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

O.Y. Svietkina, O.B. Netyaga, H.V. Tarasova

CHEMISTRY

METHODICAL INSTRUCTIONS AND TASKS
FOR SELF-WORK
ON THE DISCIPLINE

for students of all specialties
Part 2

Dnipro
2018

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FACULTY OF GEOLOGICAL PROSPECTING
Departament of Chemestry

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Автори:
О.Ю. Свєткіна, проф., д-р техн. наук (вступ, розділ 1, 2);
О.Б. Нетяга, старш. викл. (розділ 4, 5);
Г.В. Тарасова, асист. (розділ 3, 6).

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 of conducting ongoing student knowledge on the chemistry course.

Part two contains tasks of six theoretical parts of the course. Each topic is given a number: 1,2,3, etc. Inside the topics there are sections that are numbered by adding numbers to the topic number. This way, in topic 3 there are sections 3.1, 3.2, 3.3, etc. One section contains 30 tasks. If there are no tasks in the middle of the section, it is indicated that concrete examples should be taken in one of the previous sections. So, for example, to fulfill the task 15 of section 3.2 means to write the equation of the electrode reactions occurring in a galvanic element, which is formed from the metals specified in the task 15 of section 3.1, that is, from bismuth and zinc.

Each student of the group during the semester performs assignments of various topics marked with a number from 01 to 30.

1. OXIDATION-REDUCTION REACTIONS

1.1. An element that has an oxidation degree either oxidizes or reduces during an oxidation-reduction reaction:

01 – sulfur +6	02 – chrome +3	03 – zinc 0
04 – hydrogen 0	05 – oxygen 0	06 – sulfur –2
07 – nitrogen –3	08 – chlorine +7	09 – iodine –1
10 – sulfur + 4	11 – magnesium 0	12 – manganese +7
13 – chlorine + 5	14 – nitrogen +3	15 – iron +2
16 – iodine + 5	17 – bromine +5	18 – chlorine +3
19 – fluorine 0	20 – hydrogen +1	21 – cadmium 0
22 – chrome +6	23 – iodine +3	24 – aluminium +3
25 – chlorine 0	26 – flourine –1	27 – iodine 0
28 – zinc +2	29 – nitrogen –3	30 – bromine 0

1.2. An oxidizer or reducing agent a substance is:

01 – fluorine	02 – oxygen	03 – sodium chromate
04 – iodine	05 – sulphuric acid	06 – acid manganic (IV)
07 – nitric acid	08 – sulphuric acid	09 – potassium permanganate
10 – sulfur	11 – bromine	12 – iron (III) chloride
13 – iron (II) chloride	14 – sulfic oxide	15 – potassium dichromate
16 – hydrogen	17 – nitric acid	18 – sulfur (IV) oxide

19 – potassium sulfite	20 – calcium	21 – potassium sulfide
22 – hydrochloric acid	23 – zinc	24 – potassium nitrite
25 – hydrogen peroxide	26 – nitric acid	27 – potassium bromide
28 – magnesium	29 – nickel	30 – hydrosulphuric acid

1.3. Put the coefficients in the reaction equation:

01 – $KMnO_4 + H_2SO_3 \rightarrow H_2SO_4 + MnSO_4 + K_2SO_4 + H_2O$

02 – $K_2Cr_2O_7 + Na_2S + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + S + K_2SO_4 + Na_2SO_4 + H_2O$

03 – $KMnO_4 + HNO_2 + H_2SO_4 \rightarrow MnSO_4 + HNO_3 + K_2SO_4 + H_2O$

04 – $H_2O_2 + Cr_2(SO_4)_3 + KOH \rightarrow K_2CrO_4 + K_2SO_4 + H_2O$

05 – $K_2Cr_2O_7 + Zn + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + ZnSO_4 + K_2SO_4 + H_2O$

06 – $Br_2 + Cr_2(SO_4)_3 + NaOH \rightarrow Na_2CrO_4 + Na_2SO_4 + NaBr + H_2O$

07 – $I_2 + Cl_2 + H_2O \rightarrow HIO_3 + HCl$

08 – $HClO + Br_2 + H_2O \rightarrow HBrO_3 + HCl$

09 – $KI + KIO_3 + H_2SO_4 \rightarrow I_2 + K_2SO_4 + H_2O$

10 – $I_2 + HNO_3 \rightarrow HIO_3 + NO + H_2O$

11 – $FeSO_4 + HNO_3 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + NO + H_2O$

12 – $KClO_3 + MnSO_4 + KOH \rightarrow K_2MnO_4 + KCl + K_2SO_4 + H_2O$

13 – $I_2 + NaOH \rightarrow NaIO + NaI + H_2O$

14 – $HIO_3 + H_2S \rightarrow S + I_2 + H_2O$

15 – $FeCl_3 + HI \rightarrow I_2 + FeCl_2 + HCl$

16 – $HIO_3 + H_2O_2 \rightarrow I_2 + O_2 + H_2O$

17 – $HI + H_2SO_4 \rightarrow I_2 + H_2S + H_2O$

18 – $KClO_3 + FeCl_2 + HCl \rightarrow FeCl_3 + KCl + Cl_2 + H_2O$

19 – $I_2 + HNO_3 \rightarrow HIO_3 + NO + H_2O$

20 – $KBrO_3 + KI + HBr \rightarrow KBr + I_2 + H_2O$

21 – $FeSO_4 + HIO_3 + H_2SO_4 \rightarrow I_2 + Fe_2(SO_4)_3 + H_2O$

22 – $H_2S + H_2O_2 \rightarrow H_2SO_4 + H_2O$

23 – $PbS + HNO_3 \rightarrow Pb(NO_3)_2 + S + NO_2 + H_2O$

24 – $NaCrO_2 + Br_2 + NaOH \rightarrow Na_2CrO_4 + NaBr + H_2O$

25 – $K_2Cr_2O_7 + FeSO_4 + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + Fe_2(SO_4)_3 + K_2SO_4 + H_2O$

26 – $KMnO_4 + H_2O_2 + H_2SO_4 \rightarrow MnSO_4 + K_2SO_4 + O_2 + H_2O$

27 – $KMnO_4 + Zn + KOH \rightarrow K_2MnO_4 + K_2ZnO_2 + H_2O$

28 – $K_2Cr_2O_7 + H_2S + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + S + K_2SO_4 + H_2O$

29 – $K_2Cr_2O_7 + HCl \rightarrow CrCl_3 + Cl_2 + KCl + H_2O$

30 – $KMnO_4 + K_2SO_3 + H_2SO_4 \rightarrow MnSO_4 + K_2SO_4 + H_2O$

1.4. Make a complete equation of reaction and set the coefficients

01 – Ca + H_2SO_4 (c)*→
02 – Mg + HNO_3 (d) →
03 – Be + HNO_3 (c) →
04 – Mn + H_2SO_4 (c) →
05 – Zn + HNO_3 (d) →
06 – Cd + HNO_3 (c) →
07 – Mg + H_2SO_4 (c) →
08 – Co + H_2SO_4 (c) →
09 – Sn + HNO_3 (d) →
10 – Pb + HNO_3 (d) →
11 – Cu + H_2SO_4 (c) →
12 – Cu + HNO_3 (c) →
13 – Hg + H_2SO_4 (c) →
14 – Bi + HNO_3 (d) →
15 – Mg + HNO_3 (d) →
16 – Ca + HNO_3 (d) →
17 – Ag + HNO_3 (d) →
18 – Zn +HNO_3 (c) →
19 – Cu + HNO_3 (c) →
20 – Zn + H_2SO_4 (d) →
21 – Cu + H_2SO_4 (d) →
22 – Cd + HNO_3 (d) →
23 – Mg + HNO_3 (d) →
24 – Zn + H_2SO_4 (c) →
25 – C_O + HNO_3 (c) →
26 – Sn + H_2SO_4 (c) →
27 – Fe + H_2SO_4 (c) →
28 – Ca + HNO_3 (c) →
29 – Pb + HNO_3 (c) →
30 – Zn + HNO_3 (d) →

2. ELECTROLYTIC POTENTIALS

2.1. Calculate the electronic potential of a metal immersed in a solution of its salt with a concentration of ions equal to **[Me^{n+}]** mol / l. The value **[Me^{n+}]** for the corresponding metal is:

01 – 0,01; Mg
02 – 0,10; Pd
03 – 0,001; Pb
04 – 0,02; Sn
05 – 0,30; Al
06 – 0,05; Bi
07 – 0,003; Cr
08 – 0,04; Mn
09 – 0,20; Co
10 – 0,07; Ni
11 – 0,002; Zn
12 – 0,30; Ag
13 – 0,05; Cr
14 – 0,09; Pb
15 – 0,25; Fe
16 – 0,004; Cu
17 – 0,06; Cd
18 – 0,40; Mg
19 – 0,035; Co
20 – 0,042; Al
21 – 0,022; Ni
22 – 0,005; Ag
23 – 0,07; Sn
24 – 0,33; Pd
25 – 0,50; Pb
26 – 0,44; Sb
27 - 0,006; Bi
28 – 0,08; Cu
29 – 0,55; Ag
30 – 0,60; Zn

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*Note: c is a concentrated acid, d is a dilute acid.

2.2. Calculate the electrode potential of a metal located in the solution of its salt with a molar concentration of $\mathbf{C_m}$, if the degree of electrolytic dissociation of salt is α, %. The values of $\mathbf{C_m}$ and α for the salt of the corresponding metal are:

01 – 0,1; 43;	$FeSO_4$;	Fe		16 – 0,1; 65;	$FeCl_3$;	Fe
02 – 0,01; 66;	$CdSO_4$;	Cd		17 – 0,001; 95;	$CuCl_2$;	Cu
03 – 0,1; 75;	$Pb(NO_3)_2$;	Pb		18 – 0,01; 66;	$FeSO_4$;	Fe
04 – 0,001; 87;	$CuSO_4$;	Cu		19 – 0,1; 43;	$ZnSO_4$;	Zn
05 – 0,1; 85;	$AgNO_3$;	Ag		20 – 0,1; 75;	$SnCl_2$;	Sn
06 – 0,1; 75;	$ZnCl_2$;	Zn		21 – 0,01; 88;	$Pb(NO_3)_2$;	Pb
07 – 0,01; 88;	$FeCl_2$;	Fe		22 – 0,001; 95;	$MgCl_2$;	Mg
08 – 0,1; 43;	$MgSO_4$;	Mg		23 – 0,01; 88;	$ZnCl_2$;	Zn
09 – 0,001; 95;	$Cu(NO_3)_2$;	Cu		24 – 0,1; 43;	$NiSO_4$;	Ni
10 – 0,01; 66;	$CoSO_4$;	Co		25 – 0,01; 93;	$AgNO_3$;	Ag
11 – 0,01; 88;	$SnCl_2$;	Sn		26 – 0,001; 87;	$ZnSO_4$;	Zn
12 – 0,001; 98;	$AgNO_3$;	Ag		27 – 0,001;95;	$Pb(NO_3)_2$;	Pb
13 – 0,1; 65;	$CrCl_3$;	Cr		28 – 0,01; 66;	$CuSO_4$;	Cu
14 – 0,1; 43;	$CuSO_4$;	Cu		29 – 0,01; 88;	$NiCl_2$;	Ni
15 – 0,01; 88;	$SnCl_2$;	Sn		30 – 0,1; 43;	$SnSO_4$;	Sn

2.3. Determine the potential of a hydrogen electrode immersed in a solution with **pH** equal to:

01 – 7,8	11 – 6,8	21 – 4,9
02 – 9,2	12 – 7,3	22 – 7,0
03 – 2,3	13 – 12,2	23 – 5,1
04 – 4,8	14 – 5,2	24 – 2,4
05 – 6,7	15 – 9,3	25 – 8,5
06 – 12,1	16 – 7,4	26 – 7,1
07 – 8,2	17 – 6,9	27 – 3,7
08 – 7,5	18 – 5,3	28 – 12,5
09 – 5,4	19 – 2,6	29 – 7,2
10 – 2,8	20 – 2,9	30 – 4,6

2.4. Calculate the molar concentration of HCl solution, in which the potential of the hydrogen electrode is equal to **φ**, B. The value **φ** is:

01 – (–0,256)	11 – (–0,636)	21 – (–0,236)
02 – (–0,315)	12 – (–0,225)	22 – (–0,582)
03 – (–0,528)	13 – (– 0,745)	23 – (–0,672)
04 – (–0,624)	14 – (– 0,334)	24 – (–0,346)
05 – (–0,832)	15 – (–0,549)	25 – (–0,712)
06 – (–0,764)	16 – (–0,544)	26 – (–0,248)
07 – (–0,267)	17 – (–0,215)	27 – (–0,592)
08 – (–0,536)	18 – (–0,734)	28 – (–0,368)
09 – (–0,325)	19 – (–0,658)	29 – (–0,728)
10 – (–0,756)	20 – (–0,562)	30 – (–0,277)

3. GALVANIC ELEMENTS

3.1. Determine the signs of the electrodes, the anode and the cathode in the galvanic element formed by the electrons $\mathbf{Me_1/Me_1^{n+}}$ and $\mathbf{Me_2/Me_2^{n+}}$ in the case $\mathbf{[Me_1^{n+}] = [Me_2^{n+}] = 1}$ **mol / l.**

01 – Al/Al^{3+};	Zn/Zn^{2+}	16 – Bi/Bi^{3+};	Sb/Sb^{3+}
02 – Mg/Mg^{2+};	Fe/Fe^{2+}	17 – Sn/Sn^{2+};	Cu/Cu^{2+}
03 – Zn/Zn^{2+};	Sn/Sn^{2+}	18 – Cu/Cu^{2+};	Fe/Fe^{2+}
04 – Mn/Mn^{2+};	Co/Co^{2+}	19 – Bi/Bi^{3+};	Cr/Cr^{3+}
05 – Ag/Ag^{+};	Ni/Ni^{2+}	20 – Ag/Ag^{+};	Mn/Mn^{2+}
06 – Ni/Ni^{2+};	Al/Al^{3+}	21 – Fe/Fe^{2+};	Co/Co^{2+}
07 – Sn/Sn^{2+};	Al/Al^{3+}	22 – Pb/Pb^{2+};	Cd/Cd^{2+}
08 – Mg/Mg^{2+};	Ni/Ni^{2+}	23 – Mg/Mg^{2+};	Sn/Sn^{2+}
09 – Ni/Ni^{2+};	Fe/Fe^{2+}	24 – Pb/Pb^{2+};	Cu/Cu^{2+}
10 – Co/Co^{2+};	Zn/Zn^{2+}	25 – Sn/Sn^{2+};	Pb/Pb^{2+}
11 – Bi/Bi^{3+};	Ag/Ag^{+}	26 – Co/Co^{2+};	Pd/Pd^{2+}
12 – Pb/Pb^{2+};	Al/Al^{3+}	27 – Ni/Ni^{2+};	Cu/Cu^{2+}
13 – Sn/Sn^{2+};	Cd/Cd^{2+}	28 – Mg/Mg^{2+};	Ag/Ag^{+}
14 – Ni/Ni^{2+};	Co/Co^{2+}	29 – Bi/Bi^{3+};	Cu/Cu^{2+}
15 – Bi/Bi^{3+};	Zn/Zn^{2+}	30 – Pb/Pb^{2+};	Cr/Cr^{3+}

3.2. Write the equation of electrode reactions in the galvanic element indicated in section 3.1.

3.3. Calculate the **EMF** and draw up the scheme of a galvanic element formed by metal electrodes $\mathbf{Me_1}$ and $\mathbf{Me_2}$ immersed in solutions of their salts with molar concentrations $\mathbf{C_{M1}}$ and $\mathbf{C_{M2}}$ with degrees of dissociation α_1**, %** and α_2**, %**. The values $\mathbf{C_{M1}}$, α_1 and C_{M2}, α_2 for the salts of the corresponding metals $\mathbf{Me_1}$ and $\mathbf{Me_2}$ are equal to:

01	–	Cu;	0,001;	95;	Ni;	0,1;	43
02	–	Fe;	0,01;	88;	Sn;	0,001;	95
03	–	Cd;	0,1;	43;	Co;	0,1;	43
04	–	Pb;	0,001;	95;	Ni;	0,01;	88
05	–	Ag;	0,01;	85;	Mg;	0,01;	66
06	–	Zn;	0,01;	88;	Co;	0,001;	87
07	–	Cu;	0,01;	88;	Ni;	0,1;	75
08	–	Cd;	0,001;	87;	Sn;	0,1;	75
09	–	Ag;	0,001;	98;	Co;	0,01;	66
10	–	Mg;	0,1;	43;	Fe;	0,1;	43
11	–	Zn;	0,1;	75;	Mg;	0,001;	87
12	–	Fe;	0,001;	95;	Zn;	0,001;	95
13	–	Sn;	0,01;	88;	Fe;	0,1;	42
14	–	Cr;	0,1;	65;	Ag;	0,01;	93
15	–	Cu;	0,1;	43;	Cd;	0,01;	66
16	–	Ni;	0,001;	95;	Cu;	0,01;	43
17	–	Cd;	0,01;	66;	Cr;	0,01;	65
18	–	Ag;	0,01;	95;	Sn;	0,01;	88
19	–	Zn;	0,001;	95	Fe;	0,001;	95
20	–	Fe;	0,1;	43;	Zn;	0,1;	75
21	–	Mg;	0,001;	87;	Ag;	0,001;	98
22	–	Co;	0,01;	66;	Mg;	0,1;	43
23	–	Sn;	0,1;	75;	Cd;	0,001;	87
24	–	Cu;	0,01;	88;	Zn;	0,01;	88
25	–	Ni;	0,1;	75;	Ag;	0,1;	85
26	–	Co;	0,001;	87;	Cu;	0,01;	88
27	–	Mg;	0,01;	66;	Pb;	0,001;	96
28	–	Ni;	0,01;	88;	Cd;	0,1;	43
29	–	Co	0,1;	43;	Fe;	0,01;	88
30	–	Sn;	0,001;	95;	Cu;	0,001;	95

3.4. Define the **EMF**, write the equation of the electrode reactions, indicate the direction of motion of the electrons in the element chain, whose scheme is given below:

01 – $Sn/SnSO_4$ (0,01M, α = 43 %) // $CdSO_4$ (0,01M, α = 66 %) /Cd
02 – $Ni/NiCl_2$ (0,01M, α = 88 %) // $FeSO_4$ (0,1M, α = 48 %) /Fe
03 – $Cu/CuSO_4$ (0,001M, α = 87 %) // Pb $(NO_3)_2$ (0,1M, α = 75 %) /Pb
04 – $Zn/ZnSO_4$ (0,001M, α = 87 %) // $AgNO_3$ (0,1M, α = 85 %) /Ag
05 – $Ag/AgNO_3$ (0,01M, α = 93 %) // $CuSO_4$ (0,001M, α = 87 %) /Cu
06 – $Ni/NiSO_4$ (0,1M, α = 43 %) // $ZnCl_2$ (0,1M, α = 75 %) /Zn
07 – $Mg/MgCl_2$ (0,001M, α = 95 %) // $FeCl_2$ (0,01M, α = 88 %) /Fe
08 – $Zn/ZnCl_2$ (0,1M, α = 75 %) // $MgSO_4$ (0,1M, α = 43 %) /Mg
09 – $Pb/Pb(NO_3)_2$ (0,01M, α = 88 %) // Cu $(NO_3)_2$ (0,001M, α = 95 %) /Cu
10 – $Sn/SnCl_2$ (0,1M α = 75 %) // $AgNO_3$ (0,001M, α = 98 %) /Ag
11 – $Zn/ZnSO_4$ (0,1M, α = 43 %) // $CrCl_3$ (0,1M, α = 65 %) /Cr
12 – $Fe/FeSO_4$ (0,01M, α = 65 %) // $CuSO_4$ (0,1M, α = 43 %) /Cu
13 – $Cu/CuCl_2$ (0,001M, α = 95 %) // $SnCl_2$ (0,01M, α = 88 %) /Sn
14 – $Cd/CdSO_4$ (0,01 M, α = 66 %) // $CuSO_4$ (0,001M, α = 87 %) /Cu
15 – $Pb/Pb(NO_3)_2$ (0,1M, α = 75 %) // $NiCl_2$ (0,01M, α = 88 %) /Ni
16 – $Ag/AgNO_3$ (0,1M, α = 85 %) // $NiSO_4$ (0,1M, α = 43 %) /Ni
17 – $Cu/CuSO_4$ (0,001M, α = 87 %) // $MgCl_2$ (0,001M, α = 95 %) /Mg
18 – $Zn/ZnCl_2$ (0,1M α = 75 %) // $Pb(NO_3)_2$ (0,01M, α = 88 %) /Pb
19 – $Fe/FeCl_2$ (0,01M, α = 88 %) // $SnCl_2$ (0,1M, α = 75 %) /Sn
20 – $Mg/MgSO_4$ (0,1M, α = 43 %) // $FeSO_4$ (0,01M, α = 60 %) /Fe
21 – $Cu/Cu(NO_3)_2$ (0,001M, α = 95 %) // $CdSO_4$ (0,01M, α = 66 %) /Cd
22 – $Sn/SnCl_2$ (0,01M, α = 43 %) // $Pb(NO_3)_2$ (0,1M, α = 75 %) /Pb
23 – $Cu/CuSO_4$ (0,01M, α = 66 %) // $ZnSO_4$ (0,1M, α = 43 %) /Zn
24 – $Cr/CrCl_3$ (0,1M, α = 65 %) // $MgCl_2$ (0,001M, α = 95 %) /Mg
25 – $Ni/NiCl_2$ (0,1M, α = 75 %) // $CuSO_4$ (0,001M, α = 87 %) /Cu
26 – $Sn/SnSO_4$ (0,01M, α = 66 %) // $AgNO_3$ (0,1M, α = 85 %) /Ag
27 – $Mg/MgSO_4$ (0,001M, α = 87 %) // $FeSO_4$ (0,1M, α = 43 %) /Fe
28 – $Cu/Cu(NO_3)_2$ (0,01M, α = 88 %) // $CrCl_3$ (0,1M, α = 65 %) /Cr
29 – $Fe/FeCl_2$ (0,1M, α = 75 %) // $Co(NO_3)_2$ (0,001M, α = 95 %) /Co
30 – $Co/CoSO_4$ (0,001M, α = 87 %) // $Mg(NO_3)_2$ (0,01M, α = 88 %) /Mg

4. ELECTROLYSIS

4.1. 193000 Kl of electricity was conducted through aqueous solution of nitrate metal. Calculate the amount (g) of metal allocated on the cathode *

01; 16 – copper	08; 23 – bismuth
02; 17 – silver	09; 24 – chrome
03; 18 – zinc	10; 25 – manganese
04; 19 – cadmium	11; 26 – iron
05; 20 – mercury	12; 27 – cobalt
06; 21 – tin	13; 28 – nickel
07; 22 – lead	14; 29 – palladium
	15; 30 – platinum

4.2. Write the equation of reactions occurring on insoluble electrodes, with electrolysis of aqueous solution of metal nitrate, specified in section 4.1.

4.3. Write the equation of reactions occurring on the electrodes in the electrolysis of the aqueous solution of the metal nitrate specified in section 4.1 if the anode is made of this metal.

4.4. The current was conducted with power of **I**, A and during **t**, h through an aqueous solution of metal chloride. Calculate the amount of metal emitted on the cathode; **Metal, I** and **t** are respectively given below.

01; 30 – chrome;	2,0; 1,0 ;	05; 26 – nickel;	3,0; 2,0
02; 29 – cobalt;	2,5; 2,0;	06; 25 – palladium;	3,5; 3,0
03; 28 – iron;	1,0; 3,0;	07; 24 – platinum;	4,0; 1,0
04; 27 – cobalt;	1,5; 1,0;	08; 23 – copper;	4,5; 2,0
09; 22 – manganese;	5,0; 3,0	12; 19 – mercury;	6,5; 3,0
10; 21 – zinc;	5,5; 1,0	13; 18 – tin;	7,0; 1,0
11; 20 – cadmium;	6,0; 2,0	14; 17 – nickel;	7,5; 2,0
		15; 16 – zinc;	8,0; 3,0

4.5. Write the equation of reactions occurring on insoluble electrodes in an electrolyte of an aqueous solution of metal chloride specified in section 4.4.

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* In those tasks where the current output is not given, its value is conventionally assumed to be equal to 100 %.

4.6. The current was suppressed with power of **I**, A and during **t**, h through an aqueous solution of metal chloride. Calculate the volume of gas released on the cathode under normal conditions; **Metal**, **I** and **t** are respectively as follows:

01, 02, 03, 04 – sodium; 1,8; 1,5
05, 06, 07, 08 – barium; 2,4; 2,0
09, 10, 11, 12 – potassium; 1,8; 2,4
13, 14, 15, 16 – calcium; 2,0; 1,5
17, 18, 19, 20 – lithium; 1,3; 8,0
21, 22, 23, 24 – beryllium; 1,7; 5,0
25, 26, 27 – magnesium; 1,6; 6,0
28, 29, 30 – aluminum; 1,0; 4,3

4.7. Write the equation of reactions occurring on insoluble electrodes, in the electrolysis of aqueous solution of metal chloride, indicated in section 4.6.

4.8. When passing the current with power **I**,A, during time *t* through a metal of (II) chloride there was released **m**, g of metal on the cathode. Calculate the atomic mass of a metal, if **I**, **t** and **m** are respectively equal:

01	2,0;	1 hour 20 min 25 sec;	3,269
02	- « -	- « -	5,620
03	- « -	- « -	10,025
04	- « -	- « -	5,930
05	- « -	- « -	2,748
06	- « -	- « -	2,994
07	2,5;	25 min 30 sec;	1,295
08	- « -	- « -	1,089
09	- « -	- « -	2,228
10	- « -	- « -	3,974
11	- « -	- « -	2,352
12	- « -	- « -	1,164
13	5,0;	1 h 4 min 20 sec;	11,240
14	- « -	- « -	6,538
15	- « -	- «-	20,059
16	- « -	- « -	11,868
17	- « -	- « -	5,494
18	- « -	- « -	5,893

19	1,0;	1 h 20 min 25 sec;	5,871
20	- « -	- « -	1,588
21	- « -	- « -	1,634
22	- « -	- « -	2,810
23	- « -	- « -	1,373
24	- « -	- « -	5,014
25	- « -	- « -	1,468
26	1,0;	1 h 3 min 45 sec;	1,295
27	- « -	- « -	1,089
28	- « -	- « -	2,228
29	- « -	- « -	3,974
30	- « -	- « -	2,352

4.9. Write the equation of reactions occurring on insoluble electrodes, in the electrolysis of an aqueous solution of metal chloride, whose atomic mass is calculated in section 4.8.

4.10. 25A·h of electricity was conducted through cadmium sulfate . At that, there was allocated **m (g)** of cadmium on cathode. Calculate output by current, if **m** equals:

01 – 38,2	07 – 41,2	13 – 44,2	19 – 47,2	25 – 50,2
02 – 38,7	08 – 41,7	14 – 44,7	20 – 47,7	26 – 50,7
03 – 39,2	09 – 42,2	15 – 45,2	21 – 48,2	27 – 51,2
04 – 39,7	10 – 42,7	16 – 45,7	22 – 48,7	28 – 51,7
05 – 40,2	11 – 43,2	17 – 46,2	23 – 49,2	29 – 52,2
06 – 40,7	12 – 43,7	18 – 46,7	24 – 49,7	30 – 52,7

4.11. Write the equation of reactions occurring on the electrodes, in the electrolysis of aqueous solution of cadmium sulfate, if the anode is cadmium.

4.12. With electrolysis of ferum(II) sulfate, **V ml** of oxygen was released on an anode, measured under normal conditions. Calculate how much g of iron is allocated to the cathode if **V** is equal to:

01 – 100	06 – 350	11 – 600	16 – 850	21 – 225	26 – 475
02 – 150	07 – 400	12 – 650	17 – 900	22 – 275	27 - 525
03 – 200	08 – 450	13 – 700	18 – 950	23 – 325	28 – 575
04 – 250	09 – 500	14 – 750	19 – 125	24 – 375	29 – 625
05 – 300	10 - 550	15 – 800	20 - 175	25 – 425	30 – 675

4.13. Write the equation of reactions occurring on insoluble electrodes, with electrolysis of an aqueous solution of FeSO4.

4.14. The current was conducted with power I, A during time t through the solution of copper(II) sulfate. Output current η, %. Calculate the amount (g) of copper released on the cathode and the volume (ml) of oxygen (normal conditions) that is allocated to the anode if I, t, η are respectively

01 –	1,1;	1 h 13 sec;	90	16 –	4,1;	2 h;	92
02 –	1,3;	2 h 20 min;	95	17 –	4,3;	2 h 50 min;	86
03 –	1,5;	2 h 10 sec;	80	18 –	4,5;	1 h 50 sec;	94
04 –	1,7;	2 h;	85	19 –	4,7;	1 h 5 min;	82
05 –	1,9;	3 h 20 min;	90	20 –	4,9;	1 h;	83
06 –	2,1;	3 h;	75	21 –	5,1;	3 h 20 sec;	85
07 –	2,3;	20 min 30 sec;	92	22 –	5,3;	4 h;	84
08 –	2,5;	66 min 25 sec;	84	23 –	5,5;	4 h 10 min;	91
09 –	2,7;	32 min 15 sec;	82	24 –	5,7;	2 h 15 sec;	92
10 –	2,9;	2 h 10 min;	84	25 –	5,9;	2 h 15 min;	93
11 –	3,1;	2 h 20 min;	92	26 –	6,0;	45 min;	98
12 –	3,3;	25 min;	94	27 –	6,2;	1 h 45 min;	82
13 –	3,5;	3 h;	89	28 –	6,4;	1 h 45 sec;	95
14 –	3,7;	1 h 30 min;	88	29 –	6,6;	2 h 50 min;	97
15 –	3,9;	1 h 10 min;	96	30 –	6,8;	2 h 50 sec;	88

4.15. Write the equation of reactions occurring on insoluble electrodes with electrolysis of aqueous solution of $CuSO_4$

4.16. How many grams of H_2SO_4 was formed in a solution near the insoluble anode in the electrolysis of aqueous solution of K_2SO_4, if an anode isolated **V l** of oxygen measured under normal conditions. Values **V** are:

01 – 0,56	07 – 0,28	13 – 1,75	19 – 4,25	25 – 4,10
02 – 0,23	08 – 0,35	14 – 4,48	20 – 1,20	26 – 1,88
03 – 1,12	09 – 2,78	15 – 1,80	21 – 2,64	27 – 2,44
04 – 0,75	10 – 6,81	16 – 3,25	22 – 7,22	28 – 5,64
05 – 2,40	11 – 3,25	17 – 0,55	23 – 9,34	29 – 4,82
06 – 5,60	12 – 0,15	18 – 2,48	24 – 0,98	30 – 1,63

4.17. Write the equation of reactions occurring on insoluble electrodes at the electrolysis of aqueous solution of K_2SO_4 and the total equation of the process.

4.18. At an electrolysis of an aqueous solution of potassium iodide, there was released **m (I_2), g**, on the anode at output of current **η, %** . Calculate the volume of hydrogen released on the cathode under normal conditions, if **m** and η are respectively:

01 – 0,25; 90	11 – 7,50; 72	21 – 3,85; 72
02 – 0,50; 92	12 – 6,28; 90	22 – 8,25; 90
03 – 1,25; 95	13 – 8,45; 92	23 – 6,50; 92
04 – 1,50; 80	14 – 4,80; 90	24 – 4,25; 95
05 – 4,28; 82	15 – 4,25; 70	25 – 4,50; 77
06 – 3,45; 87	16 – 5,50; 75	26 – 8,28; 75
07 – 2,81; 70	17 – 6,25; 80	27 – 1,35; 78
08 – 3,25; 75	18 – 8,50; 81	28 – 1,74; 79
09 – 3,50; 90	19 – 9,28; 83	29 – 2,63; 80
10 – 6,25; 85	20 – 1,45; 85	30 – 3,90; 85

4.19. Write the equation of the reactions occurring on insoluble electrodes in the electrolysis of aqueous KI solution, and the total equation of the process.

5. CORROSION OF METALS

5.1. A pair of metals **Me_1** and **Me_2** in contact are in an acidic medium (HCl). Which of the metals will be oxidized by corrosion? Give the scheme of the galvanic element that is being formed. Metals **Me_1** and **Me_2** are following:

01 – Mg, Zn	11 – Mn, Mg	21 – Sn, Mg
02 – Pd, Ni	12 – Ni, Cu	22 – Fe, Co
03 – Sn, Cu	13 – Al, Mg	23 – Al, Fe
04 – Al, Ni	14 – Zn, Sn	24 – Sn, Zn
05 – Cr, Co	15 – Fe, Al	25 – Cr, Ni
06 – Ni, Fe	16 – Cu, Mn	26 – Cu, Mg
07 – Cu, Zn	17 – Mg, Ni	27 – Mn, Cu
08 – Cd, Mg	18 – Fe, Mg	28 – Cu, Co
09 – Zn, Ni	19 – Cr, Cu	29 – Cr, Sn
10 – Mg, Co	20 – Al, Ni	30 – Cr, Fe

5.2. What corrosion processes occur in a neutral environment at the damage of the metal coating applied on iron? Metal coating is as follows:

01 – 05 – Cd	16 – 20 – Ni
06 – 10 – Cr	21 – 25 – Zn
11 – 15 – Cu	26 – 30 – Sn

5.3. When working on the galvanic element specified in Section 5.1, **V, l** of hydrogen was isolated on the cathode at **t, sec**. How many grams of metal dissolved during this time and what power of current will this galvanic couple give? The values of **t** and **V** are respectively:

01 – 40; 0,01	16 – 35; 0,016
02 – 15; 0,019	17 – 65; 0,034
03 – 35; 0,013	18 – 52; 0,042
04 – 20; 0,032	19 – 48; 0,016
05 – 50; 0,02	20 – 80; 0,05
06 – 25; 0,014	21 – 62; 0,035
07 – 45; 0,033	22 – 74; 0,043
08 – 32; 0,037	23 – 68; 0,051
09 – 38; 0,018	24 – 26; 0.067
10 – 60; 0,03	25 – 90; 0,06
11 – 55; 0,015	26 – 45; 0,036
12 – 42; 0,041	27 – 75; 0,044
13 – 58; 0,021	28 – 82; 0,063
14 – 27; 0,017	29 – 21; 0,015
15 – 70; 0,04	30 – 30; 0,07

6. WATER HARDNESS

6.1. Calculate the concentration of ions Ca^{2+} in the solution (in mec / liter), if **V, l** of water contains **m, g** $Ca(HCO_3)_2$. The values of **m** and **V** are respectively:

01 – 1,0; 2,5	11 – 2,5; 4,0	21 – 8,0; 6,4
02 – 1,5; 5,4	12 – 1,2; 3,5	22 – 6,0; 5,4
03 – 1,5; 3,8	13 – 1,3; 4,2	23 – 7,0; 6,3
04 – 1,5; 4,5	14 – 1,7; 3,2	24 – 5,5; 3,0
05 – 2,0; 2,5	15 – 5,0; 8,4	25 – 6,5; 4,0
06 – 2,0; 5,4	16 – 5,0; 2,0	26 – 7,5; 5,8

07 – 2,0; 4,5	17 – 6,0; 2,5	27 – 7,0; 1,2
08 – 2,0; 5,0	18 – 7,0; 9,5	28 – 4,0; 2,8
09 – 2,5; 3,0	19 – 7,0; 6,8	29 – 3,0; 5,1
10 – 2,5; 1,0	20 – 8,0; 7,2	30 – 3,0; 8,1

6.2. 1 liter of water contains n-milliequivalent of magnesium sulfate. Calculate the amount (g) of $MgSO_4$ in **V, l** of water. The values of **n** and **V** are respectively:

01 – 1,2 ; 7,1	11 – 2,7; 5,1	21 – 3,8; 3,3
02 – 1,5; 6,9	12 – 2,8; 4,9	22 – 3,9; 3,1
03 – 1,7; 6,7	13 – 2,9; 4,7	23 – 4,0; 2,9
04 – 1,9; 6,5	14 – 3,1; 4,5	24 – 4,1; 2,7
05 – 2,1; 6,3	15 – 3,2; 4,3	25 – 4,2; 2,5
06 – 2,2; 6,1	16 – 3,3; 4,3	26 – 4,3; 2,3
07 – 2,3; 5,9	17 – 3,4; 4,1	27 – 4,4; 2,1
08 – 2,4; 5,7	18 – 3,5; 3,9	28 – 4,5; 1,9
09 – 2,5; 5,5	19 – 3,6; 3,7	29 – 4,6; 1,7
10 – 2,6; 5,3	20 – 3,7; 3,5	30 – 4,7; 1,5

6.3. **V, l** of water contains **m, g** Ca $(HCO_3)_2$. Calculate the hardness of water if **V** and **m** are respectively:

01 – 1,5; 0,05	11 – 1,2; 0,03	21 – 4,2; 0,93
02 – 2,0; 0,08	12 – 1,7; 0,08	22 – 4,4; 0,85
03 – 3,0; 0,15	13 – 1,8; 0,18	23 – 4,6; 0,74
04 – 4,0; 0,24	14 – 2,2; 0,48	24 – 4,8; 0,98
05 – 2,5; 0,08	15 – 2,4; 0,50	25 – 5,2; 0,76
06 – 3,5; 0,15	16 – 2,6; 0,65	26 – 5,4; 0,48
07 – 4,5; 0,30	17 – 2,8; 0,79	27 – 5,6; 0,52
08 – 5,0; 0,40	18 – 3,2; 0,24	28 – 5,8; 0,64
09 – 5,5; 0,48	19 – 3,4; 0,36	29 – 6,2; 0,88
10 – 6,0; 0,78	20 – 3,6; 0,48	30 – 6,4; 0,94

6.4. Write the equation of reactions used to eliminate the temporary hardness of water.

6.5.**V, l** of water contains **m_1, mg** of calcium hydrogen carbonate, **m_2 , mg** of magnesium hydrogen carbonate, **m_3, mg** of calcium sulphate and **m_4, mg** of magnesium sulfate. Calculate the total hardness of water if **V, m_1, m_2, m_3, m_4** are respectively:

01 – 1,3; 120; 25; 100; 25	16 – 2,8; 110; 38; 210; 60
02 – 1,4; 100; 30; 120; 30	17 – 2,9; 230; 62; 135; 45
03 – 1,5; 150; 35; 100; 35	18 – 3,0; 135; 45; 230; 62
04 – 1,6; 100; 35; 150; 35	19 – 3,1; 240; 70; 170; 52
05 – 1,7; 170; 42; 120; 30	20 – 3,2; 170; 52; 240; 70
06 – 1,8; 120; 30; 170; 42	21 – 3,3; 250; 75; 190; 54
07 – 1,9; 160; 24; 110; 20	22 – 3,4; 190; 54; 250; 75
08 – 2,0; 110; 20; 160; 24	23 – 3,5; 270; 77; 210; 63
09 – 2,1; 180; 55; 120; 35	24 – 3,6; 210; 63; 270; 77
10 – 2,2; 120; 35; 180; 55	25 – 3,7; 280; 80; 215; 67
11 – 2,3; 200; 60; 140; 44	26 – 3,8; 315; 67; 280; 80
12 – 2,4; 140; 44; 200; 60	27 – 3,9; 300; 85; 270; 65
13 – 2,5; 220; 58; 130; 42	28 – 4,0; 270; 65; 300; 85
14 – 2,6; 130; 42; 220; 58	29 – 4,1; 400; 90; 350; 75
15 – 2,7; 210; 60; 110; 38	30 – 4,2; 420; 70; 250; 50

6.6 Write the equation of the reactions occurring when eliminating the temporary and constant hardness of water by adding sodium phosphate.

6.7. For softening of **V, l** of water it is necessary **m, g** soda. Calculate the total hardness of water if **V** and **m** are respectively:

01 – 60; 25	11 – 95; 60	21 – 84; 58
02 – 65; 40	12 – 95; 40	22 – 84; 32
03 – 70; 25	13 – 93; 65	23 – 72; 60
04 – 75; 25	14 – 93; 48	24 – 72; 38
05 – 80; 40	15 – 90; 70	25 – 78; 64
06 – 85; 40	16 – 90; 25	26 – 78; 36
07 – 90; 45	17 – 88; 72	27 – 72; 72
08 – 95; 30	18 – 88; 27	28 – 72; 80
09 – 97; 35	19 – 86; 75	29 – 74; 28
10 – 98; 30	20 – 86; 35	30 – 74; 90

6.8. Write the equations of reactions that describe softening of water with soda.

6.9. Water hardness is equal to **H, mekv / l.** Calculate how many grams of Na_3PO_4 should be added to **V, m³** of water to eliminate hardness. The values of **H** and **V** are respectively:

01 – 8,0; 10,0	11 – 6,5; 11,0	21 – 5,5; 50,0
02 – 12,0; 10,0	12 – 7,6; 7,5	22 – 5,3; 5,5
03 – 16,0; 10,0	13 – 7,0; 8,0	23 – 4,0; 66,0
04 – 4,0; 25,0	14 – 6,4; 0,6	24 – 4,2; 0,2
05 – 4,0; 0,5	15 – 8,5; 16,0	25 – 7,5; 0,5
06 – 6,0; 20,0	16 – 4,5; 16,0	26 – 5,4; 1,2
07 – 6,0; 0,7	17 – 11,0; 9,0	27 – 5,5; 2,5
08 – 5,0; 0,8	18 – 10,5; 5,0	28 – 7,8; 10,5
09 – 3,0; 12,0	19 – 8,4; 0,2	29 – 8,2; 6,5
10 – 3,0; 0,7	20 – 8,2; 4,5	30 – 9,5; 1,5

6.10. **V, l** of water contains $\mathbf{m_1}$**, mg** of ions $Ca^{2+}$and $\mathbf{m_2}$**, mg** of Mg^{2+}ions. Calculate the total hardness of water if **V,** $\mathbf{m_1}$**,** $\mathbf{m_2}$**,** are respectively:

01 – 2; 120; 24	11 – 4; 550; 30	21 – 6; 750; 110
02 – 2; 250; 30	12 – 4; 550; 48	22 – 6; 750; 300
03 – 2; 360; 35	13 – 4; 570; 40	23 – 6; 650; 300
04 – 2; 420; 40	14 – 4; 570; 70	24 – 6; 800; 200
05 – 2; 400; 48	15 – 4; 590; 60	25 – 6; 800; 150
06 – 3; 400; 24	16 – 5; 620; 120	26 – 7; 850; 300
07 – 3; 420; 40	17 – 5; 640; 80	27 – 7; 850; 180
08 – 3; 420; 60	18 – 5; 640; 100	28 – 7; 900; 100
09 – 3; 500; 40	19 – 5; 660; 140	29 – 7; 900; 320
10 – 3; 500; 68	20 – 5; 700; 100	30 – 7; 950; 250

6.11. When boiling **V, l** of water, **m, g** $CaCO_3$ precipitated. Calculate the temporal hardness of water if **V** and **m** are respectively:

01 – 1,5; 25	11 – 3,0; 62	21 – 4,5; 44
02 – 2,0; 30	12 – 4,0; 28	22 – 2,5; 63
03 – 3,0; 45	13 – 4,5; 34	23 – 3,5; 53
04 – 4,0; 35	14 – 2,5; 52	24 – 5,0; 82
05 – 4,5; 60	15 – 3,5; 45	25 – 1,5; 30

06 – 2,5; 40	16 – 5,0; 62	26 – 2,0; 37
07 – 3,5; 65	17 – 1,5; 35	27 – 3,0; 50
08 – 5,0; 75	18 – 2,0; 34	28 – 4,0; 32
09 – 1,5; 28	19 – 3,0; 55	29 – 4,5; 75
10 – 2,0; 40	20 – 4,0; 50	30 – 5,0; 55

6.12. Write the reaction equation to eliminate the temporary hardness of water by boiling.

6.13. Calculate the amount (g) of quenched lime necessary for softening 1 $м^3$ of water, if the temporary hardness (mekv / l) is:

01 – 1,2	06 – 1,8	11 – 2,3	16 – 2,8	21 – 3,3	26 – 3,8
02 – 1,4	07 – 1,9	12 – 2,4	17 – 2,9	22 – 3,4	27 – 3,9
03 – 1,5	08 – 2,0	13 – 2,5	18 – 3,0	23 – 3,5	28 – 4,0
04 – 1,6	09 – 2,1	14 – 2,6	19 – 3,1	24 – 3,6	29 – 4,1
05 – 1,7	10 – 2,2	15 – 2,7	20 – 3,2	25 – 3,7	30 – 4,2

6.14. Write the equations of reaction occurring when removing the temporary hardness of water with quenched lime.

Свєткіна Олена Юріївна
Нетяга Ольга Борисівна
Тарасова Ганна Володимирівна

ХІМІЯ

МЕТОДИЧНІ РЕКОМЕНДАЦІЇ ТА ЗАВДАННЯ
до самостійної роботи з дисципліни
для студентів усіх спеціальностей (Частина 2)
(Англійською мовою)

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