissolved substance are contained in:
01 – 250 ml 20% solution of ammonium hydroxide (ρ*= 0,923); 02 – 175 ml 8 % solution of aluminum chloride (ρ = 1,071); 03 – 310 ml 50 % solution of sodium hydroxide (ρ = 1,525); 04 – 160 ml 40 % solution of calcium chloride (ρ = 1,395); 05 – 220 ml 4 % solution of sodium carbonate (ρ = 1,039); 06 – 50 ml 8 % solution of acetic acid (ρ = 1,010); 07 – 300 ml 5 % solution of potassium hydroxide (ρ = 1,045); 08 – 190 ml 27 % solution of hydrochloric acid (ρ = 1,135); 09 – 40 ml 50 % solution of potassium carbonate (ρ = 1,540); 10 – 420 ml 8 % solution of potassium dichromate (ρ = 1,055); 11 – 165 ml 20 % solution of silver nitrate (ρ = 1,194); 12 – 69 ml 4,2 % solution of cooper(II) sulfate (ρ = 1,040); 13 – 170 ml 60 % solution of zinc chloride (ρ = 1,568); 14 – 150 ml 35,5 % solution of phosphoric acid (ρ = 1,220); 15 – 115 ml 8 % solution of sodium sulfate (ρ = 1,072);

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*[ρ] = g/ml

16 – 56 ml 50 % solution of potassium iodide (ρ = 1,545); 17 – 250 ml 4 % solution of iron(III) sulfate(ρ = 1,033); 18 – 620 ml 4 % solution of barium chloride (ρ = 1,034); 19 – 160 ml 27 % solution of nitric acid (ρ = 1,160); 20 – 170 ml 8 % solution of cooper(II) sulfate (ρ = 1,084); 21 – 360 ml 50 % solution of iron(III) chloride (ρ = 1,551); 22 – 112 ml 4 % solution of lithium hydroxide (ρ = 1,043); 23 – 170 ml 5 % solution of cadmium sulfate (ρ = 1,047); 24 – 370 ml 13,5 % solution of hydrochloric acid (ρ = 1,066); 25 – 450 ml 40 % solution of potassium bromide (ρ = 1,374); 26 – 107 ml 8 % solution of zinc chloride (ρ = 1,071); 27 – 210 ml 50 % solution of silver nitrate (ρ = 1,608); 28 – 650 ml 20 % solution of aluminum sulfate (ρ = 1,226); 29 – 340 ml 5 % solution of lithium hydroxide (ρ = 1,047); 30 – 700 мл 4 % solution of potassium dichromate (ρ = 1,026).

4.3. How many grams, moles, and equivalents of the dissolved substance are contained in:

01 – 0,5 l 0,3 M solution of hydrochloric acid; 02 – 4,2 l of 0,16 M ammonium chloride solution; 03 – 6,2 l 0,35 M solution of strontium nitrate; 04 – 0,25 l of 0,18 M potassium dichromate solution; 05 – 3,2 l 0,21 M solution of lithium hydroxide; 06 – 1,5 l of 0,8 M sodium carbonate solution; 07 – 10,0 l of 0,01 M boron acid solution; 08 – 10,5 l of 0,1 M sodium sulfide solution; 09 – 0,5 l of 0,25 M potassium bromide solution; 10 – 1,5 l 0,7 M solution of chloride acid; 11 – 8,0 l 1 M solution of cobalt nitrate; 12 – 4,6 l 0,5 M solution of silver nitrite; 13 – 6,0 l 12 M solution of sulphuric acid; 14 – 20,0 l of 2 M potassium iodide solution; 15 –3,0 l 1,25 M solution of ammonium hydroxide; 16 – 16,0 l 10,5 M solution of nitrite acid; 17 – 14,0 l 2 M solution of potassium carbonate; 18 – 15,0 l 2,5 M solution of ammonium carbonate; 19 – 7,0 l 0,18 M solution of sodium sulfate; 20 – 2,4 l 0,15 M solution of sulphurous acid; 21 – 1,25 l 0,4 M solution of aluminum chloride; 22 – 1,75 l 2 M solution of hydrosulphuric acid; 23 – 1,96 l 0,17 M solution of magnesium sulfate; 24–2,6 l of 0,002 M potassium bromide solution; 25 – 0,5 l 0,7 M solution of copper(II) sulfate; 26 – 3,7 l 0,75 M solution of cesium sulfate; 27 – 5,2 l 0,2 M solution of lithium iodide; 28 – 3,73 l 0,14 M solution of nickel (II) chloride; 29 – 2,8 l 0,7 M solution of potassium sulfate; 30 – 16,0 l 0,3 M solution of iron(III) sulfate.

4.4. Determine the molar, normal and molar concentration of the solution, the percentage concentration and density of which are given in section 4.2.

4.5. Determine the molar concentration of the solution:

01 – 2 N iron(III) chloride; 02 – 1,5 N – phosphoric acid; 03 – 6 N ammonium hydroxide; 04 – 1,2 N sodium carbonate; 05 – 0,02 N barium chloride; 06 – 0,17 N zinc sulfate; 07 – 1,5 N sulphuric acid; 08 – 3 N sodium hydroxide; 09–4 N hydrochloric acid; 10 – 1,7 N ammonium chloride; 11 – 0,2 N sulphuric acid; 12 – 0,11 N ammonium sulfate; 13 – 0,6 N potassium chloride; 14 – 0,04 N

potassium nitrate; 15 – 0,15 N sodium phosphate; 16 – 0,05 N copper(II) sulfate; 17 – 0,01 N sodium hydroxide; 18 – 0,3 N of iron(II) chloride; 19 – 0,5 N calcium chloride; 20 – 0,2 N aluminum nitrate; 21 – 0,7 N – nitrous acid; 22 – 0,25 N sulphurous acid; 23 – 2,2 N calcium bromide; 24 – 2,8 N lithium iodide; 25 – 0,3 N barium hydroxide; 26 – 2,4 N aluminum sulfate; 27 – 0,5 N nitric acid; 28 – 0,01 N lithium carbonate; 29 – 1,75 N rubidium sulfate; 30 – 0,82 N of potassium permanganate,

4.6. Determine the normal concentration of the solution:

01 – 2 M sulphuric acid; 02 – 1,5 M phosphoric acid; 03 – 0,21 M iron(III) chloride; 04 – 0,5 M aluminum sulfate; 05 – 7,4 M nitric acid; 06 – 0,32 M zinc chloride; 07 – 1,7 M potassium bromide; 08–3M acetic acid; 09 – 0,14 M hydrofluoric acid; 10 – 0,2 M hydrosulphuric acid; 11 – 0,2 M iron(II) sulfate; 12 – 0,4 M potassium permanganate; 13 – 0,4 M potassium sulfate; 14–2,1 M ammonium chloride; 15–3 M – phosphoric acid; 16 – 1,7 M nitric acid; 17 – 0,002 M lead(II) chloride; 18 – 0,02 M aluminum sulfate; 19 – 1,7 M sodium chloride; 20 – 0,3 M potassium carbonate; 21 – 0,75 M ammonium hydroxide; 22 – 1,8 M calcium iodide; 23 – 0,5 M copper(II) sulfate; 24 – 0,1 M cadmium sulfate; 25 – 0,35 M sodium chromate; 26 – 0,8 M tin(II) chloride; 27 – 0,8 M barium nitrate; 28 – 0,33 M sodium sulfide; 29 – 0,13 M zinc sulfate; 30 – 0,7 M magnesium bromide.

5. PROPERTIES OF SOLUTIONS OF NON–ELECTRICITY

5.1. Determine the osmotic pressure of the solution, which is contained in **V** l **m** g non-electrolyte at **t** ^{o}C, The values **m**, **V**, and **t** respectively correspond to:

5.1.1. (glucose $\mathbf{C_6H_{12}O_6}$)

01	– 24;	1,5;	20,2	04	– 36;	1,2;	14,0
02	– 44;	2,2;	37,0	05	– 12;	0,8;	22,9
03	– 62;	4,6;	32,6	06	– 16;	1,1;	18,0

5.1.2. (glycerin $\mathbf{C_3H_8O_3}$)

07	– 12,0;	1,2;	16,0	10	– 3,2	1,2;	14,0
08	– 8,4;	0,8;	5,6	11	– 4,8;	2,2;	18,0
09	– 4,6;	0,6;	12,9	12	– 5,2;	4,2;	20,0

5.1.3. (sugar $\mathbf{C_{12}H_{22}O_{11}}$)

13	– 2,22;	0,8;	16,2	16	– 2,44;	1,4;	20,9
14	– 3,28;	0,6;	18,0	17	– 4,22	1,6;	14,9
15	– 1,46;	1,2;	22,6	18	– 3,12;	0,8;	12,2

5.1.4. (aniline $C_6H_5NH_2$)

19	– 10,2;	0,8;	20,0	22	– 8,6;	1,26;	14,0
20	– 12,6;	1,2;	10,6	23	– 9,8;	1,6;	18,2
21	– 14,4;	1,4;	12,0	24	– 13,2;	1,8;	16,9

5.1.5. (methyl alcohol CH_3OH)

25	– 3,2;	1,0;	18,2	28	– 5,2;	0,8;	10,2
26	– 4,6;	1,2;	12,3	29	– 5,6;	1,4;	15,2
27	– 2,8;	1,6;	14,5	30	– 4,2;	1,8;	17,4

5.2. Determine the boiling and freezing point of **A %** solution of the non–electrolyte in a suitable solvent, The value of **A** equals:

5.2.1. niatrobenzene $C_6H_5NO_2$ in benzene, $K_з$ = 5,1 grade/mol; $K_к$ = 2,57 grade/mol, $t_з$ = –5,4 °C; $t_к$ = 80,2 °C.

01	– 5,0	04	– 12,4	07	– 8,6	10	– 5,2	13	– 2,4
02	– 7,2	05	– 8,3	08	– 6,8	11	– 4,8	14	– 3,6
03	– 10,8	06	– 9,6	09	– 7,6	12	– 3,6	15	– 4,2

5.2.2. glycerine $C_3H_8O_3$ in acetone, $K_з$ = 2,4 grade/mol; $K_к$ = 1,48 grade/mol; $t_з$ = –94,6 °C; $t_к$ = 56,0 °C.

16	– 1,2	19	– 4,2	22	– 7,8	25	– 14,4	28	– 6,8
17	– 4,8	20	– 5,8	23	– 10,2	26	– 16,8	29	– 7,2
18	– 6,6	21	– 3,6	24	– 12,4	27	– 10,8	30	– 8,4

6. PROPERTIES OF SOLUTIONS OF HIGH ELECTROLYTES, IZOTONIC COEFFICIENT, DISSOCIATION DEGREE OF ELECTROLYTE

6.1. Calculate the isotonic coefficient $C_м$ of the electrolyte solution, whose osmotic pressure at **t** ° C is **P** kPa, The values of $C_м$, **P** and **t**, respectively, are:

6.1.1. $ZnSO_4$; $C_м$ = 0,05 M.

01	– 159;	0	04	– 167;	14		
02	– 160;	2	05	– 165;	10		
03	– 162;	5					

6.1.2. $Ca(NO_3)_2$; $C_м$ = 0,1 M.

06	– 569;	3	09	– 598;	17		
07	– 581;	9	10	– 575;	6		
08	– 590;	13					

6.1.3. **HNO_3**; **$C_м$** = 1 M.

11	– 4130;	0	14	– 4267;	9
12	– 4367;	15	15	– 4372;	16
13	– 4237;	7			

6.1.4.**$Ca(OH)_2$**; **$C_м$** = 0,05 M.

16	– 299;	8	19	– 303;	12
17	– 295;	4	20	– 310;	19
18	– 294;	3			

6.1.5. **$BaCl_2$**; **$C_м$** = 0,01 M.

21	– 328;	13	24	– 326;	11
22	– 335;	19	25	– 320;	6
23	– 318;	4			

6.1.6. **HCl**; **$C_м$** = 0,5 M.

26	– 2238;	15	29	– 2184;	7
27	– 2254;	17	30	– 2200;	10
28	– 2192;	8			

6.2. Calculate the isotonic coefficient of solution, which contains **a** g of electrolyte in1000 g of water and boil at **t °C** (K_b = 0,156 grade/mol), the values of **a** and **t** tare respectively:

6.2.1. NaOH

01	– 8;	100,184
02	– 13;	100,299
03	– 17;	100,390
04	– 25;	100,574
05	– 41;	100,940

6.2.2. KBr

06	– 180;	101,330
07	– 210;	101,550
08	– 150;	101,110
09	– 140;	101,030
10	– 130;	103,960

6.2.3. $Ba(NO_3)_2$

11	– 20;	100,076
12	– 24;	100,091
13	– 38;	100,144
14	– 45;	100,170
15	– 32;	100,122

6.2.4. KCl

16	– 210;	102,530
17	– 215;	102,590
18	– 225;	102,710
19	– 230;	102,770
20	– 248;	102,980

6.2.5. $ZnCl_2$

21	– 6;	100,063
22	– 12;	100,037
23	– 4;	100,068
24	– 10;	100,093
25	– 15;	100,140

6.2.6. KOH

26	– 8;	100,137
27	– 15;	100,257
28	– 20;	100,342
29	– 17;	100,291
30	– 6;	100,103

6.3. Calculate the degree of dissociation of the electrolyte, whose isotonic coefficient of solution is equal to **i**, The value **i** is equal to:

01	– HBr;	1,89	11	– NaOH;	1,73	21	– $CaCl_2$;	2,76
02	– HCl;	1,78	12	– KCl;	1,85	22	– Li_2SO_4;	2,90
03	– HF;	1,07	13	– KI;	1,93	23	– CsCl;	1,85
04	– HI;	1,90	14	– K_2S;	1,98	24	– RbCl;	1,93
05	– HNO_3;	1,80	15	– $BaCl_2$;	2,76	25	– NaI;	1,85
06	– H_3PO_4;	1,51	16	– LiCl;	1,85	26	– NaBr;	1,97
07	– H_2SO_4;	2,00	17	– Na_2SO_4;	2,76	27	– $ZnCl_2$;	2,38
08	– $Ba(OH)_2$;	2,38	18	– $MgSO_4$;	1,43	28	– $CrCl_3$;	2,95
09	– $Ca(OH)_2$;	2,56	19	– $MnSO_4$;	1,66	29	– Rb_2SO_4;	2,74
10	– KOH;	1,77	20	– K_3PO_4;	2,92	30	– Cs_2SO_4;	2,86

6.4. Calculate the degree of dissociation of the electrolyte, in which the water solution contains **n** mole of substance per **V** l of water, if the freezing point of the solution is t °C (K_f = 1,86 grade/mol), the values of **V** and **t** respectively are:

6.4.1. **HNO_3**; **n** = 0,25.

01	– 1,7;	(–0,51)	04	– 3,5;	(–0,25)	06	– 3,4;	(–0,04)
02	– 2,2;	(–0,40)	05	– 4,6;	(–0,20)	07	– 2,6;	(– 0,10)
03	– 2,5;	(–0,35)				08	– 1,8;	(– 0,15)
09	– 2,0;	(–0,13)						
10	– 3,0;	(–0,09)						

6.4.2. **$MgSO_4$**; **n** = 0,1.

6.4.3. **$Ba(OH)_2$**; **n** = 1,5.

11	– 2,7;	(–2,45)	14	– 1,5;	(– 4,4)	16	– 3,6;	(– 0,19)
12	– 3,8;	(– 1,74)	15	– 3,2;	(–2,06)	17	– 5,0;	(– 0,14)
13	– 1,2;	(– 5,50)				18	– 2,0;	(– 0,34)
19	– 4,4;	(–0,16)						
20	– 3,1;	(–0,22)						

6.4.4. **LiCl**; **n** = 0,2.

6.4.5. **K_3PO_4**; **n** = 0,3.

21	– 2,5;	(–0,65)	24	– 5,2;	(–0,31)	26	– 0,8;	(– 0,26)
22	– 4,5;	(–0,36)	25	– 3,8;	(– 0,43)	27	– 1,2;	(– 0,17)
23	– 3,0;	(–0,56)				28	– 0,5;	(– 0,41)
29	– 4,0	(– 0,05)						
30	– 2,2	(– 0,09)						

6.4.6. **Na_2SO_4**; **n** = 0,04.

6.5. Exchange reactions between electrolytes in a solution. Write in the molecular and molecular-ionic form the reaction interaction equation for the following substances:

01 – $KCN + HCl \rightarrow$	16 – $Zn(OH)_2 + KOH \rightarrow$
02 – $Na_2S + FeSO_4 \rightarrow$	17 – $Ba(OH)_2 + HCl \rightarrow$
03 – $NaCN + HNO_3 \rightarrow$	18 – $Al(OH)_3 + NaOH \rightarrow$

04 – $CH_3COONa + HNO_3 \rightarrow$
05 – $Na_2S + HCl \rightarrow$
06 – $H_2SO_4 + KOH \rightarrow$
07 – $Pb(NO_3)_2 + NaI \rightarrow$
08 – $Cu(NO_3)_2 + Na_2SO_4 \rightarrow$
09 – $BaCl_2 + K_2SO_4 \rightarrow$
10 – $KNO_3 + NaCl \rightarrow$
11 – $AgNO_3 + KCl \rightarrow$
12 – $CaCO_3 + HCl \rightarrow$
13 – $Ba(OH)_2 + HNO_3 \rightarrow$
14 – $SrSO_4 + BaCl_2 \rightarrow$
15 – $NH_4Cl + Ca(OH)_2 \rightarrow$
19 – $Cu(OH)_2 + H_2SO_4 \rightarrow$
20 – $CH_3COOK + HCl \rightarrow$
21 – $LiCN + H_2SO_4 \rightarrow$
22 – $Na_2CO_3 + HNO_3 \rightarrow$
23 – $K_2S + H_2SO_4 \rightarrow$
24 – $(NH_4)_2SO_4 + KOH \rightarrow$
25 – $Ag\ NO_3 + Na_2S \rightarrow$
26 – $CdCO_3 + HNO_3 \rightarrow$
27 – $AlCl_3 + NaOH \rightarrow$
28 – $CuSO_4 + Na_2CO_3 \rightarrow$
29 – $CuCl_2 + K_2S \rightarrow$
30 – $H_2SO_4 + Ca(OH)_2 \rightarrow$

6.6. Ionic product of water, Hydrogen index (pH)

6.6.1. Calculate the **pH** of the solution of strong acid (α= 1), The value of $\mathbf{C_м}$ mol/l, is equal to:

6.6.1.1. $\mathbf{H_2SO_4}$

01 – $2{,}2\cdot10^{-2}$
02 – $5{,}6\cdot10^{-4}$
03 – $4{,}2\cdot10^{-3}$
04 – $1{,}2\cdot10^{-3}$
05 – $7{,}2\cdot10^{-4}$

6.6.1.2. $\mathbf{HNO_3}$

06 – $1{,}6\cdot10^{-3}$
07 – $2{,}4\cdot10^{-2}$
08 – $1{,}7\cdot10^{-3}$
09 – $2{,}3\cdot10^{-1}$
10 – $5{,}8\cdot10^{-3}$

6.6.1.3. **HCl**

11 – $2{,}9\cdot10^{-3}$
12 – $5{,}7\cdot10^{-4}$
13 – $9{,}2\cdot10^{-5}$
14 – $1{,}4\cdot10^{-2}$
15 – $7{,}8\cdot10^{-3}$

6.6.1.4. $\mathbf{HClO_4}$

16 – $7{,}7\cdot10^{-3}$
17 – $8{,}1\cdot10^{-6}$
18 – $2{,}5\cdot10^{-3}$
19 – $3{,}5\cdot10^{-2}$
20 – $4{,}4\cdot10^{-4}$

6.6.1.5. **HI**

21 – $2{,}5\cdot10^{-5}$
22 – $4{,}5\cdot10^{-3}$
23 – $3{,}0\cdot10^{-4}$
24 – $5{,}7\cdot10^{-3}$
25 – $3{,}8\cdot10^{-5}$

6.6.1.6. **HBr**

26 – $0{,}8\cdot10^{-6}$
27 – $1{,}2\cdot10^{-7}$
28 – $0{,}5\cdot10^{-5}$
29 – $4{,}0\cdot10^{-3}$
30 – $2{,}2\cdot10^{-5}$

6.6.2. Calculate the **pH** and **pOH** of the solution of alkali (α= 1), The value of $\mathbf{C_м}$ mol/l, is equal to:

6.6.2.1. **NaOH**

01 – $5{,}2\cdot10^{-2}$
04 – $6{,}2\cdot10^{-3}$

6.6.2.2. $\mathbf{Ca(OH)_2}$

06 – $1{,}9\cdot10^{-3}$
09 – $8{,}3\cdot10^{-1}$

02 – $9{,}6\cdot10^{-4}$ 05 – $3{,}6\cdot10^{-4}$ 07 – $6{,}4\cdot10^{-2}$ 10 – $3{,}8\cdot10^{-3}$
03 – $4{,}3\cdot10^{-3}$ 08 – $7{,}7\cdot10^{-3}$

6.6.2.3. **LiOH**

11 – $2{,}6\cdot10^{-3}$ 14 – $5{,}4\cdot10^{-2}$ 16 – $7{,}8\cdot10^{-3}$ 19 – $6{,}5\cdot10^{-2}$
12 – $3{,}7\cdot10^{-4}$ 15 – $7{,}8\cdot10^{-3}$ 17 – $5{,}1\cdot10^{-6}$ 20 – $4{,}9\cdot10^{-4}$
13 – $3{,}2\cdot10^{-5}$ 18 – $2{,}8\cdot10^{-3}$

6.6.2.4. **$Ba(OH)_2$**

6.6.2.5. **KOH**

21 – $6{,}5\cdot10^{-5}$ 24 – $5{,}3\cdot10^{-3}$ 26 – $5{,}8\cdot10^{-6}$ 29 – $4{,}3\cdot10^{-3}$
22 – $5{,}5\cdot10^{-3}$ 25 – $3{,}4\cdot10^{-5}$ 27 – $6{,}2\cdot10^{-7}$ 30 – $2{,}6\cdot10^{-5}$
23 – $3{,}5\cdot10^{-4}$ 28 – $4{,}5\cdot10^{-5}$

6.6.2.6. **RbOH**

6.6.3. Calculate the concentration of $\mathbf{H}^+$ and $\mathbf{OH}^-$ ions in a solution, whose **pH** is:

01	– 1,28	11	– 3,86	21	– 13,17
02	– 2,34	12	– 4,56	22	– 12,89
03	– 11,07	13	– 8,12	23	– 4,68
04	– 10,12	14	– 3,14	24	– 3,08
05	– 2,52	15	– 7,18	25	– 8,35
06	– 7,34	16	– 9,28	26	– 9,12
07	– 12,83	17	– 2,67	27	– 5,63
08	– 5,46	18	– 12,84	28	– 3,89
09	– 11,28	19	– 13,58	29	– 6,54
10	– 5,18	20	– 11,23	30	– 7,38

6.7. Hydrolysis of salts

6.7.1. Make up the molecular and ionic hydrolysis equation of a strong acid and weak base:

01	– $CuSO_4$	11	– NH_4Br	21	– $CdCl_2$
02	– $Fe(NO_3)_2$	12	– $CuCl_2$	22	– $Ni(NO_3)_2$
03	– $(NH)_2SO_4$	13	– $Al_2(SO_4)_3$	23	– AlI_3
04	– $ZnCl_2$	14	– NiI_2	24	– $NiBr_2$
05	– CuI_2	15	– $ZnSO_4$	25	– $Fe_2(SO_4)_3$
06	– $Al(NO_3)_3$	16	– $Fe(NO_3)_3$	26	– CdI_2
07	– NH_4NO_3	17	– NH_4Cl	27	– $NiSO_4$
08	– $ZnBr_2$	18	– $CuBr_2$	28	– $NiCl_2$
09	– $CdSO_4$	19	– $FeSO_4$	29	– $AlBr_3$
10	– $FeCl_3$	20	– $FeCl_2$	30	– $Co\ (NO_3)_2$

6.7.2. Make a molecular and ionic hydrolysis equation of a weak acid and strong base:

01	– $NaNO_2$	11	– $Ca(CN)_2$	21	– Rb_2CO_3
02	– $CaCl_2$	12	– Li_2S	22	– $CaSO_3$
03	– $Ba(CN)_2$	13	– K_2SO_3	23	– $CsNO_2$
04	– Li_3PO_4	14	– NaCN	24	– LiCN
05	– Na_2SO_3	15	– Rb_2S	25	– Cs_2S
06	– Li_2CO_3	16	– K_3PO_4	26	– Na_2SO_3
07	– KNO_2	17	– K_2S	27	– CsCN
08	– Cs_2CO_3	18	– RbCN	28	– $Ca(NO_2)_2$
09	– $BaSO_3$	19	– Na_3PO_4	29	– $LiNO_2$
10	– Na_2S	20	– $RbNO_2$	30	– Li_2SO_3

6.7.3. Make a molecular and ionic equation for the hydrolysis of a weak acid and weak base:

01 – 05	– Cr_2S_3	16 – 20	– $(NH_4)_3PO_4$
06 – 10	– $Al(CH_3COO)_3$	21 – 25	– Al_2S_3
11 – 15	– $Al_2(CO_3)_3$	26 – 30	– $Fe_2(SO_3)_3$

7. Atomic Structure

7.1. Write the electronic formula of the atom and show WHICH **s–, p–, d–** or **f–**elements it belongs to:

01	– Radon	11	– Titanium	21	– Arsenic
02	– Bismuth	12	– Sulfur	22	– Erbium
03	– Lead	13	– Iron	23	– Germanium
04	– Hafnium	14	– Antimony	24	– Magnesium
05	– Osmium	15	– Niobium	25	– Prometheum
06	– Barium	16	– Selenium	26	– Nickel
07	– Platinum	17	– Rhodium	27	– Indium
08	– Yttrium	18	– Cobalt	28	– Xenon
09	– Chromium	19	– Bromine	29	– Zinc
10	– Strontium	20	– Tin	30	– Mendelevium

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Хімія

МЕТОДИЧНІ РЕКОМЕНДАЦІЇ ТА ЗАВДАННЯ
до самостійної роботи з дисципліни
для студентів усіх спеціальностей (Частина 1)
(Англійською мовою)

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